TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

Date: *October 17, 2012*

Lead Agency: *Montana Department of Transportation*

INSTRUCTIONS:
Project Managers and/or research project investigators 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 #:	**Transportation Pooled Fund Program – Report Period:**
TPF-5(251)	☐ Quarter 1 (January 1 – March 31) ☐ Quarter 2 (April 1 – June 30) ■ Quarter 3 (July 1 – September 30) ☐ Quarter 4 (October 1 – December 31)

Project Title:
Relative Operational Performance of Geosynthetics Used as Subgrade Stabilization

Name of Project Managers:	**Phone Numbers:**	**E-Mails**
Eli Cuelho *Steven Perkins*	*(406) 994-7886* *(406) 994-6119*	*elic@coe.montana.edu* *stevep@ce.montana.edu*
Lead Agency Project ID: *MDT Project #7712*	**Other Project ID:** *MSU/OSP: 4W3850*	**Project Start Date:** *December 1, 2011*
Original Project End Date: *November 30, 2013*	**Current Project End Date:** *November 30, 2013*	**Number of Extensions:** *0*

Project schedule status:

☐ On schedule ☐ On revised schedule ☐ Ahead of schedule ■ Behind schedule

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
$581,726	*$278,499*	*37%*

Quarterly Project Statistics:

Total Project Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
20%	*$116,521*	*42%*

Project Description:

State departments of transportation (DOTs) routinely use geosynthetics for subgrade stabilization. This construction practice involves placing an appropriately specified geosynthetic on a weak subgrade prior to placement of roadway subbase. The geosynthetic provides stabilization of the subgrade by increasing the load-carrying capacity of the system and maintaining separation between the soft subgrade and subbase materials. Subgrade stabilization allows for a firm construction platform to be built with less aggregate and less construction time as compared to construction without the stabilization geosynthetic. There is a general consensus concerning the effectiveness of geosynthetics in this application; however, there is a lack of understanding and agreement on the material's properties needed for performance. Those properties should be specified in order to ensure its beneficial use and to allow a broad range of products to be considered. In order to provide for the most economical geosynthetic selection while minimizing conflicts and promoting competitiveness, MDT and other states are conducting a study to examine the performance of various geosynthetics for subgrade stabilization. The aim of the study is to relate this performance to material properties that can be incorporated into standard specifications to allow for broad and economical use of geosynthetic products for a specific application.

Progress this quarter:

Task 1 – Material Characterization

- *cut samples from geosynthetic rolls for laboratory tests*
- *began in-air tension and cyclic pullout tests on geosynthetics*

Task 2 – Setup Monitoring Equipment

- *finished constructing instrumentation boxes*
- *wrote programs for data acquisition computers*
- *built completion circuitry for strain gages, LVDTs and pore-pressure gages*
- *set up mobile laboratory to house circuitry, power systems and data acquisition computers*

Task 3 – Planning and Construction

- *began excavating trench on July 6*
- *began installing plastic liner on July 11*
- *began constructing subgrade on July 11; finished on August 10*
  - *mixed subgrade and water using large excavator; monitored water content for consistency prior to placing in the trench*
  - *placed and spread subgrade in trench using excavator in 6 inch lifts*
  - *compacted using single-drum vibratory roller (four passes per lift)*
  - *measured in-place strength of each lift of subgrade using vane shear and LWD*
  - *measured in-place strength of final lift of subgrade using DCP and in-field CBR*
  - *measured in-place density of final lift of subgrade using nuclear gage*
- *final leveling of subgrade*
  - *screeded to top of adjacent paved trench edge*
  - *installed pore pressure gages, geosynthetics, and LVDT lead wires from August 15 to 21*
  - *conducted topographic survey of top surface of subgrade*
- *installation of 12 inches of base course aggregate (16 inches in Control 2, and 24 inches in Control 3) began on August 16 in two lifts; finished on August 23*
  - *first lift was approximately 8 inches; second lift was approximately 4 inches*
  - *compacted using single-drum vibratory roller (six passes per lift)*
  - *measured stiffness using LWD after second and final roller passes of first lift and final roller pass of second lift*

- *topographic survey of top surface of base course*
- *measured in-place strength of base course using DCP and in-field CBR*
- *measured in-place density of base course using nuclear gage*
- *painted lines on top of finished base course for trafficking and rut measurement purposes*

Task 4 – Install Instrumentation

- *installed LVDTs; connected lead wires*
- *installed pore pressure gages*
- *installed strain gages on the geosynthetics*
- *wired gages to completion circuitry and data acquisition system in mobile laboratory*

Task 5 – Trafficking and Data Collection

- *loaded tandem-axle dump truck to 45 kips*
- *trafficking began on September 13*
- *225 truck passes were made by September 30*

Task 6 – Forensic Investigations *– no progress on this task during this period*

Task 7 – Data Analysis *– no progress on this task during this period*

Task 8 – Reporting

- *Progress Report #3 was written*

Anticipated work next quarter:

Task 1 – Material Characterization

- *continue testing geosynthetics*
  - *wide-width tension tests*
  - *cyclic tension tests*
  - *cyclic pullout tests*

Task 2 – Setup Monitoring Equipment (completed)

Task 3 – Planning and Construction (completed)

Task 4 – Install Instrumentation (completed)

Task 5 – Trafficking and Data Collection

- *continue trafficking test sections and measuring rut*

Task 6 – Forensic Investigations

- *conduct forensic excavations once trafficking is complete*

Task 7 – Data Analysis

- *begin formal analysis of construction and trafficking data: vane shear, LWD, DCP, in-field CBR, instrumentation, and rut data*

Task 8 – Reporting

- *write Task Report #2 (combination of TR#2 and TR#3)*
- *write Progress Report #4*

Significant Results:

- *The relationship between CBR and vane shear for the subgrade was finalized with a correlation of $R^2 = 0.84$ as CBR = 30.83*(vane shear, kPa) + 5.5. This relationship was used to determine the acceptable range of subgrade strength measured with a vane shear device during construction. For CBR = 1.7±0.1 (the majority of the test sections), the target vane shear range was 55 to 61 kPa.*
- *The maximum dry unit weight of the base course aggregate is 139 lb/ft^3 (21.8 kN/m^3) at an optimum moisture content of 6% according to modified Proctor tests (ASTM D1557).*
- *A cyclic plate load test was constructed in a large box with subgrade prepared to CBR = 1.7, Tensar BXType 2 geogrid, and 10 in (254 mm) of compacted base (constructed γ_d = 133 lb/ft^3 = 20.9 kN/m^3). A 90 psi (690 kPa) cyclic load was applied to a 12-in. (300 mm) diameter rigid plate at 0.68 Hz. After 1,852 load cycles there was 3 in (75 mm) of rut, but 45,900 load cycles were needed for 4 in (100 mm) of rut. The results of this laboratory test led to the decision to use 12 in of base course in the field test sections.*
- *Method of constructing the subgrade resulted in very consistent shear strengths throughout.*

Circumstances Affecting Project or Budget:

- *Construction took about 1 month longer than anticipated which has put this project somewhat behind schedule.*

Potential Implementation:

It is anticipated that the information from this project will be useful to departments of transportation seeking to improve their specification of and use of geosynthetics for subgrade stabilization.