

**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, & 3
Mountain-Plains Consortium, North Dakota State University
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**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, 2016
Semi-Annual PPPR#6**

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**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 course work 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

Seventy-four research projects were selected from 2013 to present under this grant. Projects have been selected for the original grant, Modification 1, and 2 while projects are still being submitted for the Modification 3 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, 447, 451, 472 (Year 2), MPC-446 through MPC-518.

Table 1: MPC Research Projects Most Directly Correlated with Safety

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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-461: Analytical Modeling for Progressive Failure Assessment of Curved and Skewed Highway Bridges Subjected to Seismic Hazards
 7. MPC-462: Implementation of Aerial LiDAR Technology to Update Highway Feature Inventory
 8. MPC-465: Development of Performance Matrices for Evaluating Innovative Intersections and Interchanges
 9. MPC-467: Self-Regulation and Distraction
 10. MPC-469: Improving Efficiency and Reliability of Bus Rapid Transit
 11. MPC-471: Enhancement of Mechanistic-Empirical Pavement Design Guide for Roadway

Design, Construction and Rehabilitation

12. MPC-472: Developing an Optimization Model for Managing County Paved Roads
13. MPC-473: Bicycle and Pedestrian Design for Rural Communities
14. MPC-474: Highway Safety Manual Part D: Validation and Application in Wyoming
15. MPC-475: Analysis of the Relationship of Roadside Inspections on Large Truck Crashes
16. MPC-476: Highway-Rail Grade Crossing Traffic Hazard Forecasting Model
17. MPC-479: Modeling Multi-class Truck Traffic Assignment Method with Different Traffic Restraint Constraints
18. MPC-480: A Comprehensive Safety Assessment Methodology for Innovative Geometric Designs
19. MPC-483: Interaction Analysis of Girder Bridges and Traffic System subjected to Earthquakes
20. MPC-486: Sustainable Heated Pavements for Infrastructure Longevity, Safety and Economic Competiveness
21. MPC-487: Investigation of Cross Laminated Timber Bridge Decks as a Sustainable Solution for Repair of Deficient Rural Wood Bridges
22. MPC-491: Self-Centering Buckling Restrained Braces for Curved Bridges
23. MPC-495: Safety Effects of Protected and Protected/Permitted Left-Turn Phases
24. MPC-502: Experimental and Computational Study of Self-Consolidating Concrete for Prestressed Bridge Girders
25. MPC-503: Characterization of Crushed Bases in Wyoming
26. MPC-504: Improved Element-Level Bridge Inspection Criteria for Better Bridge Management and Preservation
27. MPC-505: An Intelligent Transportation Systems Approach to Railroad Infrastructure Performance Evaluation
28. MPC-515: Redefining the Child Pedestrian Safety Paradigm
29. MPC-517: Route Planning for Enhanced Transportation Network Utilization: A System Optimization Approach for Route Planning in Advanced Traveler Information Systems

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

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1. MPC-447: Post-Fire Ground Treatments for Protection of Critical Transportation Structures
 2. MPC-448: Reducing Flood Vulnerability of Communities with Limited Road Access by Optimizing Bridge Elevation
 3. MPC-449: Determining the Uncertainty in the Current Condition of Bridges for Use in Risk Based Inspection and Management
 4. MPC-450: Using Building Information Modeling to Track and Assess Structural Condition
 5. MPC-451: Assessing the Cost-Effectiveness of Wyoming's CMAQ Unpaved Road Dust Suppression Program
 6. MPC-452: Updating the Highway Safety Manual 2010 - Part C: Regional Consideration of the Rocky Mountains and Plain Regions
 7. MPC-456: Performance of Steel Girders Repaired with Advanced Composite Sheets in a Corrosive Environment: A Multi-Physics Approach Leading to Practical Design Recommendations
 8. MPC-458: Application of a Multi-Agent System with the Large-Scale Agent-Based Model for Freight Demand Modeling
 9. MPC-460: Technology and Workforce Development for Remote Sensing of the Transportation Infrastructure
 10. MPC-461: Analytical Modeling for Progressive Failure Assessment of Curved and Skewed

Highway Bridges Subjected to Seismic Hazards

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
14. MPC-465: Development of Performance Matrices for Evaluating Innovative Intersections and Interchanges
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
17. MPC-471: Enhancement of Mechanistic-Empirical Pavement Design Guide for Roadway Design, Construction and Rehabilitation
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
21. MPC-479: Modeling Multi-class Truck Traffic Assignment Method with Different Traffic Restraint Constraints
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-486: Sustainable Heated Pavements for Infrastructure Longevity, Safety and Economic Competitiveness
26. MPC-487: Investigation of Cross Laminated Timber Bridge Decks as a Sustainable Solution for Repair of Deficient Rural Wood Bridges
27. MPC-492: Early-Age Fiber-Reinforced Concrete Properties for Overlays
28. MPC-493: Incorporating Maintenance Costs and Considerations into Highway Design Decisions
29. MPC-494: Statistical Analysis and Sampling Standards for Maintenance Management Quality Assurance (MMQA)
30. MPC-496: Prevention of Low Temperature Cracking of Pavements
31. MPC-497: Compaction Testing of Granular Materials
32. MPC-500: Rehabilitation of Longitudinal Joints in Double-Tee Bridge Girders
33. MPC-501: Development of an Alternative to the Double Tee Bridge System
34. MPC-502: Experimental and Computational Study of Self-Consolidating Concrete for Prestressed Bridge Girders
35. MPC-503: Characterization of Crushed Bases in Wyoming
36. MPC-504: Improved Element-Level Bridge Inspection Criteria for Better Bridge Management and Preservation
37. MPC-505: An Intelligent Transportation Systems Approach to Railroad Infrastructure Performance Evaluation
38. MPC-506: Reliable Prediction of Shear Strength of Swelling Clays
39. MPC-511: Mechanical Bar Splices for Accelerated Bridge Construction of Columns
40. MPC-512: Pre-stress Losses and Development of Short-Term Data Acquisition System for Bridge Monitoring
41. MPC-516: Innovative Strengthening for Deteriorated Concrete Bridges Using Embedded

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-471: Enhancement of Mechanistic-Empirical Pavement Design Guide for Roadway Design, Construction and Rehabilitation
11. MPC-472: Developing an Optimization Model for Managing County Paved Roads
12. MPC-479: Modeling Multi-class Truck Traffic Assignment Method with Different Traffic Restraint Constraints
13. MPC-483: Interaction Analysis of Girder Bridges and Traffic System subjected to Earthquakes
14. MPC-486: Sustainable Heated Pavements for Infrastructure Longevity, Safety and Economic Competitiveness
15. MPC-488: Effects of Infill Development and Regional Growth on At-Risk Populations' Exposure to Traffic Density
16. MPC-494: Statistical Analysis and Sampling Standards for Maintenance Management Quality Assurance (MMQA)
17. MPC-497: Compaction Testing of Granular Materials
18. MPC-498: Development of Mixed Media Filtration for Stormwater Runoff Treatment
19. MPC-499: Reuse of Aqueous Waste Streams in Transportation-Related Applications
20. MPC-500: Rehabilitation of Longitudinal Joints in Double-Tee Bridge Girders
21. MPC-501: Development of an Alternative to the Double Tee Bridge System
22. MPC-502: Experimental and Computational Study of Self-Consolidating Concrete for Prestressed Bridge Girders
23. MPC-503: Characterization of Crushed Bases in Wyoming
24. MPC-504: Improved Element-Level Bridge Inspection Criteria for Better Bridge Management and Preservation
25. MPC-505: An Intelligent Transportation Systems Approach to Railroad Infrastructure Performance Evaluation
26. MPC-509: Expansive Soil Mitigation for Transportation Earthworks by Polymer Amendment
27. MPC-511: Mechanical Bar Splices for Accelerated Bridge Construction of Columns
28. MPC-513: Optimal Deployment of Wireless Charging Facilities for an Electric Bus System
29. MPC-514: Impacts of Ridesourcing on VMT, Parking Demand, Transportation Equity, and Travel Behavior

30. MPC-516: Innovative Strengthening for Deteriorated Concrete Bridges Using Embedded Composite Sheets Bonded with Polyester-silica
31. MPC-517: Route Planning for Enhanced Transportation Network Utilization: A System Optimization Approach for Route Planning in Advanced Traveler Information Systems

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-483: Interaction Analysis of Girder Bridges and Traffic System subjected to Earthquakes
8. MPC-485: Development of a Model to Assess the Feasibility of Transit-Oriented Development (TOD) Projects
9. MPC-489: The Unresolved Relationship between Street Trees and Road Safety
10. MPC-490: Longevity of Air Pollution Mitigating Photo-Catalytic Coatings on Transportation Infrastructure
11. MPC-491: Self-Centering Buckling Restrained Braces for Curved Bridges
12. MPC-498: Development of Mixed Media Filtration for Stormwater Runoff Treatment
13. MPC-499: Reuse of Aqueous Waste Streams in Transportation-Related Applications
14. MPC-510: Business and Commute Optimization System: Development and Denver-Based Case Study
15. MPC-513: Optimal Deployment of Wireless Charging Facilities for an Electric Bus System
16. MPC-514: Impacts of Ridesourcing on VMT, Parking Demand, Transportation Equity, and Travel Behavior
17. MPC-515: Redefining the Child Pedestrian Safety Paradigm
18. MPC-517: Route Planning for Enhanced Transportation Network Utilization: A System Optimization Approach for Route Planning in Advanced Traveler Information Systems

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
5. MPC-471: Enhancement of Mechanistic-Empirical Pavement Design Guide for Roadway Design, Construction and Rehabilitation
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 Competiveness
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
 17. MPC-503: Characterization of Crushed Bases in Wyoming
 18. MPC-509: Expansive Soil Mitigation for Transportation Earthworks by Polymer Amendment
 19. MPC-510: Business and Commute Optimization System: Development and Denver-Based Case Study
 20. MPC-513: Optimal Deployment of Wireless Charging Facilities for an Electric Bus System
 21. MPC-514: Impacts of Ridesourcing on VMT, Parking Demand, Transportation Equity, and Travel Behavior
 22. MPC-517: Route Planning for Enhanced Transportation Network Utilization: A System Optimization Approach for Route Planning in Advanced Traveler Information Systems

iii. Educational Accomplishments

The transportation and transportation-related courses offered during spring, summer, and, fall 2016 are listed in Table 6, 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 6: Transportation and Transportation-Related Courses Offered This Period

Major Subject Area	Course Title
Engineering & Design	CIVE 302 Evaluation of Civil Engineering Materials
	CIVE 466 Design and Behavior of Steel Structures
	CIVE 560 Advanced Mechanics of Solids
	CIVE 355 Introduction to Geotechnical Engineering
	CIVE 566 Intermediate Structural Analysis graduate
	CIVE 576 Civil Engineering Applications of GIS and GPS
	CIVE 655 Advanced Soil Mechanics
	CEE 452/552 Prestressed Concrete
	CEE 455 Steel Design
	CEE 346 Geotechnical Engineering and Lab
	CEE 732 Advanced Foundation Engineering
	CEE 754 Advanced Design of Steel Structures
	EM 741 Finite Element Analysis
	CEE 106-106/L Elementary Surveying and Lab
	CEE 443 Matrix Analysis of Structures
	CEE 792 Topics-Advanced Topics in Reinforced Concrete
	CEE 769 Bridge Design
	CEE 456 Theory and Design of Reinforced Concrete
	CEE 446/546 Advanced Geotechnical Engineering
	CEE 765 Pavement Design
CVEN 3602 Transportation Engineering	

	CVEN 4602 - Highway Engineering
	CVEN 5602 - Advanced Street & Highway Design
	CVEN 5682 - Pavement Design
	CvEEN 3510 Civil Engineering Materials Undergraduate
	CvEEN 5220 Concrete Design II Undergraduate
	CvEEN 5500 Sustainable Materials Undergraduate
	CvEEN 5510 Highway Design Undergraduate
	CvEEN 5570 Pavement Design Undergraduate
	CvEEN 6225 Concrete Science Graduate
	CE 3500 Transportation Engineering
	CE 4510 Pavement Design
	CEE 5070 Steel Design
	CEE 6130 Structural Dynamics and Seismic Design
	CEE 6930 Design Loads
Freight & Logistics	TRAN 4010 Introduction to Transportation Systems
	TRAN 4330 Principles of Supply Chain: Management and Technologies
	TRAIN 4080 Transportation Law and Regulation: Domestic and International
Planning & Environment	CVEN 5612 Traffic Impact Assessment
	CVEN 5460 Introduction to Sustainable Urban Infrastructure
	URPL 5040 Urban Sustainability
	URPL 5050 Urban Development
	URPL 6300 Planning Healthy Communities
	URPL 6350 Form and Formation of Cities
	URPL 6399 Introduction to Sustainable Urban Infrastructure
	URPL 6400 Community Development
	URPL 6550 Transportation Planning/Policy
	URPL 6645 Disaster/Climate Change Planning
	URPL 6370 Sprawl and Growth Management
	URPL 5000 Planning History and Theory
	URPL 5010 Planning Methods
	URPL 6650 Planning in the Developing World
	CVEEN 5560 Transportation Planning
	CEE 5240 Urban and Regional Transportation Planning
	TRAIN 4710 Transportation Finance
	TRAN 4020 Transportation Economics
	TRAN 4060 Transportation Marketing and Sales Tools
	TRAIN 4320 Transportation Management, Leadership, and Values
	TRAIN 4330 Principles of Supply Chain Management and Technologies
Public Transportation	CVEN 5800 Transit Construction II
	TRAN 4080 Transportation Law and Regulation : Domestic and International

Traffic & Operations	CEE 363 Highway and Traffic Engineering
	CVEN 5621 Highway Capacity Analysis
	CVEN 5622 Traffic Operations and Control
	CVEEN 3520 Transportation Engineering
	CVEEN 7545 Transportation Modeling Graduate
	CEE 5220/6220 Traffic Engineering
Transportation Safety	CVEN 5611 Traffic and Safety Data Analysis
	CVEN 5662 Transportation System Safety
	CVEEN 7520 Transportation Safety
Transportation Systems	URPL 6555 Transportation and Land Use
	CVEN 5633 Case Studies in Sustainable Transportation
	CVEEN 7920 Statistics and Econometrics Graduate
	TRAN 4010 Introduction to Transportation Systems
	TRAN 4050 Intermodal Transportation Systems
	CEE 6210 Transportation Systems Analysis

Altogether, 75 transportation and transportation-related courses have been offered this reporting period, for a total of 437 total transportation courses offered this grant period. In addition to the courses listed in Table 6, foundational courses in engineering materials, mechanics, structural analysis, and geotechnical engineering were offered at most MPC universities.

iv. Workforce Development Accomplishments

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

1. ATSSA Flag Certification
2. ATSSA Flagger Instructor Training
3. ATSSA Traffic Control
4. Asphalt Paving Maintenance 1
5. Basics of good Roads
6. Communication Skills for Supervisors
7. Evaluation and Mitigation of Vehicle Impact Hazards for Overpasses
8. Heavy Equipment Safety Operations
9. Precast Bridge Girder Details for Improved Performance
10. Registered Stormwater Inspector
11. Retroreflectivity for signs
12. Road and Safety Fundamentals
13. Roadway Drainage
14. Roadway Materials
15. Street Lighting
16. Street Sweeper
17. Winter Road Maintenance
18. Workplace, Equipment and Jobsite Safety
19. Workzone Safety
20. Wyoming Transportation and Safety Congress

v. Research Accomplishments

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

Project #	Title	Date	Report No.
371	Analysis of Risk Factors in Severity of Rural Truck Crashes	April 2016	MPC 16-308
426	Does the Livability of a Residential Street Depend on the Characteristics of the Neighboring Street Network?	July 2016	MPC 16-309
450	Using Building Information Modeling to Track and Assess the Structural Condition of Bridges	Aug 2016	MPC 16-310
460	Remote Sensing of Multimodal Transportation Systems	Sep 2016	MPC 16-313
380	Investigation of Interaction between Traffic Safety, Law Enforcement and Environment	Sep 2016	MPC 16-311
415	Earthquake Fragility Assessment of Curved and Skewed Bridges in Mountain West Region	Sep 2016	MPC 16-312

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

- 2nd Serbian Road Congress
- ASCE GeoChicago 2016: Sustainability, Energy, and the Geoenvironment
- Asphalt Maintenance: Crack Sealing/Pouring & Spot Surface Repairs
- ATSSA Traffic Control Technican

- ATSSA Truck Mounted Attenuators
- Basic Construction Survey
- Basic Sign Installation
- Changing Perspectives
- Construction Project Management: Contract Administration
- Construction Research Congress
- Development of a Model to Assess the Feasibility of Transit-Oriented Development
- Electrical Plan Reading - Inspection & Installation
- Erosion Control Options
- Ethics Awareness for the Transportation Industry
- Evaluation of Grouted Spliced Sleeve Connections Reinforced Precast Concrete Bridge Piers - MPC Research Project
- Fundamentals of Geometric Design: Exploring the Green Book
- Gravel Roads Maintenance - New Manual Review
- Guardrail Installation & Inspection
- Guardrail Maintenance
- Highway Capacity Manual Overview & Related Software Changes 6th Edition 2015
- Highway Pipe Installation
- Hosted by Mineta Transportation Institute/San Jose State University
- Implementation of Low Temperature Tests for Asphalt Mixtures
- International Conference on Transport & Health
- ITE Colorado-Wyoming Section Transportation Symposium
- ITE Western District Annual Meeting
- John Maxwell: 15 Invaluable Laws of Growth
- John Maxwell: Sometimes You Win, Sometimes you Learn
- John Maxwell: Today Matters
- John Maxwell's Becoming A Person of Influence: How to Positively Impact the Lives of Others
- Joint Detailing for Improved Performance of Double Tee Bridge Systems - MPC Research Project
- Keyhole Technology for Urban Utility Excavations to Reduce the Impact of Pavement Cuts
- Leadership - Developing a Presence
- Leading a Successful Change Initiative
- Live Ride Share
- Math for Survey and Construction
- Midyear Meeting of the TRB Geometric Design Committee (AFB10), Operational Effects of Geometrics Committee, and AASHTO Technical Committee on Geometric Design
- Midyear Meeting of the TRB Highway Safety Performance Committee (ANB25)
- Negotiation Strategies & Techniques to Improve Construction Project Mgmt
- Organized by the Transportation Public Health Link in Partnership with the
- PE Exam for Civil Engineers
- Pedestrian and Bicycle Safety
- Pipe Jacking for Culverts and Storm Sewers
- Practical Bridge Scour Analysis, Methods & Countermeasures
- Presenting the Story of Your Data
- Preventing Runovers and Backovers
- Pro Walk/Pro Bike/Pro Place
- Reducing Roadway Departure Crashes

- Results Based Performance Mgmt
- Route & Preliminary Survey and LiDar 3-D Modeling
- Seal Coat Workshop
- SHRP2 Implementation Assistance Program Issues Resolution Workshop
- Stormwater Detention & Design
- The Balancing Act: Stress and Productivity
- The Transportation Research Board Innovations in Travel Modeling Conference
- Tier IV Regeneration & Digital Multi-Meter Principles
- Tractor Mower Safety Training
- Traffic Data Collection
- Trenching Safety Practices
- Understanding Linear Scheduling for Roadway Construction Projects
- United States Centers for Disease Control & Prevention
- Utah Society of Professional Engineers Continuing Education Conference

ii. Key Publications

- Bridgelall, R., Rafert, J. B., Tolliver, D., Lee, E., Resolution Agile Remote Sensing for Detection of Hazardous Material Spills
- Clevenger, C.M., Ozbek, M.E., Simpson, S., and Atadero, R.(2016). "Challenges in Developing a Transportation Sustainability Rating System that meets the Preferences of a Department of Transportation."
- Henaio, A. and Marshall, W. "A Framework for Understanding the Impacts of Ridesourcing on Transportation"
- Marshall, W. and Ferenchak, N. Assessing Equity and Urban/Rural Road Safety Disparities in the U.S. Journal of Urbanism
- McGuire, B., Atadero, R., Clevenger, C.M., and Ozbek, M.E. (2016). 'Bridge Information Modeling for Inspection and Evaluation.'
- McGuire, Brendan; Atadero, Rebecca; Clevenger, Caroline; Ozbek, Mehmet. Using Building Information Modeling to Track and Assess the Structural Condition of Bridges
- Musunuru, A., Wei, R. and Porter, R.J. "Predicting Day and Night Traffic Volumes on Rural Roads for Statistical Road Safety Modeling,"
- Pan Lu, and Denver Tolliver. Accident Prediction Model for Public Highway-Rail Grade Crossings, Accident Analysis & Prevention, 90, 73-81, 2016
- Peterson, S.J., Fagnant, D.J., and Porter, R.J. "Potential Impacts of Self-Driving Vehicles on the Road Construction Industry,"
- Romero, P.: Using the Bending Beam Rheometer for Low Temperature Testing of Asphalt Mixtures
- Sudbury, D. and Romero, P.: Performance Evaluation of Surface Treatments, Interim Report to Utah Department of Transportation
- Taylor, J. Liu, X.C., and Porter, R.J. "Using Bikeshare Trajectory Data to Explore Roadway Characterization,"
- Thiese, M.S., Hanowski, R.J., Kales, S.N., Porter, R.J., Moffitt, G., Hu, N., and Hegmann, K.T. "Multiple Conditions Increase Preventable Crash Risks among Commercial Truck Drivers in a Cohort Study,"
- Torres, E. and Seo, J. State-of-the-Art and Practice Review and Recommended Testing Protocol: Self-Consolidating Concrete for Prestressed Bridge Girders.
- Zijian Zheng, Pan Lu, and Denver Tolliver. Accident Prediction for Highway-Rail Grade Crossings using Decision Tree Approach

iii. Key Conference Papers

- Bondanza & Sherry "A22 A Study of Female Shift Workers and Health in the Transportation Industry."
- Chen, Z. and Liu, X. Sampling Scheme for Multiple Asset Management using Locality Sensitive Hashing
- Clevenger, C., Abdallah, M., Tawfik, A., Adame, B., Akalp, D., & Ozbek, M. Exploring Student Commute Behavior and Identifying Opportunities to Minimize Commute GHG and Air Pollution Emissions
- Clevenger, C.M., Abdallah, M., Tawfik, A., Adame B., Akalp, D., and Ozbek, M. E. (2016). "Exploring Student Commute Behavior and Identifying Opportunities to Minimize Commute GHG and Air Pollution Emissions: A Case Study."
- Dinesh R. Katti, and Kalpana S. Katti, "Bridging Molecular Interactions to Macroscale Properties in Swelling Clays"
- Dinesh R. Katti, and Kalpana S. Katti, "Molecular Interactions Control Macroscale Properties in Swelling Clays"
- Hong Pan, Ruisi Ge, Jinhui Wang, Na Gong and Zhibin Lin, "Integrated Wireless Sensor Networks with UAS for Damage Detection and Monitoring of Bridges and Other Large-Scale Critical Civil Infrastructures"
- Kalpana S. Katti, and Dinesh R. Katti, "Applications of FTIR Spectroscopy in Flow and Swelling Behavior of Smectite Clays"
- Kim, Min Ook, Amanda Bordelon. "Age-Dependent Properties of Fiber Reinforced Concrete Used in Thin Overlays"
- R. Ge, H. Pan, Z. Lin, L. Hou, N. Gong, and J. Wang. "RF-Powered Battery-less Wireless Sensor Network"
- R. Ge, H. Pan, Z. Lin, N. Gong, and J. Wang. "RF-Powered Battery-less Wireless Sensor Network in Structure Monitoring", IEEE 2016 International Electro-Information Technology Conference (EIT 2016), 2016, Grand Forks, ND, USA, pp.547-552.
- Sherry & Philbrick "A46 Models of Accident Risk and Fatigue in Railroad Operations"
- Song, Y., Zlatkovic, M., and Porter, R.J. A Corridor-Level Evaluation of GPS-Based Transit Signal Priority
- Torres, E., Seo, J., and Lederle, R. A Framework to Examine Experimental Material Properties of Self-Consolidating Concrete for Prestressed Bridge Girder Fabrication
- Upadhyay, A., Pantelides, C.P., Ibarra, L. "Seismic Performance of Curved Bridges on Soft Soils Retrofitted with Buckling Restrained Braces"
- Xingyu Wang, Xiaoning Qi, Zhibin Lin*, Jinhui Wang and Na Gong "Electrochemical Characterization of Soils Surrounding Buried or Embedded Steel Elements"

iv. Key Presentations

- Abdallah, M. and Clevenger Exploring Student Commute Behavior and Identifying Opportunities to Minimize Commute GHG and Air Pollution Emissions
- Carnahan, Z., Tazarv, M., and Wehbe, N. Development of an Alternative to the Double Tee Bridge System
- Dinesh R. Katti, and Kalpana S. Katti, "Bridging Molecular Interactions to Macroscale Properties in Swelling Clays"
- Dinesh R. Katti, and Kalpana S. Katti, "Molecular Interactions Control Macroscale Properties in Swelling Clays"

- Fayyaz, K. and Liu, X. Development of Open Source Tool using General Transit Feed Specification (GTFS) for Transit Spatiotemporal Connectivity Analysis.
- Fayyaz, K. and Liu, X. GTFS-enabled Spatiotemporal Analysis of Transit Services. ITS Professional Capacity Building Program Talking Technology and Transportation Education
- Ferenchak, N. and Marshall, W. The Relative (In)Effectiveness of Bicycle Sharrows on Safety Outcomes.
- Hansen, G., Hua, G., Min, K., and Schmit, C. Reuse of Aqueous Waste Streams in Transportation Related Applications
- Henao, A. and Marshall, W. A Framework for Understanding the Impacts of Ridesourcing on Transportation.
- Henao, A. and Marshall, W. Impacts of Lyft and Uber on Transportation. ITE Western District Annual Meeting
- Henao, A. and Marshall, W. The Sustainability Impacts of Ridesourcing. The Transportation Research Board Innovations in Travel Modeling Conference
- Hong Pan, Ruisi Ge, Jinhui Wang, Na Gong and Zhibin Lin, "Integrated Wireless Sensor Networks with UAS for Damage Detection and Monitoring of Bridges and Other Large-Scale Critical Civil Infrastructures"
- Kalpana S. Katti, and Dinesh R. Katti, "Applications of FTIR Spectroscopy in Flow and Swelling Behavior of Smectite Clays"
- Kim, Min Ook, Amanda Bordelon. "Age-Dependent Properties of Fiber Reinforced Concrete Used in Thin Overlays"
- Tasic, I., and Porter, R.J. "Multimodal Transportation Safety in Major U.S. Cities,"
- Marshall, W. Vision Zero: Shared Mobility, Shared Network, Shared Safety, Live.Ride.Share Conference
- Mingo, M., Tazarv, M., and Wehbe, N. Development of an Alternative to the Double Tee Bridge System
- Porter, R.J. "Substantive Safety Analysis: Tools for Practitioners,"
- Seo, J., and Schaffer, W. Experimental Study of Self-Consolidating Concrete for Prestressed Bridge Girders.
- Song, Y., Zlatkovic, M., and Porter, R.J. "A Corridor-Level Evaluation of GPS-Based Transit Signal Priority,"
- Taylor, J. and Liu, X. Characterizing Bikeshare Usage with Network Modeling Techniques. ITS Professional Capacity Building Program Talking Technology and Transportation Education
- Tazarv, M., Wehbe, N., and Bohn, L. Rehabilitation of Longitudinal Joints in Double-Tee Bridge Girders
- Upadhyay, A., Pantelides, C.P., Ibarra, L. "Seismic Performance of Curved Bridges on Soft Soils Retrofitted with Buckling Restrained Braces"
- Wehbe, N. and Konrad, M. Precast Bridge Girder Details for Improved Performance.
- Wehbe, N., Qin, X., Tigges, B., Shen, Z., and Boudaqa, A. Precast Evaluation and Mitigation of Vehicle Impact Hazards for Overpasses.
- Zijian Zheng, Pan Lu, and Denver Tolliver. Accident Prediction for Highway-Rail Grade Crossings using Decision Tree Approach

v. Other Items Produced During this Period

- Dinesh R. Katti, Anurag Sharma and Kalpana S. Katti, "Predictive Methodologies for Design of Bone Tissue Engineering Scaffolds" Chapter 10, Materials and Devices for Bone Disorders, Elsevier 2016. Accepted

- Wired Magazine, April 2016. “Want a Bike-Friendly City? Get Ready to Fail Until It Works” by Aarian Marshall, www.wired.com/2016/04/how-to-make-bike-friendly-city
- Chicago Tribune, April 2016. “5 Myths about Bicycling” by Lydia Depillis, www.chicagotribune.com/news/opinion/commentary/ct-bicycling-traffic-laws-helmets-20160401-story.htm
- Rosenlieb, Evan, Carolyn McAndrews, Wesley Marshall, Austin Troy. 2016. Urban Development Patterns and Exposure to Hazardous and Protective Traffic Environments.

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=2015>

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, Paul Heyliger, John W. van de Lindt, Bolivar Senior, Rebecca Atadero, Mehmet Ozbek, Caroline Clevenger, Suren Chen, Jeffrey D. Niemann, Hussam Mahmoud, Kelly Strong, and Scott Glick. In addition, sixteen students are working on MPC research projects at **Colorado State University**: Doctorate Students – Kristen Peterson; Masters Students - Taylor Ray, David Turner, Patrick Sanders, Brendan McGuire, Luke Chen, Yufen Zhou, Guangyang Hou, Almotasem Maamon, Kelsey Czyzyk, Aliena Debelak, Avi Sharma, and Trai Nguyen.

Eight principle investigators, faculty, and administrators participating in MPC projects at **North Dakota State University** are: Bruce J. Rafert, Raj Bridgelall, Brenda Lantz, Pan Lu, Denver Tolliver, Zhibin Lin, Dinesh Katti, and Kalpana Katti. In addition, eight students are working on MPC projects at **North Dakota State University**: Ali Rahim Talegani, Zijian Zheng Fei Yan, Mingli Li, Mohsen Azimi, Leonard Chia, Keshab Thapa, and H M Nasrullah Faisal.

Ten principle investigators, faculty, and administrators participating in MPC projects at **South Dakota State University** are: Wesley Marshall, Carolyn McAndrews, Bruce Janson, Austin Troy, Matthew Cross, Moatasse Abdallah, Caroline M. Clevenger, E. Ozbek, Yail Jimmy Kim, and Farnoush Banaei-Kashani. In addition, ten students are working in MPC research projects at **South Dakota State University**: Masters Students - Ghaem Hooshyari, Peng Dai, Gregory Hansen, Lucas Bohn, Michael Mingo, Zachary Carnahan, Eduardo Torres, William Augustus Schaffer, Abdullah Al Hashib, Jason Weber; Undergraduate Student - Jason Weber.

Seven principle investigators, faculty, and administrators participating in MPC projects at the **University of Colorado Denver** are: Wesley Marshall, MPC Director and PI; Carolyn McAndrews, PI and Co-PI; Bruce Janson, Co-PI; Jimmy Kim, PI; Krista Nordback Postdoctoral student and Co-PI; Austin Troy, Faculty; and Matthew Cross, Faculty. In addition, five students are working on MPC research projects at the **University of Colorado Denver**: Doctorate Students - Nick Ferenchak, Yaneev Golombek, Alejandro Henao, Abdullah Alajmi, Rob Fitzgerald, Omar Alqahtani; Masters Students - Nick Coppola and Evan Rosenlieb.

One principle investigator, faculty, and administrators participating in MPC projects at the **University of Denver** is: Patrick Sherry. In addition, 2 students are working on MPC research projects at the **University of Denver**: Masters Students - Jessica Mantia and Clare Jinzhao Zhao.

Fourteen principle investigators, faculty, and administrators participating in MPC projects at the **University of Utah** are: Richard J. Porter, Milan Zlatkovic, Tiffany Hortin, Cathy Liu, David Sanbonmatsu, David Strayer, Joel Cooper, Pedro Romero, Amanda Bordelon, Chris P. Pantelides, Juan Medina, and Brendan Duffy. In addition, twenty-four students are working on MPC research projects at the **University of Utah**: Doctorate Students - Ivana Tasic, Jeff Taylor, Kiavash Fayyaz, Arwen Behrends, Yu Song, Catalina Arboleda, Joel Parks, MJ Ameli, Anurag Upadhyay, Ruoyang Wu, Min Ook Kim, Anusha Musunuru, Zhuo Chen, and M. Scott Shea; Masters Students - Jem Locquaio, Daniel Sudbury, Yang Li, Lingkun Li, James Holt, Martin Dinsmore, Siddartha Rayaprolu, , Ryan Betz, Ariel Froerer, Daniel Sudbury, Joseph Herkimer, Kyle Strayer, Sean Strayer, and Donald Godfrey.

Seven principle investigators, faculty, and administrators participating in MPC projects at the **University of Wyoming** are: Bart Evans, Mohamed Ahmed, Dennis Trusty, Promotes Saha, Rhonda Young, Kam Ng, and Khaled Ksaibati. In addition, ten students are working on MPC research projects at the **University of Wyoming**: Masters Students - Chris Chamberlin, Mohammed Okok, Rameshwor Chalise, Sandeep Thapa, Trena Terrell, Melake Brhanemeskel, Waleed Mohammed Abd Allah Al Eadelat, Sadia Sharmin, and Dawit Mebrahtom; Undergraduate Student - Nicole Peterson.

Eleven principle investigators, faculty, and administrators participating in MPC projects at **Utah State University** are: Anthony Chen, Xiangdong Xu, Sarawut Jansuwan, Jim Bay, John Rice, Paul Barr, Marv Halling, Paul J. Barr. In addition, ten students are working on MPC research projects at **Utah State University**: Doctorate Students - Majid Khalilikhah, Seungkyu Ryu, and Ann Heaslip; Masters Students - Yi He, Holly Lloyd, Nirdosh Gaire, Jen Ostrowski, Phillip Powelson, Ethan Pickett, and Holly Llyod.

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. American Association of SHortline Railroads

4. American Short Line Railroad Association
5. California State Fresno
6. Campbell Scientific, Bridge Diagnostic Inc.
7. Campbell County Road and Bridge Department
8. City of Watertown, SD
9. Colorado Department of Transportation
10. Converse County Road and Bridge Department
11. Crook County Road and Bridge Department
12. Denver Regional Transportation District
13. Digital Glove Foundation
14. Dust Suppression Program
15. East Dakota Water Development District
16. Fehr & Peers
17. FHWA, Wyoming Division.
18. Inberg Miller Engineers
19. James River Water Development District
20. Key Laboratory of Road and Traffic Engineering
21. LA Metro Rail
22. Lincoln County Road and Bridge Department
23. MetroLink Railroad
24. Michigan Technological Research Institute
25. National Institute of Development Administration (NIDA)
26. Roaring Fork Transportation Authority
27. Sisseton Wahpeton Oyate Reservation
28. South Dakota Department of Environment and Natural Resources
29. South Dakota Department of Transportation
30. Standing Rock Sioux Tribe Indian Reservation
31. StarSeismic LLC
32. Teton County Road and Bridge Department
33. Union Pacific Railroads
34. University of Utah
35. Utah Department of Transportation (UDOT)
36. Utah Transit Authority (UTA)
37. Virginia Tech
38. Wasatch Front Regional Council (WFRC)
39. Wisconsin Department of Transportation
40. Wyoming Technology Transfer Center
41. 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

North Dakota State University: Students supported by UTC funds here at North Dakota State University have gone onto very successful positions with fortune 500 companies, academia, federal, state, and local transportation agencies. Students continue to excel while building transportation skills that will enhance the transportation workforce now into the future. With the support of UTC funds, NDSU

researchers have been able to focus on tribal needs throughout the state, infrastructure assessment, asset management, bridge strength analysis, and technology transfer. These efforts will continue to develop the skills and knowledge of the transportation workforce to face the challenges of the 21st century. NDSU researchers continue to move into sensor networks, smart city applications, and addressing the needs and challenges of public transportation in rural and metropolitan areas. Research findings are being disseminated through webinars, transportation learning network, newsletters, social media, and email blasts.

Wyoming: The MPC projects provided excellent learning opportunities to students at the graduate level as well as the undergraduate levels. Several students graduated from the program. The UW research projects helped in implementing PMS on county paved roads. In addition, the tribal safety studies helped several tribes in the region implement a safety improvement program.

Colorado State University:

Several graduate students working on MPC projects at CSU have earned their degrees and are now part of the civil engineering and transportation workforce. The journal paper on using BIM for tracking bridge structural condition has been a frequently downloaded paper for the Journal of Bridge Engineering, which suggests that it is having an impact on the research community.

South Dakota State University: The projects provided research and learning experience for eight graduate students. Thirty-one engineers learned about a new detailing for longitudinal joints in double tee girders which will lead to the design of better and long lasting bridges on county roads in transportation Region 8. SDDOT will achieve efficiency with construction quality control of compaction activities. Potential reuse of MIEX brine for ice control at SDDOT which could lead to the implementation of beneficial reuse of this waste stream at SDDOT. Development of standard SCC mix design and new recommendations for prestressed SCC mix design.

University of Colorado Denver: For the Civil Engineering discipline, the MPC associated research and education efforts have been instrumental in helping grow our transportation program and establish a solid reputation. We have once again broadened our reach and brought in researchers from not only Urban Planning but also Geography, GIS, Computer Science, and Construction Engineering. Our efforts are helping build a transportation workforce with both technical skill and expertise as well as the ability to understand the larger context of their work. Our affiliation with the MPC and the UTC program is the improving national reputation of CU Denver's research and education work within the field of transportation. This program period continues our successes with regard to publications, presentations, and popular press articles related to these efforts. The research activities address three important national issues - infrastructure deterioration, safety, and sustainability. Our educational program is also helping building better students in areas of national need.

University of Utah: As noted in previous progress reports, one of the biggest, early impacts of the program comes from MPC-496: Prevention of Low Temperature Cracking of Pavements. Results from this project have led to a new specification for testing asphalt mixtures has been developed and will be an AASHTO provisional standard. Another project PI has noted that early ideas generated from the initial tasks of MPC-493 has already been incorporated into a graduate-level highway engineering class at the University of Utah. MPC-495 has already resulted in expanded real-time connections between Utah DOT's Traffic Operations Center and the Utah Traffic Lab to support data collection for the project, which includes an interface to detailed information on all traffic signals throughout Salt Lake City. This interface will likely be incorporated into the University of Utah's Introduction to Transportation Engineering course during signal timing lectures and homework problems. This will allow undergraduate students to more readily "visualize" traffic signal operations. MPC-490 has helped to create and revise a

physical NO_x photocatalytic analysis system at the University of Utah Civil Engineering Concrete Lab. This analysis box can be used for all types of materials to measure their NO and NO₂ photocatalytic efficiency. The new MS student on MPC-490 has been trained on using SEM as a tool for measuring chemistry and microstructure topography. The prototype system was used for a middle-school student science fair project in spring 2016. The technology was also incorporated into CVEEN 6225 in spring 2016. As part of MPC-492, the University of Utah was able to build a wedge-splitting test apparatus for fracture testing and a ring shrinkage concrete test apparatus at the Utah Department of Transportation.

The program already shows substantial support in the area of workforce development, with 28 undergraduate and graduate students heavily involved in the research projects.

Utah State University: We have a multi-disciplinary approach with transportation, structures and geotechnical engineering on these projects so the research impact is broad in terms of scope within civil engineering. Each project has at least one graduate student (at the MS or PhD level) and many also involve undergraduate students. We also hope and anticipate that the technology or research findings will be distributed through reports, conferences and journal publications.

b. Expected Impacts

North Dakota State University: NDSU transportation and logistics students will continue to infiltrate the transportation workforce bringing excellent data analysis and assessment skills to the organizations. Students continue to present and participate in industry workshops and conferences, and seek top level transportation positions around the world. NDSU researchers continue to disseminate the results of ongoing projects and research to transportation professionals around the state. Expected outcomes will continue to be shared through technology transfer opportunities, webinars, and social media.

Wyoming: The MPC funding will continue supporting graduate students who will join the transportation workforce after graduation. The research studies conducted will facilitate selecting maintenance and rehabilitation strategies on local paved roads, reduce crashes on tribal roads, enhance the effectiveness of air quality programs such as the CMAQ program, and reduce truck related crashes in rural areas.

Colorado State University: As documented in the individual project reports, the MPC program at CSU is expected to impact engineering practice through recommendations such as those for post-fire ground treatments in MPC-447 or ways to estimate flow rates from MPC-481 or to evaluate the quality of TOD in MPC-485. Our research is also expected to impact transportation research as new tools are developed to assess the efficacy of varying ground treatments, or ways to model physical phenomena.

South Dakota State University: Development of a low-maintenance, low-cost mixed-media filtration system for stormwater treatment. This filtration system can be used to reduce the impact of highway runoff on surface waters and improve the environmental sustainability of transportation. Transform waste streams that are now environmentally and financially expensive to discard into valuable materials for transportation-related applications and improve the performance of ice and dust control on roadways. Reuse of waste streams for transportation applications in South Dakota. Development of new rehabilitation techniques for bridge girder joints. Extending the useful life and eliminating the need for replacement of many existing bridges on local roads. Final reports and digital brochures will be prepared to disseminate the findings to DOTs, bridge engineers, local governments, and bridge owners.

University of Colorado Denver: Expanding our portfolio of work has continued to help grow the UTC program at CU Denver. More importantly, the work we are doing is helping develop the next generation

of transportation professionals and doing so in a way that will benefit society in many different fashions. These projects will be of particular benefit to those looking to provide and promote a safer and more resilient transportation system.

University of Utah: Results of the ongoing projects 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. Example 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.

Utah State University: The individual projects have addressed the specific impacts for their projects. From an overall prospective, the UTC funding is creating opportunities. These opportunities are within the university as well as with agencies outside the university. They are providing students with unique transportation related research that they would not have otherwise and giving them connections for potential jobs and mentoring after school. There is long term impacts of a growth in the transportation workforce through projects that are exciting for these students.

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