

## TRANSPORTATION POOLED FUND PROGRAM QUARTERLY PROGRESS REPORT

Date: 12/31/2016

Lead Agency (FHWA or State DOT): Vermont Agency 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.*

<b>Transportation Pooled Fund Program Project #</b> <i>(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX))</i>  TPF-5(222)	<b>Transportation Pooled Fund Program - Report Period:</b>  <input type="checkbox"/> Quarter 1 (January 1 – March 31) <input type="checkbox"/> Quarter 2 (April 1 – June 30) <input type="checkbox"/> Quarter 3 (July 1 – September 30) <input checked="" type="checkbox"/> Quarter 4 (October 1 – December 31)	
<b>Project Title:</b> New England Transportation Consortium (VI)		
<b>Name of Project Manager(s):</b> Joe Segale	<b>Phone Number:</b> 802-828-2561	<b>E-Mail</b> Joe.Segale@vermont.gov
<b>Lead Agency Project ID:</b> CA0306	<b>Other Project ID (i.e., contract #):</b> NETC 06-4 NETC 07-1 NETC 09-2 NETC 09-3 NETC 10-3 NETC 13-1 NETC 13-2 NETC 13-3 NETC 14-1 NETC 14-2 NETC 14-4 NETC 15-3	<b>Project Start Date:</b> 9/16/13 7/1/13 9/1/13 9/1/13 9/16/13 9/1/14 6/1/14 12/1/14 3/1/15 2/1/15 7/06/15 8/1/16
<b>Original Project End Date:</b> NETC 06-4 9/15/15 NETC 07-1 3/31/16 NETC 09-2 2/28/16 NETC 09-3 8/31/15 NETC 10-3 9/15/15 NETC 13-1 8/31/16 NETC 13-2 5/31/16 NETC 13-3 11/30/15 NETC 14-1 4/2/16 NETC 14-2 4/2/16 NETC 14-4 7/05/17 NETC 15-3 7/31/18	<b>Current Project End Date:</b> 9/15/15, NCE to 9/15/16 3/31/16, NCE to 6/30/16 2/28/16 8/31/15, NCE to 12/31/15 9/15/15, NCE to 5/31/17 4/2/16, NCE to 1/14/17 4/2/16, NCE to 12/1/17 3/31/16, NCE to 4/2/17 4/2/16, NCE to 12/31/16 4/2/17, NCE to 5/31/17* 7/05/17 7/31/18	<b>Number of Extensions:</b> 1 1 0 1 2 (for NETC) 2 (for NETC) 1 (for NETC) 2 (for NETC) 2 (for NETC) 1 (for NETC) 0 0

\* NCE in process between UVM and Partner University

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
NETC 06-4	\$242,909	\$191,675.12	95%
NETC 07-1	\$198,154	\$190,421.37	100%
NETC 09-2	\$80,000	\$80,000.00	100%
NETC 09-3	\$165,000	\$149,695.39	95%
NETC 10-3	\$150,158	\$65,317.38	80%
NETC 13-1	\$174,923	\$155,825.00	90%
NETC 13-2	\$249,785	\$55,042.07	45%
NETC 13-3	\$100,000	\$70,810.41	90%
NETC 14-1	\$100,000	\$22,521.32	30%
NETC 14-2	\$205,554	\$123,031.96	95%
NETC 14-4	\$200,000	\$78,862.00	50%
NETC 15-3	\$150,000	\$0.0	0%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter			Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
NETC 06-4	\$0.0	0%	\$0.0	166% (based on 24 months)
NETC 07-1	\$0.0	0%	\$0.0	127% (based on 33 months)
NETC 09-2	\$0.0	0%	\$0.0	133% (based on 30 months)
NETC 09-3	\$0.0	0%	\$0.0	157% (based on 28 months)
NETC 10-3	\$8,091.60	5.4%	\$8,091.60	166% (based on 24 months)
NETC 13-1	\$12,314.40	7.0%	\$12,314.40	116% (based on 24 months)
NETC 13-2	\$0.0	0%	\$0.00	129% (based on 24 months)
NETC 13-3	\$0.0	0%	\$0.0	208% (based on 12 months)
NETC 14-1	\$0.0	0%	\$0.0	141% (based on 22 months)
NETC 14-2	\$8,747.81	4.3%	\$8,747.81	135% (based on 26 months)
NETC 14-4	\$36,663.88	18.0%	\$36,663.88	71% (based on 24 months)
NETC 15-3	\$0.0	0%	\$0.0	21% (based on 24 months)

Project Description:

- 06-4 Preventative Maintenance and Timing of Applications
- 07-1 In-Place Response Mechanisms of Recycled Layers Due to Temperature and Moisture Variations
- 09-2 Effective Establishment of Native Grasses on Roadsides
- 09-3 Advanced Composite Materials: Prototype Development and Demonstration
- 10-3 Low Temperature and Moisture Susceptibility of RAP Mixtures with Warm Mix Technology
- 13-1 Development of High-Early Strength Concrete for Accelerated Bridge Construction Closure Pour Connections
- 13-2 HMA Mixtures Containing Recycled Asphalt Shingles (RAS): Low Temperature and Fatigue Performance of Plant-Produced Mixtures
- 13-3 Improved Regionalization of Quality Assurance (QA) Functions
- 14-1 Measuring the Effectiveness of Competency Models for Job-Specific Professional Development of Engineers & Engineering Technicians
- 14-2 Investigation of Northern Long Eared Bat Roosting Sites on Bridges
- 14-4 Optimizing Future Work Zones in New England for Safety and Mobility
- 15-3 Moisture Susceptibility Testing for Hot Mix Asphalt Pavements in New England

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

NETC 06-4, UMass Dartmouth and the technical committee held a conference call to discuss the draft final report. The

technical committee provided questions and feedback that UMass agreed to incorporate into the final report.

NETC 07-1, In this quarter, the research team completed the final report in the NETC format and worked with the NETC Coordinator to address minor edits.

NETC 09-2, In this quarter, the research team completed the final report in the NETC format and worked with the NETC Coordinator to address minor edits.

NETC 09-3, Upon approval of the draft report by the technical committee, the research team worked to complete the final report and tech transfer material in NETC format.

NETC 10-3,

1. On October 14th, 2016; UMass Dartmouth received a no-cost extension for the project until 5/31/17. This agreement for this project expired on 6/30/16. The extension time was so that the remainder of mixtures can be produced, tested and analyzed.
2. UMass Dartmouth continued analysis of the test data for all the mixtures tested to date.
3. A Transportation Research Board (TRB) paper was submitted in August of 2016 related to this research work for this project. The paper was accepted for presentation at the Transportation Research Board 96th Annual Meeting in Washington DC on January 10th, 2017. The paper entitled "Understanding Influence of Moisture on Performance of Plant-Produced High Reclaimed Asphalt Pavement Content Mixtures Incorporating Warm-Mix Asphalt Technologies" will be presented in TRB session 636 "Reclaimed Asphalt Pavement and Recycled Asphalt Shingles in Asphalt Mixtures."

NETC 13-1,

Task 1: Literature Search

- Completed the literature review and summarized findings.

Task 2: Develop Mixture Design Specification

- Created a mixture design specification based on the development procedure used in this research project

Task 3: Develop Mix Design

- No further development was required of the mixture design. The two selected concrete mixtures were used for final testing.

Task 4: Test Mixture

- Completed the shrinkage testing (AASHTO PP 34-99). A minimum of three tests were performed on each of the final selected concrete mixtures.
- Completed the design and fabrication for the bar pullout test setup, including strength analysis of members within the setup (ASTM A944)
- Design and fabrication of steel reinforcement used within each bar pullout test concrete specimen completed
- Completed fabrication of formwork used for the bar pullout test concrete specimens for No.4 and No.6 test bars, including tying of steel reinforcement within each specimen.
- Performed bar pullout test on two selected concrete mixtures developed through trial batches on No. 4 and No. 6 epoxy coated test bars
- Gradation of aggregates used for the selected mixes was modified as required to conduct alkali-silica reactivity test (ASTM C1567) using fine aggregates and a crushed coarse aggregates
- Mixed the sodium hydroxide solution required for the alkali-silica reactivity testing
- Performed alkali-silica reactivity aggregate tests on two mortar mix designs compatible with the selected concrete mixtures, one using coarse aggregates and the other using fine aggregates

NETC 13-2,

1. On October 14th, 2016; UMass Dartmouth received a no-cost extension for the project until 12/01/17. This agreement for this project expired on 5/31/16. The extension time was so that the mixtures can be produced, tested and analyzed.
2. UMass Dartmouth has consistently contacted and met with the contractor during the last quarter to discuss production of the mixtures for this study. The contractor stated they would attempt to produce the mixtures as soon their schedule permits but no mixtures were delivered to date.
3. In September, since no plant produced mixtures had been received, UMass Dartmouth obtained Post Consumer Asphalt Shingles (PCAS) to begin development of the mixtures designs with this new source of

RAS. Previous mixture work had been completed with Manufactures Shingle Waste (MSW).

4. The PCAS source material was tested to determine its properties (binder content, gradation, etc.).
5. Mixture design using 5% PCAS and 15% RAP + 5% PCAS were developed using the same source of aggregates as the previous MSW RAS testing.
6. Performance testing of the two mixtures developed with PCAS commenced. Specifically dynamic modulus testing, flexural beam fatigue, Thermal Stress Restrained Specimen Test (TSRST), Illinois Flexibility Index Test (IFIT), and Disk Shaped Compact Tension Test (DC(T)) were undertaken.

#### NETC 13-3,

In this past quarter, the research team finalized two spreadsheets with recommendations for (1) plant certification; (2) sampling and testing as part of QA inspection. These spreadsheets are instrumental in adoption of common acceptance standards for precast and prestressed concrete elements for all six New England DOTs. The spreadsheets were emailed to the project technical committee in early November and a conference call between researchers and the technical committee was held on November 18th 2016. During the conference call researchers presented their recommendations and the technical committee provided their feedback. Minutes of the conference call are attached with this report. On basis of the technical committee feedback researchers revised the recommendations. Revised recommendations are also attached with this report.

During the conference call there was discussion of setting up a Share Point site by Vermont Agency of Transportation (VAOT). The Share Point site will be used to share QA data between the states. Since the call, VAOT has obtained necessary approvals for setting of the Share Point data sharing site. MassDOT and ConnDOT staff has already obtained necessary login information to access this site. Once other states also obtain the login information from VAOT, another conference call will be organized to go over the Share Point site as well as to further discuss pilot projects during 2017 construction season where sharing of QA resources will be tried by different states.

The final report for the project was prepared during the previous quarter. The report is currently being revised to incorporate recommendations made by technical committee during the November conference call.

NETC 14-1, Our graduate student has completed her thesis work. That work forms the base information for this research project. The literature search and data are directly transferrable and her results and conclusions should transfer as key parts for a model under this research.

We have brought in two new researchers: Dr. Michael Knodler, Associate Professor at UMass will be providing direction and support for the project; Cole Fitzpatrick, Research Fellow here at UMass will be applying his expertise to move the project forward.

#### NETC 14-2

- Guano samples sent to 2 labs for species identification.
- Hand vetting results of MYSE calls received from Sarah Boyden of MaineDOT.
- Continued evaluation of data.
- Began compiling inspection and data collection forms into report format.
- Obtained quotes from consultants for data analysis.
- Sent acoustic data to two consultants for further acoustic analysis with automated programs and select hand vetting.
- Continued work on Draft Final Report.
- Modified presentation of research and revised for conferences as appropriate.
- Presented at the North American Society for Bat Research (NASBR) conference at San Antonio TX.
- Presented (remotely) at Maine Bat Working Group Annual Meeting.
- Submitted abstract to the Northeastern Bat Working Group (NEBWG) conference.

#### NETC 14-4,

Task 3 – Development of Methodology for Testing and Analyzing TTCs  
Naturalistic Driving Study Data

For the initial data request, we only asked for a subset of the data we budgeted for. During the past 5th quarter, the team submitted a second data request. We restricted this new data request to work zones on divided highways with 1~2 through lanes in each direction. The request has to be approved by VTTI and UMass Lowell Office of Research Administration (ORA). VTTI has approved it. Currently, it is under review by UMass Lowell ORA. This reviewing process

has caused substantial delay to the first data request. We anticipate that this will again cause delay to the second data request and our data analysis.

#### Smart Work Zone (SWZ) Data

The team has finished analyzing the data obtained from one SWZ in Massachusetts. The observed and simulated data will be shared at the upcoming 5th quarterly project meeting.

#### Driving Simulation Study

As reported in the 4th quarterly meeting, the team would like to utilize a virtual reality driving simulator to simulate how drivers will react to different work zone TTCPs. In the 5th quarter, the team was able to customize an existing software program to create work zones with the needed TTCP features such as radar speed sign, concrete barrier, variable message sign, pavement marking, and tubular markers.

Also, the team has identified several well-recognized strategies for speed control and throughput maximization. These strategies were identified through an extensive literature review conducted in the 4th quarter. In the 5th quarter, we have finished creating the following four types of work zones for evaluating different speed control strategies in a virtual reality environment:

Radar speed signs that are distributed evenly throughout a work zone. The distance between two radar speed signs is 800 ft;

Tubular markers that are evenly spaced for speed control inside a work zone's work activity area. The distance between two tubular markers is 15 ft;

Based on the second scenario, a varying (decreasing) spacing strategy is proposed. The distance between two consecutive tubular markers starts with a large initial value and decreases continuously. Once the distance reaches a minimum value, it goes back to the large initial value and repeats the same decreasing pattern;

Considering narrow pavement marking. The strategy does not change the existing lane width. Instead, it uses narrow pavement marking to give drivers the narrow lane impression so that they may slow down.

In addition to strategies to reduce vehicle speed or maintain a uniform speed, the team also coded late and early merge strategies in a virtual reality environment, to see how individual drivers will react to different merge control strategies.

The early and late merge strategies are realized by adding variable message signs to display messages such as "merge now", "merge ahead", and "stay in your lane".

#### Task 4 – Development of New TTCPs

Based on the review reported in the 4<sup>th</sup> quarter, we have identified radar speed sign, variable message sign, tubular marker, and narrow lane for further consideration in the past 5th quarter. As described in the last subtask of Task 3, these strategies have been successfully coded in a virtual reality driving simulator.

#### Task 5 – Evaluation of New TTCPs

The team has been working on two strategies to evaluate the proposed TTCPs: 1) virtual reality driving simulator (VRDS) and 2) VISSIM microscopic traffic simulation. The VRDS is mainly for evaluating speed control strategies (i.e., strategies 1–4). The team has coded all four strategies and prepared recruiting materials, and is ready to conduct the driving simulation study once the semester starts and students are back on campus.

The VISSIM microscopic simulation will be used to evaluate when late and early merge strategies should be considered. The main objective is to determine where and when drivers should start to merge in order to maximize the throughput of a work zone. One approach to solve this problem is to consider model predictive control (MPC) and several studies have investigated how to use MPC for optimal ramp metering. The team has conducted an extensive literature review in the past 5th quarter to investigate the feasibility of using MPC for work zone merge control and found that developing such an approach will be very time consuming. We decided to adopt a simulation based optimization approach, which is more straightforward but more computationally demanding. The simulation based optimization approach has been utilized to optimize traffic signal timing plans and has been adopted in this project to find the best location for drivers to merge under various traffic conditions. The team utilized the VISSIM DriverModel DLL Interface to modify vehicles' behaviors so that they will follow the lane-change instructions given by roadside variable message signs. The simulation network coding work is almost completed and we are now in the process of improving the simulation speed. This work is expected to be done within a month. More details regarding the simulation based optimization approach will be shared at the upcoming 5th quarter meeting.

An abstract entitled "Modelling Highway Work Zone Traffic Safety and Driver Behaviours in the United States Using a

Virtual Reality Driving Simulator” has been accepted by the 2017 Road Safety & Simulation Conference to be held in The Hague, Netherland in October 2017.

NETC 15-3,

Researchers have started to collect published literature on the topic of moisture-induced damage in asphalt mixtures and have started to also collect standard specifications from various agencies to conduct a state of the practice review.

A survey is under development to collect additional information from various agencies regarding their practices as well as experiences in context of moisture-induced damage in asphalt mixtures.

**Anticipated work next quarter:**

NETC 06-4, Continue final report.

NETC 07-1, No work projected at this time.

NETC 09-2, No work projected at this time.

NETC 09-3, The research team will completed the final report in the NETC format.

NETC 10-3, UMass Dartmouth will continue testing the plant produced mixtures as they are received.

The paper entitled “Understanding Influence of Moisture on Performance of Plant-Produced High Reclaimed Asphalt Pavement Content Mixtures Incorporating Warm-Mix Asphalt Technologies” will be presented in TRB session 636 “Reclaimed Asphalt Pavement and Recycled Asphalt Shingles in Asphalt Mixtures” on January 10th, 2017.

NETC 13-1,

Task 4: Test Mixture

- Fabricate and test freeze-thaw specimens (ASTM C666)
- Fabricate and test specimens for chloride permeability (ASTM 1543 & ASTM C672)
- Full-scale test, including design and fabrication of test setup, fabrication of test specimen and testing

NETC 13-2, UMass Dartmouth will meet with contractor to discuss production. Continue work with PCAS mixtures.

The paper entitled “Performance Characterization of Asphalt Mixtures Incorporating Recycled Asphalt Shingles: Mechanical Approach to Asphalt Binder Degree of Blending” will be presented in TRB session 636 “Reclaimed Asphalt Pavement and Recycled Asphalt Shingles in Asphalt Mixtures.”

NETC 13-3,

- Submission of the final report
- Selection of agencies and manufacturers for pilot implementation of common acceptance standards

NETC 14-1,

1. We will then pull already developed model parts into a comprehensive model.
2. The model will be tested in Maine.
3. The final report will be written.

NETC 14-2,

- Receive results from guano ID
- Receive acoustic analysis from consultants.
- Complete data analysis
- Complete inspection and data collection forms for report
- Deliver Draft Final Report to technical committee for comment
- Present at the Transportation Research Board 2017 Annual Meeting
- Present at the Northeastern Bat Working Group Annual Meeting
- Coordinate with Technical Committee to schedule late winter/early spring meetings to disseminate results through workshop meetings

NETC 14-4,

The project team will continue working on tasks 3) development of methodology for testing and analyzing TTCPs; 4)

development of new TTCPs; 5) evaluation of new TTCPs through simulation; 6) project meetings; and 7) reporting.

NETC 15-3,

- Project kick-off meeting. Polls to the project technical committee will be sent in next few days to determine their availability for scheduling project kick-off meeting.
- Completion of literature and agency specification review
- Distribution of agency surveys to collect information on the state of the practice as well as for identifying various mixtures and their attributes that have shown good or poor moisture induced damage potentials.
- On basis of the literature review and the state of the practice review, initial testing and sampling plan for this project will be developed.

### Significant Results:

None as of this reporting period.

**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).**

NETC 06-4, None during the current period.

NETC 07-1, None during the current period.

NETC 09-2, None during the current period.

NETC 09-3, None during the current period.

NETC 10-3, The research team has been consistently making arrangements with contractors to provide plant produced mixtures as stated in the scope of work. UMass Dartmouth is consistently following up with the second contractor to produce more of the mixtures noted in the test matrix. No new mixtures were received this quarter even though the contractor had promised delivery of some mixtures in the fall. The mixtures UMass is awaiting are high RAP mixtures prepared using foaming as the WMA technology.

NETC 13-1,

- Variability occurred within the trial batch mixture designs; therefore, more tests were required per mixture design to ensure accuracy of results
- Mixing procedures were altered to reduce variability in the small-scale mixtures
- The time until cracking of shrinkage ring tests according to AASHTO P 34-99 was longer than anticipated causing delay of other activities in the project. Due to limits on availability of equipment in our laboratory, data could only be simultaneously recorded for two tests at any given time; in order to perform sufficient shrinkage ring tests for the two mixes selected, it took longer to perform the full number of tests required.
- The project was extended at no cost for 6 months from August 2016 to December 2016. Approval for this extension was granted officially in early 2017.
- Funding for the graduate student working in the project expired in August 2016; a teaching assistantship was used to keep funding the graduate student (Stephanie Castine) while she continued working on the project from August-December 2016 in order to try to finish project activities. There are still a few activities that were proposed to conduct in the proposal (freeze-thaw testing, chloride penetration, large-scale component testing) that will not be able to be concluded by January 14, 2017, the current expiration date of the project. The PI will communicate with the Chair of the Technical Advisory Committee to discuss the appropriate action to take.

NETC 13-2,

1. The contractor assisting producing the mixtures for this study only utilizes one source of RAS which is manufacturers shingle waste (MSW). The contractor does not utilize post-consumer asphalt shingles (PCAS) or a blend of MSW and PCAS.

2. The project PI has continued efforts to find a contractor willing to produce mixtures for this study, preferably one that utilizes other RAS sources. To date, the PI has only been able to get commitment from one local contractor which has not produced the mixtures yet.

NETC 13-3, None during the current period.

NETC 14-1, We were again forced to stop formal work on the project in January and are now working toward getting a project extension. Our graduate student finishing her degree work in the fall and our subcontractor not performing were issues.

NETC 14-2, None during the current period.

NETC 14-4,

During the past 5th quarter, the team submitted a second Naturalistic Driving Study (NDS) data request. The request has to be approved by both VTTI and UMass Lowell Office of Research Administration (ORA). VTTI has approved it. Currently, it is under review by UMass Lowell ORA. This reviewing process has caused substantial delay to the first NDS data request. We anticipate that this will again cause delay to the second NDS data request and our data analysis.

NETC 15-3, None during the current period.

**Potential Implementation:**

The eight of the 12 research projects listed above are still in progress. Implementations of the results of those seven of projects are not anticipated in the near future. One research project (NETC 13-3) is nearing conclusion and the technical committee and researcher are considering options for pilot implementation projects. Four research projects (NETC 06-4, 07-1, 09-2 and 09 -3) are in the process of completing their final report and technical transfer process. During this process, the technical committees and researchers will work to identify strategies for implementing the results of this research.