Version Control

Version	Description	Date
1.0	Solicitation proposal	02/08/2022
1.1	Feedback received during solicitation period	11/26/2022

1. PROJECT INFORMATION AND TEAM

Project Information

Project title:	Continuous Bituminous Pavement Stripping Assessment Through Non-Destructive Testing Technologies
Lead organization:	Minnesota Department of Transportation (MnDOT)
Study number:	TPF-5 (504)
Solicitation number:	TPF1569
Commitments received:	$800,000
Financially Contributing Partners:	FHWA, MN, IL, MO, MS, TN, TX
Total Project Duration:	Estimated Start Date: March 1st, 2023 Estimated end date: February 28th, 2027
Subjects:	Pavement Scoping; Pavement Evaluation; Pavement Design; Non-Destructive Evaluation (NDE) and Non Destructive Testing (NDT) Technologies; Technology Transfer; Implementation

Project Team

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    - Position Title: Principal Research Engineer
    - Organization: Minnesota Department of Transportation (MnDOT)
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- Co-Investigator:
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    -
- Subcontractors:
    - TBD

2. PROJECT BACKGROUND

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.

2. PURPOSE AND 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.

3. PROJECT KICK-OFF MEETING

During the pool fund solicitation period, MnDOT developed an initial work plan and identified key tasks, goals and deliverables for the study. The lead state will gather important feedbacks and changes made during the solicitation period and send a revised project charter to the participant states at least two weeks before the formal project kick-off meeting. At the project kick-off meeting, the partner states will discuss the project's scope of work, form a Technical Working Group (TWG), and finalize and approve the project charter. The meeting will be only for participating states.

4. SCOPE OF WORK

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

- Task 1 – Finalizing and Planning 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

5. TASK DESCRIPTIONS AND DURATIONS

Task 1 – Finalizing and Planning the Scope of Work

MnDOT, in consultation with the state partners and the TWG, will finalize the details of the tasks approved in the project charter. The group will also produce a final schedule of activities, allocate a budget for each job, and identify and solicit organizations interested in accomplishing some of the project tasks. This will include obtaining cost estimates for products, services and proposals (work plans) for accomplishing task activities.

Responsible	MnDOT
Est. Budget	$9,200
Anticipated Start Date:	February 1st, 2023
Anticipated Due Date:	April 30st, 2023
Deliverables	• Cost estimates • Identify responsible for each task • Finalize schedule & budget allocation

Task 2– Survey and Literature Review

Survey

A survey will be administered to the states participating in the pool fund study to gather and document information regarding the types and severity of pavement stripping observed in their roads, current practices and challenges for detecting stripping and gauge the states' expectations from the present study. Through this survey, the participant states will identify and propose pavement sections (2 x states) and additional testing methodologies

Responsible	MnDOT
Est. Budget	$14,000
Anticipated Start Date:	March 1st, 2023
Anticipated Due Date:	June 30th, 2023
Deliverables	• Survey • Literature review • Identify 2 roads from each state

(i.e., FWD, GPR, mixtures, real estate) that partners would like to include in the study.

	• Report

The literature review will begin by documenting and analyzing the survey results. Then, it will describe various pavement stripping mechanisms and document the factors causing and affecting the phenomenon, emphasizing experiences from the pool fund partner states (shared in the survey). Similarly, the task will include a review of existing literature on the non-destructive testing (NDT) technologies proposed for this study and document relevant applications of these technologies to detect stripping. Findings from this effort will inform the factors that may be considered in developing and finalizing the testing plans for the laboratory and field experiments.
Furthermore, the literature review will examine and document previous or existing algorithms for processing GPR data relevant to the present investigation. The lessons learned in the literature review will be considered in further refining the project tasks and designing the artificially stripped sections to be constructed in MnROAD.

Task 3 – Building GPR Signal Stripping Signature Database

At present, there exists very limited guideline for users on what type of GPR signals indicate possible stripping activities. The task will perform review of existing GPR data, controlled laboratory experiments, numerical simulations (theoretical modeling), and field experiments to explore the forms of GPR signals in various pavement geometry and conditions. The database will inform the study's efforts to developing an automated data processing algorithm: it will be employed to train the algorithm on how to recognize and evaluate stripping from GPR data of actual roads. Initial thoughts for the proposed experiments are outlined next.

Responsible	MnDOT/Subcontractor
Est. Budget	$96,500
Anticipated Start Date:	July 1st, 2023
Anticipated Due Date:	June 31st, 2024
Deliverables	• Analysis of existing data • Laboratory experiments • Numerical simulations • Database

Review and analysis of existing 3D-GPR data

Several states have already collected considerable 3D-GPR and GPR data on their pavements. MnDOT surveyed around 1000 miles of highway roads in the past four years using the 3D-GPR and other NDE technologies. Based on visual examinations of the GPR images and other forensic data (coring, boring, FWD, etc.), it was observed that some of these roads have moisture-related damages and stripping issues. This subtask will look into the available 3D-GPR and forensic data of roads with stripped sections and extract GPR signals representing this issue. Additionally, static (time-mode) 3D-GPR surveys may be conducted on spots identified from the data to confirm and validate the signals if the roads have not been rehabilitated.

Controlled laboratory testing

The laboratory testing will rely on static GPR tests conducted on laboratory-fabricated asphalt mixture slabs containing various levels of artificial induced stripped regions. The slabs may be produced in the laboratory (e.g., 3 ft x 3 ft slabs) or extracted from field test sections (e.g., 4ft x4ft, 4 ft x 8 ft). The factors affecting GPR stripping detection (i.e., moisture, layer thicknesses) and others identified during task 2 will be further explored and integrated into the testing plan. Ideally, a 3D-GPR antenna will be directly employed to test the fabricated samples and obtain typical GPR signal patterns. However, depending on the size of the samples, it may be necessary to rely on hand-held (small-dimension) high-frequency antennas (e.g., 2.6 GHz) for the testing to minimize or avoid the interference of boundary reflections.

Numerical simulation (Theoretical modeling)
Numerical simulation (theoretical modeling) will be used to validate the experimental results and expand the range of the factors considered. The tool proposed for this effort is the Finite-Difference Time-Domain (FDTD) based open source program GPRMax. The program has in the past been used to successfully simulate GSSI ground couple signals on pavements with artificial stripping (LSU work). In the present study, the program would be utilized to simulate and verify 3D-GPR signals corresponding to various stripping levels and locations. See the example below:

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

The present task will involve designing and building artificially stripped sections in the MnROAD test facility. These test sections will be employed to verify and validate the ability of 3D-GPR and other NDE technologies to recognize stripping. Data collected from these test cells will be instrumental for recommendations on precision, reliability and limitations. Ideally, all the traditional and NDE tools considered in this study will be employed to evaluate these sections. The consortium will advise how to build artificially stripped sections of different dimensions, severity levels and/or moisture conditions.

Responsible	MnDOT
Est. Budget	$100,000
Anticipated Start Date:	July 1st, 2023
Anticipated Due Date:	October 31st, 2024
Deliverables	• Construction plan • Construction • Testing • Evaluation • Validation • Verification

The consortium and the TWG will work with MnROAD engineers to identify appropriate test sections, draft and execute a construction plan. In our current thought process, we envision including these configurations:

- Stripped sections placed at different depths of an intact bituminous layer
- Stripped sections placed at different spacing from each other
- Stripped section at interface between a bituminous and base aggregate layers and between a bituminous and concrete layers

These test cells, along with the database produced in Task 3, will be employed for verification, calibration and training of the stripping detection algorithm produced in this study

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

Responsible	MnDOT/Subcontractor
Est. Budget	$110,000
Anticipated Start Date:	July 1st, 2023
Anticipated Due Date:	June 30st, 2025
Deliverables	• Software • Verification • Validation

This task aims to achieve one of the study's main objectives, which is to develop algorithms for automated processing of the 3D-GPR and automatic detection and quantification of stripped areas. The task will be guided and trained by the GPR stripping signature database created in Task 3. The MnROAD test cells in Task 4 will be employed to verify, validate and refine the algorithm. Furthermore, it is anticipated that the algorithms will also include features for linking and synchronizing data from other NDE sources (FWD, TSD, etc.) that could be useful in further interpreting the GPR findings.
The outcome should include a tabulated output of the parameters found to characterize stripping and visualization of the result in a geographical map. Several proof-of-concept studies conducted by MnDOT, Infrasense, and others showed that this could be accomplished. The present task should start by revising the techniques adopted in the previous algorithms. An important aspect of this task will involve incorporating the algorithms and principles produced into standard user-friendly software applications that are easier to use by agency employees. The goal is to avoid passing around scripts, executables and macros. The software should be able to process large data and report the outputs outlined in task

Subcontract (optional) – Developing Base Aggregate Moisture Detection Algorithm Using 3D-GPR data
Moisture is the leading cause of stripping. Hence, evaluating moisture and moisture fluctuations in pavement foundations would help define the link between these two variables. In a recently completed, two-year-long proof of concept study, MNDOT evaluated the use of GPR to monitor the seasonal moisture fluctuation in the unbound aggregate layers of in-service pavements. The study put forward an algorithm for estimating the moisture content on the base aggregate layers from a ground couple 2D GSSI GPR data. The moisture contents and fluctuations obtained from the GPR data matched those obtained from the in-place sensors. In particular, and most importantly for the present study, the proof-of-concept study demonstrated that GPR could be used to discern and identify aggregate base materials and pavement sections likely to experience high moisture spikes (due to material characteristics or poor drainage). This task will explore and, if possible, develop an algorithm for moisture measurement in pavement structures from continuous 3D-GPR data. This tool will provide a companion tool for predicting sections that are likely to strip based on the moisture susceptibility of the section.

Task 6 – Data collection on Roads from Participant States

Responsible	MnDOT/FHWA/Subcontractors/
Est. Budget	$240,000
Anticipated Start Date:	July 1st, 2024

3D-GPR and the other NDE testing methodologies proposed in the study will be employed to collect data on the roads selected by state participants. The participating states will identify and suggest two roads suspected of stripping to the present task. In addition to the roads chosen by the states, the data collection will include two newly paved roads that will serve as baseline (control) data for the study. The primary tool for data collection will be the 3D-GPR, which will be used to continuously survey the entire length of the proposed roads according to the agreed testing procedure.

Anticipated Due Date:	December 31st, 2025
Deliverables	• Data collection • 3D-GPR • FWD • Coring, Boring • IE/SASW, PASP, MIRA • TSD

It is anticipated that 3D-GPR data collection for these roads will be carried out by participating agencies who own the equipment or by consulting firms hired by the consortium. The GPR data will be examined to identify critical sections suspected of stripping and moisture-related damage. Then, the panel will request participating states to collect and provide FWD and ground truth data (i.e., coring boring) at the sections identified upon examining the GPR data. Furthermore,
the NDE office of FHWA will assist with IE/SASW, PASP and MIRA on the critical spots. Finally, the panel will work to obtain TSD data on the roads selected for this study. Some states may already have TSD collected on the proposed data. For the states who don't have TSD data, the panel will work with the TSD data provider(AARB) to collect data on these roads within the available budget.

Task 7 – Review, Analysis, Data Fusion, Interpretation and Report

This task will gather and document all the deliverables produced in the above tasks, including database, software, and data collected on MnROAD and the state roads. All the data generated in this study will be linked together based on geographical coordinates and analyzed using the software developed in Task 6 and other appropriate analytical and statistical tools. The analysis will evaluate, validate and verify the effectiveness of the various testing methodologies and the software developed in Task 6 in detecting, locating and quantifying stripped sections. Furthermore, the review and analysis effort will identify improvements to the testing procedures or the software. Finally, the results of these analyses and the documents gathered in this task will be compiled in a final report.

Responsible	MnDOT
Est. Budget	$50,000
Anticipated Start Date:	January 1st, 2025
Anticipated Due Date:	June 30st, 2026
Deliverables	• Gather all deliverables • Review • Analysis • Identify needs for improvement • Final Report

Task 8 – Development of AASHTO Specification - Testing and Analysis Procedures

Tieng together all the efforts, tools and lessons accomplished in the above tasks, this task will focus on developing draft AASHTO specification(s), guidelines, standards for data collection and processing based on

Responsible	MnDOT
Est. Budget	$24,000
Anticipated Start Date:	May 1st, 2026

the tools developed in this study. It is anticipated the specifications will include accuracy and precision thresholds (recommendation) as well as implementation plan that agencies can customize to fit their states' needs.

Anticipated Due Date:	December 30st, 2026
Deliverables	• AASHTO Draft • Testing & analysis procedures • Implementation plans • Precision, accuracy thresholds

Task 9 – Training and Technical Assistance

This task aims at providing necessary training and technical assistance to participant state agencies, and it will primarily focus on hardware (i.e., 3D-GPR, FWD, TSD) and data processing software selected for the project:

1. Hands-on training if needed
2. Executive level training
3. Webinar training and on-call assistance
4. Support participant agency in the development of specifications for data collection and data processing.
5. Training material (video, website etc.,)

Responsible	MnDOT/Subcontractor
Est. Budget	$35,000
Anticipated Start Date:	Throughout the project
Anticipated Due Date:	Throughout the project
Deliverables	• Hands-on training • Executive level trainings • Webinars • Call assistance • Training materials

Task 10 – Support and Communication

Provide a platform for communication, support and sharing information to monitor progress and identify next steps and additional research/implementation gaps that need to be addressed. This task will be essential for collecting and sharing agency concerns related to stripping and technology improvements and challenges from vendors. An in-person user group meeting will be held ones per year to discuss progress, chart roadmaps, take corrective actions and share knowledge

Responsible	Facilitated by MnDOT
Est. Budget	$86,300
Anticipated Start Date:	Throughout the project
Anticipated Due Date:	Throughout the project
Deliverables	• User group seminars • Quarterly conferences • Annual face-to-face meetings • Website

The task will include:

1. Semi-annual user group seminars
    a. Opportunity for pooled fund agencies to give updates and feedback on the direction of the project

2. Annual face-to-face user group meetings including invitational travel
   a. These meetings will be designed to give a more comprehensive evaluation of the project progress and research needs. It is anticipated that these meetings will be conducted at the end of fall after northern State construction season is over. It is anticipated that the meetings will be conducted over a 2.5 day period with the first half of day 1 dedicated to discussion of the work plan advancement efforts. The latter portion of the meeting will be dedicated to identifying areas of the work plan that may need to be modified based on feedback from participating agencies
3. Quarterly conference call updates with participating agencies, vendors, and consultants
   a. Quarterly conference call updates with interested parties included. These meetings can be held, as needed, when results of special importance are found that are beneficial to share with a larger audience.
4. Quarterly conference call with the Technical Working Group
   a. Quarterly Conference call with the TWG to provide brief updates. They can be a consistent way to check-in on project progress lasting 1 to 2 hours
5. Website establishment and maintenance

Task 11 – Strategic Technology Promotion

To successfully accomplish the objective of the project, vendors should continue to develop their equipment (hardware and software) with the goal to provide real-time stripping measurements for project and network level pavement. The vendors efforts to this end can be supported and incentivized by bringing more transportation agencies willing to include NDT technologies in their pavement assessment

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Responsible	MnDOT/Subcontractor
Est. Budget	$35,000
Anticipated Start Date:	Throughout the project
Anticipated Due Date:	Throughout the project
Deliverables	• Promotional material • Dissemination of knowledge

The task will include:

1. Preparing technology promotion material
2. Technology promotion to potential vendors on the use of GPR to evaluate bituminous pavements affected by stripping
3. Technology promotion to other DOTs and local transportation agencies
4. Dissemination of knowledge through articles and digests

6. DELIVERABLES

Each task has a set of expected deliverables indicate in tables. In general, the most important deliverables of this study will be:

- Final report documenting all the work accomplished in this study
- Specification(s) for collection and processing of GPR data used to evaluate stripped roads
- Commercially available computer programs for automatic detection and quantification of stripping

- Implementation plans that agencies can duplicate
- Training documents

7. KEY MILESTONES

Key Milestone	Target Date	Description
1.Project Kick-off Meeting	01/2023	Approve project charter; form technical group and formally initiate the project
2. MnROAD Constructions	05-10/2024	Begin and complete construction of the section with artificially stripped section according to approved construction plan
3.In-Person User Group Meeting	10/2023	Progress update, feedback on successes and corrective actions
4. In-Person User Group Meeting	10/2024	Progress update, feedback on successes and corrective actions
5. In-Person User Group Meeting	10/2025	Progress update, feedback on successes and corrective actions
6. In-Person User Group Meeting	10/2026	Progress update, feedback on successes and corrective actions
5.In-Person Training and data collection	8/2025	Training, Data collection with different equipment and Calibration of equipment in MN ROAD
5.Project Closing Meeting	01/2027	Close out meeting

8. OVERVIEW OF PROJECT SCHEDULE

FY22 (7/1/22 – 6/30/23)													
Month of Contract													
Calendar Month	J	A	S	O	N	D	J	F	M	A	M	J	
Task 1								X	X	X			
Task 2									X	X	X	X	
Task 3													
Task 4													
Task 5													
Task 6													
Task 7													
Task 8													
Task 9													
Task 10							X				X		

Task 11													

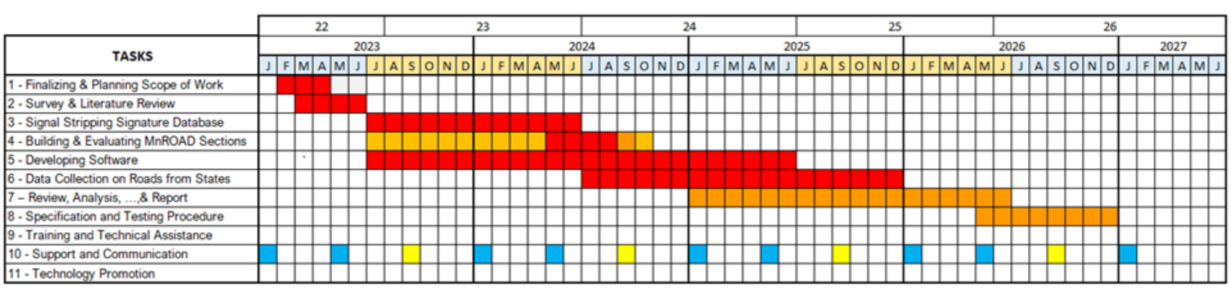
FY23 (7/1/23 – 6/30/24)													
Month of Contract													
Calendar Month	J	A	S	O	N	D	J	F	M	A	M	J	
Task 1													
Task 2													
Task 3	X	X	X	X	X	X	X	X	X	X	X	X	
Task 4	X	X	X	X	X	X	X	X	X	X	X	X	
Task 5	X	X	X	X	X	X	X	X	X	X	X	X	
Task 6													
Task 7													
Task 8													
Task 9													
Task 10			X				X				X		
Task 11													

FY24 (7/1/24 – 6/30/25)													
Month of Contract													
Calendar Month	J	A	S	O	N	D	J	F	M	A	M	J	
Task 1													
Task 2													
Task 3													
Task 4	X	X	X	X									
Task 5	X	X	X	X	X	X	X	X	X	X	X	X	
Task 6	X	X	X	X	X	X	X	X	X	X	X	X	
Task 7							X	X	X	X	X	X	
Task 8													
Task 9													
Task 10			X				X				X		
Task 11													

FY25 (7/1/25 – 6/30/26)													
Month of Contract													
Calendar Month	J	A	S	O	N	D	J	F	M	A	M	J	

Task 1													
Task 2													
Task 3													
Task 4													
Task 5													
Task 6	X	X	X	X	X	X							
Task 7	X	X	X	X	X	X	X	X	X	X	X	X	
Task 8											X	X	
Task 9													
Task 10			X				X				X		
Task 11													

FY26 (7/1/26 – 6/30/27)													
Month of Contract													
Calendar Month	J	A	S	O	N	D	J	F	M	A	M	J	
Task 1													
Task 2													
Task 3													
Task 4													
Task 5													
Task 6													
Task 7													
Task 8	X	X	X	X	X	X	X						
Task 9													
Task 10			X				X						
Task 11													



9. OVERVIEW OF PROJECT BUDJET

TASKS	RESPONSIBLE AGENCY	ESTIMATED % of TOTAL COST	ESTIMATED COST
Task 1 – Finalizing and Planning the Scope of Work	MnDOT	1%	$ 9,200.00
Task 2– Survey and Literature Review			
Survey	MnDOT	2%	$ 14,000.00
Literature Review			
Task 3 – Building GPR Signal Stripping Signature Database			
Review & Analysis of Existing Data	MnDOT	2%	$ 12,500.00
Laboratory Experiments	TBD	7%	$ 57,000.00
Numerical simulations	TBD	3%	$ 27,000.00
Task 4 – Building and Evaluating Artificially Stripped Section in MN ROAD	MnDOT	13%	$ 100,000.00
Task 5 – Development of a Software for Automated Detection and Quantification of Stripping			
Developing algorithm	TBD	14%	$ 110,000.00
Incorporating algorithms in a sSoftware package	TBD		
Verifying, validating and refining	MnDOT		
Task 6 – Evaluation of Roads from Participant States (2 X States)			
3D-GPR	MnDOT/Consultant	30%	$ 240,000.00
FWD, Coring Boring	States		
TSD	AARB		
IE/SASW, PASB, MIRA	FHWA		
Task 7- Review, Analysis, Data Fusion, and Interpretation of the collected data	MnDOT	6%	$ 50,000.00
Task 8 – Development of AASHTO Specification - Testing and Analysis Procedures	MnDOT & Others	3%	$ 24,000.00
Task 9 – Training and Technical Assistance	MnDOT/Consultant	4%	$ 35,000.00
Task 10 – Support and Communication			
Four (4) Annual face to face user meeting	Partner States	11%	$ 86,300.00
2 person agency (1400/person) + Other costs			
Task 11 – Strategic Technology Promotion	Consultant	4%	$ 35,000.00
TOTAL			**$ 800,000.00**

The funds will be used to cover:

1. MnDOT personnel time spent on the project.
2. Partial costs for construction of test cells in MnROAD
3. Contracts to vendors, universities and consultants identified in the project
4. Travel expenses for meetings
5. Production and dissemination of training and promotional material
6. Purchase of equipment and software needed for the project

9. SUBCONTRACTORS

To be identified throughout the project