U.S. Department of Transportation
Research and Innovative Technology Administration
University Transportation Center Grant Agreement

Grant No. DTRT13-G-UTC38
DTRT13-G-UTC38, Mod 1 & 2
Mountain-Plains Consortium, North Dakota State University
Denver Tolliver, Director
Denver.tolliver@ndsu.edu
(701)231-7190

October 30, 2015

DUNS: 803882299 and EIN: 45-6002439

North Dakota State University
Upper Great Plains Transportation Institute
NDSU Dept. 2880, P.O. Box 6050, Fargo, ND 58108-6050

Grant period: October 1, 2013 – September 30, 2018

Reporting Period End Date: September 30, 2015
Semi-Annual PPPR#4

Denver D. Tolliver
Director, Mountain-Plains Consortium
North Dakota State University
1. Accomplishments: What was done? What was learned?

a. What are the major goals of the program?

The overall objectives are to: (1) conduct basic and applied research, the products of which are judged by peers or other experts in the field of transportation to advance the body of knowledge in transportation; (2) offer an education program in transportation that includes multidisciplinary coursework and participation in research; (3) conduct workforce development activities and programs to expand the workforce of transportation professionals; and (4) provide an ongoing program of technology transfer to make transportation research results available to potential users in a form that can be readily used. Other program goals are to select projects and activities using peer review principles and procedures and client input that: (1) address the Secretary’s five strategic goals, and (2) leverage UTC funds with matching funds from state and local governments and private industry. The chief operational goals are to make important contributions to research and technology transfer in key areas related to the Secretary’s goals of State of Good Repair, Safety, and Economic Competiveness, while addressing critical issues of the region and stakeholder groups.

b. What was accomplished under these goals?

i. Project Selection

Sixty research projects were selected for the 2014-2015. Projects have been selected for the original grant, while projects are still being submitted for the Modification 2 to the original grant. Thus the peer review process is ongoing for possible selection. The projects reflect substantial input and matching resources from state departments of transportation and MPOs in the region. Collectively, this set of projects addresses all five of the Secretary’s strategic goals and several of USDOT’s requested emphasis areas under State of Good Repair—e.g., (1) bridge condition monitoring, (2) locating critical infrastructure defects, (3) identifying tools to prevent and detect corrosion in transportation infrastructure, (4) analytical tools for infrastructure performance management, and (5) methods and criteria to measure performance of new materials and methods. Other research projects are related to the Secretary’s strategic goals of Safety, Economic Competiveness, Livable Communities, and Environmental Sustainability. MPC Projects selected under this grant include; MPC-371, 409, 451 (Year 2), MPC-446 through MPC-502.

Table 1: MPC Research Projects Most Directly Correlated with Safety

| 1. MPC-453: Speed Selection Behavior during Winter Road Conditions |
| 2. MPC-454: Regional Implementation of Tribal Transportation Safety Program |
| 3. MPC-455: Why Are Bike-Friendly Cities Safer for All Road Users? |
| 4. MPC-458: Application of a Multi-Agent System with the Large-Scale Agent-Based Model for Freight Demand Modeling |
| 5. MPC-460: Technology and Workforce Development for Remote Sensing of the Transportation Infrastructure |
| 6. MPC-462: Implementation of Aerial LiDAR Technology to Update Highway Feature Inventory |
| 7. MPC-465: Development of Performance Matrices for Evaluating Innovative Intersections and Interchanges |
8. MPC-467: Self-Regulation and Distraction
9. MPC-469: Improving Efficiency and Reliability of Bus Rapid Transit
11. MPC-472: Developing an Optimization Model for Managing County Paved Roads
12. MPC-473: Bicycle and Pedestrian Design for Rural Communities
14. MPC-475: Analysis of the Relationship of Roadside Inspections on Large Truck Crashes
15. MPC-476: Highway-Rail Grade Crossing Traffic Hazard Forecasting Model
17. MPC-480: A Comprehensive Safety Assessment Methodology for Innovative Geometric Designs
18. MPC-483: Interaction Analysis of Girder Bridges and Traffic System subjected to Earthquakes
19. MPC-486: Sustainable Heated Pavements for Infrastructure Longevity, Safety and Economic Competitiveness
20. MPC-487: Investigation of Cross Laminated Timber Bridge Decks as a Sustainable Solution for Repair of Deficient Rural Wood Bridges
21. MPC-491: Self-Centering Buckling Restrained Braces for Curved Bridges
22. MPC-495: Safety Effects of Protected and Protected/Permitted Left-Turn Phases
23. MPC-502: Experimental and Computational Study of Self-Consolidating Concrete for Prestressed Bridge Girders

Table 2: MPC Research Projects Most Directly Correlated with State of Good Repair

1. MPC-446: A Modified Approach for Predicting Fracture of Steel Components under Combined Large Inelastic Axial and Shear Strain Cycles
2. MPC-447: Post-Fire Ground Treatments for Protection of Critical Transportation Structures
3. MPC-448: Reducing Flood Vulnerability of Communities with Limited Road Access by Optimizing Bridge Elevation
4. MPC-449: Determining the Uncertainty in the Current Condition of Bridges for Use in Risk Based Inspection and Management
5. MPC-450: Using Building Information Modeling to Track and Assess Structural Condition
6. MPC-451: Assessing the Cost-Effectiveness of Wyoming's CMAQ Unpaved Road Dust Suppression Program
7. MPC-452: Updating the Highway Safety Manual 2010 - Part C: Regional Consideration of the Rocky Mountains and Plain Regions
9. MPC-458: Application of a Multi-Agent System with the Large-Scale Agent-Based Model for Freight Demand Modeling
10. MPC-460: Technology and Workforce Development for Remote Sensing of the Transportation Infrastructure
11. MPC-462: Implementation of Aerial LiDAR Technology to Update Highway Feature Inventory
12. MPC-463: Rehabilitation Project Selection and Scheduling in Transportation Networks
13. MPC-464: Development of Network-Based Measures and Computational Methods for Evaluating the Redundancy of Transportation Networks
15. MPC-468: Performance Evaluation of Highway Surface Treatments (Phase I: Short-Term Performance)
16. MPC-469: Improving Efficiency and Reliability of Bus Rapid Transit
18. MPC-472: Developing an Optimization Model for Managing County Paved Roads
19. MPC-477: Characterizing the ductility of Portland cement stabilized soil
20. MPC-478: Long-Term Behavior of Precast Concrete Bridges
22. MPC-481: Incorporating River Network Structure for Improved Hydrologic Design of Transportation Infrastructure
23. MPC-482: Coupled Numerical Simulation of Debris Flow-Soil-Structure Interactions for Flexible Barrier Mitigation Systems
24. MPC-483: Interaction Analysis of Girder Bridges and Traffic System subjected to Earthquakes
25. MPC-484: Effect of Service Temperature on Joint Removal in Steel Bridges
26. MPC-486: Sustainable Heated Pavements for Infrastructure Longevity, Safety and Economic Competitiveness
27. MPC-487: Investigation of Cross Laminated Timber Bridge Decks as a Sustainable Solution for Repair of Deficient Rural Wood Bridges
28. MPC-492: Early-Age Fiber-Reinforced Concrete Properties for Overlays
29. MPC-493: Incorporating Maintenance Costs and Considerations into Highway Design Decisions
31. MPC-496: Prevention of Low Temperature Cracking of Pavements
32. MPC-497: Compaction Testing of Granular Materials
33. MPC-500: Rehabilitation of Longitudinal Joints in Double-Tee Bridge Girders
34. MPC-501: Development of an Alternative to the Double Tee Bridge System
35. MPC-502: Experimental and Computational Study of Self-Consolidating Concrete for Prestressed Bridge Girders

Table 3: MPC Research Projects Most Directly Correlated with Economic Competitiveness

1. MPC-451: Assessing the Cost-Effectiveness of Wyoming's CMAQ Unpaved Road Dust Suppression Program
2. MPC-456: Performance of Steel Girders Repaired with Advanced Composite Sheets in a Corrosive Environment: A Multi-Physics Approach Leading to Practical Design Recommendations
3. MPC-460: Technology and Workforce Development for Remote Sensing of the Transportation Infrastructure
4. MPC-463: Rehabilitation Project Selection and Scheduling in Transportation Networks
5. MPC-464: Development of Network-Based Measures and Computational Methods for Evaluating the Redundancy of Transportation Networks
6. MPC-465: Development of Performance Matrices for Evaluating Innovative Intersections and Interchanges
7. MPC-466: First and Last Mile Strategies for Transit Systems
8. MPC-468: Performance Evaluation of Highway Surface Treatments (Phase I: Short-Term Performance)
9. MPC-469: Improving Efficiency and Reliability of Bus Rapid Transit
10. MPC-470: Evaluating Transportation Professional Development and Continuing Education Courses
12. MPC-472: Developing an Optimization Model for Managing County Paved Roads
13. MPC-486: Sustainable Heated Pavements for Infrastructure Longevity, Safety and Economic
Competence
14. MPC-488: Effects of Infill Development and Regional Growth on At-Risk Populations' Exposure to Traffic Density

Table 4: MPC Research Projects Most Directly Correlated with Livable Communities

1. MPC-454: Regional Implementation of Tribal Transportation Safety Program
2. MPC-455: Why Are Bike-Friendly Cities Safer for All Road Users?
3. MPC-465: Development of Performance Matrices for Evaluating Innovative Intersections and Interchanges
4. MPC-466: First and Last Mile Strategies for Transit Systems
5. MPC-469: Improving Efficiency and Reliability of Bus Rapid Transit
6. MPC-473: Bicycle and Pedestrian Design for Rural Communities
7. MPC-485: Development of a Model to Assess the Feasibility of Transit-Oriented Development (TOD) Projects
8. MPC-489: The Unresolved Relationship between Street Trees and Road Safety
9. MPC-490: Longevity of Air Pollution Mitigating Photo-Catalytic Coatings on Transportation Infrastructure
10. MPC-491: Self-Centering Buckling Restrained Braces for Curved Bridges
11. MPC-498: Development of Mixed Media Filtration for Stormwater Runoff Treatment
12. MPC-499: Reuse of Aqueous Waste Streams in Transportation-Related Applications

Table 5: MPC Research Projects Most Directly Correlated with Environmental Sustainability

1. MPC-447: Post-Fire Ground Treatments for Protection of Critical Transportation Structures
2. MPC-458: Application of a Multi-Agent System with the Large-Scale Agent-Based Model for Freight Demand Modeling
3. MPC-460: Technology and Workforce Development for Remote Sensing of the Transportation Infrastructure
4. MPC-469: Improving Efficiency and Reliability of Bus Rapid Transit
6. MPC-472: Developing an Optimization Model for Managing County Paved Roads
7. MPC-473: Bicycle and Pedestrian Design for Rural Communities
8. MPC-477: Characterizing the ductility of Portland cement stabilized soil
9. MPC-485: Development of a Model to Assess the Feasibility of Transit-Oriented Development (TOD) Projects
10. MPC-486: Sustainable Heated Pavements for Infrastructure Longevity, Safety and Economic Competitiveness
11. MPC-487: Investigation of Cross Laminated Timber Bridge Decks as a Sustainable Solution for Repair of Deficient Rural Wood Bridges
12. MPC-488: Effects of Infill Development and Regional Growth on At-Risk Populations' Exposure to Traffic Density
13. MPC-489: The Unresolved Relationship between Street Trees and Road Safety
14. MPC-490: Longevity of Air Pollution Mitigating Photo-Catalytic Coatings on Transportation Infrastructure
15. MPC-498: Development of Mixed Media Filtration for Stormwater Runoff Treatment
16. MPC-499: Reuse of Aqueous Waste Streams in Transportation-Related Applications
ii. Programmatic Milestones

In addition to the programmatic milestones described below, several milestones embedded within individual projects have been achieved. Most of the research projects call for literature reviews. The literature reviews for those projects with the earliest starts are substantially complete. Interim reports are not required after the literature review stage. At this time, all projects are on schedule to be completed as planned during the program period.

Table 6: Program Milestones

<table>
<thead>
<tr>
<th>Milestone Event</th>
<th>Description</th>
<th>Start Date</th>
<th>End Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development of Proposal Guidelines</td>
<td>Proposal guidelines were developed by the director, in consultation with other consortium members, to ensure a consistent solicitation and project selection process that facilitates peer review and links program activities to the Secretary’s strategic goals. Similar but different guidelines were developed for education, workforce development, and technology transfer projects, to reflect the differences in tasks and outcomes associated with these projects. The proposal guidelines and related information have been posted on the Center’s webpage.</td>
<td>09/1/2013</td>
<td>09/15/2013</td>
</tr>
<tr>
<td>Call for Proposals</td>
<td>The solicitation of proposals occurred on each university campus, using proposal guidelines developed by the director. Modification 1 call for proposals. Modification 2 call for proposals</td>
<td>09/15/2013</td>
<td>11/15/2013</td>
</tr>
<tr>
<td>Execution of Grant Agreement</td>
<td>The grant was received from RITA and executed by NDSU’s Sponsored Programs office. All of the necessary internal accounting and financial procedures were established, including subcontract agreements with consortium universities. Modification 1 execution Modification 2 execution</td>
<td>11/08/2013</td>
<td>11/08/2013</td>
</tr>
<tr>
<td>Center Directory</td>
<td>A directory of key center personnel was completed and published on the center’s web page. Updated</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Center Webpage</th>
<th>The MPC webpage was updated and is fully functional for the current grant period. Updated</th>
<th>12/15/2013 12/15/2014 12/15/2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>UTC/CUTC Meeting</td>
<td>The director and administrative staff attended the UTC/CUTC meeting at TRB and received guidance from RITA regarding the forthcoming grant.</td>
<td>01/11/2014 01/16/2014 06/02/2014 06/05/2014 01/11/2015 01/11/2015 06/1/2015 06/4/2015 1/10/2016 01/14/2016</td>
</tr>
<tr>
<td>Peer Review of Proposals</td>
<td>All project proposals were subjected to external and internal peer review.</td>
<td>01/15/2014 03/15/2014 05/19/2014 12/30/2014 04/01/2015 12/30/2015</td>
</tr>
<tr>
<td>Primary Focus</td>
<td>MPC’s proposal targets the following MAP-21 research and technology deployment objectives under the goal of Improving Infrastructure Integrity: A) increase the reliability of life-cycle performance predictions used in infrastructure design, construction, and management; B) improve the ability of transportation agencies to deliver projects that meet expectations for timeliness, quality, and cost; C) reduce user delay attributable to infrastructure system performance, maintenance, rehabilitation, and construction; D) improve highway condition and performance through increased use of design, materials, construction, and maintenance innovations; and E) study vulnerabilities of the transportation system to seismic activities and extreme events and methods to reduce those vulnerabilities.</td>
<td>03/15/2014 12/31/2015</td>
</tr>
<tr>
<td>Selection of Projects</td>
<td>Projects were selected from the proposals received and awards were made to principal investigators, based on the peer reviews of proposals, stakeholder commitments, and the overall availability of funds.</td>
<td>03/15/2014 06/15/2014 09/19/2014 12/30/2014 04/01/2015 12/30/2015</td>
</tr>
<tr>
<td>Posting of Projects</td>
<td>The selected projects were posted on the MPC webpage and added to the Research in Progress database.</td>
<td>05/15/2014 08/15/2014 09/19/2014 12/30/2014 04/01/2015 12/30/2015</td>
</tr>
<tr>
<td>Site Visit</td>
<td>A site visit to all MPC Universities.</td>
<td>Annually</td>
</tr>
</tbody>
</table>

iii. Educational Accomplishments
The transportation and transportation-related courses offered during Spring, Summer, and Fall 2015 are listed in Table 7, organized by major subject area. In some cases, courses with the same titles were offered at more than one MPC university. In these cases, the number of courses offered is shown in parenthesis.

<table>
<thead>
<tr>
<th>Major Subject Area</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering &amp; Design</td>
<td>CIVE 302 Evaluation of Civil Engineering Materials</td>
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<tr>
<td></td>
<td>CIVE 355 Introduction to Geotechnical Engineering</td>
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<tr>
<td></td>
<td>CIVE 466 Design and Behavior of Steel Structures</td>
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<td></td>
<td>CIVE 367 Structural Analysis</td>
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<td></td>
<td>CIVE 563 Structural Reliability</td>
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<tr>
<td></td>
<td>CIVE 566 Intermediate Structural Analysis</td>
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<td></td>
<td>CIVE 576 Engineering Applications of GIS and GPS</td>
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<td></td>
<td>CIVE 664 Mechanics of Fatigue and Fracture</td>
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<tr>
<td></td>
<td>CEE 792: Topics-Advanced Topics in Reinforced Concrete</td>
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<tr>
<td></td>
<td>CEE 759: Structural Dynamics</td>
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<td></td>
<td>CEE 458/558: Timber Design</td>
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<td></td>
<td>CEE 456: Theory and Design of Reinforced Concrete</td>
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<td></td>
<td>CEE 455: Steel Design</td>
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<td></td>
<td>CEE 769: Bridge Design</td>
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<td>CEE 755: Advanced Reinforced Concrete</td>
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<td>CEE 447/547: Foundation Engineering</td>
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<td></td>
<td>CEE 363: Highway and Traffic Engineering</td>
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<td></td>
<td>CEE 346: Geotechnical Engineering</td>
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<td>CEE 749: Geotechnical Testing</td>
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<td></td>
<td>CVEN 3602 - Transportation Engineering</td>
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<td></td>
<td>CVEN 4602 - Highway Engineering</td>
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<td></td>
<td>CVEN 5602 - Advanced Street &amp; Highway Design</td>
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<td></td>
<td>CVEN 5682 - Pavement Design</td>
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<tr>
<td></td>
<td>CvEEN 5510 Highway Design Undergraduate</td>
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<td></td>
<td>CvEEN 5920 Sustainable Materials Undergraduate</td>
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<td></td>
<td>CvEEN 5220 Concrete Design II Undergraduate</td>
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<td></td>
<td>CvEEN 6225 Concrete Science Graduate</td>
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<td></td>
<td>CvEEN 6330 Soil Dynamics Graduate</td>
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<td></td>
<td>CvEEN 2130 Statistics and Economics Undergraduate</td>
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<td>CvEEN 5420 Open Channel Flow Undergraduate</td>
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<td>CvEEN 5570 Pavement Design Undergraduate</td>
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<td></td>
<td>CE 3500 Transportation Engineering</td>
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<td>CE 4510 Pavement Engineering</td>
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<td>CE 5510 Pavement Engineering</td>
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</tbody>
</table>
Altogether, 69 transportation and transportation-related courses have been offered this reporting period, for a total of 279 total transportation courses offered this grant period. In addition to the courses listed in Table 7, foundational courses in engineering materials, mechanics, structural analysis, and geotechnical engineering were offered at most MPC universities.

<table>
<thead>
<tr>
<th>Planning &amp; Environment</th>
<th>CE 4555 Geometric Design of Highways</th>
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<tbody>
<tr>
<td></td>
<td>CE 4900 CDE in Transportation</td>
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<td>CEE 6120 Bridge Design</td>
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<td>CEE 5070 Steel Design</td>
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<td></td>
<td>CEE 6130 Structural Dynamics and Seismic Design</td>
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<td>CVEN 5612 - Traffic Impact Assessment</td>
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<tr>
<td>CVEN 5460 - Introduction to Sustainable Urban Infrastructure</td>
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<tr>
<td>URPL 5040 - Urban Sustainability</td>
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<td>URPL 5050 - Urban Development</td>
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<td>URPL 6300 - Planning Healthy Communities</td>
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<td>URPL 6350 - Form and Formation of Cities</td>
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<tr>
<td>URPL 6399 - Introduction to Sustainable Urban Infrastructure</td>
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<tr>
<td>URPL 6400 - Community Development</td>
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<tr>
<td>URPL 6550 - Transportation Planning/Policy</td>
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<td>URPL 6645 - Disaster/Climate Change Planning</td>
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<td>URPL 6370 - Sprawl and Growth Management</td>
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<tr>
<td>URPL 5000 - Planning History and Theory</td>
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<td>URPL 5010 - Planning Methods</td>
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<tr>
<td>URPL 6650 - Planning in the Developing World</td>
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<tr>
<td>URPL 6565 - Pedestrian and Bike Planning</td>
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<tr>
<td>CvEEN 5560 Transportation Planning Undergraduate</td>
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<tr>
<td>CEE 5240/6220 Urban and Regional Transportation Planning</td>
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<tr>
<td>CVEN 5621 - Highway Capacity Analysis</td>
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<td>CVEN 5622 - Traffic Operations and Control</td>
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<tr>
<td>CvEEN 3520 Transportation Engineering Undergraduate</td>
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<tr>
<td>CvEEN 6525 Highway and Traffic Engineering Graduate</td>
<td></td>
</tr>
<tr>
<td>CEE 5220/6220 Traffic Engineering</td>
<td></td>
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<tr>
<td>CVEN 5611 - Traffic and Safety Data Analysis</td>
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<tr>
<td>CVEN 5622 - Transportation System Safety</td>
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<tr>
<td>CE 5560 Traffic Safety</td>
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<td>URPL 6555 - Transportation and Land Use</td>
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<tr>
<td>CVEN 5633 - Case Studies in Sustainable Transportation</td>
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<tr>
<td>CvEEN 7920 Statistical and Econometric Analysis Graduate</td>
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<tr>
<td>CvEEN 7540 Intelligent Transportation Systems</td>
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<tr>
<td>CEE 6210 Transportation Systems Analysis</td>
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</tbody>
</table>
iv. Workforce Development Accomplishments

Training: A list of training events provided for transportation professionals during this reporting period is presented below.

1. Aggregate Certification
2. Asphalt Certification
3. Asphalt Paving Maintenance 1 and 2
4. ATSSA Flag Certification
5. ATSSA Flagger Instructor Training
6. ATSSA Traffic Control
7. ATSSA Traffic Control Supervisor
8. Basics of good Roads
9. Communication Skills for Supervisors
10. Concrete Certification
11. Flagger Certification
12. Heavy Equipment Safety Operations
13. Preventing Runners and Backovers
14. Registered Stormwater Inspector
15. Retroreflectivity for signs
16. Road and Safety Fundamentals
17. Roadway Drainage
18. Roadway Materials
19. Street Lighting
20. Street Sweeper
21. Transportation and Safety Congress
23. Future Directions in Highway and Street Design and Analysis, Workshop at the 5th International Symposium on Highway Geometric Design
24. Welding
25. Winter Road Maintenance
26. Workplace, Equipment and Jobsite Safety
27. Work-zone Safety

v. Research Accomplishments

The following peer reviewed research reports were published during the rating period from grant DTRT13-G-UTC38.

<table>
<thead>
<tr>
<th>Project #</th>
<th>Title</th>
<th>Date</th>
<th>Report No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>370</td>
<td>Anticipatory Guidance Provision Related to Driving Safety/Cessation for Older Drivers: A Rural-Urban Comparison</td>
<td>Dec 2014</td>
<td>MPC 14-277</td>
</tr>
</tbody>
</table>
c. How have the results been disseminated?

The results are being disseminated in a variety of ways, including: (1) workshops and conferences, (2) videoconferences, (3) online modules, (4) presentations at conferences, (5) publications, (6) webpage postings and displays, and (7) Internet-based dissemination media, including broadcast emails and webinars.

d. What do you plan to do during the next reporting period to accomplish the goals/objectives?

No changes are foreseen to the accepted plan and implementation schedule.

2. Products: What has the program produced?

a. Publications, conference papers, presentations

   i. Key Conferences and Workshops
   - 18th Annual National Transportation Conference; September 21-24, 2015; Myrtle Beach, South Carolina
   - 2015 American Society of Engineering Education Annual Conference and Exposition, Seattle, WA
   - 20th International Conference on Composite Materials, Copenhagen, Denmark
   - 21st International Symposium on Transportation and Traffic Theory (ISTTT21), Kobe, Japan
   - 3rd International Conference on Human Factors in Transportation, Las Vegas, NV
   - 55th Annual ITE Intermountain Section Meeting, May 14 – 16, 2015, Jackson, WY
   - 5th International Symposium on Highway Geometric Design, Vancouver, Canada
   - ACI Spring 2015 Convention. Kansas City, MO
   - American Concrete Institute: Spring convention, Kansas City, MO
   - Associated Schools of Construction 51st Annual International Conference, College Station, TX
   - Congress for the New Urbanism Annual Conference, Dallas, TX
ii. Key Publications

- Kim, M.O. and Bordelon, A. “Fiber Effect on Interfacial Bond Between Concrete and Fiber Reinforced Mortar,” Transportation Research Record: Journal of the Transportation Research Board, 2015, submitted.
- Pan Lu, and Denver Tolliver. Accident Prediction Model for Public Highway-Rail Grade Crossings, Accident Analysis & Prevention,2015 (under review)
- Tasic, I., Porter, R.J., and Brewer, S.C. “Applications of Generalized Additive Models and Bayesian Hierarchical Models for Areal Safety
Analysis of Urban Multimodal Transportation Systems,” Transportation Research Record: Journal of the Transportation Research Board, 2015, submitted.


### iii. Key Conference Papers

- Kim, Min Ook, and Amanda Bordelon. “Age-Dependent Properties of Fiber Reinforced Concrete Used in Thin Overlays”. Accepted to 11th ICCP 2016 Conference in San Antonio 6/25/2015.
- Pan Lu, and Denver Tolliver. Accident Prediction Model for Public Highway-Rail Grade Crossings 2015 (under review)
• Zijian Zheng, Pan Lu, and Denver Tolliver. Accident Prediction for Highway-Rail Grade Crossings using Decision Tree Approach: An Empirical Analysis 2015 (under review)

iv. Key Presentations
• Bumadian, I. and Kim, Y.J. 2015. Galvanic corrosion of steel-composite interface bonded with a polymeric adhesive, ASCE Structures Congress 2015, Portland, OR, USA
• MPC-497: Compaction Testing of Granular Materials - A presentation was made to the SDDOT as part of project kickoff.
• MPC-502: Experimental and Computational Study of Self-Consolidating Concrete for Prestressed Bridge Girders - A kickoff presentation was made to the WisDOT.
• Parks, J.E., Brown, D.N., Ameli, M.J., and Pantelides, C.P. “Repair of damaged precast bridge columns with grouted splice sleeve connections using CFRP shells and plastic hinge relocation.” 20th International Conference on Composite Materials, Copenhagen, Denmark, 2015.
• Romero, P. Prevention of Low Temperature Cracking of Pavements, AASHTO Subcommittee on Materials (SOM) meeting. Pittsburgh, PA, August 2015.
• Siriwardanage, T. and Kim, Y.J. 2015. Thermal-conduction modeling of a composite material embedded in a concrete substrate, 4th International Conference on Material Modeling, Berkley, CA, USA
- Wehbe, N., Tazarv, M., Bohn, L. "Rehabilitation of Longitudinal Joints in Double-Tee Bridge Girders." South Dakota Department of Transportation, Oct. 08, 2015.
- Zlatkovic, M. "Deterministic Tool for Operational and Safety Assessment of Innovative Intersection/Interchange Design Alternatives" 55th Annual ITE Intermountain Section Meeting, May 14–16, 2015, Jackson, WY.

v. Other Items Produced During this Period
- Sensor Acquisition and Evaluation: XIMEA Hyperspectral Camera. Installed Matlab, ENVI, and the sensor software to evaluate the image quality.
b. Books or other non-periodical, one-time publications

Nothing to report at this time.

c. Website(s) or other internet site(s)

The MPC website is fully operational at:  http://www.mountain-plains.org/

The MPC Center Director can be found at:  http://www.mountain-plains.org/resources/downloads/KeyCenterDirectory.pdf?year=2014

d. Technologies or Techniques

Nothing to report at this time.

e. Inventions, patent applications, and/or licenses?

Nothing to report at this time.

f. Other

Nothing to report at this time.

3. Participants and Other Collaborating Organizations: Who has been involved?

a. What individuals have worked on the program?

The principle investigators, faculty, and administrators participating in MPC projects:

Twelve principle investigators, faculty, and administrators participating in MPC projects at Colorado State University are: Christopher Bareither, PI; Paul Heyliger, Co-PI; John W. van de Lindt, PI; Bolivar Senior, Co-PI; Rebecca Atadero, MPC Director and PI; Mehmet Ozbek, Co-PI; Caroline Clevenger, Co-PI; Jeffrey D. Niemann, PI; Hussam Mahmoud, Co-PI; Suren Chen,
In addition, eleven students are working on MPC research projects at Colorado State University: Doctorate Students- Kirsten Peterson, Yufen Zhou, and Luke Chen; Masters Students- Taylor Ray, David Turner, Patrick Sanders, Almotasem Maamon, Aliena Debelak, and Avi Sharma; Undergraduate Students- Kole Van Trese and Kayla Moden.

Five principle investigators, faculty, and administrators participating in MPC projects at North Dakota State University are: Bruce J. Rafert, PI; Raj Bridgelall, Co-PI; Pan Lu, PI; Brenda Lantz, PI; Kimberly Vachal, PI; EunSu Lee, PI; Alan Dybing, PI; and Denver Tolliver, MPC Director and PI. In addition, twenty four graduate students are working on MPC projects at North Dakota State University: Doctorate Students- Poyraz Kayabas, Christopher DeHaan, Neeraj Dhingra, Kathryn Ferguson, Mingwei Guo, Luke Holt, Amin Keramati, Osama Khan, Babak Mirzazadeh, Dilip Mistry, Yong Shin Park, Yuan Xu, Fangzheng Yuan, Anne Campbell, Elvis Ndembe, Chijioke Ifepe, Ali Rahim Talegani, Zijian Zheng, Zhiming Zhang, Asif Arshid, and Keshab Thapa; Masters Students- Ashkan Saboori, Sara Mamani, and Liuqing Hu.

Seven principle investigators, faculty, and administrators participating in MPC projects at South Dakota State University are: Allen L. Jones, PI; Guanghui Hua, PI; Christopher Schmit, Co-PI; Kyungnan Min, Co-PI; Nadim Wehbe, MPC Director and PI; Mostafa Tazarv, Co-PI; and Junwon Seo, PI. In addition, seven students are working in MPC research projects at South Dakota State University: Masters Students- Gregory Hansen, Suraiya Akter, Lucas Bohn, Michael Mingo, Zachary Carnahan, and Eduardo Torres; Undergraduate Student- Jason Weber.

Five principle investigators, faculty, and administrators participating in MPC projects at the University of Colorado Denver are: Wesley Marshall, MPC Director and PI; Carolyn McAndrews, Co-PI; Bruce Janson, Co-PI; Jimmy Kim, PI; and Krista Nordback, Postdoctoral student and Co-PI. In addition, five students are working on MPC research projects at the University of Colorado Denver: Doctorate Students- Ibrahim Bumadian, Nick Ferenchak, and Matthew Cross; Masters Students - Jennifer Niemann and Yufei Chai.

Ten principle investigators, faculty, and administrators participating in MPC projects at the University of Utah are: Richard J. Porter, MPC Director and PI; Milan Zlatkovic, PI and Co-PI; Cathy Liu, PI and Co-PI; David Sanbonmatsu, PI; David Strayer, Co-PI; Joel Cooper, Technical Advisor; Pedro Romero, PI; Amanda Bordelon, PI; Chris P. Pantelides, PI; and Daniel Fagnant, Technical Advisor. In addition, twenty-one students are working on MPC research projects at the University of Utah: Doctorate Students- Ivana Tasic, Jeff Taylor, Arwen Behrends, Yu Song, Anusha Musunuru, Zhuo Chen, M. Scott Shea, Kiavash Fayyaz, Catalina Arboleda, Joel Parks, MJ Ameli, Anurag Upadhyay, Ruoyang Wu, and Min Ook Kim; Masters Students- Jem Locquiao, Daniel Sudbury, Yang Li, Dillon Li, and Siddartha Rayaprolu; Undergraduate Students- Ryan Betz and Ariel Froerer.

Five principle investigators, faculty, and administrators participating in MPC projects at the University of Wyoming are: Khaled Ksaibati, MPC Director, PI, and Co-PI; Mohamed Ahmed, PI; Rhonda Young, Associate Professor and PI; Kam Ng, PI; and Bart Evans, Administration. In addition, seven students are working on MPC research projects at the University of Wyoming: Masters Students- Chris Chamberlin, Rameshwar Chalise, Sandeep Thapa, Trenna Terrell, Dawit
Mebrahtom, and Sadia Sharmin; Undergraduate Student- Nicole Peterson. Others participating in MPC projects at the University of Wyoming include Dennis Trusty, Director NP TTAP.

Six principle investigators, faculty, and administrators participating in MPC projects at Utah State University are: Ziqi Song, PI and Co-PI; Anthony Chen, PI and Co-PI; James Dorward, PI; Jim Bay, PI; John Rice, PI; and Paul Barr, MPC Director and PI. In addition, seven students are working on MPC research projects at Utah State University: Doctorate Students- Majid Khalilikhah, Seungkyu Ryu, and Ann Heaslip; Masters Students- Jen Ostrowski, Phillip Powelson, Yi He, and Holly Lloyd. Others participating in MPC projects at the Utah State University include Xiangdong Xu, Collaborator; Sarawut Jansuwan, Collaborator; and Keechoo Choi, Collaborator.

b. What other organizations have been involved as partners?
The timing of match funding and the commitments of collaborators vary widely throughout the life of the grant. During this period, we have the following committed collaborators.
1. AAA Foundation for Traffic Safety
2. Ajou University, Korea
3. Campbell County Road and Bridge Department
4. Campbell's Scientific
5. City of Watertown, SD
6. Colorado Department of Transportation
7. Converse County Road and Bridge Department
8. Crook County Road and Bridge Department
9. East Dakota Water Development District
10. Federal Highway Administration, Wyoming Division
11. Fehr & Peers
12. Inberg Miller Engineers, Casper WY
13. James River Water Development District
14. Key Laboratory of Road and Traffic Engineering, Tongji University, Shanghai, China.
15. Lincoln County Road and Bridge Department
16. Michigan Technological Research Institute
17. National Institute of Development Administration (NIDA), Bangkok, Thailand.
18. Sisseton Wahpeton Oyate Reservation
19. South Dakota Department of Environment and Natural Resources
20. South Dakota Department of Transportation
21. Standing Rock Sioux Tribe Indian Reservation
22. StarSeismic LLC
23. Teton County Road and Bridge Department
24. Utah Department of Transportation
25. Utah State University College of Education
26. Utah Transit Authority
27. Virginia Tech
28. Wasatch Front Regional Council
29. Wisconsin Department of Transportation
30. Wyoming Department of Transportation
31. Yankton Sioux Tribe
c. Have other collaborators or contacts been involved?

The list of collaborating organizations in 3(b) is complete, as of this grant period.

4. Impact/ Expected Impacts

a. Impacts

Colorado State University’s projects are having an impact by helping to support the transportation education of undergraduate, masters, and doctoral students. The projects have had some impact on their respective research disciplines, although it is still early for many projects.

The University of Colorado Denver projects listed under this reporting period represent emerging and innovative research topics that will impact the research community and broader society. The impact of these MPC efforts (via both research and workforce development) is being felt in Transportation Engineering, Planning, and Structural Engineering. The MPC work had facilitated the workforce development of multiple students in research methods and skill development (particularly with respect to GIS, statistical approaches/software, and structural steel girder corrosion investigations). All of this work is combining to improve the reputation of CU Denver as a research university with strengths in transportation, which assists both the University as well as the students in the workforce. These MPC projects have led to multiple popular press articles and a broader discussion of these research topics in society.

Implementation of the University of Utah’s program is still in early stages, and measurable research impacts are difficult to quantify at this point in time. One project PI has noted that early ideas generated from the initial tasks of one project has already been incorporated into a graduate-level highway engineering class at the University of Utah. The program already shows substantial support in the area of workforce development, with 22 undergraduate and graduate students heavily involved in the research projects. Two of these students were recognized as the 2015 American Road & Transportation Builders Association (ARTBA) Future Industry Leader Spotlight Award, recognizing women who have achieved outstanding academic records and demonstrated extraordinary leadership skills within and outside of the academic environment.

The University of Wyoming’s projects have impacts in the following ways; The tribal safety projects are enhancing the safety on Indian reservations and the infrastructural projects are helping DOTs implement more cost effective designs for infrastructures.

b. Expected Impacts

Colorado State University’s projects are expected to have impacts on their disciplines by contributing to ongoing advances in various transportation related fields.

South Dakota State University’s projects have the following expected impacts. Identify and select modern techniques for verifying target compaction levels in the field for granular materials. Develop a low-maintenance, low-cost mixed-media filtration system for storm water treatment. Produce guidance for evaluating the suitability of aqueous waste streams for transportation-related applications in South Dakota. Develop rehabilitation techniques for
longitudinal joint in double tee bridge girder bridge systems on local roads. Develop new economically competitive alternative systems to double tee bridge girders. Develop SCC mix designs for use in prestressed bridge girders in Wisconsin.

The University of Colorado Denver’s projects have the following expected impacts. While difficult to quantify, we expect the work under investigation to set the stage for continued growth of the UTC program at CU Denver with respect to both future research projects that will leave a positive impact on society as well as the careers and the students and faculty that work on these projects. The outcomes of these projects will be of particular benefit to cities serious about providing a safe transportation system for all road users and reducing fatalities on the roadway.

Results of the ongoing projects for the University of Utah are expected to be implemented in state transportation and transit agency policies, procedures, and practices related to road and transit infrastructure planning, design, construction, and operations. An example is expected broader project outcomes include: the ability to more thoroughly assess innovative intersection/interchange designs; increase transit ridership through more accessible stations, improve infrastructure resiliency to earthquakes, gain greater insights to distracted driving behavior, extend pavement life, quantify benefits of transit signal priority implementations, and improve air quality. Expected outcomes will also include training of the next generation of the transportation workforce in these areas, by working with undergraduate and graduate students in the research and by incorporating results into existing and future transportation courses at the University of Utah. Chances of implementation and technology transfer have been maximized by including transportation agency practitioners in the formulation and review of research problem statements. Practitioners are also providing feedback to the research teams on a regular basis through technical advisory committees formed for each project.

5. Changes/Problems

No changes are foreseen at this time.

5a. Additional Information Regarding Products and Impacts

Nothing to report at this time.

PROGRAM OUTPUTS: Nothing to report at this time.

PROGRAM OUTCOMES: Nothing to report at this time.

PROGRAM IMPACTS: Nothing to report at this time.

6. SPECIAL REPORTING REQUIREMENTS: None