RESEARCH

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ANNUAL UDOT WORKSHOP ON TRANSPORTATION RESEARCH NEEDS:

2013 PROCEEDINGS

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16. Abstract

An annual Research Workshop (also known as the UTRAC Workshop) was held on April 8, 2013 to discuss and prioritize the research needs of the Utah Department of Transportation (UDOT) in preparation for the 2014 fiscal year. Participants included UDOT managers and employees, Federal Highway Administration (FHWA) staff, individuals from other government agencies, researchers from local universities, consultants, and other interested parties. Problem Statements, describing research needs of the Department, were submitted prior to the workshop and then evaluated, modified, and prioritized by working groups at the workshop. This document describes the UDOT research prioritization process, the Research Workshop, and the resultant list of prioritized Problem Statements.

The Research Workshop included plenary sessions, with a keynote address by Carlos Braceras, Acting Director of UDOT; presentations on the UDOT Research program, past workshops, workshop instructions, and the project selection process; and presentation of the Trailblazer Award to Dr. Marvin Halling of Utah State University for his outstanding contributions to transportation research. Much of the workshop was devoted to the evaluation of Problem Statements by groups organized by subject area. The seven subject area groups were: Materials & Pavements, Maintenance, Traffic Management & Safety, Geotechnical, Preconstruction, Planning & Asset Management, and Transportation Innovation. Each group used a voting process to determine the most important research needs in their subject area, in ranked order. A total of 59 unique Problem Statements were considered. An additional 20 ideas were proposed and discussed in the Transportation Innovation breakout session. Of those statements and ideas, 27 have been listed for potential funding by the Research Division.

The workshop was held at the Larry H. Miller Campus of the Salt Lake Community College. A total of 89 people participated.

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1.0 INTRODUCTION

The Utah Department of Transportation (UDOT) Research Division is charged with promoting, executing, and implementing research activities within UDOT in order to advance the mission of the Department and increase its use of new products and techniques. A key component of the execution of this charge is the UDOT Research Workshop, also known as the UTRAC Workshop, which is an annual collaborative event held to discuss and prioritize the research needs of the Department.

The 2013 UDOT Research Workshop was held on April 8, 2013, at the Larry H. Miller Campus of the Salt Lake Community College in Sandy, Utah. The results of this workshop will contribute significantly to the development of UDOT's research programs for the 2014 fiscal year.

2013 UTRAC
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The Research Workshop also serves to satisfy federal regulations relating to the use of federal research funds. Research efforts at UDOT depend on support from federal funds. Federal regulation mandates that states certify the proper use of these funds and stipulates that they develop, establish, implement, and document a management process that identifies and implements research, development, and technology transfer activities to address priority transportation issues. The Research Workshop is a key element in the identification portion of this process and aids the Division in allocating research funding and efforts.

Initiated in 1993, the UTRAC (now "Research") Workshop was named for the Utah Transportation Research Advisory Council, a group of UDOT leaders who were originally

assigned with overseeing the prioritization process. In the current application of this process, the Research Division invites UDOT staff and other interested parties to submit Problem Statements prior to the workshop and then gather for the purpose of evaluating those statements and prioritizing UDOT's research needs. After the workshop, the list of new projects recommended for Research Division funding is presented to the UTRAC council.

Attending the 2013 workshop were 89 individuals representing various UDOT divisions, the Federal Highway Administration (FHWA), other government agencies, the three research universities in Utah, consulting firms, and other people with interest in transportation research.

Research needs were identified by Problem Statements that were submitted prior to the convening of the workshop. These Problem Statements were assigned to one of seven subject area groups of workshop attendees: Materials & Pavements, Maintenance, Traffic Management & Safety, Geotechnical, Preconstruction, Planning & Asset Management, and Transportation Innovation. A voting process was instituted within each group for the purpose of determining which Problem Statement was most important in relation to their needs as a subject area. The remaining Problem Statements were also ranked in order of importance. The Transportation Innovation group also brainstormed new ideas during their breakout session and ranked these according to interest along with relevant submitted Problem Statements.

The 2013 Research Workshop considered a total of 59 unique Problem Statements. An additional 20 ideas were proposed and discussed in the Transportation Innovation breakout session. Of these Problem Statements and ideas, 27 were ultimately selected for potential funding using Research Division funds. Lists of all the submitted and prioritized Problem Statements are included in this Proceedings document, along with the complete text of each statement.

Among other workshop details, this Proceedings document also includes the agenda of the workshop, the text of the addresses given by the UDOT Director of Research, Cameron Kergaye; keynote speaker, Carlos Braceras, Acting Director of UDOT; the presentation of the Trailblazer Award to Dr. Marvin Halling of Utah State University; and presentation on the workshop agenda and project selection process by UDOT Research Technical Writer, Steve Bagley.

2.0 RESEARCH PRIORITIZATION PROCESS

2.1 Process Overview

The process of prioritizing research needs for UDOT is based around an annual collaborative workshop organized by the UDOT Research Division. This workshop is known as the UDOT Research Workshop. It has also been known as the UTRAC Workshop, which includes an acronym for the Utah Transportation Research Advisory Council, a group of UDOT leaders who were previously assigned to oversee the prioritization process. In the current prioritization process, UDOT staff, FHWA staff, key consultants, research partners, and people from associated agencies gather to evaluate and prioritize UDOT's research needs. These needs are defined by Problem Statements submitted by many parties prior to the workshop. Available funding is applied to the highest priority Problem Statements as determined during the workshop through a voting process. After the workshop, the proposed funding list is presented to the UTRAC council.

The annual Research Workshop was initiated in 1993, has been held most years since, and has been very successful. The process has been modified several times and underwent some significant revisions in 2005.

The key steps employed in the 2013 research prioritization process at UDOT are shown below. Although the Research Workshop played a central role in the process (step 6), a number of steps were needed before and after the workshop to make the process complete. The steps were:

1. Identifying key leaders in UDOT to lead the Problem Statement generation process in each of seven subject areas, which were recognized as high-value research areas for UDOT in discussions with UDOT senior leaders (other subject areas may be included in subsequent

years). Those areas were:

a. Materials & Pavements

b. Maintenance

c. Traffic Management & Safety

d. Geotechnical

e. Preconstruction

f. Planning & Asset Management

g. Transportation Innovation

2. Assigning a person from the Research Division staff to work with each subject area.

3. Providing background information to the subject leaders on the prioritization process and their role in it.

4. Soliciting Problem Statements from UDOT and interested research partners and stakeholders for each of the subject areas, and making the subject leaders responsible to lead the Problem Statement development process. The 2013 Problem Statement form was available for download at the 2013 Research Workshop webpage. Submitters of Problem Statements were encouraged to fill out the form with a UDOT Champion and include a basic implementation plan.

   The Problem Statement submission deadline was set for March 25 for the April 8, 2013 Research Workshop. No Problem Statements from outside UDOT were accepted for the 2013 workshop after this deadline. Problem Statements applicable to the subject areas were accepted from any entity and did not need to come through the subject leader. Problem Statements received by the Research Division were posted on the workshop webpage prior to the workshop.

   Tools provided to each subject leader included:

   a. List of Problem Statements from the past workshop.

   b. Problem Statement form (revised from previous years).

   c. Suggestions about coordinating with contractors, consultants, and key researchers

during this early stage in the process to ascertain their needs, interests, and resources.

5. Reviewing of the submitted Problem Statements by Research Division staff. Their review usually included a literature search to determine if similar work has been performed in Utah or elsewhere and if significant knowledge on the topic could be provided to the discussion, and checking for well-defined work tasks, clear deliverables, and implementation plans. Subject leaders were provided with the results of this preliminary review to aid them in their review of the Problem Statements and in leading discussions at the Research Workshop.

6. Convening a one-day workshop on April 8, 2013 to review the Problem Statements and prioritize them. The workshop included 89 people from UDOT, FHWA, consulting firms, the three research universities in Utah, other state agencies, and other parties interested in transportation research. Elements of the 2013 workshop included:

   a. Presentation on the overall UDOT Research program, summary of past workshops, and information on national transportation research funding opportunities by Cameron Kergaye, UDOT Director of Research.

   b. Keynote address from Carlos Braceras, Acting Director of UDOT.

   c. Presentation on the workshop instructions and project selection process by Steve Bagley, Research Technical Writer.

   d. Division into seven subject area working groups to evaluate the Problem Statements, discuss scopes and deliverables, and establish priorities. Background information was orally presented by the authors and champions of the statements in many cases. A total of 59 unique Problem Statements were evaluated by the groups. The number of submitted Problem Statements per group ranged from 1 to 20.

e. Prioritization of the statements through a voting process using ballots, with the voting being limited to UDOT staff and at the subject leaders' discretion. Voting criteria included: 1) Importance, 2) Implementation.

f. Brainstorming by the Transportation Innovation group for new ideas (20) during their breakout session and ranking of these ideas according to interest along with relevant submitted Problem Statements.

g. During breaks throughout the day, groups interacted to share ideas, gather supporting information, and provide input on cross-discipline problems.

h. Each subject area working group concluded the workshop by submitting a list of their priority-ranked Problem Statements based on the voting.

7. Communicating the approximate funding limits to the workshop subject leaders and their division leaders, based on anticipated available research funding for fiscal year 2014. After the workshop, subject leaders and division leaders were allowed to re-order their priority Problem Statements based on available funding and select the ones they would like funded by the Research Division. Appropriate UDOT Champions were selected for the top projects if not already identified.

8. Identifying with subject leaders and division leaders any additional Problem Statements from the workshop that could potentially be funded by their divisions and coordinated by the Research Division.

9. Assembling the prioritized Problem Statements from each subject area into a master list of research priorities by subject area group, including voting summaries and showing the projects selected for Research Division funding. This resulted in a total of 27 prioritized Problem Statements (and brainstormed ideas from the Transportation Innovation group) selected for potential funding by the Research Division during the 2014 fiscal year, or three to five Problem Statements (or ideas) per subject area group.

10. Convening a meeting with the UTRAC council, applicable division leaders and their workshop subject leaders, and Research Division staff to present each subject area's project priority list for research funding. Obtain the council's feedback on the priority list and funding scenario. The UTRAC council included the following:
    a. UDOT Acting Director, Carlos Braceras
    b. Project Development Director, Randy Park
    c. Program Development Director, Cory Pope
    d. Operations Director, Ahmad Jaber
    e. Region Director on a rotating position basis, Nathan Lee of Region Four
    f. Research Director, Cameron Kergaye
    g. FHWA Utah Division representative, John Haynes.
11. Obtaining FHWA approval of the final funding list as part of the Research Division Annual Work Program funding document.
12. Assigning Research Division staff as Project Managers for each of the new projects. With the Champions' help, the Research Division selects Principal Investigators and Technical Advisory Committees for the new projects.
13. Coordinating with other divisions and Principal Investigators on beginning additional research projects to be funded by the other divisions.
14. Refining the project scopes, preparing contracts, and initiating the research projects on or after July 1, 2013 (beginning of State fiscal year).

2.2 2013 Research Workshop Team

Each year, it takes a large group of people to organize and execute the Research Workshop. The following people were involved in 2013:

- Director of Program Development: Cory Pope
- Director of Research: Cameron Kergaye
- Chair of Workshop, Problem Statement and Workshop Coordinator: Steve Bagley

- Problem Statement Literature Reviews: Research Division
- Workshop Logistics Team (workshop logo, posters, signs, participant packets, catering arrangements, onsite registration, and video recording): Joni DeMille, Steve Bagley, David Stevens, Michelle Lewis, Jessee Hill
- Workshop photography: Steve Bagley, Joni Demille,
- FHWA Liaison: John Haynes

2.3 2013 Subject Leaders and Research Contacts

The following worked together as subject leaders and research contacts from UDOT before, during, and after the 2013 Research Workshop, coordinating efforts for new projects from each subject area working group:

- Group 1: Materials & Pavements
  - Subject Leader: Scott Andrus
  - Research Contact: David Stevens
- Group 2: Maintenance
  - Subject Leader: Rukhsana Lindsey
  - Research Contact: Russ Scovil
- Group 3: Traffic Management & Safety
  - Subject Leader: Robert Miles
  - Research Contact: Cameron Kergaye
- Group 4: Geotechnical
  - Subject Leader: Darin Sjoblom
  - Research Contact: Daniel Hsiao
- Group 5: Preconstruction
  - Subject Leader: George Lukes
  - Research Contact: Steve Bagley

- Group 6: Planning & Asset Management
    - Subject Leader: John Thomas
    - Research Contact: Kevin Nichol
- Group 7: Transportation Innovation
    - Subject Leader: Fred Doehring
    - Research Contact: Cameron Kergaye

2.4 2013 Research Workshop Basic Agenda

The 2013 Research Workshop was held on April 8, 2013, at the Larry H. Miller Campus of the Salt Lake Community College, in Sandy, Utah. Attending the 2013 workshop were 89 individuals representing various UDOT divisions, FHWA, other government agencies, three research universities in Utah, consulting firms, and other people with interest in transportation research. The workshop consisted of two main sessions and two breakout sessions. During the breakout sessions, subject area groups discussed, refined, and prioritized Problem Statements. The complete Workshop Agenda is included in Appendix A of these Proceedings. A list of individuals who attended the workshop is included in Appendix B. The basic outline of the workshop sessions was as follows:

- General Session:
    - Welcome and Research Program Status – Cameron Kergaye, Research Director
    - Keynote Address – Carlos Braceras, UDOT Acting Director
    - Workshop Instructions and Project Selection Process – Steve Bagley, Research Technical Writer
- First Breakout Session:
    - Problem Statement discussion, Prioritization voting
- Lunch Session:
    - Presentation of Trailblazer Award – Carmen Swanwick, Chief Structural Engineer
- Second Breakout Session:
    - Problem Statement discussion and refinement, Prioritization voting

Each workshop participant was given a packet of information, which included an agenda, a list of breakout groups and room assignments, a list of all the Problem Statements being

considered by each group, and a copy of each of the Problem Statements being considered by the group to which the participant was assigned. The Subject Leader and Research Contact assigned to each group were each given a binder containing a copy of every Problem Statement being considered by all the groups, ballots for voting in their group, and a spreadsheet (on a flash drive) to be used to tally the ballots. They were also given an instruction sheet on how to manage the group and the voting process.

3.0 RESEARCH WORKSHOP ACTIVITIES

Following are the transcription, slides, and selected photographs from the general and lunch sessions during the 2013 Research Workshop.

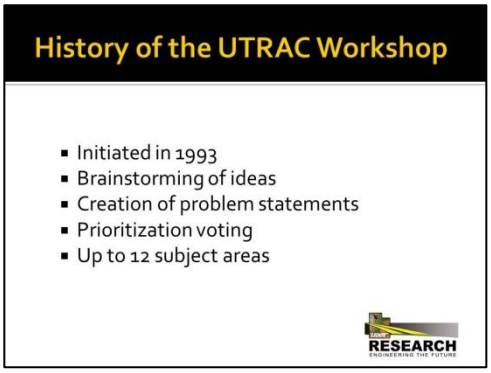
3.1 Opening Remarks

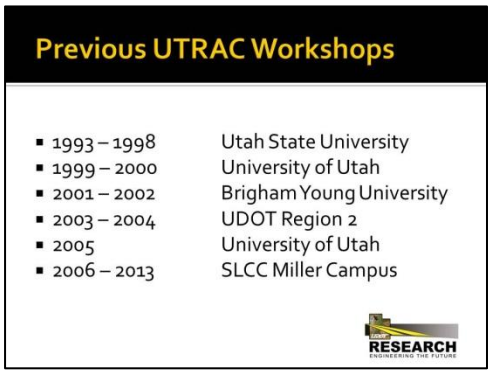
Cameron Kergaye, UDOT Director of Research

Good morning everyone. I would like to welcome you here. This is the Research Division's Workshop. This is where we come together to discuss the ideas many of you have submitted, with the hope that we can solve some of the challenges and problems – whether we know about them or not – that can help improve our transportation system. This has been a sort of tradition here at UDOT to have this workshop. We have had nineteen of these workshops so far. I would like to welcome all of you from various aspects or areas of transportation research. We have people from UDOT as well as people from our FHWA partners, universities, contractors, and consultants. We have about the same number pre-register this year as we had last year, about ninety people. We'll probably have a little bit more than that roll in.

What is UTRAC? It is actually the Utah Transportation Research Advisory Council. We kind of adopted the acronym to describe this workshop. The council itself is composed of UDOT's leadership. We go through a number of things here

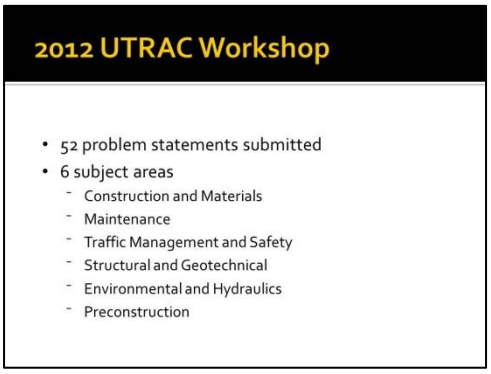
today to try to address some of the needs we have in transportation. We are going to discuss problem statements that were submitted and be able to ask questions of those who have submitted problem statements. In the end, we are going to go through a prioritization process. This is very much a working session. I appreciate all of you coming here, submitting ideas, asking questions, answering questions, and we hope to have a prioritized list that we will use to fund research and that goes back to that council there of UDOT's leadership. They will go through the list, ask questions to make sure this really addresses UDOT's needs.



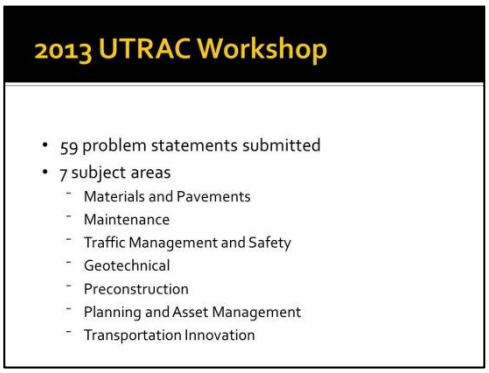


A little bit of history here. UTRAC was initiated in 1993 and back then it wasn't as formalized. It was a little more of an open session with brainstorming. It was a two day session and they actually created problem statements by the end of the second day and went through a different kind of prioritization. We do address the same areas. There has been up to twelve subject areas and we will have a good number of those areas from year to year although they will change a little bit.

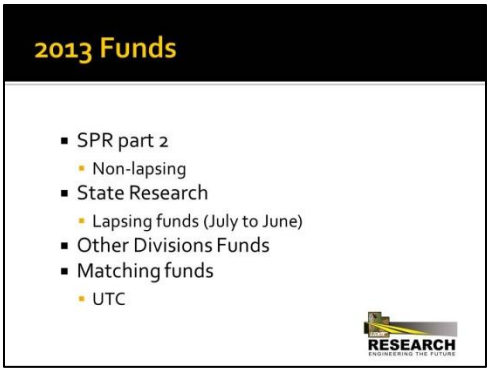
We have had it at different locations. It has been at UDOT or one of our academic institutions. This Salt Lake Community College campus here has been a pretty good location for us, and we are really happy with it.



Last year we had fifty-two problem statements submitted and those following six subject areas, and this year it's roughly the same with a few more problem statements. That last subject area is catering a little bit to construction innovations. We have reached out to our construction community and asked for some of them to come and bring their ideas. We are looking forward to see what kind of innovations they can bring us from other states and other places that they have been working.



The other subject areas have been here at UTRAC from time to time. We have follow a process where problem statements may be submitted by anybody. If they are submitted by our university professors or consultants we generally turn around and award them according to what has been prioritized at the top to do that work for us. If it has been submitted by UDOT, then it is our choice as to who we hire, and we try to match skills with the problem statement and subject. Nationally it is a little bit different. As many of you know, for NCHRP and other areas, you submit a problem statement and there is no guarantee that you as a research professor would get that work. In fact, odd are, you probably wouldn't because there is some national competition. So we really have the best of both here, and we are pretty happy with that system.



We use various funding sources. We have federal SPR funds as well as State funds. In the last couple of years, we have noticed that other divisions within UDOT see value in other problem statements that have been submitted that we are unable to fund because of our limited funding, and they volunteer to fund those projects. This allows us to extend our reach a little bit. There are also matching funds from universities. There are also pooled funds from other state DOT's. There are a few problem statements that have been submitted that are actually listing some of those as the funding sources.

I would like to mention about the pooled fund, there are some national groups and agencies out there. It is good to keep that in mind because when there is a call for problem statements nationally, there are bigger pots of money out there. We would like to work with and support our university professors and others to try to achieve that kind of funding level. I know for my counterparts at CALTRANS, they do everything they can and they have a two year timeline where they plan ahead to try to submit first for national research funding for their projects rather

than use their own state dollars. We have put a little bit more emphasis on that. We have been fairly successful on some of the problem statements that have been submitted nationally that have gone forward and have been awarded.

I would like to end here by saying that we would really like to partner with all of you here on trying to achieve some of the same things. We are ready and willing in the Research Division to help co-author or co-submit problem statements for research calls outside of our annual research workshop. If you check our website we have some information there and in our newsletter that was recently sent out and published on Friday, that has a number of deadlines that could be helpful.

So with that, I would like to ask Cory Pope, the Director of Program Development to please approach the podium and announce our keynote speaker.

3.2 Keynote Introduction

Cory Pope, UDOT Program Development Director

Thanks Cameron. Good morning and welcome everybody. UTRAC has come a long way. I remember back in 1995 or 1996, I was a Project Engineer at my first workshop. It was in Logan. It was a little chaotic; it was interesting. We have come a long way. This is a great group of people that have come together, and it is exciting to see the progress that has been made over the last decade or so. Many great innovations have come out of transportation research in Utah over the years. We are moving bridges into place over night. It is common place now. It is something that started out as a scanning tour in New York and was brought back to Utah, and all the great people here turned it into a common place thing. We do a lot of precast concrete slabs. We don't even think about it anymore. It wasn't that long ago when I had a bad experience on I-15, even though it

was a Saturday. Thanks to a lot of people in this room who put a lot of effort into precast concrete slabs, we don't do that anymore. We get in and out and we don't disrupt traffic. I was trying to use some conventional highway concrete. I was thinking we would be in and out in a few hours and things didn't quite work out that well and created a lot of problems on I-15.

Currently we are working with the greatest signal technology across the world. We have developed a world class signal system here in Utah. We are working with high-end GIS technology to better utilize all of the data sources we have and to make better business decisions. Right now, UDOT is in the process of transitioning into a very unique data collection system. That new system is something that is going to change the game plan for the state of Utah and transportation and how we do that. This is something that is very innovative. It seems like you can go on and on and list all kinds of innovations that are out there.

Everyone in this room will make some contribution to innovation in the future. One of the things that has kept the State of Utah in the forefront of the transportation industry are those innovations. And the fact that we are not afraid to take a little bit of a risk, and we are not afraid to get out there and try some new things because we have had some great leadership over the last decade or so that makes us able to do that. The real good ideas come from these rooms. We are very fortunate here in the State of Utah to have a lot of really great intellectual resources, a lot of them are in this room.

At this time I have the distinct pleasure to introduce someone who really doesn't need an introduction here today. Carlos Braceras is our acting Executive Director right now. Carlos has served as our Chief Engineer since 2001. If you look back that has been where a lot of our innovation started. Carlos, after earning his Bachelor's degree in Geology back east in Vermont, he came out west and worked as a geologist for several years. He came to Salt Lake City for a weekend of skiing and never left. He decided that there was enough here that needed to be fixed that he thought maybe he would stick around here for a while. We are fortunate enough that he did. Carlos went to school at the University of Utah and earned his Civil Engineering degree. He started with the Department in 1986. He was a young kid who was ambitious and he decided he would drag us all either kicking and screaming or cheering into a new world of innovation, and we haven't turned back since.

Carlos has served in several positions over the last twenty-six and one-half years. He was Region Director in Region Three for a few weeks. He was the Project Manager for the Legacy Parkway. He was the Chief Geotechnical Engineer. In 1998, Carlos was named the State of Utah Governor's Manager of the Year, which is a pretty distinct honor. Like I said, we are very fortunate. Carlos has done some great things in driving innovation across UDOT. I could go on for a long time talking about all of the things that have happened in his time at UDOT. Rather than doing that, I am going to let Carlos come up and talk. Please welcome Carlos Braceras.

3.3 Keynote Address

Carlos Braceras, PE, UDOT Acting Director

Thank you Cory, that was completely embarrassing and unnecessary, especially since your performance evaluation is coming up. Good morning everybody. It is a very nice feeling this morning. Driving in on a Monday, it's raining out and it feels like your typical spring day. Life is being renewed. It is a really nice feeling.

I appreciate you all being here today and the goal here is for you to become incredibly relaxed and to just talk to everybody because you are going to pick up ideas from each other, probably not in a formal setting but it might be on break or sitting next to each other, and you are going to have unique ideas to share. You are going to take that new idea and use it in a completely different way than the person who shared it with you, and that is how we are going to make leaps forward as a transportation agency.

I am going to share about fifteen to twenty slides. Then what I would like to do, if we have time, is to open it up for question and answers. So I am setting that up for you if you have anything you would like to ask, whether it be the research area, the transportation area. If you want to ask how the skiing was this weekend, I can give you some info on that as well. I am going to step through these slides. I told people I am acting but in real life I am the Deputy Director and that is my position.

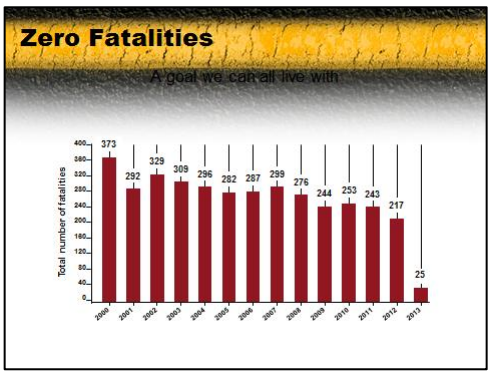
What I wanted to share with you guys today are kind of the keys to how to be successful in getting your transportation ideas and research ideas advanced and funded. So I am going to talk a little bit about what fuels us at the Department. Most of you have heard this before, but I want to just touch quickly on a couple of our strategic goals and a few key measures. The idea is to try to give you some thoughts into areas where you can start to make changes and how those changes are going to be important to us.

I will talk a little bit about what I see as opportunities, and Cory touched a little bit on that but I believe that we have systems in place today that have not been available ever before. With this type of information and tools, I believe researchers can start to ask questions that we haven't even thought we would ask much more sophisticated questions that are going to help us make leaps forward. Lastly, I wanted to talk a little bit about a challenge. I want to challenge each one of us to think about how we are going to make a transformation as an agency. Because that is really what we have to do in the future; we need to be transformational.

I am going to step into our strategic goals and bounce around here. Let's start with Zero Fatalities. When we talk about Zero Fatalities in the department, we are driving towards this goal in several ways. I think most of us would think first of all that we are looking at it from an engineering perspective. You know when you think about engineering, most people think about the geometrics and how we address the geometrics. You think about the engineering aspects. How flat do you make the slopes? Where do you put the guardrail, the rumble strips? Those types of engineering functions are incredibly important. The area that we have had a huge influence in, and it touches your heart, and I encourage everyone of you to participate in our activities where we go out to the schools and we talk Zero Fatalities. We drive a wrecked car around, and we talk about texting and driving. If you want to see a remarkable sight, go into an auditorium with 500 to 600 juniors and seniors in high school and ask their opinion. It is absolutely remarkable how much attention has been paid because it's hitting them. They are starting to see and understand things that they may otherwise never use to before.

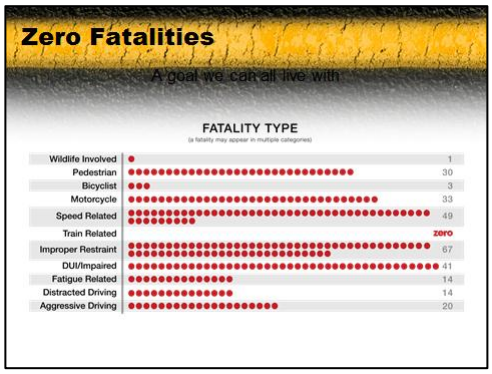
That's your department of transportation getting out there into the community and talking with children about behaviors. Those behaviors can drive an awful lot of poor decisions when we are driving and lead to those fatalities that we are absolutely trying to avoid. So you know, we have all these educational programs like Zero Fatalities or our Don't Drive Stupid program, our SNAP program which is really cool because we work with schools to come up with routing plans so that they can start to design how kids will come and leave from school as pedestrians, walking, and biking. Then we have gone out and actually walked and biked with kids to school to show them the proper way to do it. It is really a lot of fun and that is where you start to make these lifelong changes with folks.

We work with Traffic Operation Center services. You have seen their IMT trucks out there. We want to implement one of the SHRP 2 products which was the IMT program. Federal Highways has invested 4 million dollars for us to try to work with our instant responders. This includes: medical responders, police, and fire. We want to help train them on how best to alleviate that congestion quickly, to improve the reliability but also to improve safety. That is an area we have been very much focusing on. We included into Zero Fatalities things such as our maintenance program when they are out there clearing your ice and snow. So all areas, if you think about how are you going to connect to Zero Fatalities, there are an awful lot of different ways from a research perspective you can start to make that connection in a different way.



What we are trying to say: Is our work making a difference? I am here to tell you that this is not just lip service. We can get to zero. We can get to where zero people die on our highways. Look at these numbers and the drops that we have seen here over the last ten years. We have had 155 fewer fatalities occurring on our roadways since 2000. Since that time, the traffic has increased dramatically in the State of Utah. We have seen a constant increase in our population and the amount of miles everyone has been driving. So the trends are going in the right direction. This has been a nationwide trend last year, I would say, from a nationwide perspective maybe not as good as we would have like to have seen, but the state of Utah is driving this number down. And it has to do with those four things I have been talking about: Engineering, Education, Emergency Response, and Enforcement.

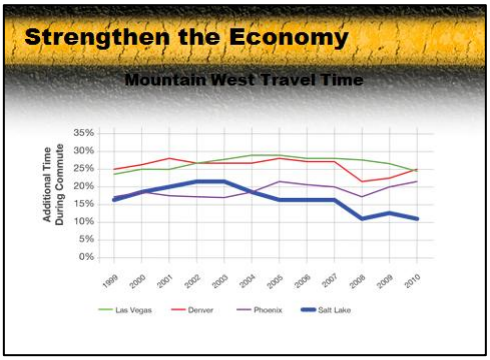
We are making a difference here; so connect your research ideas with the desired outcomes. Now this is just a snapshot but if you get a chance, go to our Zero Fatalities website and you can start to drill into the different information that is available. Now you can't add up all these dots and get to the 217. There are many cases where there are multiple reasons for a fatality. One of the things that stands out here in these numbers to me is, if you eliminate the motorcycle crashes and you eliminate the pedestrian bicyclists, over 50% of our fatalities have a contributing factor of improper restraint. Think about that, isn't that remarkable. Did anyone drive here and not wear a seatbelt? I wouldn't expect transportation professionals to not use a seatbelt, but right now recent counts we have out there show that about 80% of our public do wear seatbelts. We have a secondary law in the state of Utah. That means you cannot be pulled over and given a citation for improper restraint. You have to be pulled over for another reason, and then if you are not buckled up, you will receive a citation for not wearing your seatbelt. So this is an area that we keep working on for improvement. At this last session I did testify in front of the State Legislature in support of a primary seatbelt law. We have seen around the country, where primary seatbelt laws are implemented, a significant increase in the amount of folks wearing seatbelts. In fact, I would probably have projected that we could have saved 30 lives last year with a primary seatbelt law. 217 minus 30, think about that. We would be starting to get really remarkable figures. My point here is, on our Zero Fatalities website, we publish this data every year. There are countless amounts of analysis behind this, data such as this that can be used to try to figure out how to get us to zero.



A little bit about strengthening the economy, I jumped ahead a little bit here. This was a reasonable goal for us; we are in our second year of adding strengthening the economy. For those of you who have been following this very important development of our strategic goals over the last twelve years, we went from taking care of what we have, making it work better, improving safety, and adding capacity. Those were our four strategic goals. What we did several

years ago, is we combined making things work better with optimizing mobility and we added the goal of strengthening the economy. This is a goal that is like Zero Fatalities for some people. Well, wait a minute, we don't have a direct connection there. How can we be responsible for something when we can't exactly turn the dial and make a difference? This is one of the goals that has really led me to have a much better understanding of what us in the transportation business, what our business means to our public out there. I have used this as an opportunity to reach out to some of our business partners. I have recently met with Randy Rigby, the President and CEO of the Utah Jazz and asked him this question: What can the DOT do to improve your business? He steps back for a minute, and he didn't know quite how to respond to that. He said he never had a government official come to him and ask him how he can make his business work better. We should have been doing this of course, because these are the people we work for.

I met with Scott Anderson who is the President and CEO of Zions Bank a few weeks ago. To hear him talk about what's important to Utah, he did not mention once his bank, which is obviously the most important thing from a caretaker's perspective. What he was talking about was education and transportation. These are the two things that he said he was trying to focus on as CEO of a large bank, because he was convinced that the strength of the State of Utah will be an educated workforce. We need to do a better job educating these folks so when they find themselves sitting in a center like this, you have collective brain power to solve much bigger problems than we do today.



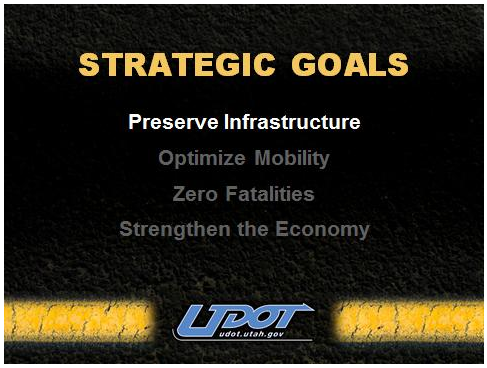
Strengthening the economy has allowed us to ask questions that I don't think we have asked in the past. What you see in front of you here is something that a lot of us intuitively know but it is nice to see an outside measurement. This is from the Texas Transportation Institute, and it is looking at four different cities around the West. I will call them our competitors. If you are a private business and are thinking about locating a company, that as part of your bottom line is mobility. Now I am going to tell you that every company has this as part of their bottom line, and mobility plays a key part of that bottom line. If you see here, Salt Lake City is really the only one of our competitors where we have seen the lean times when the peak period went down. When I say we know this intuitively, if you think about the I-15

reconstruction in Salt Lake and Utah Counties, the Legacy Parkway, Mountain View Corridor, you can go on and on with the improvements we have made around the state, the mobility is better. What I am going to put forward to you is that importance that that mobility has on business has a lot to do with people. If I am a company and I want to attract talent, I want to attract the best talent. I want the smartest people and the hardest working people I can get. People will choose to work at an employer's area, to me is based on time. Everyone has so much time they are willing to donate towards the commute part of their work. If you can travel 50 miles in the same amount of time you can travel somewhere else for 20 miles, think about drawing that circle, and within that circle is your opportunity to attract the brightest and best talent there is because you are on a world stage competing with the world. So you want the best talent. If you can draw people in from a 50 mile radius rather than a 20 mile radius, you're going to get better people. You will have a stronger economy if you can move your goods in and out much quicker. When talking to UPS, and when they run their trucks out of Cache Valley, it is dependent on how much traffic they expect to hit before they get to the airport. The later they can get that truck out of Cache Valley, the more packages they can put on that truck and get down to the airport in that day. That is an important measurement. So if they can delay that truck by a half an hour, because they know they have reliability on the systems, or they know they are getting reliable information and that information is real information in terms of actual travel times, they can make on the fly decisions as to how long they are going to wait. There are a lot of things we do in our business that affect the economy.

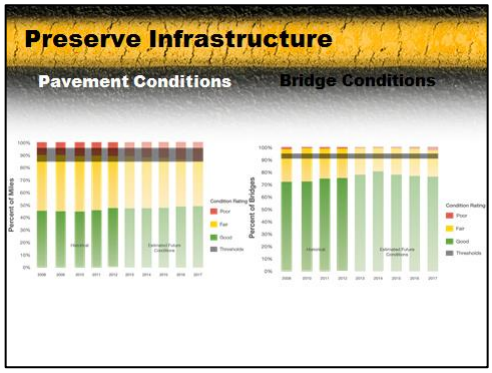
This has created quite a few stresses I'll say within the organization. We find employees at the department wrestling with, well is it Zero Fatalities or is it strengthening the economy? Is it one or the other? If I grant this access perhaps to this business, it could help this business, but is it going to impact safety? Everything we do every day involves making best informed decisions we can. Nobody said it was going to be easy. There is not going to be a black and white answer here that will satisfy all of the strategic goals or balance between them. Every decision we make, we are going to have to make a conscious decision on how best to balance that.

Preserving the infrastructure: I think that this is probably the bread and butter of what we have been working on here at the department for a long, long time. We want to make sure as engineers we are keeping our eye on the ball. I remember Cory, it wasn't a few short weeks as

Region 3 Director, it was almost a full six months. They finally put me in a place where I would do less damage in the department. One of the things that was told to me when I went down there is you keep your eye on maintenance. You keep your eye on your pavement and your bridges. You are not going to get promoted for taking care of them but you will sure get fired if you let your pavement and bridges go. That is something that has never left me because that is really the essence of what is expected of every one of us in the transportation business. They just expect us to take care of the roads and bridges. Now like everything else in this world, you don't get less things expected of us, you get one more thing piled on top of the other. This is a given that we have to take care of. We need to preserve our pavements. We need to preserve our bridges. We are going to do ongoing maintenance. This is an area again that does not receive the attention that our mobility does. There is no surprise here. We hear this a lot, we don't cut ribbons for a maintenance project. When you do an overlay, you don't cut a ribbon, right? So it is hard to gain that political will to support doing a better job of our roads and bridges.



Look at what we have here. We have a lot of different measures. We have four different graphs and we have taken them and put them into one bracket. The one on the left here, you can see our overall systems conditions. This is for all the 6,079 miles in the state of Utah. We are in remarkably good shape. Most of you in this room know that we have a category of roads that we call level two, out of our poor step-children that don't get treated quite as well as the rest of the roads in our system. We have got over 1,971 miles, that we have reduced from 2,700 because of the good job that you all have been doing in Asset Management in helping us make good decisions. We have been able to bring back some of these second-class citizens from our roads systems. Those level two roads are dragging down our level two pavement condition. I am here to tell you that our big roads with heavy traffic are in excellent condition. We have a very good future in that.



Our bridge conditions, I would say, are the envy of the nation. We have been able to address most of our significant bridge challenges with our major capacity projects because those are the bridges that have taken a beating. Those are the bridges that have been part of the first interstate construction. We have a few bridges up in the Davis County area that will be taken down with the Region 1 project starting later this year. We are doing a good job on this, but this is an area that we continue to have concern. I can tell you that the legislators have heard this and we have had the chance to give them a presentation showing the projected condition of our road systems looking out into the next five years and ten years. There is concern out there. There was even a discussion that took place. The Salt Lake Chamber was leading it. Some of our metropolitan planning organizations were talking about indexing fuel tax so when the price of fuel goes up we see a corresponding increase in transportation funding or even a gas tax increase. These discussions are taking place. I spoke to our Governor on Friday and he mentioned his concern about maintenance as well and wanted to continue to have an ongoing discussion as to what we can do to better maintain our infrastructure: taking care of what we have, essentially.

This is an area that we have to continue to keep a focus on from a research perspective. We need materials that are better, faster, and lighter. We need to build under traffic with less impact and provide the highest value to the public. We are going to keep looking for those opportunities to do a better job to maintain our infrastructure.

Optimize mobility: This is a graph that has a few years on it now but it is a very important piece of information because it is representative of the Wasatch Front area and it is of our four, more urbanized counties here along the Wasatch Front. Take a look at the blue line. If we, starting in 1997, had not done the Centennial Highway program, if we had not done the Critical Highway Needs program, the Centennial Highway was a 3.8 billion dollar program, Critical Highway Needs program was a 1.2 billion dollar program. The Transportation Investment Fund was a 2.2 billion dollar program, where we finished up I-15, continues into the

future. It is a dedicated, earmarked 8.3% of the State's sales tax coming to the Transportation Investment Fund for the Transportation Commission to program the projects. If you look at the blue line, that's the amount of accumulated delay we would have seen along the Wasatch Front had we not done all of those programs.

Now, we have done a pretty good job if you look at where we are today. If we were to program no more capacity projects, the red line would start to show how fast we would start to see congestion delay occurring along the Wasatch Front. It means we can't keep our eye off the ball. What it means to me also is that we have to be thinking more broadly about the solutions we bring to the table. Those of you who came here a little early and partook of the breakfast, you may have noticed some of the simulation that was running up on the screen. Those were taken from a presentation that John Njord gave to the Transportation Research Board in January of this year. They were things that we were doing as a community to make the system that we have essentially work better, to optimize the system we have. It is looking for opportunities to make those tweaks at intersections, at interchanges, where we have choke points; maybe it is a passing lane in a certain location, maybe it is an auxiliary route. We can't solve every problem with a major capacity program. There is flat out not enough money to do that. So we need to be thinking, what ways can we take this system, take this right of way that we have and squeeze more people through. It is not about moving cars. It is about moving people. How can we best move more people through this system? I am convinced we can take that existing right of way and squeeze more people through it.

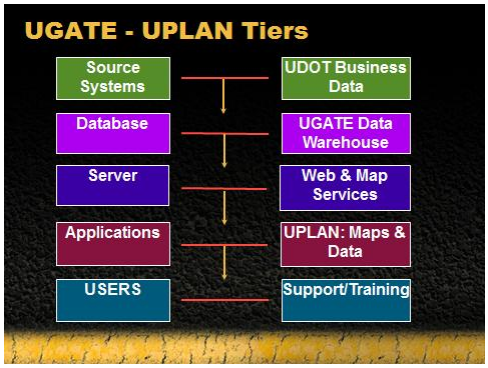
We can do things like, I know this is a little crazy, we can improve the environment with our work. Remember CSS: context sensitive solutions? This Department is one of the leaders in the nation for implementing CSS in all of our work, our design activities, our construction activities, and our maintenance activities. We can do things that meet the transportation need, improve the environment and improve the communities. When we think, we are pretty smart people, we think we are going to go into a community and we are going to improve you. Nobody likes to have someone else come in and improve things. People want to help improve themselves in their own image. Every community needs the opportunity to define what that means to them. We need to listen. We need to hear what's important to them.

I recently sat down with Mayor Dan McArthur down in St. George before our Commission meeting last month, just to get a temperature reading from the Mayor of how are things going and what's important to you. The Mayor went on and on just ranting about the good work that our Region 4 is doing down there. You know what he loves the most? He loves the trail systems. He had this one question. He said that he really wanted the name of St. George on a rock or a hardscape at the interchange. I said really? That is your big thing? He said yes that will really help me define my community. So guess what? Region 4 is looking into ways to make that happen because that is the mayor's image as to what is important to him and what is important to his people. That is what we have to be constantly reaching out for.

Real quick here, let's talk about some opportunities. My goal here now is that you have got the recipe, and I don't expect every research idea to be implementable. Otherwise, we will not be making those major leaps forward, but I do expect to see a mixture of stuff that is implementable and stuff that might be right out on the cutting edge that might be leading us forward as an agency. There are some tools out there that I think will allow researchers to ask much more sophisticated questions than we have ever asked before. These are tools that you can use to help get us the answers that we need.

Cory touched a little bit on data collection. We are collecting more data than we have ever collected before. It is better data. It is more consistent data and it talks to other data. Now, I am not a data guy so when I say it talks to other data, I am sure it means a lot to some people. We honestly believe that with better information and information that is more organized, you guys are going to think of ways that we can use that data in ways that we have no idea right now. Essentially, we are serving stuff up and what we want to do is to see as many people using this as possible. Cory talked about the data collection effort. This, we believe, is part of the future. It is going to be how other DOT's do this business as well, once we start to show the value of what we extract out of this. The value of what we extract out of this is all that pavement distress stuff.

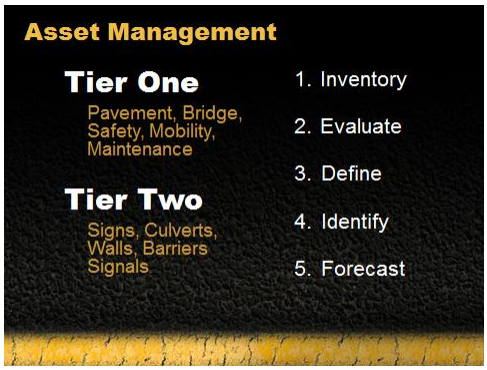
We are going to be able to ask questions from a statistical perspective: What were the pavement conditions associated with our pavement tolerance, and what were the geometrics associated with it? How bright are the lines on the road? We are going to start to be able to drill down, to what I believe, into things that will help us make better investment decisions. The public expects us to make really good investment decisions because it is their money. It is our job to make sure we are doing the best we can with our client's money.



This is an interesting graphic. I am going to have someone else explain this if we get too many detailed questions here. The bottom line is that we have a UGATE and a UPLAN. UGATE is essentially the techno guy's way of where all of the data is at and the way we are relating all of our data sourcing. All of our legacy systems, we want to bring all of our systems together so that we can be smarter about how we use our data. UPLAN is really how we are serving it up. You are going to be able to access the data through UPLAN. You are going to be able to store your data back in here as well. One of the things that has frustrated me in the research world is that – I have had chances with AASHTO and TRB to be involved in a lot of different committees – you hear a lot of good ideas. My counterpart in CALTRANS, Rick Land, and I always hear the word silo. The geotech guys were really diving deep and were working on theirs, the geometric guys are here, the data guys are here, the traffic guys are here; and Rick refers to them as cylinders of excellence. I thought that was a nice way of calling them silos. We have been a community of cylinders of excellence. I believe those cylinders have been both functional, but they have also been institutional where we may have a Region competing against a Region or we may have a university competing against a university. What our challenge needs to be is how we bring us all together and break down those cylinders of excellence and weave them into something that allows us to be a community of excellence. I believe that will be so much better. The point about this graphic is we have now been able to bring together our systems and our data in ways that we have never been able to do so before. We are going to be able to use this information to ask more sophisticated questions.

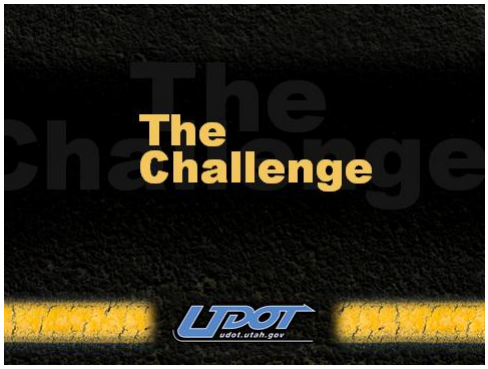
Asset Management: I wanted to touch on this because right now we have a, I'll say, a nationally recognized system. When people talk to us about this (excuse me Stan), I am a little

dumbfounded that this is nationally recognized because I keep thinking of how far we have to go. We have been recognized because we have come so far, and we have been able to use it in ways to help make decisions. So the message to me was as soon as you stop having all those places you want to go and you stop feeling anxious, maybe it is time to move aside. We have been very busy having states come into the State of Utah or having some of our folks travel around the country and explain to them what we are doing with Asset Management. One of the basics here is we have been able to, I believe, we are able to say we have such good stable conditions here in the State of Utah is because we are using – when we say Asset Management do not think computer systems; yes it is a component, that is the easy part. Asset Management is people. Asset Management is bringing together experts to look at the data, help us understand what the data is telling us, but then to be able to think about what are the appropriate questions to ask of this system so we can then get together and make recommendations. The way we use this now is this is really what drives our investments in pavements and bridges. This is the basis for us making our recommendations to the Transportation Commission for how much money to put into those types of things. It is all coming from there. I believe because we have been able to make improved decisions, that is why we have been able to recall almost 700 miles from our state's system. We can recall them from level 2 back to level 1. When they are now going to be cared for in a proactive way, now roads that carry almost 1,000 vehicles per-day can be level 1 or 200 trucks per-day can be level 1. It was 2,000 vehicles per-day or 500 trucks. You, with your work, can get in and use the Asset Management system to ask those questions to try to figure out how we are going to deal with how to make better use of all that data mining.



I talked a little bit about this earlier. To me it is all about people. One of the presentations I went to at TRB was a Senior Vice President for 3M. I remember thinking to myself, well jeez, we are just going to go and listen to him talk about striping or sales and I wasn't quite sure what I was going to get out of it. What this gentleman talked about is the way they formed their

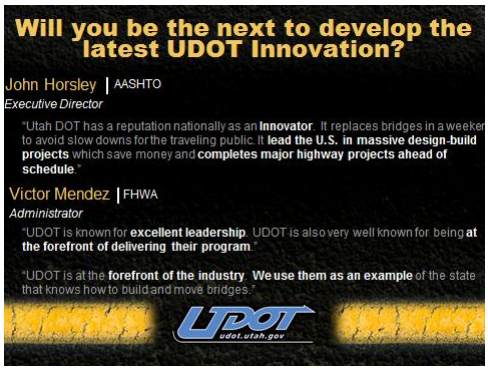
company to advance innovation. I am not going to get the numbers quite right, but they had set some incredible goal where 30% of the products that they were selling needed to be technology they developed over the last 10 years. That was one of their benchmark measures that they had. The concept that in order for them to be successful as a company, they needed to be constantly innovative. One of the ways they were doing it was the way they brought people together and how then, out the different cylinders of excellence, together even in the office layouts they would have where they would be creating areas for people to just bump into each other to collaborate, to gossip really, because that is where a lot of great things came out. That is, different people from different technical areas talking about something that would then light the fire of something else. They built their buildings in a way that would try to facilitate this. I find that very interesting and it pertains to all of us here today. You guys are all brought here together because you really constitute those thought views in our business in terms of where are you going to take this. What is the next product that you are going to be putting down on the road? Anything from how are we going to put a message up on the VMS board and what should that message be? What is the message that is going to resonate? So it is really about people working together.



So a little bit about the challenge, then I will wrap up here. You have heard about things that we want to try to advance. The outcome goals of our strategic plan of what we are trying to move forward. Really this is how we are trying to do it: faster, less impact to the public, we want it to last longer. The last thing we want to do is lay down pavement and have it come up quicker than we

expected. We want to save money. Let's use the data we have that might be meaningful but let's find new data. We have an incredible resource that is available right now for us to be able to do those things.

This is an area that we have to broaden our understanding on. If you look around the room here, I don't want to say that there is anything wrong here, but most of us are on the top of that bell curve, but what are we doing to actively engage the younger generation – elementary school, high school, college – to interest them in this field so that when we leave, when we move on, we are out on the golf course or wherever, we know that this Department, this transportation industry will be in better hands than it is today. Because you know, that was the goal of the people who came before us. They wanted nothing more than to make this organization a better place than when they were there. So I am going to ask you to think about ways of how to challenge yourself to interest some of the younger generation in our business. I think this is pretty important. We can't take our eye off of this.



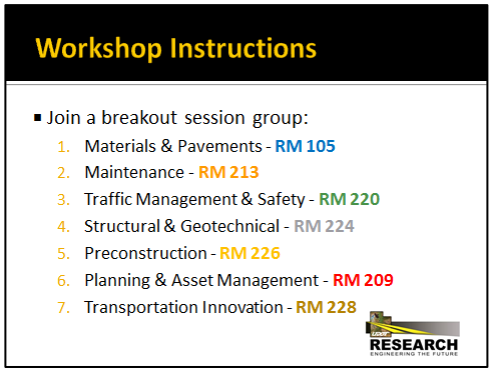
As the last slide here, some of you may have seen this from John Njord's presentation at our annual conference last year, but it is always good to remind ourselves of this. I think in our business, like it is in human nature, we tend to be critical. We tend to be critical of ourselves and sometimes of our organization. What I want you to completely understand is that you guys are the best of the best. The Utah Department of Transportation with our partners, local governments, our Federal Highway Administration, our universities really do represent the best there is in this country. You guys have made a difference, and I need you to keep thinking about how you are going to continue making a difference because you are recognized as leaders in transportation. Every little thing and every little idea has merit. So don't let it hide beneath the covers. That concludes my remarks. I am sorry if I went on a little long, but I really do enjoy participating in this event. What I want to do now is open it up for questions.

3.4 Workshop and Process Overview

Steve Bagley, Workshop Coordinator and UDOT Research Technical Writer

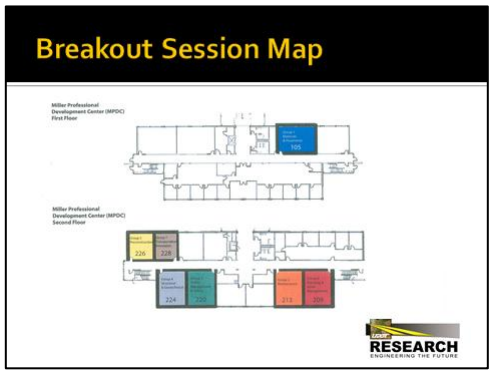
Alright, thank you Carlos, Cory and Cameron. I am new to UDOT. I am Steve Bagley and I have been here for a year-and-a-half, almost two years, and I am this year's coordinator for UTRAC. I am always humbled by our leadership's humility and great poise and the knowledge that they have and how open they are to share their knowledge with us. They are easy to approach and I do appreciate their insight.

I have a few different things to go over with you. It is a little bit of housekeeping. I also want to say thank you to the Research folks who helped put this together: all the papers you see, all the folders you see, the laptops in the classrooms. There they are with their orange on, stuffing folders getting ready for today. I just wanted to say thank you to them because without them and without a team effort this wouldn't have happened today.



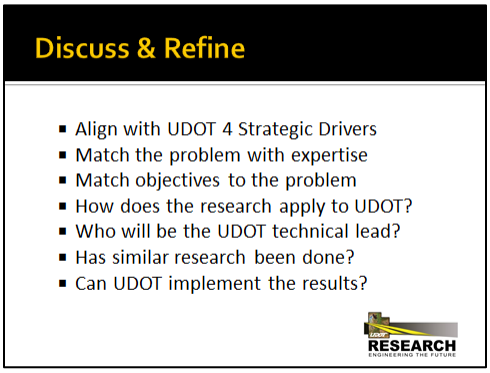
So let's get on with the housekeeping issues and the different things we need to go over. The workshop has been broken down into seven groups this year. As has been mentioned before, the seventh group is new, it's experimental, it's its own sticky little wicket this year. We are going to try to define a little bit more this year to see what we can do with it in the future years to come. However, one through six are your typical, traditional different UTRAC working groups. They all have different room assignments and they are color coordinated. You have maps in your folders. Number one is Materials & Pavements in room number 105. That is on the first floor, if you go straight back this way and hang a left you will see it. Two through six you are all upstairs. Preconstruction is on the right along with Geotech. If you notice there is not a Construction

category this year, so a lot of the problem statements that would fit under that category will most likely be in Geotech in room number 224 which is also upstairs and to the right.



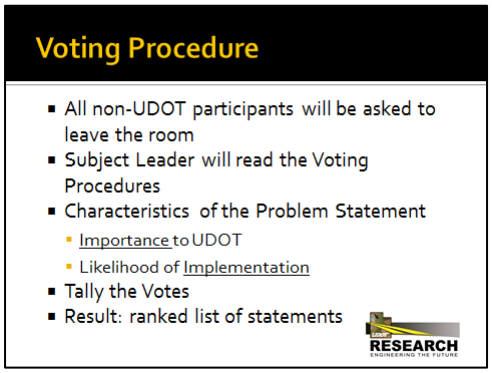
Moving on to the next slide, here is the map in case you get lost and in case some people are visual and this will help you see where the rooms are and those are in your folders.

Also just a little bit of housekeeping, every group is assigned a Subject Leader. They are running the show. They are in charge of that room and everything that goes on in that room with regards to the review process and the voting process. They also have a Research Representative, and they are there to help take notes and to help the Subject Leader in any way. Everyone who has submitted a problem statement has a five minute presentation and you are allowed to use PowerPoint, with the exception of in the Traffic Management & Safety group. We had an overwhelming number of submittals this year. We had over twenty of them and there just isn't enough time for everyone in that group to use PowerPoint. But everyone else, you are allowed to use PowerPoint. During that process of your presentation, if the Subject Leader or the Research Representative would like to refine or add to or take away things to better fit UDOT's needs, they can do that. They do have that authority to do that.



In that discussion and refining process there are a few things to keep in mind. The first and most important is to align the problem statement with the UDOT Strategic Drivers that Carlos mentioned. There are a few other things in there. I won't read them all to you. A lot of them are self-explanatory but it is good to refresh. Another thing to keep in mind is, has similar research been done? How can this be implemented? That is also important because a lot of times you

have good ideas but implementation may be more difficult than you had suspected. I will give you a second to glance at those to make sure you understand a little bit of what's involved here with the refining of the problem statements.



Moving on to the next slide, we have the voting process. Now those of you who have been here before, a few years ago, and maybe you didn't show up for a while and this is your first time coming back. For those of you who are new, this is a good review process because we have changed a few things within the last year or two. I have a bulleted outline here and the biggest one to note is, that the voting procedures in the past used to do a lot of different things with everyone in the room. We found that the best way to meet UDOT needs is to have UDOT folks vote. At one point, the Subject Leaders are going to ask the non-UDOT folks to leave the room so that UDOT folks can focus on UDOT needs and what problem statements fit those needs. The criteria for that is bullet number three. What is the importance or relevance to UDOT, and what is the likelihood of implementation? Those are the two criteria that the Subject Leaders and the people voting will focus on and will discuss in the voting process. At the end, the Research Contact and the Subject Leader will work together to tally up all the votes. Then at some point after today, we will discuss those with the experts in those groups, the senior leaders at UDOT, and identify the ones that will be funded. We will keep in touch with everyone and we will also post on our research website, the results of the UTRAC Council and what they decided to fund so please check our website frequently.

The last slide is about what is going to happen later today. Lunch is at noon and there is a pasta bar. We will line up out here to your left. We will line up at these doors over here and then make your way through the line and enter from those doors over here where you can sit down and enjoy your lunch. That will be at noon; so Subject Leaders please make sure you end your groups at noon. There will be a Trailblazer Award during lunch. If you need more time and your groups didn't have a chance to go through all of the presentations, the reviewing, and the

voting, we do have the building until 3:00 p.m. If you need a little extra time because you aren't done by 3:00 p.m. the building is willing to accommodate that but we do encourage you to be done by 3:00 p.m. Again, please watch the website for updates and results. With that, I am told the coffee has been refilled, so please feel free to stand up and shake the jitters out and go to your breakout sessions. Thank you.

3.5 UTRAC Trailblazer Award Presentation

The 18th UTRAC Trailblazer Award for

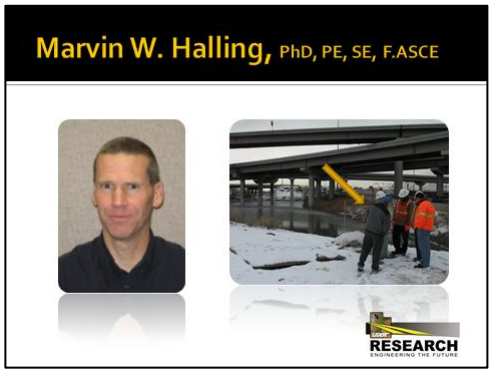
Outstanding Contributions to Transportation Research

2013 Recipient: Marvin Halling

Carmen Swanwick, UDOT Chief Structural Engineer

It is my pleasure to announce Marvin W. Halling as the winner of this Trailblazer Award. I would like to introduce him and give you some facts about Marv. He has a PhD, PE, SE, and Fellow of ASCE. He is a Professor of Civil Engineering at Utah State University and head of the Structural Engineering Department since 2001.

His professional career includes four years of professional consulting in Los Angeles and 19 years as a university faculty member. He has made significant contributions to the profession at both the national level and local level. He received a Ph.D. from Caltech in 1995, an M.S. from Stanford University in 1986 and a B.S. from Utah State University in 1985.



Marv was elected an ASCE Fellow in 2008 following many years of activity in that organization. He served as an Associate Editor for the ASCE Journal of Structural Engineering from 2005 to 2010. He is the Chair of the ASCE Methods of Monitoring Structural Performance Technical Committee, and a member of the ASCE Seismic Effects Committee. He is also a member of a TRB Committee on Field Testing and Nondestructive Evaluation of Transportation Structures. I don't think he has any free time at this point. He served as USU's ASCE Team Advisor from 1996 to 2006, where he was involved in many service and professional activities.

He also served as Advisor to the USU student chapter Tao Beta Pi from 1995 to the year 2000. He has been honored for his contributions in teaching, research and advising, including state college engineering and departmental recognitions. He has authored and co-authored over 90 scholarly publications, including over ten UDOT reports.

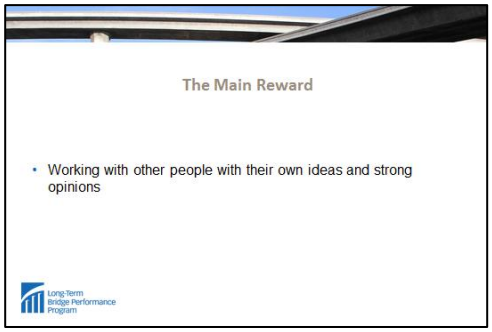
Marv has been involved with UDOT research since the late 1990's. In particular, the I-15 test bed research study that occurred prior to the 2002 Olympics. His recent work has been the Principal Investigator for the long term bridge performance program which has been one of the flagship programs funded by the Federal Highway Administration, and we are very fortunate to have one of those bridges in our state.

Finally, Marv enjoys running, mountain biking, and is a member of a very select group who can ride a unicycle, juggle and play a kazoo simultaneously. Now I would have to say that that takes a lot of talent. So please welcome Marv up here, and I just want to thank him for his contributions to UDOT.

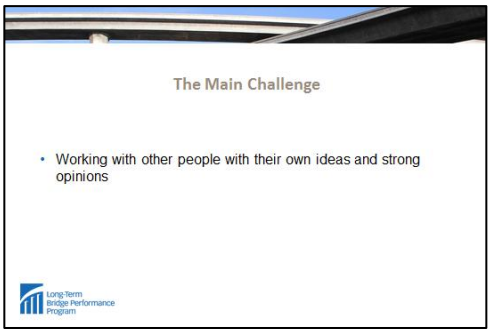
Marvin Halling, Utah State University, Trailblazer Award Recipient

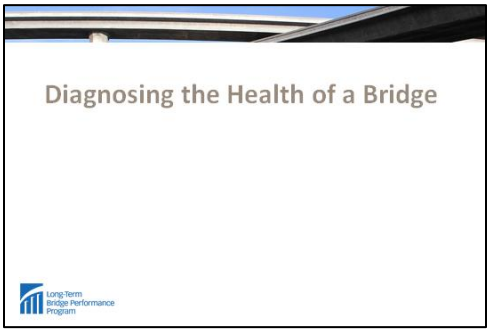
Hello and thank you. I guess I get the opportunity to do a short presentation. I appreciate that introduction; that was very kind. Anyone who would like to see the unicycle, juggling, and kazoo, come on up to Logan anytime and I will demonstrate that. It is quite a sight. I appreciate the opportunity to speak for a few minutes today. I have seen a lot of names on this award over the years that I have been coming, and I am honored to have been selected to be a part of this tradition.

The topic of my presentation today is collaborative research. The things that I wanted to talk about are both the rewards and challenges. I will start off by saying that the main reward of collaborative research is working with other people, their own ideas and strong opinions. Similarly the main challenge of collaborative research is working with other people, their own ideas and strong opinions. Any of you who have done things as a group will recognize that those were both the worst and the best of times. I do feel like that I have been very lucky and honored to be able to work with a lot of people here at UDOT as well as researchers from my own university and other universities within the state and other states.



I would like to talk a couple minutes about diagnosing the health of a bridge. I owe a lot to UDOT. Over the years, I have done quite a few projects with either the Federal Highway Administration or the Department of Transportation. I feel like most of these bridges, I wouldn't have been able to do what I do without the great help from so many people who made that available.

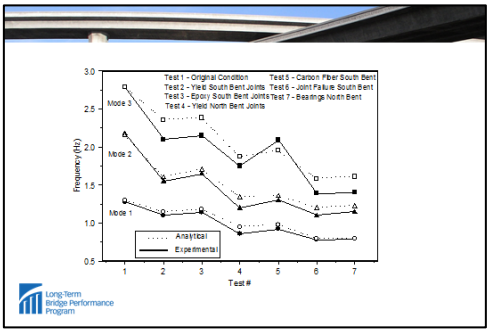


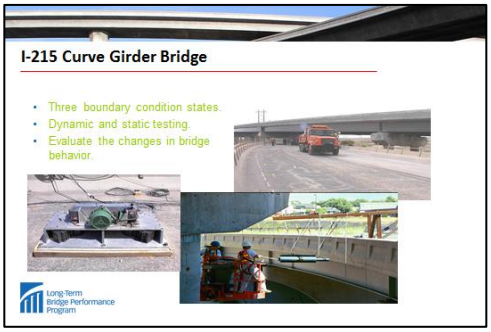


I will talk about previous research that Carmen actually mentioned, the I-15 test bed and some of that work that was done quite a few years ago and some of the current research that I am involved with right now.

I guess the one place to start would be the South Temple bridge. I would certainly need to mention all the people who were involved in this project as well. This project was back when the I-15 corridor was going to be redone. There was a large effort from many at UDOT as well as the universities to create a test bed situation where a significant amount of research could be done. It really turned into a national focus. This particular bridge, the I-15 on South Temple, this particular project involved many researchers from the University of Utah, BYU and ourselves at Utah State and it was very interactive. This is the sister structure here where the northbound structure was demolished down to a single span. Many of you who were out there at that time remember that Chris Pantelides and others from the University of Utah were involved in pushing and pulling on that structure creating damage of various sorts. The piles and abutments were studied. The one part that I was involved with as you can see up on the deck, we actually put a shaker up there, and between each state of damage and repair we were able to shake the structure.

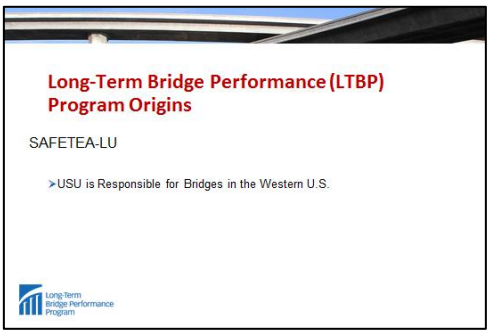
I will show a quick plot showing you the three frequencies and the first three modes of this structure. If you look down here you will see, 1, 2, 3, 4, 5, 6, 7, each time this requires significant coordination in between various universities as well as UDOT personnel. They would push or pull on the bridge, back and forth, cyclic loading. Once the damage had occurred, we would test the bridge dynamically, in other words, vibration. You can see that each time, here is the original of 1, 2, and 3 and when the damage had occurred you could see the changes in the three frequencies indicating a softening of the structure. Then there would be epoxy of the south bent, there would be a recovery and then the damage again, and then the recovery, and then the damage. So this was actually a very significant project because not very often in the field structure are you able to do this much testing on an actual bridge. Quite a few publications came out of this, and again I will recognize the contribution of the Department of Transportation.

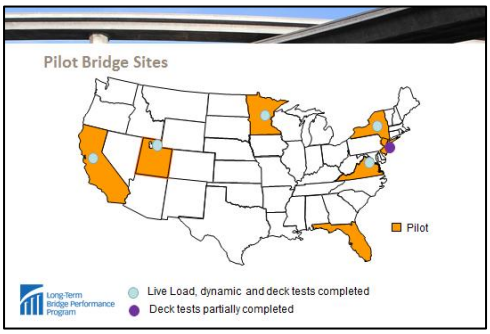




Along with that we did several other projects here on I-215 with this curved girder bridge. We performed some live load testing. Here is our eccentric mass shaking machine, where we are able to vibrate bridges. We had some strong graduate students from Idaho. There is something magical about graduate students from Idaho; they're all very strong. You can't count on the same strength from Utah graduate students. Some are okay but these farm boys from Idaho were able to pull back these, this weighs about 400 lbs, we were able to pull it back and let it go and it would smack up against the bridge. It was dynamic testing using an impact hammer.

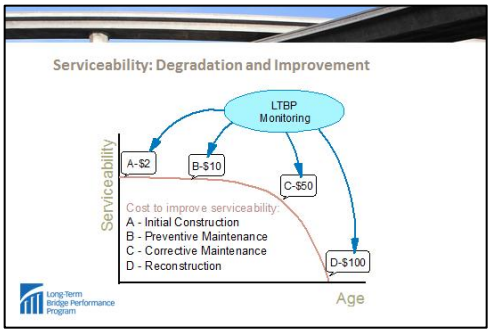
So now I will take just a moment about the long term bridge performance

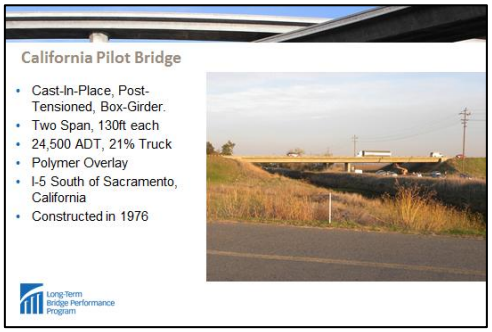




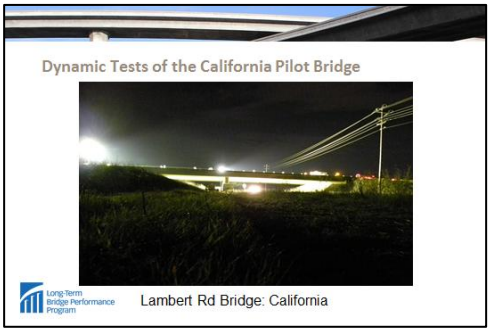
program. USU is responsible for the bridges in the western United States. And I will show a quick map. At this point, as you can see here there are some states in the East that our colleagues like Virginia Tech that we are involved with. The three bridges we have done testing on are here. You have Minnesota, Utah, and one in Sacramento.

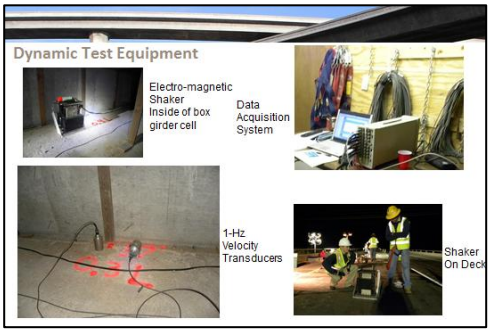
This slide I put in to show a short kind of description of the ideas of the long term bridge performance program. Here is a degradation curve showing age verses serviceability. The end goal of the long term bridge performance program is to have good data in order to base good asset management decisions or decisions about what should be done to care for the infrastructure. There is something on the degradation curve that is always difficult is to determine is when to do an action to a bridge. In this case, I know that the Department has to worry about other assets besides just bridges but this program is focusing on bridges.



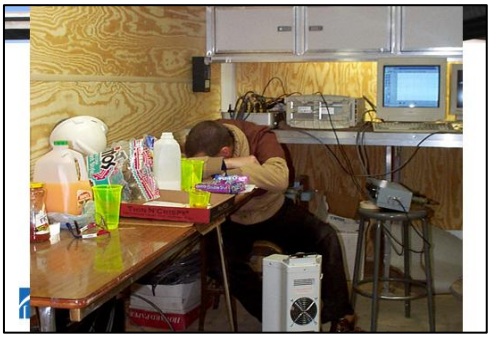


I will just go through these bridges. The bridge in California is a two-span, concrete box girder bridge. Each span is 130 ft. It has significant traffic. It is on the I-5 just south of Sacramento on the way to Los Angeles. Here is a test at night. Most of our testing was done at night because the traffic is a little bit less but as you know, it never stops on I-5. We have some photographs of some of our dynamic testing. A couple of unique things we were able to do here were, we were able to put the shaker and the sensors inside of the boxes. The box girders had enough room that we could hunch over and walk up and down the bridge while the traffic was going up above.

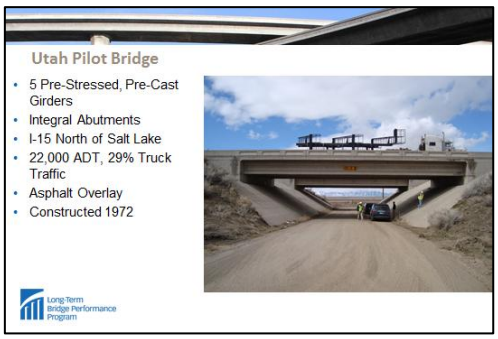


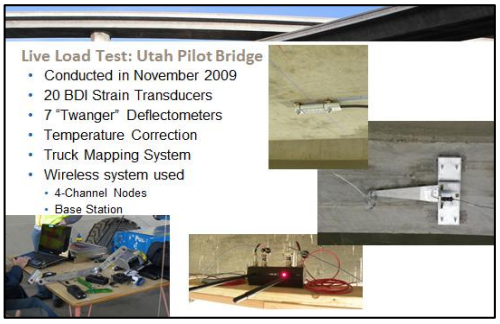


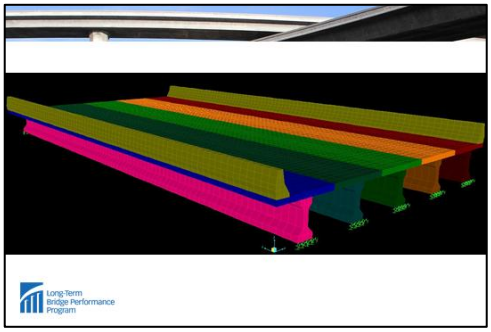
Here am I after a long day working during the night time.



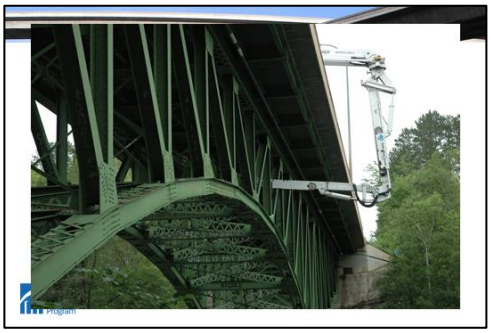
Here is the Utah Pilot Bridge. It is actually a very non-descript bridge on I-15 just north of Perry. It is by the Weigh Station there between North Ogden and Brigham City. It is a single span bridge using pre-stressed, pre-cast girders, and integral abutments. I have a couple of photographs of that. We did some live load testing on this bridge. Here are some pictures of my colleague Dr. Paul Barr leading the trucks down the bridge telling them to go left or right. He is pretty brave to stand in front of those. Here are our sensors. This is a model of that bridge. Here is some of the long term instrumentation. Here are the conduits. Here is up under the bridge where you can see some of the conduit and some of the sensors here. We have strain gauges and temperature gauges, as well as some vibration gauges.



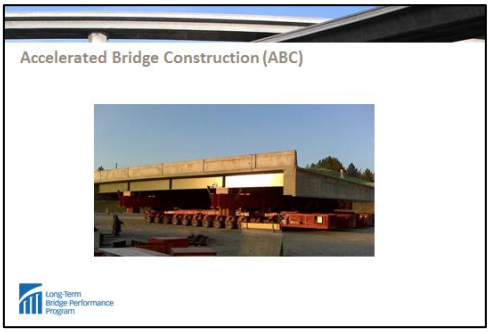




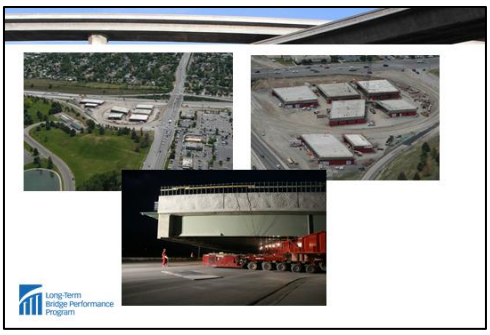
Here is the bridge in Minnesota. It is over a river and it is a three span steel truss. Here we are doing live load tests. In the next picture we are placing sensors under the bridge. It was great to be able to work in this environment.



Another couple of photographs, these are from the accelerated bridge construction here in Utah. I lifted these pictures from somebody's presentation but I can't remember which one. Since we are among friends, I figure we can share these. Just to show some of these, I know many of you are very involved in this.



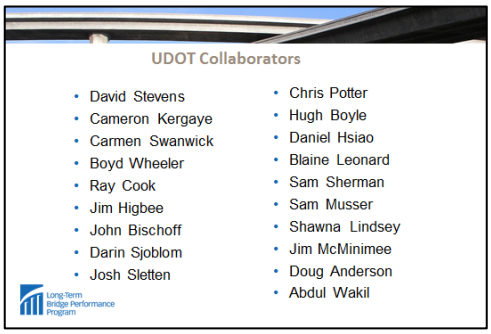
My participation on this, I was able to analyze some data on many of these moves to look at the dynamic effect of picking up and moving and placement of bridges. So I was lucky enough to get to work on some of that data. Here are some more pictures.



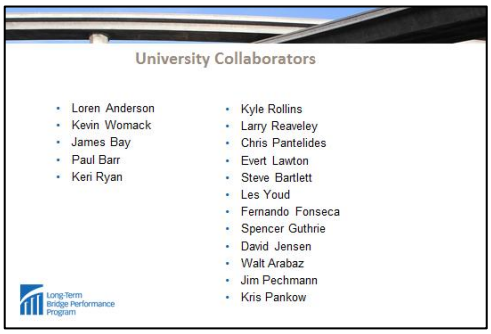
I wanted to talk about our SMASH laboratory. We actually used some of UDOT's girders in our structural lab. In the next picture, there are two girder segments that we are able to lift off of the truck and test to failure in our laboratory. We have dubbed the lab the SMASH lab which stands for Systems, Materials and Structural Health Laboratory. I am proud to say that I came up with that acronym myself. It is amazing that it just sort of churned out those letters.

Here is a photograph where we have a strong wall. As you can see here, currently we have these six girders that were taken from the I-15 CORE project in Provo. We were able to test those for shear capacity. This next photo is of more girders. We tested it for flexure and for shear. Here is one under a structural test.

We have also done several projects that are in the ABC arena. Here we are casting some slabs and we looked at some of the connections of precast test slabs, and we actually cast those slabs in our labs and placed them on steel beams and test them.



I hesitate to put some names up but I am sure I have forgotten some. Thank you to many. I have an abbreviated list of people that I have got to work with here at UDOT and in the past years. It has been a real pleasure for me. Here are some university collaborators that I would also like to acknowledge and again I hope that I haven't forgotten anyone. It has been a great time in my life over the years. To look back, I guess time really flies. It seems like I am just a brand new person working with UDOT but I realize that it actually has been about 19-years now and I appreciate that. Also the great graduate students over the years have helped tremendously. If any of you have done research, you know the graduate students really do the work and the professors just put their names on the papers. I appreciate my wife. I have a nice picture of her there with me. Again, thanks to all of you and I am honored to receive this award.



4.0 RESEARCH PROBLEM STATEMENTS

Each issue considered during the 2013 UDOT Research Workshop is described in a "UDOT Research Problem Statement" form. The statements were prepared and submitted prior to the workshop. The form includes a description of the problem to be addressed and the importance of the research, a suggested champion within UDOT who would monitor and use the results of the work, the objective of the proposed research, the steps anticipated to meet the objective, the anticipated deliverables, a description of how the research results would be implemented at UDOT, and the approximate budget and schedule needed to perform the research. An additional 20 ideas were brainstormed in the Transportation Innovation breakout session.

The Problem Statements and Transportation Innovation ideas selected for funding using UDOT Research Division funds are listed in the following section, followed in the next section by a complete list of all Problem Statements and ideas considered at the workshop. The full text of each Problem Statement considered at the workshop is given in Appendix C, along with a summary of the brainstormed Transportation Innovation ideas.

4.1 Problem Statements and Ideas Prioritized For Funding

During the Research Workshop, each subject area group discussed and prioritized the Problem Statements submitted to their group. After the workshop technical division leaders approved or re-ordered the ranked priority of problem statements, and these priorities were submitted to the Research Division for potential funding. After matching the anticipated available fiscal year 2013 research funding (from federal State Planning and Research [SPR] funds and state Construction funds) with the list of priorities, a list of 27 Problem Statements and Transportation Innovation ideas resulted. A few other problem statements were selected by other divisions to fund with their own funds or to co-fund among divisions; these details are not included in this Proceedings document since they were pending at the time of document preparation.

The 27 Problem Statements and ideas selected for funding with Research Division funds are shown in the tables below including the Problem Statement number and title and the approximate Research Division funding anticipated. The Research Division funding allocated to these projects is $832,000 not including the overhead costs needed to manage the work. Some of these projects will span more than one year, impacting research funding in subsequent years. The full text of Problem Statements for these projects and ideas is given with the others considered at the workshop in Appendix C. More information on new projects is available in the fiscal year 2014 Research Division work program document.

Group 1 – Materials & Pavements

Prob. No.	Title	Duration	UDOT Research	Total Cost
13.01.02	Establishing Low Temperature Property Limits for Asphalt Mixtures	1 Year	$19,000	$29,000
13.01.06	Correlation of Laboratory and Field Friction Measurements to Optimize Utilization of Bituminous Surface Aggregates	15 Months	$45,000	$60,000
13.01.11	Cold-In-Place Recycling (CIR) Phase IV - Performance Mix Design	6 Months	$50,000	$50,000

Group 2 – Maintenance

Prob. No.	Title	Duration	UDOT Research	Total Cost
13.02.05	Development of Mobile Applications for UDOT Maintenance: Phase 2	18 Months	$75,000	$150,000
13.02.06	Implementation of Aerial/Mobile Lidar Technology to Update Highway Feature Inventory	1 Year	$40,000	$40,000
13.02.08	Maintenance Costs and Considerations during Geometric Design			TBD

13.02.09	Driving Costs Savings Using Automatic Digital Device	$1,000	$1,000

Group 3 – Traffic Management & Safety

Prob. No.	Title	Duration	UDOT Research	Total Cost
13.03.03	Characteristics of High Risk Intersections for Pedestrians and Cyclists - Part 2	1 Year	$40,000	$40,000
13.03.11	Flashing Yellow Arrow Uses & Signage	11 Months	$25,000	$25,000
13.03.16	Development of Performance Matrices for Evaluating Innovative Intersections and Interchanges	1 Year	$40,000	$70,000
13.03.17	Calibration of Automatic Performance Measures Speed and Volume Data	1 Year	$90,000	$90,000
13.03.19	I-15 Hot Lanes Study	6-8 Months	$25,000	$25,000

Group 4 – Geotechnical

Prob. No.	Title	Duration	UDOT Research	Total Cost
13.04.02	CONDITIONAL FUNDING: Probabilistic Liquefaction and Lateral Spread Hazard Mapping for Utah County	1 Year	$25,000	$100,000
13.04.04	Evaluation of Finite Difference Approach to Estimating Consolidation Settlement	2 Years	$15,000	$15,000
13.04.06	Effect of Pile Head Geometry on Lateral Resistance	6 Months	$30,000	$30,000
13.04.07	POOLED FUND: Simplified SPT Performance-Based Assessment of Liquefaction and Effects	2 Years	$30,000	$120,000

Group 5 – Preconstruction

Prob. No.	Title	Duration	UDOT Research	Total Cost
13.05.02	Improving UDOT Program Management Business Dynamics	7 Months	$15,000	$15,000
13.05.03	Tacit Knowledge Management	6-12 Months	$20,000	$20,000
13.05.05	Knowledge Management by Peer Exchange	2 Years	$12,000	$72,000

Group 6 – Planning & Asset Management

Prob. No.	Title	Duration	UDOT Research	Total Cost
13.06.02	Asset Management 5-yr Plan	7 Months	$30,000	$60,000
13.06.03	Understanding UDOT's Role in Utah's Air Quality Challenges	3 Months	$50,000	$50,000
13.06.04	Algorithm Development for QA/QC of Asset Management Data and Forecasting of Sign Deterioration	18 Months	$75,000	$150,000
13.06.06	SMA Friction Values		$30,000	$30,000

Group 7 – Transportation Innovation

Prob. No.	Title	Duration	UDOT Research	Total Cost
13.07.03	Precast Concrete Pavements for Urban Intersection Reconstruction	1 - 2 years		TBD
N/A	Digital Construction Site			TBD
N/A	Laser Striping		$20,000	$20,000
N/A	Modular Embankment		$30,000	$30,000

4.2 Summary List of All Problem Statements and Ideas by Group

The following is a complete list of Problem Statements and ideas considered by the various subject area groups at the workshop. Those Problem Statements and ideas that were selected for Research Division full or partial funding in fiscal year 2014 are indicated with a "yellow highlight" over the problem number.

Number	Title
Group 1 – Materials & Pavements (10 Statements)	
13.01.01	Evaluation of Internal Cured Concrete for Pavements
13.01.02	Establishing Low Temperature Property Limits for Asphalt Mixtures
13.01.03	Moved to Group 6
13.01.04	Improved Characterization of In-situ Materials Using DCP for Pavement Design Reconnaissance
13.01.05	Investigation of a new paint sampler as well as coated glass beads
13.01.06	Correlation of Laboratory and Field Friction Measurements to Optimize Utilization of Bituminous Surface Aggregates
13.01.07	Evaluation of concrete sealants
13.01.08	Development of a concrete overlay standard specification
13.01.09	Accuracy of In-Situ Water-to-Cement Meters for Concrete
13.01.10	Withdrawn
13.01.11	CIR Phase IV Performance Mix Design
Group 2 – Maintenance (9 Statements)	
13.02.01	Compare Natural Colored PCCP to Darker Gray Colored PCCP for Snow Melt Potential
13.02.02	CMP culvert lining using shotcrete technology compared to HDPE slip lining and grouting technology
13.02.03	Deicer Induced Dry Road Slickness
13.02.04	Implementation of Recessed Retroreflective Pavement Markers
13.02.05	Development of Mobile Applications for UDOT Maintenance Phase 2
13.02.06	Implementation of Aerial/Mobile Lidar Technology to Update Highway Feature Inventory
13.02.07	Development of Utah highway maintenance prediction model
13.02.08	Maintenance Costs and Considerations during Geometric Design
13.02.09	Driving Cost Savings Using The Automatic Digital Device
Group 3 – Traffic Management & Safety (20 Statements)	
13.03.01	Creating a State-wide IHSDM Data Base for Project-Level Safety Analysis
13.03.02	Calibration of HSM SPF and CMF Functions for Curved Highway Segments
13.03.03	Characteristics of High Risk Intersections for Pedestrians and Cyclists-Part 2

13.03.04	Safety Benefits of Converting HOV Lanes to HOT Lanes
13.03.05	Heavy Truck Safety Study
13.03.06	Safest Path Traffic Assignment
13.03.07	Accident Delay Mitigation for UHP, Incident Management and Motorist
13.03.08	Dynamic Left-turn Phasing
13.03.09	Thermo Reactive Pavement Messages
13.03.10	Truck Inclusion Problem at Signalized Intersections
13.03.11	Flashing Yellow Arrow Uses and Signage
13.03.12	Angled Luminaires
13.03.13	Wheel chair detection loops
13.03.14	Bicycle Utilization
13.03.15	Innovative Intersection Safety Analysis - An Evaluation of Methodologies
13.03.16	Development of Performance Matrices for Evaluating Innovative Intersections and Interchanges
13.03.17	Calibration of Automatic Performance Measures Speed and Volume Data
13.03.18	Variable Speed Limits (VSL's) in Work Zones
13.03.19	I-15 HOT Lanes Study
13.03.20	Evaluating the Feasibility of Creating Virtual Driving Scenarios Using LiDAR Data for Driving Simulators
Group 4 – Geotechnical (7 Statements)	
13.04.01	Monitoring for Early Warning of Large Catastrophic Rock Slope Failures
13.04.02	CONDITIONAL FUNDING Probabilistic Liquefaction and Lateral Spread Hazard Mapping for Utah County
13.04.03	Full-Scale Load Test of a Rigid Drilled Concrete Shaft at Honeyville Research Site
13.04.04	Evaluation of Finite Difference Approach to Estimating Consolidation Settlement
13.04.05	Evaluation of Observational Method in Geotechnical Construction and Design
13.04.06	Effect of Pile Head Geometry on Lateral Resistance
13.04.07	POOLED FUND: Simplified SPT Performance-Based Assessment of Liquefaction and Effects
Group 5 – Preconstruction (5 Statements)	
13.05.01	Evaluation of Cost Savings Associated with CMGC Contracting
13.05.02	Improving UDOT Program Management Business Dynamics
13.05.03	Tacit Knowledge Management
13.05.04	Evaluation of Construction Documentation Procedures
13.05.05	Knowledge Management by Peer Exchange
Group 6 – Planning & Asset Management (7 Statements)	
13.06.01	Developing a Rubric and Best Practices for Conducting Bicycle Counts
13.06.02	Asset Management 5-yr Plan
13.06.03	Understanding UDOT's Role in Utah's Air Quality Challenges

13.06.04	Algorithm Development for QA/QC of Asset Management Data and Forecasting of Sign Deterioration
13.06.05	Innovative Display of Transportation Analysis and Results
13.06.06	SMA Friction Values
13.06.07	Route Advisory For Multi-Modal Routing and Emission Cost Estimation through TravelWise
Group 7 – Transportation Innovation (21 Statements/Ideas)	
13.07.01	Moved to Group 3
13.07.02	Moved to Group 6
13.07.03	Precast Concrete Pavements for Urban Intersection Reconstruction
13.07.04	Moved to Group 5
Unnumbered	Digital Construction Site
Unnumbered	Laser Striping
Unnumbered	Modular Embankment
Unnumbered	Drones
Unnumbered	Workers' Safety
Unnumbered	In Place Recycling
Unnumbered	Better Base for Precast Pavement Slabs
Unnumbered	Utility installation
Unnumbered	Multi-way Roadway
Unnumbered	Risk Communication
Unnumbered	Temporary Construction Striping
Unnumbered	Ideas from Europe
Unnumbered	Large Helical Piles
Unnumbered	Going Vertical
Unnumbered	Missouri Bridge Program
Unnumbered	Reflective Pavement Markers
Unnumbered	Adapting New Technology
Unnumbered	Pre-Formed CMGC Teams
Unnumbered	Split Pipe Diaphragm
Unnumbered	Permanent Deck

APPENDIX A: WORKSHOP AGENDA

- AGENDA -
2013 RESEARCH WORKSHOP

Organized by the UDOT Research Division

Salt Lake Community College – Miller Campus
Karen G. Miller Conference Center (KGMC) and Miller Professional Development Center (MPDC)
9750 South 300 West, Sandy, Utah

Monday, April 8, 2013

Registration (KGMC main foyer):
7:30 – 8:30 am ***Workshop Registration & Light Breakfast***

General Session (KGMC):
8:30 – 9:30 am ***Welcome and Research***
Program Status – *Cameron Kergaye, Research Director*
Introduction of Keynote – *Cory Pope, Program Development Director*
Keynote Address – *Carlos Braceras, Acting Director of UDOT*
Workshop Instructions – *Steve Bagley, Workshop Coordinator*

First Breakout Session by Subject Area (MPDC classrooms):
9:30 am – 12:00 pm ***Problem Statement discussion***
Prioritization voting, Workshop feedback

Featured Subject Areas: (see map for room assignments)

1. ***Materials & Pavements***
2. ***Maintenance***
3. ***Traffic Management & Safety***
4. ***Geotechnical***
5. ***Preconstruction***
6. ***Planning & Asset Management***
7. ***Transportation Innovation***

Workshop Sponsored Lunch (KGMC):
12:00 – 1:00 pm ***Lunch***
Presentation of Trailblazer Award: *Carmen Swanwick, Chief Structural Engineer*

Second Breakout Session by Subject Area (MPDC classrooms):
1:00 – 3:00 pm ***Problem Statement discussion and refinement***
Prioritization voting, Workshop feedback

Adjourn Workshop: 3:00 pm

APPENDIX B: WORKSHOP ATTENDEES

2013 UDOT Research Workshop Attendees

Breakout Groups:

1: Materials & Pavements
2: Maintenance
3: Traffic Management & Safety
4: Geotechnical
5: Preconstruction
6: Planning & Asset Management
7: Transportation Innovation

Name	Company	Breakout Group
Travis Ackermann	UDOT Traffic and Safety	3
Bryan Adams	UDOT Project Development	7
Monte Aldridge	UDOT Region 4	5
Doug Anderson	ATC, LLC	3
Howard Anderson	UDOT Materials	1
Steve Anderson	UDOT Materials	1
Jessica Andrews	UDOT Maintenance	2
Scott Andrus	UDOT Materials	1
Mike Arens	Michael Baker Jr. Inc.	7
Steve Bagley	UDOT Research	5
Dario Batioja	UDOT Maintenance	2
Lynn Bernhard	UDOT Maintenance	2
Tim Biel	CME Transportation Group	1
Jon Bischoff	UDOT Geotechnical	4
Keith Bladen	UDOT Risk Management	3
Amanda Bordelon	University of Utah	1
Carlos Braceras	UDOT Administration	-
Keith Brown	UDOT Geotechnical	4
Shaunna Burbidge	Active Planning	3 & 6
Stan Burns	UDOT Asset Management	6
John Butterfield	UDOT Materials	1
Regis Chen	UDOT Traffic and Safety	3
Rich Crosland	UDOT Region 3	5
Robert Cummings	Saguaro GeoServices, Inc.	4
Lori Dabling	UDOT Preconstruction	5
Joni DeMille	UDOT Research	-
Amalia Deslis	Somers-Jaramillo & Assoc.	7
Fred Doehring	UDOT Preconstruction	7
Paul Egbert	UDOT Region 1	3

Name	Company	Breakout Group
Walter Eggers	Kiewit Infrastructure West	5
Clifton Farnsworth	Brigham Young University	4
Fernando Fonseca	Brigham Young University	1
Brent Gaschler	UDOT Materials	1
John Grant	The Narwhal Group	3
Kevin Griffin	UDOT Maintenance	2
Grant Gummow	UDOT Geotechnical	4
Spencer Guthrie	Brigham Young University	1 & 2
Marv Halling	Utah State University	4
John Haynes	FHWA Utah Division	5
Kevin Heaslip	Utah State University	2
David Holmgren	UDOT Region 1	1
Daniel Hsiao	UDOT Research	4
Christine Isom	Hatch Mott MacDonald	1
Peter Jager	UDOT Traffic Management	3
Ming Ming Jiang	UDOT Traffic and Safety	3
Scott Jones	UDOT Traffic and Safety	3
Cameron Kergaye	UDOT Research	3
Todd Laker	Holcim US Inc.	1
Evert Lawton	University of Utah	4
Bryan Lee	UDOT Materials	1
Blaine Leonard	UDOT Traffic Management	3
Rukhsana (Shana) Lindsey	UDOT Maintenance	2
George Lukes	UDOT Preconstruction	5
Yanguo Ma	CMT Engineering Labortories	1 & 2
Jamie Mackey	UDOT Traffic Management	3
Lonnie Marchant	UDOT Region 2	1
Patrick McGann	UDOT Region 4	2
Mitzi McIntyre	ACPA, Utah Chapter	1
Mike Miles	UDOT Region 4	6
Robert Miles	UDOT Region 2	3
Kevin Mock	Kiewit Infrastructure West	7
Rick Murdock	UDOT Project Development	7
Lloyd Neeley	UDOT Maintenance	2
Jon Nepstad	Fehr and Peers	7
Kevin Nichol	UDOT Research	6
Scott Nussbaum	UDOT Region 1	1
Joseph Perrin	A-Trans Engineering	3
Cory Pope	UDOT Program Development	-
R.J. Porter	University of Utah	2
Amy Rico	UDOT Materials	1

Name	Company	Breakout Group
Matthew Riffkin	InterPlan Co.	6
Kyle Rollins	Brigham Young University	4
Pedro Romero	University of Utah	1
Mitsuru Saito	Brigham Young University	3
Grant Schultz	Brigham Young University	3 & 6
Russ Scovil	UDOT Research	2
Richard Sharp	UDOT Materials	2
Bin Shi	UDOT Materials	1
Darin Sjoblom	UDOT Geotechnical	4
Aaron Smith	Raba-Kistner Infrastructure, Inc	1
David Stevens	UDOT Research	1
Robert Stewart	UDOT I-15 CORE	7
Carmen Swanwick	UDOT Structures	-
Jesse Sweeten	UDOT Region 2	5
John Thomas	UDOT Planning	6
Tim Ularich	UDOT Maintenance	2
Kevin VanFrank	CME Transportation Group	1
Bob Vashisth	Tridex Solutions Inc.	2 & 7
Milan Zlatkovic	University of Utah	3

APPENDIX C: FULL TEXT OF ALL PROBLEM STATEMENTS AND IDEAS

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Evaluation of Internal Cured Concrete for Pavements **No. : UT-13.01.01**

Submitted By: Amanda Bordelon **Organization:** University of Utah

Email: bordelon@civil.utah.edu **Phone:** 801-581-3578

UDOT Champion (suggested): Bryan Lee

Select a Subject Area

- ☒ Materials/Pavements
- ☐ Maintenance
- ☐ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☐ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

Internal curing has been a solution for improved durability (reduced shrinkage cracking and reduced chloride ion ingress) and service longevity of concrete used recently in bridge decks. These same benefits could be utilized in main-stream concrete pavement designs and could even lead to reduced required pavement thickness or other cost-effective designs. Several internal curing concrete pavement sections have been constructed near Dallas, Texas since 2005 which demonstrated a major reduction in random and plastic shrinkage cracking, increase in compressive strengths by about 1000 psi greater, and even fuels savings and reduced equipment wear with concrete using lightweight aggregate fines. This proposed research is to utilize internal curing in a newly-constructed concrete pavement section (a similar experiment to the recent successful bridge deck demonstration) in order to determine the specific material and field performance properties for calibration in the state of Utah.

2. Describe why this research is important and how it is unique.

There is continuously a strong push for more cost-effective and durable concrete pavement designs. The concept of internal curing has been proven feasible as a cost-effective and durable bridge deck design solution in several states as well as here in Utah. Yet the utilization of the lightweight aggregate fines in concrete pavements has yet to be verified for Utah's unique climate zones. Previous material research reports have statements that internal curing can significantly reduce plastic shrinkage cracking, increase strength, decrease modulus of elasticity, and decrease the coefficient of thermal expansion of the concrete. All of these impacts would increase the life of a concrete pavement. It is anticipated that any extra cost of utilizing the unique lightweight aggregate fines would be made cost-effective through a more optimal thinner concrete pavement design. This internal curing design may be of unique solution for the state of Utah with its more arid dry climate to prevent the cracking induced by plastic shrinkage effects.

3. List the research objective(s) to be accomplished:

1. Determine the in-field performance and material properties of the internal cured concrete pavement segment to be used in calibrating ME design procedures for future internal cured concrete pavements.
2. Assess the cost and benefits involved for the incorporation of a fraction of light weight aggregate into the mixture.
3. Measure the cracking performance of the internal cured concrete pavement over a 3 to 5 year period and compare it to the cracking performance of a companion conventional concrete pavement.

4. List the major tasks to accomplish the research objective(s):

1. Identify a new constructed pavement section (at least 1 mile long) which will utilize internal cured concrete with the aid from UDOT in selecting the roadway (this should be a project constructed during summer 2013). Suggest the implementation of alternative mixtures using various lightweight aggregate amounts and variable pavement thicknesses.
2. Instrument the pavement to monitor field performance (strength gain, slab curling and joint opening due to climate and traffic)
3. Cast specimens on the same day as construction of the pavement section in order to estimate material properties
4. Determine material properties in the laboratory at the University of Utah
5. Continuous analysis of instrumentation data
6. Writing, preparation and submittal of the report and presentations
7. Continue to monitor the internally cured pavement segment as well as a nearby companion sections constructed with conventional concrete over a 3 to 5 year time period for distresses.

5. List the deliverable(s) to come to UDOT from this research study:

1. Oral presentation on the instrumentation and preliminary findings will be presented at the UDOT 2013 fall conference.
2. Report summarizing current literature, internally cured concrete mixture and construction procedures, in-field instrumentation and laboratory testing, cost and benefits assessment, results, conclusions and recommendations for future implementation or specifications. This will be submitted to UDOT by August 2014.
3. Final presentation on the findings and future design, testing and implementation recommendations will be presented at the UDOT 2014 conference.
4. Upon future monitoring of the project, up to potentially 5 years of the pavement section service, a final technical document summarizing the section distresses, cracking and any additional implementation recommendations will be provided to UDOT.

6. Describe how the results of this study will be implemented at UDOT.

UDOT has already recently performed projects utilizing the pre-saturated, lightweight aggregate fines in bridge deck projects. Similar approved mixture designs can be implemented by UDOT for the identified pavement section. Results from this study are intended to be used for calibrating the modified inputs in the next generation ME design guide software. These new inputs will be based on the extended service life and adjustments to material properties created with the use of pre-saturated, lightweight aggregate fines in the concrete.

7. Estimated cost - Total: $60,000 **UDOT Share:** $60,000 **Other/Matching Funds:** $to be determined

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

Select a suitable project in cooperation with UDOT where a short internal curing pavement section can be included. This should be a project intended to be constructed during the course of the summer (May through August 2013). Coordination will be made with the ready-mix producer supplying the concrete containing the pre-saturated, lightweight fines. Thermocouples and field instrumentation will be prepared within 2 weeks prior to construction. On the day of construction, several students will be on-site to install instrumentation and to cast standard specimen samples. The material properties will be measured at 28 days from construction from the laboratory specimens. Students will periodically upload field instrumentation recordings and perform crack map surveys at least every 6 months. This monitoring may continue on beyond the 1 year proposed scope, potentially up to 5 years, based on approval from UDOT. A preliminary presentation of findings will be given at the 2013 fall UDOT conference. A report will be handed to UDOT at 1 year after the start of the project and a final presentation will be given at the following 2014 fall UDOT conference which summarizes the findings to-date and the recommendations for implementation in Utah. After the final monitoring, an updated report with an implementation guide will be provided to UDOT.

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Establishing Low Temperature Property Limits for Asphalt Mixtures **No. : UT-13.01.02**

Submitted By: Pedro Romero **Organization:** Univeristy of Utah

Email: romero@civil.utah.edu **Phone:** 801.587.7725

UDOT Champion (suggested): Kevin VanFrank, Howard Anderson, Scott Andrus

Select a Subject Area

- ☒ Materials/Pavements
- ☐ Maintenance
- ☐ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☐ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

Throughout the state of Utah premature pavement failures have been observed that can be directly linked to inadequate intermediate and low temperature properties of the asphalt mixture. This proposal seeks to address this problem by establishing control limits on asphalt mixtures at low temperatures using the BBR. Once the limits have been set, it would give UDOT and contractors the ability to formulate crack-resistance mixtures and balance the high temperature properties with the low temperature properties to ensure longevity of the roads.

2. Describe why this research is important and how it is unique.

UDOT has spend a significant amount of effort in developing a test capable of determining the low temperature properties of asphalt mixtures using the BBR. The first part consisted in development of protocols and validation of the new tests using the Bending Beam Rheometer. The second part, 2011 UTRAC project 11.01-5, was selected to develop actual specifications. Seven sections were selected and cores where obtained from these sections. Using the protocols developed, two out of the seven sections were predicted to crack based on their high modulus. After monitoring these sections during the past severe winter, one of the predicted sections cracked thus providing preliminary validation of the models/specifications. The data suggests that to develop a specification for low temperature performance of mixtures two parameters are needed: modulus (also referred to as stiffness) and the relaxation capacity (referred to as m-value). All the preliminary work has been done so all that is left is to find roads that have cracked to establish the limits of the proposed specification and verify the range of values that can be obtained during normal field production.

3. List the research objective(s) to be accomplished:

1. Validate the specification developed during project 11.01-5
2. Set the limits for modulus and m-value of mixtures to prevent thermal-induced cracking

4. List the major tasks to accomplish the research objective(s):

1. Identify pavement sections that show thermal-induced distresses. They can be state or municipal roads
2. Obtain cores from these sections
3. Perform BBR testing on these cores
4. Relate laboratory to field mixture parameters
5. Based on BBR results, establish the actual values used to create a failure envelope
6. Suggest an implementation strategy on an 'observation' basis

5. List the deliverable(s) to come to UDOT from this research study:

1. A specification value that will show failure envelopes in the form of a MOI
2. The ability to create asphalt mixtures not prone to thermal-induced distresses

6. Describe how the results of this study will be implemented at UDOT.

Once the specification values have been established, mixture data will be collected on a trial basis for several years. Once there is an understanding of the specification limit, it can be incorporated as part of the standard mixture acceptance.

7. Estimated cost - Total: $29,000 **UDOT Share:** $19,000 **Other/Matching Funds:** $10,000

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

Summer 2013- As soon as the project is awarded, a survey of roads will be conducted. This will include UDOT roads as well as municipal roads. Once the road sections have been identified, cores will be taken to the U of U.

Fall 2013 – A detailed survey of the roads will be performed to ensure the predominant distress is low temperature cracking. Simultaneously, the cores will be tested in the lab

Winter 2013-2014 – data will be analyzed and relations will be developed between field cores and laboratory mixtures.

Spring 2014 – Roads will be surveyed after the winter. Specification limits, in the form of a failure envelope will be developed.

Summer 2014 – Projects will be monitored on an 'observation basis' to evaluate the ability of contractors to produce the desire asphalt mixtures

2013 UDOT RESEARCH PROBLEM STATEMENT

*** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ***

Problem Title: Improved Characterization of In-situ Materials Using DCP for Pavement Design Reconnaissance No. :UT-13.01.04

Submitted By: Spencer Guthrie and Aaron Smith
Organization: Brigham Young University and Raba Kistner
Email: asmith@rkci.com
Phone: 801-556-6407

UDOT Champion (suggested): Dave Holmgren

Select a Subject Area

- ☒ Materials/Pavements
- ☐ Maintenance
- ☐ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☐ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

The current practice for pavement design relies on the use of extracted soil samples from roadways. These samples are then transported back to a laboratory for California bearing ratio (CBR) testing of reconstituted samples. This approach has at least two limitations:

1) CBR testing in the laboratory does not necessarily reflect in-place material conditions.
2) Laboratory testing can be time-consuming and cost-prohibitive, requiring approximately 7 working days for each test.

2. Describe why this research is important and how it is unique.

The current standard of practice during pavement design reconnaissance includes removing soil and/or aggregate materials from the roadway section to perform CBR and other tests on disturbed samples. The results of these tests may not be well correlated to the in-situ properties due to differences between field and laboratory conditions. By incorporating the DCP into preconstruction field investigations, UDOT will have the ability to consistently measure the pre-existing stiffness of in-place materials as needed for pavement designs. Key features of a DCP exploration program include:

1) Direct measurement of in-place material properties
2) Measurement of the properties of all pavement layers in a single test
3) Established relationship between DCP penetration rate and CBR value
4) Relatively quick data analysis with no laboratory testing required
5) Relatively quick data collection (around four tests per hour)
6) Sampling program that can be based on statistical methods

Ultimately, using a DCP approach will improve the accuracy of pavement design inputs and result in more efficient pavement designs for UDOT. DCP data can also be used to calibrate backcalculation models as needed for interpretation of FWD data.

3. List the research objective(s) to be accomplished:

1. Evaluate the use of DCP as an economical and technically superior tool for pavement design.
2. Compare DCP-derived results to traditional laboratory CBR test results
3. Develop an MOI for DCP use statewide that incorporates best practices

4. List the major tasks to accomplish the research objective(s):

1. For field testing, select four sites, two in Region 1 and two in Region 2, with preference given to projects under current consideration (for example, along SR 37 from 5200 W to Midland Dr. and along I-15 from 1100 S to 2700 N in Weber County). Perform a series of DCP tests near (within 2 ft) of locations where CBR samples are taken.
2. Select additional sites (four to six in Regions 3 and 4) in the preconstruction phase and perform in-situ DCP tests concurrently with the standard region-level CBR testing program.
3. Collect laboratory CBR results from Regions 1 and 2 for comparison with the results of the corresponding DCP tests. Perform additional CBR tests at the new DCP locations in Regions 3 and 4.
4. Using proper statistical techniques, compare the results of the DCP tests to the laboratory CBR tests to quantify the degree of correlation.
5. Develop an MOI for UDOT personnel to use during preconstruction activities for pavement design. The MOI will discuss the field procedures for collecting DCP information, data analysis, and data interpretation.

5. List the deliverable(s) to come to UDOT from this research study:

1. A research report documenting all procedures and results of both the DCP testing and laboratory CBR testing
2. A draft MOI for DCP use during preconstruction activities
3. A presentation highlighting the key findings and recommendations of the research

6. Describe how the results of this study will be implemented at UDOT.

The DCP MOI would be reviewed with UDOT materials group for implementation. Each region pavements and materials engineer would receive training at an RME meeting for implementation of the DCP program. The MOI would describe recommended frequencies for testing.

7. Estimated cost - Total: $75,000 UDOT Share: $50,000 Other/Matching Funds: $25,000

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

With the start of the 2013 construction season underway, DCP testing would immediately begin at sites in Regions 1 and 2 that have recently been sampled for laboratory CBR tests. Additional preconstruction sites in Regions 3 and 4 could be visited later in the construction season with the goal of completing the field testing in 2013. Analysis and development of the MOI would proceed immediately following data collection. The deliverables would be provided to UDOT within one year after commencement of the program.

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Investigation of a new paint sampler as well as coated glass beads **No. :UT-13.01.05**

Submitted By: Yanguo Ma, PhD **Organization:** CMT Engineering Laboratories

Email: yanguo@cmtlaboratories.com **Phone:** 801 908 5859

UDOT Champion (suggested):

Select a Subject Area

- ☒ Materials/Pavements
- ☐ Maintenance
- ☐ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☐ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

During paint and glass beading sampling and testing, it is found that 1) paint sampling is problemic, complicated and not standardized, and 2) many glass beads adherence coating tests results are negative. Paint sampling issue can influence samples results accuracy and applied road quality. Glass beads with negative adherence coating results can increase road maintenance frequency and cost as well as deteriorate road safety, especially during wintery and rainy weather as well as during night time.

2. Describe why this research is important and how it is unique.

Thus research will solve the above problems, and provide a new paint sampler for Utah and other states agencies, applicators as well as paint manufacturers. No new standardized, cost effective and convenient paint sampler is on the market. Some coated glass beads are available and some cost effective beads needs to be optimized to meet Utah highway's need. All of those will finally prolong highway quality, reduce maintenance cost and improve highway safety.

3. List the research objective(s) to be accomplished:

1. Invent a new, cost effective and convenient paint smapler.
2. Provide coated glass beads products (low cost and high quality).

4. List the major tasks to accomplish the research objective(s):

1. Design a new paint sampler.
2. Fabricate the sampler.
3. Do a comparative test using the new sampler and the conventional method.
4. Investigate available coated glass beads and select 1-3 products for Utah highway.

5. List the deliverable(s) to come to UDOT from this research study:

1. New paint sampler and comparison test results.
2. 1-3 coated glass beads for UDOT references.

6. Describe how the results of this study will be implemented at UDOT.

1. UDOT can refer to the results and see if some related manual and criterions are needed to revise.

7. Estimated cost - Total: $50,000 **UDOT Share:** $ **Other/Matching Funds:** $

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

Month 1-2: Literature review for paint sampling, coated beads, criterions as well as their cost.
Month 3-4: Design a new paint sampler and optimize coated glass beads cost
Month 5-8: Fabricate the sampler
Month 9-10: Test the sampler
Month 11-12: Write the research report.

2013 UDOT RESEARCH PROBLEM STATEMENT

*** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ***

Problem Title: Correlation of Laboratory and Field Friction Measurements to Optimize Utilization of Bituminous Surface Aggregates No. : **UT-13.01.06**

Submitted By: Aaron Smith/Chien Fu Organization: Raba Kistner Infrastructure

Email: asmith@rkci.com/cfu@rkci.com Phone: 801-556-6407

UDOT Champion (suggested): Matt McCormick/Lonnie Marchant

Select a Subject Area

- ☒ Materials/Pavements
- ☐ Maintenance
- ☐ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☐ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

The basis of current UDOT specification requirement for polish value of surfacing aggregates is not supported with statistically adequate correlation. In light of the current level of understanding in substantially reducing the variability of laboratory polish value and field skid number determinations, a statistically significant correlation can be developed between the laboratory and field friction property measurements. The results of the correlation work will serve as the basis to address the engineering and economic considerations. A statistically significant correlation is needed to guide adequate prequalification of surfacing aggregates for the anticipated frictional performance and allow optimal utilization of available bituminous aggregate sources. Other benefits to be considered include enhancing the pavement frictional performance by considering the use of single-sized seal coat gradations and tiered polish value specifications for surfaces with varying friction demands. The proposed research will address the following needs:

1) a statistically significant laboratory and field data correlation as the basis of the polish value specification revision;
2) reasonable prediction of pavement friction performance based on repeatable laboratory prequalification procedure for surfacing aggregates; and,
3) available options for consideration in optimizing the utilization of bituminous surfacing aggregates.

2. Describe why this research is important and how it is unique.

From the engineering and economic perspective, the frictional performance of surfacing aggregates dictates in part the safety of the travelling public and the functional life-cycle of pavement friction. Adequate prequalification of surfacing aggregates and correlation with the pavement frictional performance allows the adequate matching of the friction supplies to the pavement friction demands. The uniqueness of this research is summarized below:

1) Partnership between UDOT, producers, and consultant/researcher to assure success of implementing research findings.
2) Research team's significant and relevant experience from TxDOT and INDOT research, as well as ASTM and AASHTO test methods for aggregate friction determinations.
3) Research approach is built on the premises of validating successful models that had been developed by the same research team
4) The producers will contribute to the cost of prequalification of surfacing aggregates
5) UDOT personnel contributing to the field data collection with the research team's assistance
6) Expediency of data collection and analysis to allow timely delivery of research deliverables.
7) Effective technology collaboration and transfer among the UDOT, producers, and researchers/consultants.
8) A reliable database of aggregate prequalification and pavement friction performance to allow further refinement of the UDOT's Wet Weather Accident Reduction Program.

3. List the research objective(s) to be accomplished:

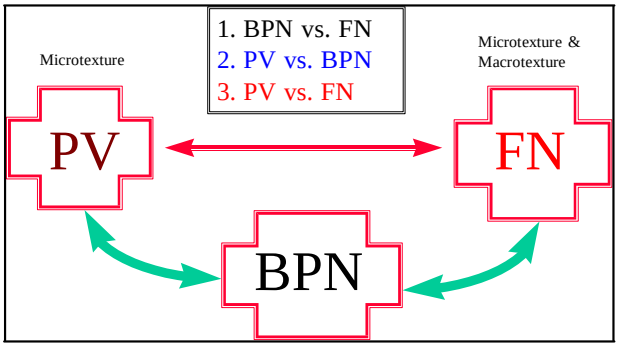
1) Perform laboratory polish value (PV) testing of surfacing aggregates and validate the BPN and PV correlation developed by TxDOT and INDOT.

2) Perform race-track locked-wheel skid testing and develop/validate the correlation between field BPN and locked-wheel Friction Number (FN). Selection of the pavement sections will consider the variations in geography and associated climatic conditions.

3) Monitor and evaluate the effects of cumulative traffic on BPN and FN measurements and develop skid life predication model.

4) Develop a correlation between laboratory PV and field FN.

5) Develop recommendations for selecting and prequalifying surfacing aggregates to meet the pavement friction demand and allowing optimal utilization of bituminous aggregates.



4. List the major tasks to accomplish the research objective(s):

1) Identify eight existing pavement sections (4 in region 1 and 4 in region 2) of known surfacing aggregate sources which have a history of consistency in production and mineralogical compositions. UDOT to secure aggregate samples from these sources and researcher will perform laboratory testing for PV and BPN and compare PV results produced from the current standard to that of the project records.

2) For the 8 selected pavement sections identified in 1) above – (a) asses the cumulative vehicle passes per lane (VPPL) data from traffic map and pavement age, (b) UDOT identify surfaces representative of the aggregate quality and perform race-track skid (FN) testing, (c) UDOT perform BPN testing within the same skid paths, (d) perform FN and BPN testing in two cycles in a year to represent Spring thaw and Fall pavement conditions.

3) Select 8 new pavement sections (2 in each of the 4 regions) in the preconstruction phase – (a) researcher perform laboratory PV testing of submitted aggregate sources, (b) research team establish 2 to 3 comparisons between the standard and single-sized seal coat aggregate gradations, and (c) research team develop skid history (FN) correlation with cumulative VPPL.

4) Research team will develop a MOI for UDOT personnel to use during field testing of FN and BPN. The MOI will include the procedures for collecting FN and BPN data.

5) Using proper statistical technique, research team will evaluate the results of the laboratory PV and field FN values, and develop a correlation between the two.

6) Logistics support is anticipated from UDOT for locked-wheel skid testing and necessary traffic control when BPN testing in the skid path is deemed necessary.

5. List the deliverable(s) to come to UDOT from this research study:

1. A research report documenting (a) all procedures and results of both the field and laboratory testing, (b) findings and discussions of data trends and analyses, and (c) surfacing aggregate design and selection recommendations and options for consideration to balance predictable friction supply with the pavement frictional demands.

2. A draft MOI to outline guidelines in the material and pavement type selections to meet the pavement frictional demands.

3. A presentation highlighting the key findings and recommendations of the research.

6. Describe how the results of this study will be implemented at UDOT.

The correlation between PV and FN, with the associated traffic and geometric considerations, will serve as the basis of aggregate material and pavement type selection. Tiered PV specification values are envisioned to appropriately match the aggregate friction supplies to the pavement friction demands. Research findings and highlights will be presentation to the UDOT RME group for consideration of a specification modification. The draft MOI will serve as the basis for region pavements and materials engineer to optimize the utilization of bituminous aggregates, giving consideration to both engineering and economic impacts.

7. Estimated cost - Total: $60,000 UDOT Share: $45,000 Other/Matching Funds: $15,000

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

The proposed data collection for the Regions 1 and 2 pavement sections and surfacing aggregates could start immediately. The laboratory work and field testing could begin once sites are screened and selected, likely within one to two weeks of receiving notice to proceed. The new pavement sections in Regions 3 and 4 will be visited later in the construction season with the goal of completing the initial field testing in 2013. Follow up field testing with increased cumulative VPPL will be performed by the Regions 3 and 4 personnel, and the researcher will evaluate and update the PV and skid history correlations. Analyses and development of the MOI and PV and FN correlations would proceed immediately following data collection. The deliverables would be provided to UDOT within 15 months after commencement of the program.

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Evaluation of concrete sealants **No. : UT-13.01.07**

Submitted By: Fernando Fonseca and Christine Isom **Organization:** Brigham Young University

Email: ffonseca@et.byu.edu **Phone:** 801-422-6239

UDOT Champion (suggested):

Select a Subject Area

- ☒ Materials/Pavements
- ☐ Maintenance
- ☐ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☐ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

This research will address the performance of concrete sealers when used in Utah. Deicing salts and/or similar products are commonly broadcast over bridge decks during winters. The resulting chloride ion saturated solution can penetrate into the concrete and the ions can corrode the reinforcing bars. The use of concrete deck and crack sealants is one method to prevent ion intrusion. Although sealants are commonly used throughout the United States, including in Utah, little is known about their performance. Furthermore, the effectiveness of sealants exposed to cycles of freezing and thawing is unknown.

2. Describe why this research is important and how it is unique.

This research is important because it will quantitatively evaluate the performance of concrete sealants when used in Utah. Paragraph A of Article 2.1 of UDOT Section 03393 was recently replaced. The original approved material was a low viscosity, low modulus, two-component, epoxy based system while the new approved material is a low viscosity, low modulus polymer or high molecular weight methacrylate (HMWM) system. Such a change prompted engineers to ask several questions including "Is a HMWM system the best concrete surface and crack sealer system available?" "Could a HMWM system and a silane system be used in combination: the HMWM as the crack sealer and the silane as the surface sealer?" Questions such as these need to be answered and this research will attempt to answer them. This research will focus on the performance of concrete sealants to be used specifically in Utah. Such an evaluation will provide UDOT Engineers specific-to-Utah data to help during the decision making process. An effective sealant can prolong deck life, saving UDOT a significant amount of money.

This research is unique in two ways: it will test concrete sealants on Utah deck materials and it will determine the performance of these sealants under cycles of freezing and thawing.

3. List the research objective(s) to be accomplished:

Determine the effectiveness and relative performance of commercially available concrete sealants when used in Utah.

4. List the major tasks to accomplish the research objective(s):

1. Conduct a comprehensive literature review
2. Determine the sealants to be tested
3. Cast specimens. Two types of specimens will be used: those for concrete surface sealants and those for crack sealants
4. Submit specimens to freeze-thaw cycles
5. Determine specimens resistance to chlorine ion intrusion
6. Write report summarizing findings

5. List the deliverable(s) to come to UDOT from this research study:

A final research report and a final oral presentation

6. Describe how the results of this study will be implemented at UDOT.

The evaluation will provide UDOT engineers specific-to-Utah data to help during the decision of what product or combination of products is more effective to seal concrete decks and cracks.

7. Estimated cost - Total: $120,000 **UDOT Share:** $120,000 **Other/Matching Funds:** $0

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

The proposed duration of this project is 24 months. Months 1 to 6: tasks 1 and 2 will be completed; months 7 to 12: task 3 will be completed and task 4 will be initiated; months 13-18: task 4 will be finished and task 5 will be initiated; months 19 to 24: tasks 5 and 6 will be completed.

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Development of a concrete overlay standard specification **No. UT-13.01.08**

Submitted By: Fernando Fonseca and Christine Isom **Organization:** Brigham Young University

Email: ffonseca@et.byu.edu **Phone:** 801-422-6239

UDOT Champion (suggested):

Select a Subject Area

- ☒ Materials/Pavements
- ☐ Maintenance
- ☐ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☐ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

UDOT does not currently have a concrete overlay standard specification. For a recent Utah overlay project, engineers used an Idaho DOT specification as the basis for the development of a concrete overlay special provision (Section 03381S – Project #F-184-6(107)92). The special provision included the use of silica fume and latex modified concrete overlays and was approved for the project; however, it needs further validation and refinement to be used as a standard specification in the State of Utah. The purpose of this research is to address the lack of a UDOT standard specification for concrete overlay.

2. Describe why this research is important and how it is unique.

A concrete overlay is approximately three times less expensive than a full deck replacement. Utah has had several concrete overlay projects completed to date. The results of these projects are varied: some have been successful while others have not. UDOT engineers are, therefore, reluctant to fully embrace the technology. This research is important because it will address the lack of a UDOT standard specification for concrete overlay; possibly saving UDOT a significant amount of money on deck rehabilitation projects. This research is unique because it will test concrete overlay materials specifically on Utah bridge deck sections, which have been constructed using local materials and have been subjected to the harsh Utah environment. Furthermore, curing of specimens will be accomplished in situ and in laboratory conditions designed to simulate the environmental conditions of Utah.

3. List the research objective(s) to be accomplished:

Refine and validate UDOT's concrete overlay special provision so it can be used as a standard specification.

4. List the major tasks to accomplish the research objective(s):

1. Conduct a comprehensive literature review
2. Obtain, if possible, sections of concrete decks from deck replacement projects; if these are not available, specimens will be cast
3. Prepare surface of decks according to surface removal specifications as well as with reasonable variations from specifications
4. Use silica fume concrete and latex modified concrete as overlay materials. Apply overlays as per manufacturers' specs as well as with reasonable variations from specifications
5. Cure overlays as per manufacturers' specifications as well as using reasonable variations from specifications
6. Test specimens
7. Write report summarizing findings
8. Write a proposed UDOT concrete overlay standard specification

5. List the deliverable(s) to come to UDOT from this research study:

A final research report, a final oral presentation, and a proposed UDOT concrete overlay standard specification

6. Describe how the results of this study will be implemented at UDOT.

The validated standard specification can be implemented by UDOT, giving UDOT an option for deck rehabilitations that is significantly less expensive than full deck replacement

7. Estimated cost - Total: $120,000 **UDOT Share:** $120,000 **Other/Matching Funds:** $0

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

The proposed duration of this project is 24 months. Months 1 to 6: tasks 1 and 2 will be completed; months 7 to 12: task 3, 4 and 5 will be completed; months 13-18: task 6 will be completed; months 19 to 24: tasks 7 and 8 will be completed.

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Accuracy of In-Situ Water-to-Cement Meters for Concrete **No. UT-13.01.09**

Submitted By: Amanda Bordelon **Organization:** University of Utah

Email: bordelon@civil.utah.edu **Phone:** 801-581-3578

UDOT Champion (suggested): Scott Strader

Select a Subject Area

- ☒ Materials/Pavements
- ☐ Maintenance
- ☐ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☐ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

A Microwave *In-Situ* Water-to-Cement Meter has been purchased to be used for DOT quality control and quality assurance by the inspector personnel to identify whether the concrete delivered to a job site meets the requested water-to-cement ratio. This same meter is intended to aid inspectors for estimating the target concrete strength while the concrete is still fresh. If the concrete hardens, it becomes more costly to the contractor and time-consuming to the owner to have to remove and re-construct any concrete that does not meet the desired specifications. Currently UDOT personnel are required to either 1) take a sample of the fresh concrete to a laboratory site to perform the AASHTO T 318 standard for w/c ratio using a microwave, or 2) wait until concrete has hardened and test core samples in compressive strength to back-calculate an estimated w/c ratio. The use of an *in-situ* w/c meter would allow for an immediate determination of the concrete mixture's w/c ratio. However, the accuracy of the w/c meter is not well understood, especially the accuracy as it relates to changes in mixture proportioning, use of admixtures, or aggregate moisture status. Therefore a study on the accuracy of the w/c meter is desired to assist UDOT personnel in understanding whether the readings in the field are accurate for deciding to accept or reject a concrete mixture.

2. Describe why this research is important and how it is unique.

If the *in-situ* w/c meter for concrete is accurate for the majority of the concrete mixtures used by UDOT, this device would allow for QC/QA inspector personnel in UDOT to have an immediate on-site tool for aiding in whether the mixture should be accepted or rejected before the concrete is allowed to set and harden. The use of an accurate on-site w/c meter would assist UDOT in reducing costs and time associated with concrete batch rejections and re-construction. Some previous work has already been done on calibrating the *in-situ* microwave w/c meter for various water contents and aggregate types. The proposed research is unique because the use of additional materials added to concrete (admixtures, supplementary cementitious materials, pre-saturated lightweight aggregates, and fibers) has not been studied for their influence on the determined w/c ratio using this type of in-situ microwave meter. It is hypothesized that the use of these materials in a concrete mixture may significantly alter the magnitude of w/c ratio indicated by the meter and therefore reduces accuracy.

3. List the research objective(s) to be accomplished:

1. Determine the influence on the w/c ratio reading from the *in-situ* microwave meter from various materials or admixtures added to the concrete for UDOT projects.
2. Develop a recommendation on the accuracy of the w/c ratio meter based on tested materials added in UDOT concrete mixtures.

4. List the major tasks to accomplish the research objective(s):

1. Perform a literature review on studies using *in-situ* w/c meters or other w/c ratio determination methods.
2. Review current UDOT standards to tailor research to cover the range of w/c ratios and materials implemented for UDOT concrete mixtures.
3. Select control "calibration" mixtures using only water and cement to determine the calibration curve for the w/c meter.
4. Mix a matrix of concrete mixtures with the addition of: air-entrainer, water-reducer, fly ash, slag, silica fume, lightweight aggregates, synthetic micro-fibers, or steel macro-fibers.
5. Test the previous matrix and control calibration concrete mixtures using the w/c *in-situ* meter, using the AASHTO standard w/c test, hardened concrete cube and cylinder compressive strengths.
6. Determine w/c ratio of select hardened concrete specimens using microscopic image analysis (can be performed at the University of Utah or through a third party organization).
7. Develop calibration curves and estimate accuracy based on different testing techniques for determining w/c ratio
8. Create recommendations for utilizing the w/c meter in the field based on selected materials added to concrete mixtures.

5. List the deliverable(s) to come to UDOT from this research study:

1. Have a mid-year meeting to report the latest findings and status on testing.
2. Oral presentation on results and recommendations will be presented at the UDOT conference for fall 2014.
3. A technical report summarizing literature, test methodology, results, and recommendations. This will be submitted to UDOT by August 2014.

6. Describe how the results of this study will be implemented at UDOT.

Assuming a calibration curve can be made or a list of materials and mixture design parameters can be known for when the w/c ratio meter is accurate, then this meter can be used for future field by QC/QA or inspector personnel in the field to assist in determining whether to accept or reject a concrete mixture delivered to a project site.

7. Estimated cost - Total: $25,000 **UDOT Share:** $25,000 **Other/Matching Funds:** $to be determined

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

A student should be selected to work on this project. Since the w/c meter is already there at UDOT central materials facility, the student could be hired on as an intern for a period of time to perform the necessary evaluation of the device. A tentative start date would be August 2013, however this can be altered due to availability of funds or required student time. The literature review will be ongoing starting in the fall of 2013 until the time the report is written and submitted to UDOT. The matrix of concrete mixtures and testing will be performed primarily during the fall months of 2013, with the microscopic image analysis will be arranged and performed in the spring 2013. A mid-year will be held around December of 2013. The final report will be submitted to UDOT by July 2014 for review, with edits completed by August 31, 2014.

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Cold-In-Place Recycling (CIR) Phase IV - Binder Content Evaluation **No. UT-13.01.10**

Submitted By: Tim Biel/Kevin VanFrank **Organization:** CME Transportation Group

Email: tim@cmetg.com **Phone:** 801-870-6740

UDOT Champion (suggested): Howard Anderson

Select a Subject Area

- ☒ Materials/Pavements
- ☐ Maintenance
- ☐ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☐ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

This is part 4 of a multi-part project. UDOT is in the middle of updating their laboratory design and field testing protocols and controls for Cold-in-place Recycling (CIR) procedures for pavement rehabilitation. Part of the update of these practices includes the development of new end-result performance procedures that can be used in the lab and field to get good materials information in a timely manner to aid in the evaluation of the construction processes and determine proper opening times to traffic. To develop these procedures, evaluation of field data must be collected from upcoming projects to use in getting a better understanding of how the materials react and perform during the construction and placement processes.

2. Describe why this research is important and how it is unique.

The use of CIR to reclaim and rehabilitate pavements has been shown to significantly reduce costs (25% TO 33%) compared to that of using virgin materials. The current versions of these tools utilize a solvent-less emulsion that provides for significantly shorter curing times and earlier opening to traffic. UDOT has fully adopted these pavement rehabilitation practices, however the current procedures used to design, control and evaluate the construction of these materials are time consuming and expensive, and have not been able to prevent some pavement failures due to inadequate timeliness and applicability of test results.

In Phase I, UDOT Central Materials identified three potential CIR projects for the 2011 Summer that presented an opportunity to develop field protocol for sampling, preparing and testing CIR mixes in the field and in the lab. These protocols have been developed and can now be used to produce consistent samples for performance evaluation and optimization of the mix.

Phase II is currently underway and is focused on the evaluation of potential field tools for the use of evaluation of the CIR field mixes for opening to traffic. Evaluations will be performed on the I-84, Henefer to Echo project and will include correlation of field testing and lab testing using protocols from Phase I.

The importance of the research lies in the possible loss of very cost-effective rehabilitation practices due to a lack of proper materials control practices and subsequent failures of the processes. CIR has become increasingly important tools for Pavement Management Engineers to use in the rehabilitation of pavements based on continued constrictions in blue-book funding. CIR is a tool that meets purple-book/rehabilitation guidelines.

3. List the research objective(s) to be accomplished:

1. Determine if CIR materials can be run in the HWT with any effectiveness
2. Maximize binder content without sacrificing rutting

4. List the major tasks to accomplish the research objective(s):

1. Develop mix designs based on current UDOT projects and practices
2. Prepare samples using linear kneading compactor and gyratory compactor
3. Perform HWT testing on samples, including replicates if successful
4. If HWT testing is successful, perform testing on standard mix + 0.25%, 0.5%, 0.75% and 1.0% additional emulsion
5. If HWT testing is successful, perform testing on standard mix - 0.5% emulsion
6. Perform additional replicates as defined by TAC

5. List the deliverable(s) to come to UDOT from this research study:

1. UDOT MOI Draft Protocol: Hamburg Wheel Tracker testing protocol for CIR mixes, with appropriate performance targets
2. Appropriate criteria for determining the maximum emulsion content for CIR mix designs

6. Describe how the results of this study will be implemented at UDOT.

The goal is that the new protocols can be used immediately to modify the current CIR specifications for project design and control. Results would likely take the form of special provisions for a construction season to address any concerns and applications issues, and to allow the contracting industry time to acclimate.

7. Estimated cost - Total: $50,000 **UDOT Share:** $50,000 **Other/Matching Funds:** $0

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

Estimated start date would be as early as July 1, 2012, beginning with a strategy meeting with UDOT and Industry and a review of surrounding state practices for states using CIR mixes. This effort would be expected to take about a month.

Materials sampling is dependent upon the schedule of the projects, but would be expected to be initiated and completed this construction season (2012) as mixes will be lab constructed using individually sampled materials in the field. Performance of lab testing is expected to take 4 to 6 weeks.

Summary of the data and protocols would be expected to take a couple additional months, giving an estimated completion date around January 1, 2013.

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Cold-In-Place Recycling (CIR) Phase IV - Performance Mix Design **No. UT-13.01.11**

Submitted By: Tim Biel/Kevin VanFrank **Organization:** CME Transportation Group

Email: tim@cmetg.com **Phone:** 801-870-6740

UDOT Champion (suggested): Howard Anderson/Scott Andrus

Select a Subject Area

- ☒ Materials/Pavements
- ☐ Maintenance
- ☐ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☐ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

This is part 4 of a multi-part project. UDOT is in the middle of updating their laboratory design and field testing protocols and controls for Cold-in-place Recycling (CIR) procedures for pavement rehabilitation. Part of the update of these practices includes the development of new end-result performance procedures that can be used in the lab and field to get good materials information in a timely manner to aid in the evaluation of the construction processes and determine proper opening times to traffic. To develop these procedures, evaluation of field data must be collected from upcoming projects to use in getting a better understanding of how the materials react and perform during the construction and placement processes.

2. Describe why this research is important and how it is unique.

The use of CIR to reclaim and rehabilitate pavements has been shown to significantly reduce costs (25% TO 33%) compared to that of using virgin materials. The current versions of these tools utilize a solvent-less emulsion that provides for significantly shorter curing times and earlier opening to traffic. UDOT has fully adopted these pavement rehabilitation practices, however the current procedures used to design, control and evaluate the construction of these materials are time consuming and expensive, and have not been able to prevent some pavement failures due to inadequate timeliness and applicability of test results.

Phases I-III were designed to develop the protocols for sampling and testing of the CIR material using conventional and mix performance testing practices with the goal of creating a series of tests that could be used for mix design purposes. The focus of phase IV is to begin using the procedures identified and developed to define and optimize the blend of emulsion, lime and aggregate, thereby creating a performance based mix design process that can be used for UDOT projects.

The importance of the research lies in the possible loss of very cost-effective rehabilitation practices due to a lack of proper materials control practices and subsequent failures of the processes. CIR has become increasingly important tools for Pavement Management Engineers to use in the rehabilitation of pavements based on continued constrictions in blue-book funding. CIR is a tool that meets purple-book/rehabilitation guidelines.

3. List the research objective(s) to be accomplished:

1. Perform Trial Run of CIR Mix Design Process on one fine and one coarse RAP source
2. Evaluate the impact of lime slurry on the performance of the CIR designs

4. List the major tasks to accomplish the research objective(s):

1. Identify RAP and Emulsion Source
2. Perform Marshall Stability testing for strength on a range of emulsion contents
3. Perform AMPT/Flow Number testing for fatigue on a range of emulsion contents
    a. AMPT Values could be supplemented with BBR testing on CIR mix
4. Perform SCBB testing for cracking resistance on a range of emulsion contents
5. Identify optimum emulsion content for each gradation
6. Repeat performance testing on optimum blend without lime slurry

5. List the deliverable(s) to come to UDOT from this research study:

1. Proposed CIR mix design process for implementation
2. Proposed Threshold value for acceptance of mix design
3. Recommendation on inclusion of lime slurry in CIR

6. Describe how the results of this study will be implemented at UDOT.

The intent is that the new design process can be used immediately to modify the current CIR specifications for mix design and control, allowing the removal of the current sole-source requirements in the specification. Proposed mix design process would also provide alternative to current mix design process that is patented by industry.

7. Estimated cost - Total: $50,000 **UDOT Share:** $50,000 **Other/Matching Funds:** $0

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

Estimated start date would be as early as July 1, 2013, beginning with a strategy meeting with UDOT. This effort would be expected to take about a month.

Research proposal is based on the use of UDOT AMPT test equipment for modulus and flow number determination.

Materials sampling is dependent upon the schedule of the projects, but would be expected to be initiated and completed this construction season (2013) as mixes will be lab constructed using individually sampled materials from the field. Performance of lab testing is expected to take 6 to 12 weeks, depending on starting date.

Summary of the data and protocols would be expected to take a couple additional months, giving an estimated completion date around January 1, 2014.

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Compare Natural Colored PCCP to Darker Gray Colored PCCP for Snow Melt Potential **No. UT-13.02.01**

Submitted By: Barry Sharp **Organization:** UDOT Materials Division-Central

Email: rsharp@utah.gov **Phone:** 801 965 4314

UDOT Champion (suggested): Kelly Barrett, Region One District Engineer

Select a Subject Area

- ☐ Materials/Pavements
- ☒ Maintenance
- ☐ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☐ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

While concrete pavement offers a durable surface and long service life, selected areas require expensive winter maintenance treatments to clear snow and ice. Does darkened PCCP clear ice and snow more readily than natural colored PCCP?

2. Describe why this research is important and how it is unique.

The darkened PCCP presumably will melt snow and ice more quickly with the same removal treatment than natural colored PCCP. This research will allow examination of the benefits of the lower albedo of darkened concrete, which should promote higher pavement surface temperatures through absorption of radiation energy from the sun. The use of darkened concrete will be especially valuable in areas of the state where sustained freezing temperatures warrant significant maintenance during winter.

3. List the research objective(s) to be accomplished:

1. Determine the effectiveness of darkened PCCP for ice removal versus natural colored PCCP

4. List the major tasks to accomplish the research objective(s):

1. Install darkened PCCP and compare the ice clearing capabilities to natural PCCP
2. Install pavement and weather probes during paving of at least two test areas, darkened and natural
3. Evaluate the test areas through direct visual observation, infrared thermography, and monitoring of the probe data for a

comparative evaluation

5. List the deliverable(s) to come to UDOT from this research study:

1. Research report documenting all findings and recommendations from study
2. Oral presentation

6. Describe how the results of this study will be implemented at UDOT.

1. Darkened PCCP will be used in selected areas where needed

7. Estimated cost - Total: $30,000 **UDOT Share:** $ **Other/Matching Funds:** $

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

1. Install test areas on 10th West site during the summer of 2013, with the exact location TBD
2. Instrument 250 LF of darkened PCCP and 250 LF of natural colored PCCP
3. Collect and evaluate data for three winters to develop criteria and recommendations

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: CMP culvert lining using shotcrete technology compared to HDPE slip lining and grouting technology.

No. UT-13.02.02

Submitted By: Patrick McGann **Organization:** UDOT

Email: pmcgann@utah.gov **Phone:** 435-259-5030 x24

UDOT Champion (suggested): ?

Select a Subject Area

- ☐ Materials/Pavements
- ☒ Maintenance
- ☐ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☐ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

Lining deteriorated CMP culverts in remote areas in a cost-effective, structurally sound manner using shotcrete technology compared to HDPE slip lining and grouting technology.

2. Describe why this research is important and how it is unique.

Shotcrete lining of deteriorated CMP culverts in remote areas offers potentially significant savings over HDPE slip lining and grouting technology.

3. List the research objective(s) to be accomplished:

1. Will shotcrete lining lend structural soundness to ongoing deterioration of CMP culverts in hot soils?
2. Cost savings of shotcrete lining technology compared to HDPE slip lining and grouting technology.

4. List the major tasks to accomplish the research objective(s):

1. Fund a shotcrete lining project and a HDPE lining/grouting project in similarly deteriorated culverts located adjacent to each other in the same soil conditions.
2. Compare the cost of each project, taking into account contractor mobilization, direct UDOT maintenance crew involvement, ease and speed of installation, etc.
3. Monitor both installations for an appropriate time period to determine long-term effectiveness and structural soundness of lined culverts.
4. Perform a national search to identify other states installations to determine the trend in performance and durability along with cost.

5. List the deliverable(s) to come to UDOT from this research study:

1. Provide an alternative lining strategy for critical culverts.
2. Using the historical installation nationwide data provide the cost effectiveness of shotcrete verses HDPE or provide a guide to determine when it would be feasible to use the different types of installation.

6. Describe how the results of this study will be implemented at UDOT. The study would help Maintenance to have different tools to maintain the culverts using a successful technologies that is proven through research.

7. Estimated cost - Total: $120,000 **UDOT Share:** $ **Other/Matching Funds:** $

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

Once the contract is signed, the installation should be done this summer and the monitoring time should be at least 18 months along with the data from other states.

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Deicer Induced Dry Road Slickness **No. : UT-13.02.03**

Submitted By: Lynn Bernhard & Roger Frantz **Organization:** Maintenance Planning Division

Email: lynnbernhard@utah.gov **Phone:** 801-965-4094

UDOT Champion (suggested): Lynn Bernhard & Roger Frantz

Select a Subject Area

- ☐ Materials/Pavements
- ☒ Maintenance
- ☐ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☐ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

During cold dry weather when inversion conditions exist pavement treated with Type C deicing salt containing magnesium chloride as a stockpile anti-freeze agent develops a white slick coating that reduces pavement friction apparently contributing to accidents. Evidence of this problem has been reported on US-189, I-80, and I-84.

2. Describe why this research is important and how it is unique.

Crashes related to treatment strategy or treatment materials are unacceptable. The range of non-deleterious use, environmental conditions affecting use, and red flag or "no treatment" conditions are not understood. This problem appears unique because the condition appears only in areas using Type C salt derived from solar salt extraction on the Great Salt Lake exposed to basin cool pool events.

3. List the research objective(s) to be accomplished:

1. Determine if there is a physical chemical component to the problem
2. Isolate environmental and possible chemical thresholds for problem initiation
3. Develop forecast models to enhance operational awareness
4. Develop mitigation strategies and treatment recommendations

4. List the major tasks to accomplish the research objective(s):

1. Determine what the white film is
2. Determine how and why the white film develops
3. Research environmental correlations from existing data

4. Gather new data to define parameters or forecast variable
5. Develop detection and mitigation strategies

5. List the deliverable(s) to come to UDOT from this research study:

1. Publication of findings describing the problem, causes, prediction, and mitigation.
2. One page treatment recommendations written in for 10th-grade comprehension
3. Presentation of findings at the UDOT Engineers conference or similar event of record
4. Annotated PowerPoint® presentation of findings

6. Describe how the results of this study will be implemented at UDOT.

UDOT will incorporate causative environmental factors into roadway condition forecast models. Detection and mitigation strategies will be distributed to maintenance stations. Training, tools, and materials required to detect and mitigate the problem will be provided.

7. Estimated cost - Total: $25000 **UDOT Share:** $25000 **Other/Matching Funds:** $5000

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

```
_____________Jul13__Aug__Sep__Oct__Nov__Dec__Jan14__Feb__Mar__Apr__May__Jun__Jul__Aug__Sep__Oct__ Nov___
Literature Review          ***********
Field Data review                   ******
  and interviews
Field Data Collection                         **********************
Analysis                                            ********************
Report Preparation                                            ********************
Presentation                                                                  **********          ***
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UDOT Share would be Cash from Methods Study Budget, in kind services from maintenance stations and meteorological unit
Other share would be in-kind services and data mining by MesoWest and University of Utah Meteorology Department.

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Implementation of Recessed Retroreflective Pavement Markers **No. :UT-13.02.04**

Submitted By: Jessica Andrews **Organization:** UDOT Central Maintenance

Email: jessicaandrews@utah.gov **Phone:** 801-631-2442

UDOT Champion (suggested): Jessica Andrews, Tim Ularich?

Select a Subject Area

- ☐ Materials/Pavements
- ☒ Maintenance
- ☐ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☐ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

One major transportation problem is reduced visibility during night and inclement weather conditions. Other states use *raised* pavement markers to increase visibility which can severely interfere with winter plow operations. By using *recessed* pavement markers, markers remain visible at long distances during low visibility conditions and have minimal interference with plows.

2. Describe why this research is important and how it is unique.

Utilizing recessed pavement markers will improve visibility thus increasing safety, reducing accidents and optimizing mobility while providing visual and audible lane delineation.

3. List the research objective(s) to be accomplished:

1. Will recessed pavement markers improve visibility on UDOT roads during night and inclement weather conditions?
2. Will recessed pavement markers withstand routine winter plow operations?

4. List the major tasks to accomplish the research objective(s):

1. Research various types of recessed pavement markers, using other DOTs as resources.
2. Test on typical sample section(s) of UDOT roadway.
3. Monitor and record marker performance (rate of failure/replacement, amount of visibility etc.).
4. Evaluate results to determine if recessed pavement markers were an improvement on roadway operations.

5. List the deliverable(s) to come to UDOT from this research study:

1. Evaluation of the effects of using recessed pavement markers along typical UDOT roadways.

6. Describe how the results of this study will be implemented at UDOT.

If determined to be successful, raised pavement markers can be utilized throughout all state roads to improve conditions and thus helping UDOT to better accomplish our goals of optimizing mobility and zero fatalities.

7. Estimated cost - Total: $50,000 **UDOT Share:** $ **Other/Matching Funds:** $

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

*Summer 2013 – research types of markers/installation methods etc.
*Fall 2013 – install markers on sample section(s) of UDOT roadway
*Winter 2013/2014 – monitor and record performance of markers
*Spring 2014 – evaluate data to determine effectiveness of using recessed pavement markers

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Development of Mobile Applications for UDOT Maintenance: Phase 2 **No. :UT-13.02.05**

Submitted By: Kevin Heaslip **Organization:** Utah State University

Email: kevin.heaslip@usu.edu **Phone:** 435-797-8289

UDOT Champion (suggested): Kevin Griffin, UDOT Maintenance

Select a Subject Area

- ☐ Materials/Pavements
- ☒ Maintenance
- ☐ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☐ Preconstruction
- ☐ Planning/Asset Mgmt
- ☒ Transportation Innovation

1. Describe the problem to be addressed.

UDOT Maintenance has many different operations that would be improved by the implementation of mobile applications for field personnel. It is anticipated that mobile applications can be used to facilitate data input and output to the Operations Management System (OMS).

USU is in the process of developing a ShedVIEW and MMQA application for UDOT maintenance. The proposed research will expand off of these initial applications to create a suite of applications for UDOT maintenance.

2. Describe why this research is important and how it is unique.

This research is importation to continue to provide innovation to UDOT maintenance and have a system that works in a way that provides the most automation of data entry and fulfillment processes. The research proposed will expand on the research previously conducted by USU.

3. List the research objective(s) to be accomplished:

1. Identification additional opportunities for development of mobile applications for UDOT maintenance
2. Providing better processes for entry of data into OMS

4. List the major tasks to accomplish the research objective(s):

1. Identify Opportunities for Development of New Applications
2. Development of Applications for Android
3. Certification of the application with the UDOT backbone
4. Development of Application for iOS
5. Testing with UDOT Personnel
6. Longitudinal survey of UDOT Personnel about the effectiveness of the Mobile App.

5. List the deliverable(s) to come to UDOT from this research study:

1. Android Applications
2. iOS Applications
3. Report on development processes and results of the longitudinal surveys.

6. Describe how the results of this study will be implemented at UDOT.

UDOT will use this research to implement data processes in maintenance.

7. Estimated cost - Total: $150,000 **UDOT Share:** $75,000 **Other/Matching Funds:** $75,000

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

The following schedule is proposed for this study. The study is scheduled for 18 months.

Page 3

- Start Date: June 1, 2013
- Decision on the Applications to Develop: December 1, 2013
- Android UDOT Backbone certification: May 31, 2014
- iOS Application: September 30, 2014
- Final Report: December 31, 2014

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Implementation of Aerial/Mobile Lidar Technology to Update Highway Feature Inventory **No. :UT-13.02.06**

Submitted By: Dario Batioja **Organization:** UDOT

Email: dbatioja@utah.gov **Phone:** 801-598-7301

UDOT Champion (suggested): Tim Ularich

Select a Subject Area

- ☐ Materials/Pavements
- ☒ Maintenance
- ☐ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☐ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

With the collection and classification of data features for our system in process it is imperative to find ways to maintain this new inventory up-to-date in the future. Changes associated to construction projects and maintenance activities are expected to vary the inventory. Thus it is vital to maintain the accuracy, reliability and usefulness of the roadway data over time. Aerial and/or Mobile Lidar technology has the ability thru repeated airborne Lidar coverages to accurately characterize and analyze changes associated to construction , maintenance activities and other projects over large areas in a reasonable time. With the increasing awareness of Lidar Technology and the development of this new industry more contractors are providing this service. Thus the cost of this technology is decreasing making its implementation more cost-effective.

2. Describe why this research is important and how it is unique.

The utilization of Aerial/Mobile Lidar technology has proven effective in capturing increases or changes in various infrastructure highway projects associated with urban development. This study will be an attempt to characterize the accuracy and precision of Aerial and/or Mobile Lidar technology to detect changes in a vast highway asset inventory over designated control areas in our state highway system. This study will also investigate the feasibility of the integration of roadway data updates into the current highway inventory system over all UDOT data platforms. If effective Aerial/Mobile Lidar will be a proven mechanism to provide the change of the asset inventory over large areas in our highway system over time.

3. List the research objective(s) to be accomplished:

1. Evaluate the efficiency and precision of the Aerial and Mobile Lidar available technology to capture changes in the highway asset inventory.
2. Assets the cost-effectiveness of Lidar technology in providing updates to the feature inventory system over ground field inventory programs.

4. List the major tasks to accomplish the research objective(s):

1. Contact local or out of state Lidar contractors that could provide the service and investigate the most cost-effective survey method (Airborne vs. Mobil)
2. Identify and designate as control sections different areas where the inventory has been changed due to construction projects or maintenance activities.
3. Perform Mobile and/or Aerial Lidar survey over designated areas.
4. Post-data processing and analysis of data.
5. Compilation of report showing the efficiency, accuracy of Aerial/Mobile Lidar Methods to capture changes over our highway inventory system.

5. List the deliverable(s) to come to UDOT from this research study:

1. A study of the evaluation of the accuracy and effectiveness of aerial and/or mobile Lidar technology to characterize and analyze changes in our highway feature inventory system and the feasibility of the integration of the new data in the system.
2. Report containing updates to the highway feature inventory over different designated areas.

6. Describe how the results of this study will be implemented at UDOT.
If Aerial/Mobile Lidar technology is proven to be a successful tool to maintain our highway feature inventory up to date it can be implemented over the years to maintain our inventory and improve its accuracy and efficiency.

7. Estimated cost - Total: $40,000 **UDOT Share:** $0 **Other/Matching Funds:** $0

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

Fall/Winter 2013: Contact local or out of state Lidar contractors that could provide the service, Analyze best survey method, Designation of control areas.

Spring/Summer 2014: Performs surveys of designated control locations.

Fall 2014: Data Compilation and Processing, Analysis of precision and accuracy of Lidar to capture updates in inventory.

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Development of Utah highway maintenance predicion model **No. :UT-13.02.07**

Submitted By: Yanguo Ma, PhD **Organization:** CMT Engineering Laboratories

Email: yanguo@cmtlaboratories.com **Phone:** 801 908 5859

UDOT Champion (suggested):

Select a Subject Area

- ☐ Materials/Pavements
- ☒ Maintenance
- ☐ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☐ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

The Utah highway maintenance cost is estimated in the range of 20 – 27 Million dollars and the maintenance cost per lane mile (US$7400/LM) is higher than the national average number (US$ 5917/LM). The ongoing federal budget cut is significantly influence Utah's highway maintenance, which definitely negatively influence the public safety on the highways.

2. Describe why this research is important and how it is unique.

In order to protect public safety, the highway maintenance must be kept at a high quality level. It has been found that there is room to save maintenance cost without influencing decreasing highway quality and deteriorating public safety. A few models have been developed in other states. This research will develop a new model for the highway maintenance with incorporating environmental factors (extreme weather and environmental quality (air quality)) , which most research do not have.

3. List the research objective(s) to be accomplished:

1. Develop a comprehensive prediction highway maintenance model for Utah
2. Optimize the model for Utah applications
3. Provide some insights to highway impacts on Utah air quality, especially during winter season.

4. List the major tasks to accomplish the research objective(s):

1. Literature review existing models and environmental factors.
2. Develop and test a new tools to model the maintance.
3. Optimize the model

5. List the deliverable(s) to come to UDOT from this research study:

1. Utah highway maintenance prediction model
2. Optimized results for Utah highway maintenance with low cost and good quality.

6. Describe how the results of this study will be implemented at UDOT.

1. This model can be used by UDOT to predict maintenance frequency and cost as well as optimum maintenance period.

7. Estimated cost - Total: $200,000 **UDOT Share:** $ **Other/Matching Funds:** $

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

Month 1-3: Literature review and site visits
Month 4-5: Finalize the prediction tools
Month 6-15: develop and test the model
Month 16-20: Optimize the model
Month 21-24: write the report.

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Maintenance Costs and Considerations during Geometric Design **No. UT 13.02.08**

Submitted By: Richard J. Porter/Rukhsana Lindsey **Organization:** UDOT

Email: rlindsey@utah.gov **Phone:** 801-965-4769

UDOT Champion (suggested): Rukhsana Lindsey

Select a Subject Area

- ☐ Materials/Pavements
- ☒ Maintenance
- ☐ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☐ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

The strategic plan of the American Association of State Highway and Transportation Officials (AASHTO) Subcommittee on Design includes stated goals related to incorporating costs and safety associated with maintenance activities into design decisions. These goals include: 1) develop cost-effective solutions for delivering projects that minimize the operational and maintenance resources needed to sustain system effectiveness and functionality; and 2) support efforts to enhance the involvement of construction, maintenance, and operations personnel in the design phase of project delivery. A project is needed to examine policies, procedures, and practices for including life-cycle maintenance costs and other maintenance considerations into geometric design decision-making at various agency levels (e.g., state, city and county).

2. Describe why this research is important and how it is unique.

Maintenance costs, while significant throughout the life-cycle of a project, may sometimes be underrepresented as inputs to planning and design decisions. Important considerations include the frequency and intensity of routine maintenance activities associated with highway and street features as well as the selection of physical highway and street dimensions to support future maintenance activities and associated temporary traffic control (e.g., allocation of lane and shoulder widths to support use of shoulder during future maintenance work). Such considerations likely vary by U.S. region/climate. Maintenance costs and considerations may be particularly relevant to innovative physical, operational, and safety improvements including roundabouts, curbing, indirect left-turn treatments, and a number of traffic calming measures. This project will examine policies, procedures, and practices for including life-cycle maintenance costs and other maintenance considerations into geometric design decision-making at various agency levels.

3. List the research objective(s) to be accomplished:

1. Develop cost-effective solutions for delivering projects that minimize the operational and maintenance resources needed to sustain system effectiveness and functionality.
2. Support efforts to enhance the involvement of construction, maintenance, and operations personnel in the design phase of project delivery.

4. List the major tasks to accomplish the research objective(s):

1. This project will address: 1) consideration of the frequency and intensity of routine maintenance activities associated with highway and street features during geometric design; 2) selection of physical highway and street dimensions to support future maintenance activities and associated temporary traffic control; 3) incorporation of maintenance considerations, as well as traditional operational and safety analysis into a life-cycle analysis of decisions related to physical highway and street features; and 4) involvement of construction, maintenance, and operations personnel in the design phase of project delivery.

5. List the deliverable(s) to come to UDOT from this research study:

1. A project and a report that will examine and analyze policies, procedures, and practices for including life-cycle maintenance costs and other maintenance considerations into geometric design decision-making at various levels in the agency.

6. Describe how the results of this study will be implemented at UDOT.

This study will identify different strategies that will help UDOT minimize operational and maintenance resources needed to sustain effectiveness and functionality of construction projects during the planning and design phases. It will also analyze how to maximize the involvement of construction and operations personnel into the different phases of design.

7. Estimated cost - Total: $ **UDOT Share:** $ **Other/Matching Funds:** $

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Driving Cost Savings Using The Automatic Digital Device **No. UT-13.02.09**

Submitted By: Cameron Kergaye & Steve Bagley **Organization:** UDOT Research

Email: ckergaye@utah.gov **Phone:** 801 633-0359

UDOT Champion (suggested):

Select a Subject Area

- ☐ Materials/Pavements
- ☒ Maintenance
- ☐ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☐ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

Fleet cost savings through digital monitoring of driving patterns and vehicle performance.

2. Describe why this research is important and how it is unique.

This concept is a new and innovative gadget that will allow UDOT to save money on gas and normal wear and tear on their fleet vehicles. *Automatic* learns about your driving style and gives you subtle audio cues when you do things that waste gas, like:

Rough Braking

Braking abruptly decreases fuel efficiency and dramatically increases wear-and-tear on your car's brake pads.

Speeding

Highway speeding may not save you much time, but driving 10 MPH over the speed limit reduces fuel efficiency by 12-15%.

Rapid Acceleration

Stepping hard on the gas pedal decreases fuel efficiency and wastes money.

Automatic shows how you're doing on every trip.

Drive Score

Automatic scores your driving every week to help you improve. A high score could save you hundreds on gas every year.

Trip Timeline

The *Automatic* app displays detailed info about your week, like how much you drive and where.
See the actual MPGs for all your trips, even for older cars that don't display fuel efficiency on the dashboard. *Automatic* also detects fill-ups and even tracks local gas prices to show you how much you're spending. The *Automatic* app displays detailed info about your week, like how much you drive and where. The *Automatic* shows how you're doing on every trip.

Crash Alert[BETA]

The *Automatic Link* includes a built-in accelerometer that can detect many types of crashes. *Automatic* uses your

phone's data connection to immediately report the crash to 911* with your name, location, and vehicle description.
Once help responds, *Automatic* can send a text message to your loved ones to let them know what happened, where you are, and that help is on the way.

Engine Health

Automatic shows you what those Engine Trouble Codes mean and in many cases offers possible solutions. For simple problems, you can even clear the light yourself, and save a trip to the shop. For more complicated issues, *Automatic* shows you well-reviewed mechanics nearby. Call them or get directions with a tap.

Easy Install, No Tools Required

The *Automatic Link* plugs into the same port your mechanic uses when you take your car in for service. It's easily accessible near the steering wheel.

3. List the research objective(s) to be accomplished:

1. Place several Automatic digital devices in UDOT fleet vehicles
2. Monitor driving patterns and analyze the date to understand how UDOT can save gas and normal wear and tear costs.

4. List the major tasks to accomplish the research objective(s):

1. Place several Automatic digital devices in UDOT fleet vehicles
2. Monitor driving patterns and analyze the date to understand how UDOT can save gas and normal wear and tear costs.
3. Submit recommendations to UDOT Senior Leaders of cost saving methods based on data analysis.

5. List the deliverable(s) to come to UDOT from this research study:

1. A small report for UDOT Senior Leaders that will contain: Method used, Data Collected, Data analyzed, and recommendations.

6. Describe how the results of this study will be implemented at UDOT.

The final report will recommend cost saving solutions to Senior Leaders and will suggest that every UDOT fleet vehicle will contain an Automatic digital device and iphone.

7. Estimated cost - Total: $1,000 **UDOT Share:** $ **Other/Matching Funds:** $

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Creating a State-wide IHSDM Data Base for Project-Level Safety Analysis **No. : UT-13.03.01**

Submitted By: M. Saito and G. Schultz **Organization:** BYU

Email: msaito@byu.edu, schultz@byu.edu **Phone:** 801-422-6326, 801-422-6332

UDOT Champion (suggested): Scott Jones

Select a Subject Area

- ☐ Materials/Pavements
- ☐ Maintenance
- ☒ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☐ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

The IHSDM (Interactive Highway Safety Design Model) is a suite of software analysis tools for evaluating safety and operational effects of geometric design decisions on highways. A previous study on IHSDM done by Dr. Saito several years ago proved its utility for UDOT engineers. However, its active use has been hampered by the lack of alignment data for majority of highways in the states. UDOT has conducted a LiDAR-based study of its highways to collect not only alignment data but also roadside objects data. Once this data set becomes available IHSDM data file can be created for all highways covered by the LiDAR project. This will allow inclusion of safety aspects in all stages of highway related tasks at UDOT.

2. Describe why this research is important and how it is unique.

In order to realize the inclusion of safety in planning, design, operation, and management of UDOT's highways, it is necessary to have a unified data file and software. IHSDM, developed by FHWA, can become a center-piece of UDOT's highway safety evaluations. The current IHSDM (version 8.1.0, February 2013 release) contains HSM 2011 predictive methods, which will allow UDOT to compare safety improvements of alternative highway designs.

3. List the research objective(s) to be accomplished:

1. Reduce LiDAR data to make it compatible to data requirements of IHSDM
2. Create a statewide IHSDM file.
3. Conduct safety analyses on selected projects and produce use manuals for conducting safety analysis for future use
4. Develop education materials for a work shop on use of IHSDM

4. List the major tasks to accomplish the research objective(s):

1. Conduct a literature review on IHSDM's features and applications and determine how IHSDM can be incorporated in UDOT's highway planning, design, operation, and management
2. Reduce LiDAR data to make it compatible to data requirements of IHSDM
3. Create a statewide IHSDM file
4. Select a few safety analysis projects to test the validity of the IHSDM file developed in the study
5. Develop a user manual for using IHSDM software in evaluating the impacts of proposed highway improvements on safety
6. Develop teaching materials for a workshop
7. Write a final report
8. Project management

5. List the deliverable(s) to come to UDOT from this research study:

1. An IHSDM data file that will be the basis of future safety analyses
2. A final technical report summarizing all the tasks performed in the project
3. Workshop materials
4. A thesis, and technical papers for publication

6. Describe how the results of this study will be implemented at UDOT.

This IHSDM file becomes the basis for safety analysis of current conditions and alternative improvement options. It will become the model UDOT engineers can use to evaluate the impact of highway improvements on safety. UDOT employees will be trained in using this software.

7. Estimated cost - Total: $72,300 **UDOT Share:** $53,000 **Other/Matching Funds:** $19,300 (BYU indirect total cost discount)

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

It is recommended that this project begin in later summer or early Fall 2013 with the initial tasks of the project scope of work and detailed estimate, followed with the literature review. It is anticipated that the project would take 12-16 months.

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Calibration of HSM SPF and CMF Functions for Curved Highway Segments **No. : UT-13.03.02**

Submitted By: Mitsuru Saito and Grant G. Schultz **Organization:** Brigham Young University

Email: msaito@byu.edu, gschultz@byu.edu **Phone:** 801-422-6326; 801-422-6332

UDOT Champion (suggested): Scott Jones

Select a Subject Area

- ☐ Materials/Pavements
- ☐ Maintenance
- ☒ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☐ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

The calibration of Highway Safety Manual (HSM) safety performance functions (SPFs) for basic segments (straight tangent) on two-lane two-way highways has successfully been completed and the calibration factor obtained. In addition, new Utah-specific negative binomial models were developed to reflect Utah's driving conditions, and a hierarchical Bayesian model was created as one method to find hot spot segments. Since the completion of this project, the Roadview program has been revised to include curvature and grade data that can be used for analysis. To apply SPFs to non-tangent segments, curvature information were absolutely necessary. Now that this information is available, the purpose of this project is to develop SPFs and crash modification factors (CMFs) and to calibrate HSM SPFs for segments with curves. Completion of this work will make a GIS-based statewide safety evaluation of the two-way two-lane highways possible.

2. Describe why this research is important and how it is unique.

UDOT will benefit from this study as it continues efforts to develop a GIS-based statewide safety evaluation of highways and prepare an annual summary of 5 percent critical highway segments in terms of safety. Statewide functional level evaluation of safety cannot be performed unless UDOT has SPFs and CMFs for curved segments of highways.

3. List the research objective(s) to be accomplished:

1. Calibrate HSM SPFs for segments with curves on two-lane two-way highways
2. Utilize UDOT databases to create a database for calibration of HSM SPFs and CMFs for curved segments of two-lane two-way highways.

4. List the major tasks to accomplish the research objective(s):

1. Develop a project scope of work and detailed task and cost estimates
2. Conduct a literature review on SPFs and CMFs on curved segments of two-lane two-way highways
3. Compile a database to conduct statistical modeling tasks
4. Develop SPFs and CMFs for segments with curves segments of two-lane two-way highways
5. Make recommendations on how these SPFs and CMFs can be incorporated in a GIS-based statewide safety evaluation
6. Report results to UDOT in the form of a written report, prepare technical papers, and present results in UDOT Annual Engineers Conference.

5. List the deliverable(s) to come to UDOT from this research study:

1. Engineering report documenting the literature review and research results
2. SPFs and CMFs to be used in a GIS-based statewide highway safety evaluation program

6. Describe how the results of this study will be implemented at UDOT.

This research would be implemented by the UDOT Traffic & Safety Division in a statewide highway safety evaluation program. Together with the models for basic straight segments the BYU researchers developed, the SPFs and CMFs developed by this study will make this statewide evaluation possible.

7. Estimated cost - Total: $72,300 **UDOT Share:** $53,000 **Other/Matching Funds:** $19,300 (BYU indirect total cost contribution)

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

It is recommended that this project begin in later summer or early Fall 2013 with the initial tasks of the project scope of work and detailed estimate, followed with the literature review. It is anticipated that the project would take 12-16 months.

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Characteristics of High Risk Intersections for Pedestrians and Cyclists-Part 2 **No. : UT-13.03.03**

Submitted By: Shaunna K. Burbidge, PhD **Organization:** Active Planning

Email: burbidge@walkbikeplan.com **Phone:** 801-336-7991

UDOT Champion (suggested): Evelyn Tuddenham, Robert Hull

Select a Subject Area

- ☐ Materials/Pavements
- ☐ Maintenance
- ☒ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☐ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

In 2011 fatal accidents involving a car and a pedestrian accounted for 14 percent of crash-related fatalities, reaching the highest rate since 2002. Fatal crashes increased by 15 percent over that time (Utah Department of Public Safety, 2013). A recently completed UDOT pilot study evaluated bicycle and pedestrian crashes throughout Salt Lake County through 2010 to determine which intersection characteristics most likely contribute to unsafe conditions for active travelers. However, due to its nature as a pilot study and due to limited funding, only locations in Salt Lake County were evaluated. Follow-up evaluations have yet to be conducted for the rest of the Wasatch Front.

2. Describe why this research is important and how it is unique.

This research will use the information acquired from that preliminary pilot study analysis as well as current collision information to expand the investigation to Davis, Weber, and Utah Counties. By evaluating similar criteria from other areas across the Wasatch Front, we will be able to confirm if the dangerous intersection characteristics previously identified in the pilot study are equally significant for the rest of the region. This information will not only allow UDOT to avoid negative design characteristics in new intersections and make appropriate improvements to existing intersections; but it will also compliment the current work of the Utah Collaborative Active Transportation Study in identifying appropriate bicycle and pedestrian infrastructure project sites.

3. List the research objective(s) to be accomplished:

1. Identify intersections in Weber, Davis, and Utah Counties that can be classified as high risk safety hot spots for pedestrian and cyclist accidents or injury (using the methodology from the pilot study cited above).
2. Conduct comprehensive inventories of each intersection and evaluate potential high risk characteristics using the rubric outlined in the preliminary analysis from Salt Lake County.
3. Produce a comprehensive list of high-risk intersections for the region and identify recommendations for improvements based on the analysis.

4. List the major tasks to accomplish the research objective(s):

1. Using data from UDOT and the Utah Office of Highway Safety, conduct an inventory of cyclist and pedestrian injuries and locations of accidents in Weber, Davis, and Utah Counties. Digitize all incidents into a GIS file.
2. Classify specific intersections by risk level based on the number of reported active mode incidents.
3. Inventory site and design characteristics for each high risk intersection and analyze these intersections alongside the high-risk intersections identified in the Salt Lake county pilot study.
4. Identify and summarize broad recommendations for intersection improvements based on the analysis.

5. List the deliverable(s) to come to UDOT from this research study:

1. List of High Risk intersections for bicycle and pedestrians in Weber, Davis, Salt Lake, and Utah Counties.
2. Statistical analysis of high risk intersection characteristics.
3. Summary of recommendations for intersection improvements which would improve active mode safety.

6. Describe how the results of this study will be implemented at UDOT.

Using the information provided by this research, UDOT can improve bicycle and pedestrian safety in two ways. 1) UDOT can avoid dangerous characteristics when designing new intersections, and 2) When implementing improvements to existing intersections and roadways UDOT can make appropriate changes to improve safety for cyclists and pedestrians.

7. Estimated cost - Total: $40,000 **UDOT Share:** $40,000 **Other/Matching Funds:** $

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

Study Start Date: July 1, 2013

Study Duration: 1 year

Research Schedule

July 2013- Notice to Proceed granted from UDOT

Aug/Sept 2013- Compile data from the Utah Office of Highway Safety and local hospital records which specifically identify accidents

or injuries to pedestrian or cyclists. Input Data into a geo-coded database.

Oct 2013- Using a weighted analysis, classify intersections based on the number of reported incidents, and identify high-risk intersections.

Nov 2013/ Feb 2014- Inventory site and design characteristics for the high-risk intersections

March 2014- Conduct statistical analyses to identify potentially dangerous intersection characteristics. Conduct comparison analysis from pilot analysis and comprehensive analysis including Salt Lake County.

Apr/May 2014- Identify and summarize broad recommendations for intersection improvements and prepare final report.

June 2013- Final report complete and presented to UDOT

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Safety Benefits of Converting HOV Lanes to HOT Lanes **No.: UT-13.03.04**

Submitted By: Grant G. Schultz and Mitsuru Saito **Organization:** Brigham Young University

Email: gschultz@byu.edu; msaito@byu.edu **Phone:** 801-422-6332; 801-422-6326

UDOT Champion (suggested): W. Scott Jones

Select a Subject Area

- ☐ Materials/Pavements
- ☐ Maintenance
- ☒ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☐ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

In September 2006 the Utah Department of Transportation (UDOT) converted the existing High Occupancy Vehicle (HOV) lanes to High Occupancy Toll (HOT) lanes, providing an opportunity for single occupant vehicles to travel in the HOV lanes for a fee. The fee charged to the vehicle is variable, based on the time of day and current level of congestion. The purpose of this research is to determine the safety effects of converting the HOV lanes to HOT lanes. The results of the research will be used to determine benefit/cost ratios and to develop crash modification factors (CMFs) for the conversion.

2. Describe why this research is important and how it is unique.

UDOT will benefit from this project by better understanding the safety benefits of converting the HOV lanes to HOT lanes. Utah is one of only a handful of states that has undergone this conversion and this will allow the benefits to be better quantified. This will benefit Utah, as well as other states who may be contemplating a similar conversion from HOV to HOT lanes.

3. List the research objective(s) to be accomplished:

1. Estimate safety benefits of converting HOV lanes to HOT lanes.
2. Utilize UDOT crash database to collect data on the safety benefits of the HOV lane conversion.
3. Develop crash modification factors (CMFs) for the improvement with a focus on specific crash types.
4. Determine benefit/cost (B/C) ratios for use in evaluating the effectiveness of the conversion.

4. List the major tasks to accomplish the research objective(s):

1. Develop a project scope of work and detailed estimate.
2. Perform literature review on safety benefits of HOV to HOT lane conversions.
3. Evaluate/summarize crash data from a representative sample of HOV/HOT segments to provide background data for analysis.
4. Develop CMFs for the improvements with a focus on specific crash types.
5. Make recommendations of B/C for the improvement.
6. Report results to UDOT in the form of a written report.

5. List the deliverable(s) to come to UDOT from this research study:

1. Engineering report documenting the literature review and research results.
2. Procedure for estimating the benefits of converting HOV lanes to HOT lanes.

6. Describe how the results of this study will be implemented at UDOT.

This research would be implemented by the UDOT Traffic & Safety Division, in consultation with the TOC to estimate safety benefits of converting HOV lanes to HOT lanes. The results of the research would assist UDOT in future decisions on HOV/HOT conversions and will provide necessary data for other states considering similar conversions.

7. Estimated cost - Total: $45,000 **UDOT Share:** $45,000 **Other/Matching Funds:** $

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

It is recommended that this project begin late summer/early Fall 2013 with the project scope of work and detailed estimate, followed with the literature review. The work will continue with an evaluation and summary of crash data and other data collection efforts, followed by the development of the CMFs, recommendations, and a written report. It is anticipated to take 12-16 months.

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Heavy Truck Safety Study **No. : UT-13.03.05**

Submitted By: Doug Anderson, P.E. **Organization:** ATC.LLC

Email: Doug.ATC@Q.com **Phone:** 801-633-6240

UDOT Champion (suggested):

Select a Subject Area

- ☐ Materials/Pavements
- ☐ Maintenance
- ☒ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☐ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

The operation of heavy trucks on Utah's highways poses a potential safety problem. When a heavy truck is involved in a crash the chance for a fatality increases four times over standard automobiles. Most trucking firms operate at a very safe level, and dedicate much of their resources to safety issues. Some companies however, are more interested in their profit margin with little regard to safety.

Even when trucking firms operate as safely as possible there are locations on our highways that have been identified as hazardous to heavy truck travel. These locations are typically on steep grades, near sharp curves, in highly congested corridors, rural routes with drowsy drivers, locations where snow pack causes problems, pavements with poor skid resistance, corridors with objects in the ROW,

2. Describe why this research is important and how it is unique.

Heavy truck safety is very important to the traveling public due to the severity of these crashes. Heavy truck crash analysis must be conducted separate from other crash studies and completed by experts understanding truck operations and safety issues. Steps can be taken to reduce these crashes through improvements to the geometrics, pavement condition, traffic control improvements, improved trucking rules and laws, etc.

3. List the research objective(s) to be accomplished:

1. Identify locations with heavy truck clusters.
2. Determine contributing factors and issues.
3. Identify a list of possible solutions to these problems at each site.
4. Recommend improvements, programs, and standards to reduce numbers and/or severity of these crashes.

4. List the major tasks to accomplish the research objective(s):

1. Compile five years of crash data involving heavy trucks in Utah.
2. Analyze the data to identify crash clusters by number and severity.
3. For these locations with crash clusters, compile data to identify contributing factors including:
   a. Geometrics: steep grades, sharp curves, narrow bridges, etc.
   b. Contributors: drowsy driving, alcohol, drugs, distracted driving, faulty equipment, heavy congestion, etc
   c. Pavement and surface condition: low skid numbers, wet pavement, snow/ice, rough pavement, etc.
   d. Object struck: wild animal hits, object in ROW, etc.
4. Coordinate with experts from the regions and divisions to determine possible corrective strategies.
5. Compile a team to study each site.
6. Recommend the best strategies for implementation at each site.

5. List the deliverable(s) to come to UDOT from this research study:

1. A Final Report will be completed describing the analysis and findings.
2. A PowerPoint presentation will be developed to illustrate each problem site and the recommended strategies.
3. A separate Site report will be prepared for use by the regions in analyzing each location in detail.

6. Describe how the results of this study will be implemented at UDOT.

A small team will be created to review each site and the Site Report developed during the study.

7. Estimated cost - Total: $45,000 **UDOT Share:** $45,000 **Other/Matching Funds:** $-0-

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

This study will require 18 months of study time. The project could be started in the Fall of 2013 and completed in the spring of 2015. This schedule delivers the Site Reports in time for some of the improvement strategies to be undertaken during the construction and hard maintenance season.

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Safest Path Traffic Assignment **No. :UT-13.03.06**

Submitted By: Matt Riffkin, P.E. **Organization:** InterPlan

Email: matt@interplanco.com **Phone:** 801-307-3400

UDOT Champion (suggested): W. Scott Jones

Select a Subject Area

- ☐ Materials/Pavements
- ☐ Maintenance
- ☒ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☐ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

UDOT has aggressively addressed the goal of Zero Fatalities through both proactive programs and reactive counter-measures. A gap in the program for achieving Zero Fatalities is the ability to move the concept up to the long-range transportation planning process. MPOs and planning agencies have few tools available to predict future safety problems and do not have a clear vision of how their plans affect safety. This research is offered to help planning divisions and agencies understand the safety impacts of their plans and align their plans with the goals of Zero Fatalities.

2. Describe why this research is important and how it is unique.

National research has been accomplished to develop crash prediction tools. These tools, as outlined in the Highway Safety Manual, are often data intensive for field attributes but provide little benefit to the planning process where design is unknown. UDOT Traffic and Safety is working to advance the Highway Safety Manual with Safety Performance Functions unique to the crash data in Utah. Despite these efforts and UDOT's advanced safety practice, there is a significant and noticeable void in the development of planning tools that integrate safety into the long range planning process. The proposed research will build on the GIS crash database developed by UDOT to create a tool that can be readily used by planning agencies in Utah and ultimately exported to other DOTs using their GIS crash data.

3. List the research objective(s) to be accomplished:

1. Create a way to assign traffic to the "safest" route
2. Measure the safety trade-off of the safest route to the routes typically selected by drivers involving the least cost or the least time route
3. Develop a tool to investigate how alternative mobility solutions can yield the highest safety benefit.

4. List the major tasks to accomplish the research objective(s):

1. Determine "impedance" estimates for building travel paths from the GIS crash database and how this impedance is measured in terms of safety at the regional level
2. Manually estimate the safe path assignment choices of several origin-destination pairs to ensure that the cumulative effects of alternative route choices results in a convergence of an optimal safe path for all trips
3. Use the historic crash database to measure safety impacts of routing in an effort to produce a useable model while building on the growing body of knowledge, include the Safety Performance Functions being developed in Utah, related to crash prediction tools for the model to be improved in the future (by others)

5. List the deliverable(s) to come to UDOT from this research study:

1. A mathematical traffic assignment process that can be written into the CUBE travel models to assign the safest traffic route that can be used by UDOT planning and MPOs
2. A quantitative evaluation of the safety impacts of alternatives transportation plans that can be applied to the 2015 cycle of UDOT and MPO transportation plans

6. Describe how the results of this study will be implemented at UDOT.

The results of this research will allow UDOT to better coordinate Zero Fatalities and other goals of the Strategic Highway Safety Plan with the long range planning process. Models will be built around Utah specific data so that transportation plans developed in the next few years can be used as prototypes to evaluate the safety trade-offs of historically capacity based plans. By beginning this research and implementing a tool into the planning process, UDOT will take a national leadership role in coordinating safety with the traditional planning process in order to ensure that safety related goals are considered in project and plan selection as well as communication with local governments and planning stakeholders.

7. Estimated cost - Total: $30,000 **UDOT Share:** $30,000 **Other/Matching Funds:** $

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

The schedule for this project is flexible and can begin at any time. It is anticipated that the entire project can be completed within approximately three months. The following include the major tasks associated with this effort.

1. Develop and select an "impedance" estimate based on link level numbers of crashes, crash rates, safety index, or other crash data to be able to route traffic by the "safest" route. Evaluate advantages and disadvantages of various methods and select one.

2. Coordinate with the UDOT Traffic and Safety Division and local MPOs to discuss the tool and solicit input for incorporation into the planning process.

3. Manually assign traffic for approximately three origin-destination pairs and develop mathematical criteria to ensure convergence of multiple paths

4. Develop steps to estimate the number of crashes, the number of severe crashes or other safety measures that can be generated from the "safest" path and can be compared to assignment resulting from travel speeds and cost impedance.

5. Outline a process where the "safe route" assignment can be integrated into the CUBE modeling script of MPOs and the Utah Statewide Travel Model

Based on the success of steps 1-5 above, UDOT Traffic and Safety will work with the UDOT planning division or a voluntary MPO to implement a pilot project of the "Safe Path Traffic Assignment" to summarize the safety impacts of an area's Long Range Transportation Plan. This pilot project is not included in the research cost defined in this statement but will be used to move research into real application. This pilot application will be used for UDOT to define a best practice for integrating safety into the urban and statewide transportation planning process.

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Accident Delay Mitigation for UHP, Incident Management and Motorist **No. :UT-13.03.07**

Submitted By: Marjorie Rasmussen **Organization:** UDOT Region 2

Email: mcrasmussen@utah.gov **Phone:** (801)887-3792

UDOT Champion (suggested):

Select a Subject Area

- ☐ Materials/Pavements
- ☐ Maintenance
- ☒ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☐ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

Work to mitigate traffic delay and increase safety by decreasing impact from accidents and getting the motorists, incident management, and Utah Highway Patrol off the road as quickly as possible.

2. Describe why this research is important and how it is unique.

This research is important for efficient and safe roads when an accident occurs. With new technologies available unique and innovative ways to keep the traveling public, the Incident Management teams and Highway Patrol safer during accidents needs to be reviewed.

3. List the research objective(s) to be accomplished:

1. Prepare a study indicating what is being done throughout the nation, what is being done in Utah by UDOT Incident Management and UHP to mitigate accident delay and summarize alternatives.
2. Provide a list of new tools that can be utilized by Traffic and Safety, Incident Management and UHP to minimize delay and increase safety during roadway incidents.

4. List the major tasks to accomplish the research objective(s):

1. Study innovative solutions to minimize accident delay and increase safety. Work to get all input from stakeholders.
2. Prepare a report summarizing the study and make recommendations.
3. Provide report to stakeholders with explanations and costs so they can plan to implement the processes.

5. List the deliverable(s) to come to UDOT from this research study:

1. Researcher will schedule meetings, obtain data and prepare report with suggested alternatives, costs and best ways to implement the alternatives.

6. Describe how the results of this study will be implemented at UDOT.

UDOT will work with UHP as needed to implement safety measures suggested by the report.

7. Estimated cost - Total: $70,000 **UDOT Share:** $70,000 **Other/Matching Funds:** $

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

Start Date: May 30, 2013
3 Stakeholder Meetings: June 30th, July 30th, August 30th -2013
Prepare Report: September 2013
Finalize Report and Present Findings: October 2013

2013 UDOT RESEARCH PROBLEM STATEMENT

*** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ***

Problem Title: Dynamic Left-Turn Phasing No.**UT-13.03.08**

Submitted By: Peter Jager Organization: UDOT - Traffic Management Division

Email: pjager@utah.gov Phone: 801-887-3715

UDOT Champion (suggested): Mark Taylor

Select a Subject Area

- ☐ Materials/Pavements
- ☐ Maintenance
- ☒ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☐ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

We currently operate all double left-turn lanes in protected only phasing. This improves safety by preventing left-turn crashes, but also increases delay for both the left-turn movement and the opposing through movement. The increased idle time also degrades air quality by increasing pollution. If a left-turn movement can alternate between protected & permissive phasing based on the usual demand at peak hours, delay can be reduced by allowing the left-turns to flow permissively in normal gaps in traffic. How would this alternate phasing affect the crash rate and intersection safety?

2. Describe why this research is important and how it is unique.

This is important because as traffic volume increase, more high capacity movements are needed, and in turn increasing delay. Controlling air pollution has become a critical need in the most populated parts of our state during the winter months, so any reduction in vehicle idle time is beneficial. If a destination only has high turning volume at certain times of day, such as a business complex or special event center, the delay could be reduced the remainder of the day. It is a unique solution that is not currently used in Utah, but considered in other states.

3. List the research objective(s) to be accomplished:

1. Determine feasibility of dynamic left-turn phasing.
2. Evaluate safety of changing left-turn phase control by time of day.

4. List the major tasks to accomplish the research objective(s):

1. Review current literature about dynamic left-turn phasing and variable lane usage.
2. Conduct a safety study of various left-turn control types.
3. Report the findings of the study to the Department with a recommendation on usage of dynamic left-turn phasing.

5. List the deliverable(s) to come to UDOT from this research study:

1. Report on the benefits and risks of using dynamic left-turn phasing.
2.

6. Describe how the results of this study will be implemented at UDOT.

If the recommendation is favorable to install them, locations will be evaluated by the Traffic Management Division and Regions to implement the dynamic left-turn phasing.

7. Estimated cost - Total: $60,000 UDOT Share: $60,000 Other/Matching Funds: $

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

July 2013 – Begin Literature Search
Sept. 2013 – Review findings with stakeholders and prepare safety study parameters.
Dec. 2013 – Progress update with stakeholders.
March 2014 – Progress update with either draft final report or discussion of need for further study.

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Thermo Reactive Pavement Signage **No. UT-13.03.09**

Submitted By: Joe Perrin **Organization:** A-Trans Enigneering

Email: atrans@comcast.net **Phone:** 801 949 0348

UDOT Champion (suggested): Research

Select a Subject Area

- ☐ Materials/Pavements
- ☐ Maintenance
- ☒ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☐ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

Icing of the roadways in Utah is fact of our mountainous terrain, elevation and seasonal weather patterns. Informing drivers as to when the roadway begins to ice is a struggle as driver awareness is a key safety element to defensive driving, particularly on bridge decks that tend to ice first. RWIS systems that detect icing and turn flashers on are occasionally used but there is an opportunity for a lower tech solution. Temperature thermoplastics that react to pavement temperature and provide pavement message signs could provide that low cost solution for State Wide implementation.

2. Describe why this research is important and how it is unique.

This research evaluates the feasibility of the low tech method of informing drivers of icy roadway conditions. This is just recently being evaluated in Europe and this research evaluates the cost feasibility of implementing this on bridge decks or other high safety concern locations.

http://www.highwaysindustry.com/News/Highways_In_Netherlands_To_Glow_In_The_Dark_112450

3. List the research objective(s) to be accomplished:

1. Feasibility review of temperature reactive Thermoplastic Pavement signs
2. Costs, life, appropriate location, sensitivity of product, opportunities for other uses

4. List the major tasks to accomplish the research objective(s):

1. Coordinate with the Dutch firm introducing this concept in the Netherlands in mid 2013, Studio Roosegaarde and Daan Roosegaarde
2. Trip to Netherlands to see the product in use
3. Accident Review of ice and snow accidents over the past 5 years
4. Comparative costs for Icy bridge dynamic signage

5. List the deliverable(s) to come to UDOT from this research study:

1. Video and field observations of product
2. Report documenting feasibility and cost of product with a cost benefit analysis and comparison of existing technologies implemented by UDOT

6. Describe how the results of this study will be implemented at UDOT.

Decisions on use of weather reactive pavement markings for driving information of roadway conditions
Continuing with innovative first in the nation concepts to be implemented.

7. Estimated cost - Total: $ **UDOT Share:** $ **Other/Matching Funds:** $

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

June 2013 through April 2014

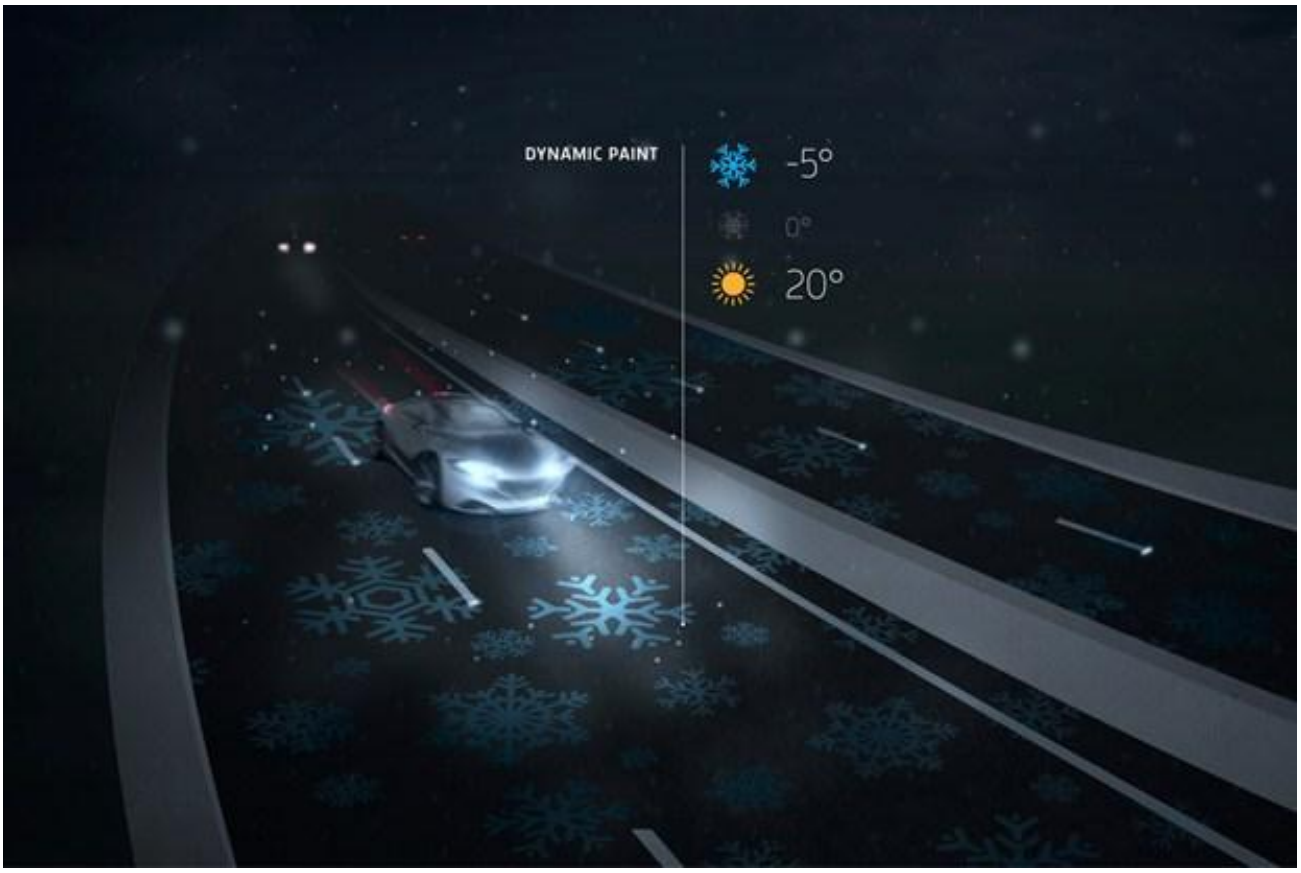
Begin Summer 2013-Fall 2013
Literature review and communication with manufacturer
Accident review of Ice accidents for hot spot locations
Attempt to procure possible samples to be installed on test area for Winter

Winter
(if available) Monitor performance and wear during winter

Page 3

Trip to Netherlands to review implemented pavement messages

Spring
Document preparation and submission to UDOT



Picture from Internet -
http://www.highwaysindustry.com/News/Highways_In_Netherlands_To_Glow_In_The_Dark_112450

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Truck Inclusion Problem at Signalized Intersections **No. UT-13.03.10**

Submitted By: Joe Perrin **Organization:** A-Trans Enigneering

Email: atrans@comcast.net **Phone:** 801 949 0348

UDOT Champion (suggested): Research / Traffic and Safety / Lighting

Select a Subject Area

- ☐ Materials/Pavements
- ☐ Maintenance
- ☒ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☐ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

Heavy Trucks make up a significant percentage of traffic on the major highways in Utah. For higher speed and higher classifications roadways that proportion increases dramatically. At traffic signals, these trucks make it difficult for following vehicles to see the signal heads creating a sight problem that increases the red light running of the following traffic.

2. Describe why this research is important and how it is unique.

The reduction of red light running is a direct safety benefit. Quantifying the problem of the red light running due to trucks blocking the visibility of the signal heads can lead to decisions as to whether pole mounted signal heads alleviate this problem and create a safe intersection. If so, the addition of pole mounted signal heads is a relatively small improvement cost that could be accomplished during signal maintenance.

3. List the research objective(s) to be accomplished:

1. Evaluate the safety concern of truck blockage of the signal heads at signalized intersections
2. Recommend if a change to signal head locations is warranted
3. Provide a cost per intersection for improvements

4. List the major tasks to accomplish the research objective(s):

1. Review accidents at intersections involving red light running and truck obscuring the signal heads
2. Use the TOC for recording red light running issue at intersections due to truck concern
3. Sight distance and impact of truck shadow area based on current UDOT signal head placement standards
4. Survey of other western states and their concern with issue

5. List the deliverable(s) to come to UDOT from this research study:

1. Quantify the truck shadow safety problem and determine distance of shadow at an intersection
2. Review safety problem based on the accident mining of the UDOT database
3. Review other western states standards

6. Describe how the results of this study will be implemented at UDOT.

Possible safety improvement at intersections by adding pole signals
Possible modification to UDOT standard signal head locations

7. Estimated cost - Total: $ **UDOT Share:** $ **Other/Matching Funds:** $

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

June 2013 through April 2014

Page 3

Begin Summer 2013-Fall 2013
Literature review and communication with other states and review of their standards
Accident review of red light running accidents to review hot spot locations
Truck shadow footprint

Winter
Review of problem through observation using TOC cameras

Spring
Document preparation and submission to UDOT

Page 4

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Flashing Yellow Arrow Uses and Signage **No. UT-13.03.11**

Submitted By: Joe Perrin **Organization:** A-Trans Enigneering

Email: atrans@comcast.net **Phone:** 801 949 0348

UDOT Champion (suggested): Research / Traffic and Safety / Lighting

Select a Subject Area

- ☐ Materials/Pavements
- ☐ Maintenance
- ☒ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☐ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

The conversion of a left turn lane from a single left turn to a dual left turn currently requires the intersection change from permitted or protected/permitted to protected only. Often, this second lane is only needed for an hour during the day for operations and is therefore the use of protected phasing is less than optimal the other 23 hours of the day. There are conditions where the use of flashing yellow could be used for protected only when needed and also allow for permitted left turns during non-peak conditions. Signage is also a concern as several common drivers have commented that the flashing yellow is unclear when first encountered.

2. Describe why this research is important and how it is unique.

While there is a location in Chandler, AZ near an Intel plant where this is being implemented, there are no locations within Utah. This research would examine the policy of if/when/where allowing flashing yellow for permitted dual left turn could be allowed. This would provide a much more efficient control instead of being constrained to protected only phasing for dual left turns which is much less efficient during off peak times.

3. List the research objective(s) to be accomplished:

1. Evaluate the conditions where dual left turns could be controlled by flashing yellow and not violate any MUTCD or sight concerns.
2. Investigate the use of signage to explain the flashing yellow, much like the sign used for the protected permitted phasing (R10-12)

4. List the major tasks to accomplish the research objective(s):

1. Survey other western states for uses of flashing yellow
2. Survey sign preference and driver acceptance (already have signs at the flashing yellows at the Thanksgiving Point flashing yellows, west of I-15)
3. Locate possible test locations
4. Observe new flashing yellow installations for driver behavior
5. Determine conflict and possible uses for flashing yellow at dual left turn lane locations. What constraints / conditions are needed to meet MUTCD and safe operations.

5. List the deliverable(s) to come to UDOT from this research study:

1. A policy on possible use of flashing yellows at dual left turn locations to provide a more efficient intersection control throughout the day
2. Recommendation of signage for flashing yellow installations

6. Describe how the results of this study will be implemented at UDOT.

Possibly lead to more efficient intersection control and significantly reduced intersection delay.

7. Estimated cost - Total: $ **UDOT Share:** $ **Other/Matching Funds:** $

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

June 2013 through April 2014

Begin Summer 2013-Fall 2013
Literature review and survey of western states
Observe operations and video a known location where flashing yellow controlled dual left turns have been installed
Visit to Chandler, AZ to talk with traffic engineer.

Winter
Use of TOC to evaluate possible locations and observe driver behavior for new flashing yellow installation locations

Spring
Document preparation and submission to UDOT

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Angled Luminaires **No. UT-13.03.12**

Submitted By: Joe Perrin **Organization:** A-Trans Enigneering

Email: atrans@comcast.net **Phone:** 801 949 0348

UDOT Champion (suggested): Research/Lighting/Signal/Safety

Select a Subject Area

- ☐ Materials/Pavements
- ☐ Maintenance
- ☒ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☐ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

At both signalized intersections and unsignalized crosswalks, lighting is an important aspect for drivers to see pedestrian during night operations. Often, overhead powerlines create a significant concern with adding luminaires and with the recent change in OSHA requirements from 10 to 20 feet between the powerlines and an upright luminaire, it is becoming increasingly difficult to place the luminaires at these intersections.

2. Describe why this research is important and how it is unique.

The ability to have another option for installing luminaires allows for enhanced safety through lighting that is often neglected because of the powerline limitations. This also has the potential to address the more restrictive spacing requirements that have been implemented recently requiring further separation of powerlines and luminaires.

3. List the research objective(s) to be accomplished:

1. Determine the feasibility of using angled poles for luminaires

4. List the major tasks to accomplish the research objective(s):

1. Review other western states and their uses of angled luminaires along corridors and at intersections
2. Manufacture specifications and available product options
3. Larry and Richard input on lighting concern and problem with powerlines
4. Accident review of past 5-year pedestrian-vehicle accidents and location lighting associated with those accidents.

5. List the deliverable(s) to come to UDOT from this research study:

1. Report documenting the review of angled luminaire and how it provides a potential benefit to situations where overhead powerlines restrict typical vertical luminaire upright.

6. Describe how the results of this study will be implemented at UDOT.

Possible new tool for addressing lighting where overhead powerlines limit options of vertical luminaire uprights

7. Estimated cost - Total: $ **UDOT Share:** $ **Other/Matching Funds:** $

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

June 2013 through April 2014

Begin Summer 2013-Fall 2013
Literature review and communication with manufacturer
Accident review of pedestrian accidents for lighting issues

Winter
Process information and review other state standards and uses of angled luminaires

Spring
Document preparation and submission to UDOT

Page 4

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Wheel chair detection loops **No. UT-13.03.13**

Submitted By: Bryan Talbot & David Stevens **Organization:** UDOT Region 2, Construction 2756

Email: btalbot@utah.gov, davidstevens@utah.gov **Phone:** 801-910-2563

UDOT Champion (suggested):

Select a Subject Area

- ☐ Materials/Pavements
- ☐ Maintenance
- ☒ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☐ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

Disabled pedestrians have a tough time crossing the street even if pedestrian ramps meet ADA requirements. As a Department we could improve the mobility of those in wheel chairs by detecting wheel chairs and making street signals adjust automatically for them.

2. Describe why this research is important and how it is unique.

As a Department we work for the public; we have the obligation to keep them safe, give them quality products and ease their travel needs as much as possible. By implementing detection loops on pedestrian ramps we would be at the forefront of making travel safer and easier for the public who are required to use wheel chairs. This would likely be the first time such technology has been used in Utah. On a small scale it would provide a prime opportunity to learn whether this technology can improve the safety and ease of wheel chair users at signalized intersections. Designs and lessons learned from others (Cupertino, CA – loops in ramps; Tucson, AZ – pedestrian microwave detector; etc.) could be applied in a Utah application of the technology.

3. List the research objective(s) to be accomplished:

1. Determine if this technology could positively impact the public in Utah.
2. Determine if such a system is feasible for use with existing systems at one or more candidate intersections in Utah.
3. Determine if one of these systems is effective at improving safety and ease of travel for wheel chair users at one intersection.

4. List the major tasks to accomplish the research objective(s):

1. Conduct a literature review. Also contact agencies, local governments, and vendors across the country about detection technologies they have used.
2. Identify loop or other detection system to be installed at an intersection for evaluation.
3. Identify the test intersection (state route or otherwise) after contacting hospitals, schools, and government buildings about

potential locations and observing vehicle, pedestrian, and wheel chair traffic at a few of these intersections.

4. Conduct a pre-installation survey of several users of the test intersection and nearby buildings to document their perception of the current intersection operation and safety. Gather and summarize available traffic, pedestrian, and accident data on the intersection.
5. Plan the loop installation effort including ramp surface repair, tie-in to the existing traffic signal system, any additional signage, traffic/signal modeling, and a public notification plan.
6. Install the detection loops at the test intersection and set the signal timing to adjust for wheelchair presence at the ramps.
7. Periodically over two months, observe the new system operation and intersection use by those in wheel chairs. Also review any available sensor/camera data from the site.
8. Conduct a post-installation survey of intersection users and nearby buildings after two months to document their perception of any improvement or otherwise to the intersection operation and safety. Document any anticipated maintenance needs for the detection system.
9. Compile observations and survey results in an evaluation report and share with UDOT traffic engineers and leadership. Draw conclusions and implementation recommendations based on the following:
    a. Is this system feasible with the systems we currently have in place?
    b. What improvement, if any, in safety or ease of passage by wheel chair users was observed at the test intersection?
    c. What are the locations in Utah where this technology would be most beneficial?
    d. Would this system be cost effective for the Department to install and operate at several intersections?

5. List the deliverable(s) to come to UDOT from this research study:

1. Evaluation report on the test intersection.
2. Recommendations on further implementation at UDOT.

6. Describe how the results of this study will be implemented at UDOT.

Information gathered in the small scale test of the system at one intersection, depending on the outcome, could lead to the decision to implement similar detection loops for wheel chairs at other intersections operated by UDOT or local governments.

7. Estimated cost - Total: $20k to 40k **UDOT Share:** $20k to 40k **Other/Matching Funds:** $

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

About 7 months total starting around July 2013:
2 months for literature review and installation planning,
1 month for installation,
2 months for field evaluation, and
2 months for report preparation and presentation.

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Bike Utilization **No. UT-13.03.14**

Submitted By: Joe Perrin **Organization:** A-Trans Enigneering

Email: atrans@comcast.net **Phone:** 801 949 0348

UDOT Champion (suggested): Research/Lighting/Signal/Safety

Select a Subject Area

- ☐ Materials/Pavements
- ☐ Maintenance
- ☒ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☐ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

The concept of multi-mode is to distribute the travel demand across many modes of transportation. Bicycle is one of those modes and with the number of recreational outdoor activities in Utah, biking, road and mountain or relatively popular in Utah. The question becomes how popular and how utilized are the bike lanes that are being implemented on many of the UDOT roadways. Biking is likely the least utilized mode of transportation that ROW is often dedicated too and therefore represents the highest cost per user. Identifying this cost per using and bike lane utilization is prudent in making future decisions about how roadway cross sections and context sensitive solutions proceed in the future.

2. Describe why this research is important and how it is unique.

It allows a quantification of bike utilization on major UDOT roadways and allows a cost per user number to be determined for including these facilities on future UDOT roadway projects and rebuilds.

3. List the research objective(s) to be accomplished:

1. Determine the use of bicycle activity on UDOT roadways
2. Determine a typical cost per user for these facilities

4. List the major tasks to accomplish the research objective(s):

1. Use UDOT TOC for data collection and observation cameras
2. Quantify the bike utilization
3. Determine costs per user based on ROW and asphalt dedicated to bike lanes and utilization
4. Accident review of past 5-year bike-vehicle accidents and type of AASHTO bike lane or shared lane associated with those accidents.

5. List the deliverable(s) to come to UDOT from this research study:

1. Report documenting the review of bike utilization and costs.

6. Describe how the results of this study will be implemented at UDOT.

Tool for understanding the utilization, costs and benefits of bike facilities in UDOT projects

7. Estimated cost - Total: $ **UDOT Share:** $ **Other/Matching Funds:** $

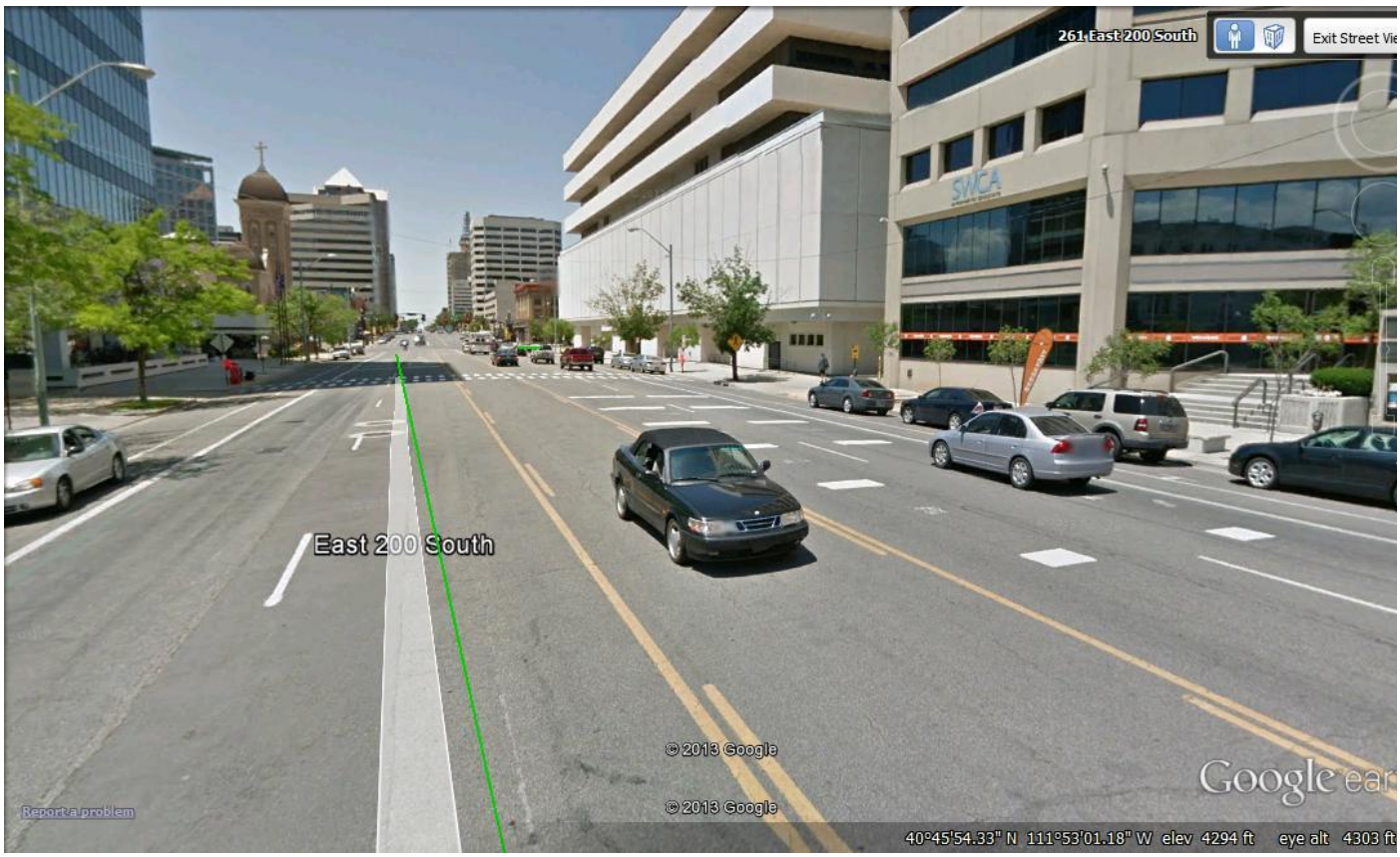
8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

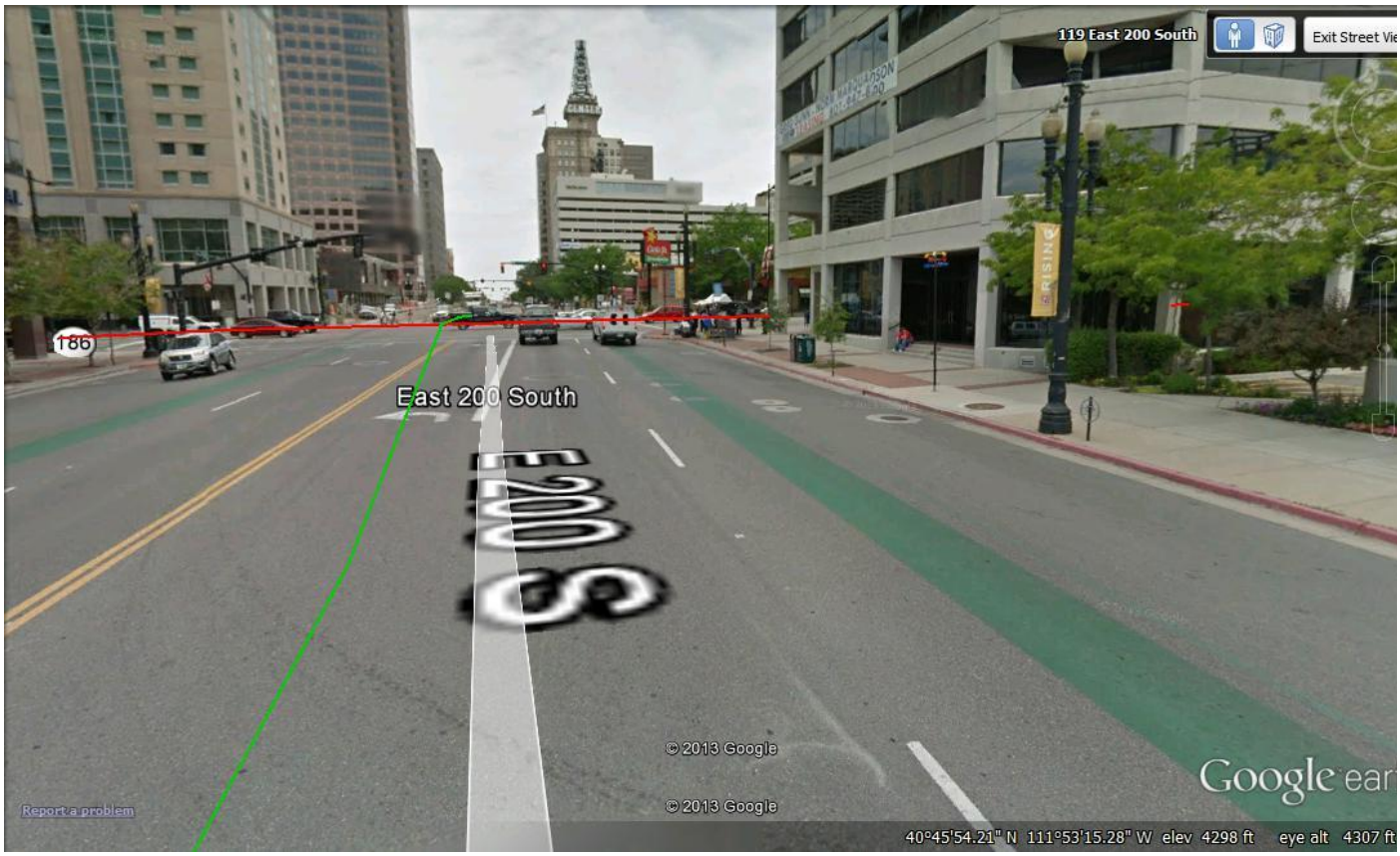
June 2013 through April 2014

Begin Summer 2013-Fall 2013
Literature review of other western states
Accident review of bicycle-vehicle accidents
Collect bicycle utilization information from TOC data collection

Winter
Process TOC information and review other state standards and use or thresholds of bicycle lane implementation

Spring
Document preparation and submission to UDOT

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2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Innovative Intersection Safety Analysis - An Evaluation of Methodologies **No. UT-13.03.15**

Submitted By: Grant G. Schultz **Organization:** Brigham Young University

Email: gschultz@byu.edu **Phone:** 801-422-6332

UDOT Champion (suggested): W. Scott Jones

Select a Subject Area

- ☐ Materials/Pavements
- ☐ Maintenance
- ☒ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☐ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

Utah is home to a large number of innovative intersections and interchanges. These include the continuous-flow intersection (CFI), the single-point urban interchange (SPUI), the diverging diamond interchange (DDI), the thru-turn, and others. The Utah Department of Transportation (UDOT) is in an interesting position to be able to be a leader in identifying both safety and operational impacts of these innovative intersections and interchanges. The majority of these intersections and interchanges have been installed within the past 2-3 years, which means that there is not currently sufficient safety 'after' data to perform an effective analysis of their benefits. To be ready to perform this analysis, however, it is important to ensure a consistent methodology for evaluation and that the right data are available when the safety data have been collected and summarized. The purpose of this research project is to develop a methodology for evaluating the safety benefits of innovative intersections and interchanges, including identifying the data that should be collected at these locations to ensure that an effective analysis can be performed.

2. Describe why this research is important and how it is unique.

This research is important in planning ahead for a safety evaluation of innovative intersections and interchanges. This project will allow provide a synthesis of best practices and the legwork to be done such that once the crash data are available for the full analysis, the remaining data collection will have already been completed.

3. List the research objective(s) to be accomplished:

1. Perform a synthesis of best practices for the evaluation of safety benefits of innovative intersections and interchanges.
2. Utilize the UDOT crash database to ensure that the necessary data have been (will be) collected to evaluate the safety benefits of innovative intersections and interchanges.
3. Develop a consistent methodology for the analysis of safety benefits of innovative intersections and interchanges in Utah.

4. List the major tasks to accomplish the research objective(s):

1. Develop a project scope of work and detailed estimate.
2. Perform literature review and synthesis of best practices and analysis techniques for intersection and interchange design.
3. Evaluate current crash database to compare collected data to data needs determined through the synthesis of best practices.
4. Develop a consistent methodology for the analysis of safety benefits of innovative intersections and interchanges in Utah.
5. Report results to UDOT in the form of a written report

5. List the deliverable(s) to come to UDOT from this research study:

1. Engineering report documenting the literature review and research results.
2. Methodology for the evaluation of safety benefits of innovative intersections and interchanges.

6. Describe how the results of this study will be implemented at UDOT.

This research would be implemented by the UDOT Traffic & Safety Division to ensure that the necessary data are available to evaluate the safety benefits of innovative intersections and interchanges. These results would then be used in a future study to perform the analysis (once sufficient 'after' data are available).

7. Estimated cost - Total: $40,000 **UDOT Share:** $40,000 **Other/Matching Funds:** $

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

It is recommended that this project begin late summer/early Fall 2013 with the project scope of work and detailed estimate, followed with the literature review/synthesis of best practices. The work will continue as outlined. It is anticipated to take 12-16 months.

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Development of Performance Matrices for Evaluating Innovative Intersections and Interchanges **No. UT-13.03.16**

Submitted By: Milan Zlatkovic **Organization:** University of Utah

Email: milan@trafficlab.utah.edu **Phone:** 801-819-5925

UDOT Champion (suggested): Robert Miles (robertmiles@utah.gov)

Select a Subject Area

- ☐ Materials/Pavements
- ☐ Maintenance
- ☒ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☐ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

Innovative intersections and interchanges, primarily Continuous Flow Intersection (CFI) and Diverging Diamond Interchange (DDI), have seen an increase in numbers in the State over the past several years, making Utah a leader in the country in implementation of these designs. Although on the surface these designs seem to improve traffic performance, their complete impacts and benefits are hard to assess. There are no clearly defined guidelines and methodologies for monitoring and measuring performance of these designs from state DOTs manuals, AASHTO, HCM, NEMA and HSM. Innovative designs have impacts on safety, accessibility, transit, pedestrian and non-motorized traffic, land use, economic development, and environment, making them an excellent candidate for an in-depth analysis of different benefit-impact combinations. There is no a defined straightforward way for this analysis. This study proposes to review the existing methodologies implemented by researchers and agencies, and develop a set of performance matrices for evaluation of innovative designs, that would help UDOT define guidelines and methodologies for existing and future implementations.

2. Describe why this research is important and how it is unique.

UDOT has already taken the lead in the country in implementing innovative intersections/interchanges. It can be expected that these implementation will continue in the future, since these innovative solutions seem to be able to alleviate some of the congestion problems on busiest intersections and interchanges. However, there are still no clearly defined guidelines and methodologies for their performance and safety evaluation. Researchers and practitioners have recognized that there are gaps when it comes to innovative solutions, so it can be expected that research in this area will increase in the next several years. This research will help make UDOT also a leader in researching innovative designs, along with their implementations. There are a lot of unknown aspects, especially when it comes to evaluating innovative solutions. This research will help identify and develop the best methodologies for an in-depth analysis of different benefit and impact of innovative solutions on the traveling public and surrounding communities.

3. List the research objective(s) to be accomplished:

1. Review the existing implementations, geometric and signal control designs, standards and guidelines for innovative intersections and interchanges
2. Review the existing methodologies for performance and safety evaluation of these designs

3. Define the needs for guidelines and methodologies for evaluation of innovative solutions
4. Develop and recommend performance matrices and evaluation guidelines to be used by UDOT on existing and future projects
5. Summarize all findings and recommendations

4. List the major tasks to accomplish the research objective(s):

1. Literature review of implementations, designs and evaluations of innovative intersections and interchanges
2. Review of existing methodologies for performance and safety evaluation of these designs
3. Review of existing standards and guidelines (including, but not limited to AASHTO, HCM, MUTCD, NEMA, HSM, state DOTs design manuals) for guidelines and methodologies that could be implemented with innovative intersections and interchanges
4. Identifying gaps in the existing guidelines and methodologies
5. Identifying potential methodologies that could fill in gaps from 4.
6. Meet with UDOT to review findings 1 – 5 and identify the best candidate methodologies
7. Development and recommendations of performance matrices and evaluation methodologies for innovative intersections and interchanges that could be implemented in current and future UDOT's projects

5. List the deliverable(s) to come to UDOT from this research study:

1. Literature review of implementations, designs and evaluations of innovative intersections and interchanges, as well as existing standards, guidelines and methodologies
2. A set of performance matrices for evaluation of innovative intersections and interchanges
3. Final report with all analyses, methodologies and recommendations

6. Describe how the results of this study will be implemented at UDOT.

The results of this study would help UDOT make better and more informed decisions about the implementation, and performance and safety evaluations of innovative solutions. Each implementation is unique, and there are a lot of parameters that have to be considered before, during and after the implementation. The evaluation has to encompass all aspects of performance, from general MOEs to impacts on safety, accessibility, transit, pedestrian and non-motorized traffic, land use, economic development, and environment. This research is expected to deliver a set of straightforward performance matrices and methodologies for these evaluations.
The University of Utah will apply for matching funds from the Mountain Plains Consortium (MPC), a University Transportation Center, and if the funds are approved, the researchers will work with the UDOT TAC to develop an additional scope that would supplement the work presented in this proposal.

7. Estimated cost - Total: $70,000.00 **UDOT Share:** $35,000.00 **Other/Matching Funds:** $35,000.00

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

The estimated duration of this project is 12 months, with a recommended start date in August 2013, and end date in August 2014.

The project would have three general phases:
Phase I (duration: 4 months): Review of existing performance evaluation methodologies
Phase II (duration: 4 months): Development of potential performance and safety evaluation methodologies, and creating performance matrices for innovative designs
Phase III (duration: 4 months): Additional reviews and analyses, and writing the final report

Phases I and II would produce Interim reports for UDOT's review and suggestions, which would be implemented in the Final report.

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Calibration of Automatic Performance Measures Speed and Volume Data **No. UT-13.03.17**

Submitted By: Mitsuru Saito and Grant G. Schultz **Organization:** Brigham Young University

Email: msaito@byu.edu and gschultz@byu.edu **Phone:** 801-422-6326 and 801-422-6332

UDOT Champion (suggested): Mark Taylor

Select a Subject Area

- ☐ Materials/Pavements
- ☐ Maintenance
- ☒ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☐ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

The Utah Department of Transportation (UDOT) has been developing a system for realizing automatic performance measure evaluations using the rich information collection infrastructure for evaluating the performance of signalized intersections. UDOT is one of only two states using this approach to signalized performance measures and the only state that is utilizing radar equipment for this purpose. The Signal Performance Metrics system is the fruit of this effort for dynamic evaluation and collection of performance of signalized intersections. The system currently provides data summaries for five performance measures: 1) Purdue Coordination Diagram, 2) Speed, 3) Approach Volume, 4) Purdue Phase Termination Charts, and 5) Split Monitor. These performance measures provide signal engineers and others immediate access to the data, which in turn, allows them to respond quickly to traffic related problems and to collect traffic data for modeling, planning, and other traffic studies. Additional metrics, such as turning movement volume counts will be developed and available (website at http://udotraffic.utah.gov/signalperformancemetrics/) no later than the end of the 2013 fiscal year.

One unknown with the current system is the accuracy level of the speed and volume data that the system reports. For this system to be utilized most effectively, it is necessary that UDOT have a better understanding of the data accuracy and confidence level of the system. The purpose of this research is to conduct a study to calibrate speed and volume data reported by the Signal Performance Metrics system with ground truth data to determine its accuracy level and to develop calibration factors so that the users of the system have confidence in the use of this significantly informative system. In addition, the project will help to better define the 'sweet spot' for the signal detection, particularly with respect to the differing radar data collection systems. As turning movement volume counts become available, these data will also be calibrated as part of the project. This project will provide practical solutions with immediate benefits.

Note: The researchers will partner with Dr. Darcy Bullock at Purdue University on the project to ensure consistency with previous work. The researchers will coordinate with Wavetronix to ensure consistency with zone placement recommendations and previous work. Dr. Saito received his Ph.D. degree at Purdue University, knows Dr. Bullock well, and has contacted him about this effort, while Dr. Schultz has worked successfully in past projects with others at Wavetronix.

2. Describe why this research is important and how it is unique.

In addition to utilizing the automatic performance measures data internally, UDOT has made the Signal Performance Metrics system available to the public, university researchers, and engineering consultants. As a result, UDOT must have confidence in the information provided by the system. Currently, speed and volume data have not been calibrated (while turning movement volume counts have not yet been available) and hence the proposed study will provide UDOT with information on accuracy of the system so that the system's reliability is increased.

3. List the research objective(s) to be accomplished:

1. Set up a design of experiments for collecting ground truth data to calibrate speed and volume data.
2. Analyze ground truth data and compare these data with the data provided by the Signal Performance Metrics system.
3. Develop necessary calibration factors for converting reported speed and volume data to become closer to reality.

4. List the major tasks to accomplish the research objective(s):

1. Develop a project scope of work and detailed estimate.
2. Literature review on automated performance measure evaluation systems.
3. Selection of study sites.
4. Set up a design of experiments and consideration of factors to be considered (radar range, installation angles, etc.) and synchronize ground truth data collection and data collection by the Signal Performance Metrics system.
5. Set up data collection procedure (e.g., direct recording using the video recording system for recording live feed from UDOT cameras, manual counts, and/or using the Data Collection Trailer from the BYU Traffic Lab to collect volume and speed data).
6. Execute data collection plan.
7. Reduce speed and volume data (both ground truth data and data obtained by the Signal Performance Metrics system).
8. Analyze the data and summarize findings.
9. Report results to UDOT in the form of a written report.

5. List the deliverable(s) to come to UDOT from this research study:

1. Engineering report documenting the literature review and research results.
2. Calibration factors for speed and volume data reported by the Signal Performance Metrics system and its accuracy level.
3. Recommended placement of radar detection zones for speed and volume collection.

6. Describe how the results of this study will be implemented at UDOT.

UDOT will know the accuracy of speed and volume data provided by the Signal Performance Metrics system and will be able to provide the public with speed and volume (including turning movement data) reported by the system with confidence.

7. Estimated cost - Total: $80,000-100,000 **UDOT Share:** $80,000-100,000 **Other/Matching Funds:** $

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

It is recommended that this project begin summer of 2013 with the initial tasks of the project scope of work and detailed estimate, followed with the literature review. The work will continue according to the tasks outlined previously. It is anticipated that the project would take 12 months to complete.

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Variable Speed Limits (VSL's) in Work Zones **No. UT-13.03.18**

Submitted By: Keith Bladen **Organization:** UDOT Risk Management

Email: kbladen@utah.gov **Phone:** 801-791-2412

UDOT Champion (suggested):

Select a Subject Area

- ☐ Materials/Pavements
- ☐ Maintenance
- ☒ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☐ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

Manage traffic speeds, and possibly queuing, by utilizing VSL's in work zones during work activities. Instead of blanket speed limit reduction requests to be used for the entire length of a project, incorporate VSL's to be used at areas of work activity. Allow the ability to better manage speed reductions only where they are applicable.

2. Describe why this research is important and how it is unique.

UDOT has been asked by the AGC Highway Safety Committee to determine if VSL's would be allowed on their contracted construction projects, what our specifications or requirements to use VSL's would be, and how UDOT determines if speed limit reduction request is approved or denied. This research may help us determine if VSL's are an effective way to manage traffic speeds and flows and if proper use will increase safety for the motorists and the workers.

3. List the research objective(s) to be accomplished:

1. Determine work zone speed limit compliance and if there is an increase in the average speeds.
2. Determine if safety is improved in the work zone.
3. Determine if traffic flow is improved through the work zone and if travel time through the work zone is decreased.
4. Be able to provide constant credible speed limit info based on work activity and traffic flows/congestion.

4. List the major tasks to accomplish the research objective(s):

1. Find a project that would best incorporate a VSL system.
2. Find a company that manufactures/supplies VSL systems.
3. Have someone to oversee and manage the implementation and use of a VSL system.
4. Analyze the data for a summary and recommendation statement.

5. List the deliverable(s) to come to UDOT from this research study:

1. Data collected from the system
2. Effectiveness
3. Recommendations for future use

6. Describe how the results of this study will be implemented at UDOT.

If effective, it may help us incorporate the concept into standard specifications and standard drawings.

7. Estimated cost - Total: $ **UDOT Share:** $ **Other/Matching Funds:** $

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

If possible, I would like to see this study incorporated in a construction project this season. The effectiveness of VSL compliance and safety may best be monitored on a project that lasts longer than 2 months. Looking at upcoming projects, one that could benefit and provide significant feedback is the Spanish Fork to Payson project (or one with similar characteristics). On the Payson project, we currently have NB posted speeds of 75 mph, two lanes in each direction, and major work activities at sporadic locations.

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: I-15 HOT Lanes Study **No. UT-13.03.19**

Submitted By: Cameron Kergaye **Organization:** UDOT

Email: ckergaye@utah.gov **Phone:** 801-965-2576

UDOT Champion (suggested):

Select a Subject Area

- ☐ Materials/Pavements
- ☐ Maintenance
- ☒ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☐ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

The toll on I-15 may be too low to provide a better level of service than the adjacent general purpose lanes. Operational costs may be also lower than current revenue. A study is needed to recommend adjustments to the toll and services based on current and future projects.

2. Describe why this research is important and how it is unique.

This study will provide an analysis and recommendations for toll adjustments and additional services.

3. List the research objective(s) to be accomplished:

1. Analyze toll rates for current and future projections.
2. Recommend additional services for HOT lane usage.

4. List the major tasks to accomplish the research objective(s):

1. Analysis of current toll rates and cost burden.
2. Sensitivity analysis of performance factors.
3. Survey of additional services relevant to HOT/HOV infrastructure.

5. List the deliverable(s) to come to UDOT from this research study:

1. Sensitivity (performance vs cost) tool.
2. Recommendations.

6. Describe how the results of this study will be implemented at UDOT.

Recommendations will be used to adjust toll rates and/or provide additional services.

7. Estimated cost - Total: $25000 **UDOT Share:** $25000 **Other/Matching Funds:** $

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

This will be an 6-8 month study.

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Evaluating the Feasibility of Creating Virtual Driving Scenarios Using LiDAR Data for Driving Simulators

No. : UT-13.03.20

Submitted By: Mitsuru Saito and Richard .J. Porter **Organization:** BYU and University of Utah

Email: msaito@byu.edu and richard.jon.porter@utah.edu **Phone:** 801-422-6326 and 801-585-1290

UDOT Champion (suggested): To be determined by the Traffic Management & Safety Group

Select a Subject Area

- ☐ Materials/Pavements
- ☐ Maintenance
- ☒ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☐ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

Crash analyses will locate high-risk safety hot spots. Network-level hot spot analyses typically use traffic data and physical data to identify them. Human factors that might have contributed to the crashes at hot spots are often excluded from such analyses because human factor data are not available in crash reports. If virtual driving scenarios can be created for driving simulators, we will be able to analyze what kind of driver behaviors might have contributed to such crashes. Creating virtual driving scenarios that reflect what's really there in the hot spot segments of highways has been difficult. LiDAR data that UDOT has collected give an opportunity to create such true-to-reality virtual driving scenarios for driving simulators. The Utah Traffic Lab owns a driving simulator and together with the availability of LiDAR data, we have a choice opportunity to explore this possibility of evaluating drivers' responses to physical and traffic stimulus that safety hot spots exert on the drivers that might lead to potential crashes.

2. Describe why this research is important and how it is unique.

Due to the lack of data, human factors are not considered in typical crash hot spot analyses. However, if virtual driving scenarios of safety hot spots are created for driving simulators, they will allow UDOT engineers to analyze human and physical environment interactions that might have contributed to the occurrence of more than usual crashes at such hot spots. Such analyses will help UDOT engineers to evaluate potential causes for crashes or likely chains of events that might have led to crashes and identify appropriate countermeasures.

3. List the research objective(s) to be accomplished:

1. Evaluate the feasibility of using LiDAR data to create virtual driving scenarios for driving simulators
2. Create a prototype scenario for a crash hot spot identified by crash analyses
3. Conduct an exploratory study to incorporate human behaviors in selecting safety countermeasures

4. List the major tasks to accomplish the research objective(s):

1. Literature review on virtual driving scenario production and driver simulator related research (Phase I)
2. Evaluate the data structure of LiDAR data (Phase I)
3. Evaluate the steps needed to transform LiDAR data for creating virtual driving scenarios (Phase I)
4. Study the tasks required to create scenarios for the driving simulator available at the Utah Traffic Lab (Phase I)
5. Create a driving scenario for the driving simulator at the Utah Traffic Lab using a hot spot identified by safety hot spot analyses as an example (Phase I)
6. Write a report summarizing the findings from Tasks 1 through 5 in the first phase (Phase I)
7. Set up an experiment to observe driver behaviors using the virtual driving scenario developed in task 5 (Phase II)
8. Collect driver behavior data and analyze them (Phase II)
9. Summarizing findings from driver observation and recommend for potential countermeasures that reflect the findings from driver observation (Phase II)
10. Recommend directions for including human factor observations process in developing design alternatives to reduce crashes
11. Write a report summarizing the findings from Task 8 through 11 in the second phase (Phase II) and a promotional video that UDOT requires (Phase II)

5. List the deliverable(s) to come to UDOT from this research study:

1. Final report summarizing all the tasks (Phase I)
2. Procedure to create virtual driving scenarios using LiDAR data for the driving simulator at the Utah Traffic Lab and a sample driving scenario (Phase I)
3. Finding from an experimental test and recommendations for full integration of the driving simulator in safety analysis of hot spots (Phase II) and a video presenting the development process, a sample human factor data collection.

6. Describe how the results of this study will be implemented at UDOT.

UDOT can collect data on human factors that might have contributed to crashes that have happened at crash hot spots and the findings from the study of human factors can be used to identify most appropriate and cost effective countermeasures to reduce crash occurrence at the selected crash hot spot.

7. Estimated cost - Total: $70,000 (Phase I) & $50,000 (Phase II) **UDOT Share:** $70,000 (Phase I) & $50,000 (Phase II)
Other/Matching Funds: $

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

It is recommended that this project begin in later summer or early Fall 2013 with the initial tasks of the project scope of work and detailed estimate, followed with the literature review. It is anticipated that the project would take 18 to 24 months, including a 4-month report review period.

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Monitoring for Early Warning of Large Catastrophic Rock Slope Failures **No. : UT-13.04.01**

Submitted By: Jeffrey Moore **Organization:** University of Utah

Email: jeff.moore@utah.edu **Phone:** 801-585-0491

UDOT Champion (suggested): Darin Sjoblom, Keith Brown

Select a Subject Area

- ☐ Materials/Pavements
- ☐ Maintenance
- ☐ Traffic Mgmt/Safety
- ☒ Geotechnical
- ☐ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

Monitoring the temporal displacement characteristics of large or deep-seated rock slope instabilities can provide essential data to characterize the hazard and mitigate risk associated with catastrophic failure. Early-warning monitoring systems and targeted avoidance are often the only defense against large slope failures, where engineering intervention is not feasible. This proposal lays out an open plan for rock slope displacement monitoring and instability characterization in the scope of a MSc thesis project at the University of Utah. The precise study site(s) will be selected in collaboration between UDOT and UU as being among high-risk potential rock slope failures affecting Utah highways. One example study area is SR-14 in Cedar Canyon, the site of previous large rockfalls, however other locations are equally possible. This study is envisioned as a pilot research investigation of rock slope displacement monitoring for instability characterization and early warning of failure, which may be augmented at the chosen site, expanded to other locations, or terminated depending on the outcomes of subsequent hazard and risk assessment.

2. Describe why this research is important and how it is unique.

Large, catastrophic rock slope failures can have devastating impact on highways and civil structures, resulting in damage, injuries, death and significant economic losses. Because of their perceived stochastic nature and relatively rare occurrence, these natural events are commonly thought of as *unpredictable*¸ however this is not always the case. Large rock slope failures often show many precursory warning signs, and with an appropriate monitoring system and proactive analysis the time of failure can be forecasted. Early-warning monitoring systems offer the capability for objective analysis to characterize hazard and mitigate risk through avoidance. Failure can be predicted from monitoring data in a number of ways, the most common being inverse-velocity methods, where the reciprocal of ground velocity is plotted against time and extrapolated to a zero value forecasting the time of impending collapse. Many successful case histories attest to the power of displacement monitoring for early warning and hazard avoidance, which is often the only practical means to mitigate risks associated with large rock slope failures.

3. List the research objective(s) to be accomplished:

1. Characterize the internal structure and kinematics of the selected rock slope instability.
2. Identify potential forcing factors and sensitivities to forecast hazardous conditions.
3. Mitigate risk of slope failure through early-warning monitoring.

4. List the major tasks to accomplish the research objective(s):

1. Thoroughly investigate geological / geotechnical structure of the selected rock slope instability.
2. Create and install appropriate monitoring system based on knowledge of instability kinematics.
3. Analyze monitoring data to identify critical forcing factors and sensitivities.
4. Define alert and action thresholds and create automated alerting system.
5. Monitor instability displacement through time, update system as needed.
6. Perform runout simulation for different failure scenarios.

5. List the deliverable(s) to come to UDOT from this research study:

1. Full research report describing instability structure and kinematics, proposed sensitivity to different forcing factors, required data for risk analysis, and recommendations for critical velocity thresholds and analyses methods for alerting.
2. Installed monitoring system for continued long-term analysis.

6. Describe how the results of this study will be implemented at UDOT.

This pilot research investigation will help lay the groundwork for future monitoring and characterization of suspected hazardous rock slope instabilities elsewhere in the state. The selected site will be instrumented with essential monitoring equipment, which will remain on site at UDOT's discretion and can be used to monitor displacements beyond the life of this project. Long-term monitoring data will create the basis to understand critical velocity thresholds and forcing factors, and thus mitigate risk. The delivered report will contain recommendations for analysis of monitoring data to identify hazardous conditions, necessary elements for full risk assessment, and in the event of accelerating displacements methods to estimate the time of failure.

7. Estimated cost - Total: $80,000 **UDOT Share:** $40,000 **Other/Matching Funds:** $40,000 (UU)

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

Estimated start date – September 1, 2013
Predicted end date – August 31, 2015

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: CONDITIONAL FUNDING: Probabilistic Liquefaction and Lateral Spread Hazard Mapping for Utah County

No. : UT-13.04.02

Submitted By: Kevin W. Franke

Organization: Brigham Young University

Email: kevin_franke@byu.edu

Phone: 801-422-1349

UDOT Champion (suggested): Darin Sjoblum

Select a Subject Area

- ☐ Materials/Pavements
- ☐ Maintenance
- ☐ Traffic Mgmt/Safety
- ☒ Geotechnical
- ☐ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

Engineers are well aware of the potential risk introduced to engineered infrastructure from soil liquefaction and its effects. However, a significant challenge is identifying *a priori* where this risk poses the greatest impact and potential disruption to society. Geologic hazard mapping for many hazards such as landslides and earthquake ground shaking has proven to be a very useful tool for engineers, emergency planners, decision makers, and risk analysts to identify areas of potential societal risk/impact. However, the hazard mapping of liquefaction and its effects presents a significant problem because liquefaction is primarily a subsurface phenomenon and it is strongly dependent on site-specific soil properties and intensity/duration of ground shaking. Recent research efforts (Olsen et al. 2007; Holzer 2008) have presented innovative ways to perform liquefaction hazard mapping.

This proposed project is a continuation of the recent research efforts initiated by the University of Utah to apply an innovative probabilistic approach to develop modernized hazard maps of liquefaction triggering and lateral spread displacement for the Wasatch Front including Salt Lake, Davis, Weber, Utah, and Cache Counties. To date, Salt Lake and Weber Counties have been successfully mapped. This project involves collaborative research between Brigham Young University (BYU) and Oregon State University (OSU), with senior guidance/oversight provided by Dr. Steven Bartlett of the University of Utah. The 2013 Utah Liquefaction Advisory Group (ULAG), which was comprised of a large body of liquefaction experts and state decision- and policy-makers (including UDOT representatives), unanimously voted the liquefaction and lateral spread hazard mapping of Utah County as the top research priority for 2014. The reason for this urgency is because Utah County is the state's second most populated county, and it is known to have substantial liquefaction and lateral spread hazard due to its proximity to Utah Lake (i.e. very high groundwater), the greater amount of sand and silt in the soil, and relatively steep topography.

2. Describe why this research is important and how it is unique.

UDOT has recently made a substantial investment in Utah County through the implementation of sizeable projects such as I-15 CORE and Pioneer Crossing. Furthermore, government agencies such as the National Security Agency (NSA) and many private industries such as Adobe, Inc. have recently selected Utah County as an ideal location to construct new facilities. This exciting new growth in Utah County is major contributor to Utah's better-than-average economy, and is one of the reasons Provo City was recently voted as the #1 Best Place in America for Business and Careers by Forbes Magazine.

The development of probabilistic liquefaction and lateral spread hazard maps will provide an important risk assessment tool to those agencies, departments, and industries who have recently invested their time and money in Utah County. State departments like UDOT could use the hazard maps to evaluate their transportation network and to identify potential "problem spots" where future liquefaction mitigative work might be a good idea. Furthermore, probabilistic hazard maps are an invaluable tool when performing emergency/disaster scenario and impact studies.

This research is unique in that it employs an innovative probabilistic process to gather soil data, make statistical inferences in areas of little data, and compute liquefaction and lateral spread hazard. Additionally, few proposed research projects have garnered the

collective endorsement that this project has due to its being championed by the 2013 ULAG session. Finally, this project is unique in that UDOT funding is being requested conditionally upon our receiving federal research funds from the US Geological Survey (USGS). If the USGS funding request is denied, then UDOT may retain its portion of the funding for use on other potential projects during 2014.

3. List the research objective(s) to be accomplished:

1. Collect a large database of soil boring logs and CPT soundings from Utah County. Multiple public and private agencies including various cities/municipalities, the Central Utah Water Conservancy District, and The Church of Jesus Christ of Latter-Day Saints have already agreed to share their available information with us for this research effort.
2. Evaluate the available properties for the various soil units from the boring/sounding database and develop probabilistic distributions for each. This effort will be performed in consideration of mapped surficial geologic units. These probabilistic distributions of the various soil units will be necessary to make statistical inference in areas where few borings/soundings are available.
3. Evaluate ground water elevation records and available topographic/survey data for Utah County.
4. Perform probabilistic hazard mapping algorithm for liquefaction and lateral spread displacement across an optimized grid of points in Utah County. This algorithm will be performed at return periods of 475 years, 1,033 years, and 2,475 years.
5. Develop GIS-friendly hazard maps for liquefaction and lateral spread and make them available to the public.

4. List the major tasks to accomplish the research objective(s):

1. Collect as many soil boring logs and CPT soundings as possible and develop the soil database for Utah County. Identify significant soil units. (Months 1-5)
2. Assess the available soil descriptions, mapped geologic information, and laboratory test results from the identified significant soil units and fit probabilistic functions to them. (Months 5-6)
3. Assess ground elevation records and topographic/survey data for Utah County. (Month 6)
4. Perform probabilistic liquefaction and lateral spread mapping at the return periods of interest. (Months 7-10)
5. Develop GIS-friendly maps for the new probabilistic liquefaction and lateral spread maps. (Month 11)
6. Prepare a summary report describing the research project and introducing the new liquefaction and lateral spread hazard maps. (Month 12)

5. List the deliverable(s) to come to UDOT from this research study:

1. A set of GIS-friendly liquefaction and lateral spread hazard maps for Utah County at three return periods (475, 1033, and 2475 years).
2. A technical report summarizing the research and introducing the maps.

6. Describe how the results of this study will be implemented at UDOT.

The probabilistic liquefaction and lateral hazard maps resulting from this study will be used much in the same way that the outdated Anderson, Keaton, and Eldredge liquefaction maps are currently used on UDOT project. Both UDOT and consulting engineers will be able to use these maps to provide a preliminary estimate as to the liquefaction hazard that exists for a given project. In addition, these maps will be used by UDOT planning experts in the evaluation of system resiliency and their various disaster impact studies.

7. Estimated cost - Total: $100k **UDOT Share:** $25k (conditional upon other/matching funds) **Other/Matching Funds:** $75k (targeting $65k from USGS, and $10k from private industry donations)

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

1/1/2014 to 6/1/2014 - Task 1
6/1/2014 to 8/1/2014 – Tasks 2 and 3
8/1/2014 to 11/1/2014 – Task 4
11/1/2014 to 12/1/2014 – Task 5
12/1/2014 to 12/31/2014 – Task 6

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Full-Scale Load Test of a Rigid Drilled Concrete Shaft at Honeyville Research Site **No. :UT-13.04.03**

Submitted By: Evert Lawton and Steven Bartlett **Organization:** University of Utah, UDOT Geotech Group

Email: Lawton@civil.utah.edu, bartlett@civil.utah.edu **Phone:** 801-585-3947, 801-585-7726

UDOT Champion (suggested): Grant Gummow

Select a Subject Area

- ☐ Materials/Pavements
- ☐ Maintenance
- ☐ Traffic Mgmt/Safety
- ☒ Geotechnical
- ☐ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

Many of the software programs and other methods of analysis currently used to analyzed laterally loaded piles do not reliably predict the behavior of rigid and semi-rigid drilled concrete shafts. Therefore, the continued use of these programs creates uncertainty with respect to their use in the design and analysis of these types of deep foundation elements.

2. Describe why this research is important and how it is unique.

A thorough literature review has shown that very few full-scale load tests on rigid or semi-rigid drilled shafts are described in the open literature. In particular, there are very few papers and/or reports that contain sufficient geotechnical information to perform a proper comparison of the results from the load tests with analyses conducted using software programs such as LPILE, FLPIER, and DFSAP to determine how accurate are the methods used by these programs to predict the response of a rigid or semi-rigid shaft to lateral and overturning loads. This research is unique for two primary reasons: (1) A thorough geotechnical and geological characterization has already been conducted at a site near Honeyville, Utah in anticipation of conducting a full-scale lateral load test on a rigid drilled shaft. The field portion of the geotechnical investigation consisted of cone penetration tests, dilatometer tests, pressuremeter tests, standard penetration tests, and continuous undisturbed piston sampling to a depth of 100 ft. The laboratory investigation consisted of triaxial compression, one-dimensional compression, and classification tests conducted on the samples. (2) This research is applicable to many different governmental and commercial organizations who install or oversee the installation of rigid drilled concrete shafts in soft-soil conditions. These organizations include many state DOTs (e.g. CA, WA, OR, MT), the offshore oil industry (e.g. individual oil companies and the American Petroleum Institute), and the electrical power industry (e.g. local and regional power companies, the Electrical Power Research Institute).

3. List the research objective(s) to be accomplished:

1. Conduct a full-scale load test on a well-instrumented rigid drilled concrete shaft at a soft-soil site.
2. Determine how well existing methods of analysis and design are in predicting the results of the load test.
3. Develop improvements to existing methods and/or develop new methods of analysis that work well for rigid and semi-rigid drilled concrete shafts.

4. List the major tasks to accomplish the research objective(s):

1. Perform *a priori* predictions of the results of the full-scale load test using software programs and other methods commonly used to analyze laterally-loaded piles, including LPILE, FLPIER, and DFSAP.
2. Conduct a full-scale field test on a rigid drilled concrete shaft at the Honeyville research site. It is anticipated that the size of the shaft will be in the range of 6 to 9 ft in diameter and 45 to 70 ft in length. This shaft will be fully instrumented so that as much usable data as possible can be obtained from this test.
3. Reduce the data from the test.
4. Compare the *a priori* predictions with the results of the load test and determine how successful each method was in predicting the outcome of the test.
5. Make recommendations for improvements to existing methods, or develop new or substantially improved methods for design and analysis of rigid and semi-rigid drilled concrete shafts subjected to lateral and overturning loads.
6. Write a final report describing the results of the research.

5. List the deliverable(s) to come to UDOT from this research study:

1. A final written report
2. Depending on the outcome of the research, it is possible that a new computer program will be developed for the analysis of laterally loaded rigid and semi-rigid drilled concrete shafts.

6. Describe how the results of this study will be implemented at UDOT.

Depending on the outcome of the research, there are different possible scenarios: (1) It is determined that there is an existing computer program or method of analysis that provides much more accurate predictions of the response of drilled concrete shafts to lateral and overturning loads than other existing methods. In this case, UDOT will use the existing method for in-house design of laterally loaded drilled shafts and require the use of this program by others performing analyses for UDOT projects. (2) Two or more methods are determined to provide better predictions than the other methods. UDOT will use these better methods for in-house design and require the use of these methods by others performing analyses for UDOT projects. (3) None of the existing methods provide reasonable predictions of the results of the load tests. Improvements to existing methods or new methods are developed. UDOT implements these improved or new methods for in-house design and requires others performing similar analyses to use these improved or new methods.

7. Estimated cost - Total: $300K - $800K **UDOT Share:** $50K **Other/Matching Funds:** $250K - $750K

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

April – July 2013: Other organizations are contacted for participation in the pool fund study and funding commitments from other organizations are obtained.

August-September 2013: *A priori* predictions are conducted using existing methods of analysis

August-September 2013: Site is prepared and drilled concrete shaft is installed with all instrumentation

October 2013: Load test is conducted

November 2013 – March 2014: Data from the load test is reduced and analyzed

April – June 2014: Comparisons are performed between a priori predictions and results from load test

July – November 2014: Improvements to existing methods are developed, and/or significantly improved or new methods of analysis are developed.

November – December 2014: Final report is prepared and finalized after review by UDOT

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Evaluation of Finite Difference Approach to Estimating Consolidation Settlement **No. UT-13.04.04**

Submitted By: Clifton Farnsworth **Organization:** Brigham Young University

Email: cfarnsworth@byu.edu **Phone:** 801-422-6494

UDOT Champion (suggested): Grant Gummow, Darin Sjoblom, Jon Bischoff

Select a Subject Area

- ☐ Materials/Pavements
- ☐ Maintenance
- ☐ Traffic Mgmt/Safety
- ☒ Geotechnical
- ☐ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

A recently completed UDOT research project investigated the use of the finite difference technique in estimating consolidation settlement of foundation soils with horizontal drainage. This particular project demonstrated that the finite difference technique could be utilized, and is highly beneficial in conjunction with magnet extensometer data. However, this research study utilized existing I-15 reconstruction data (from the Salt Lake Valley 1998-2002) as part of the demonstration to show that it was a viable technique, but has yet to be field verified. A very near future construction project, located at University Avenue and I-15 in Provo, Utah, is a prime candidate to field verify the finite difference technique. This site is ideal for the following reasons:

1) The author of this proposal has already performed an extensive evaluation of consolidation settlements at this location in conjunction with the southbound access to University Avenue (bridge over the interstate),
2) The current design indicates that PV drains will not penetrate to a sufficient depth to mitigate drainage of deeper clay layers, and for these reasons the upper layer will consolidate much more rapidly than the lower layers strictly due to drainage path, with a total projected time of consolidation on the order of 18 months,
3) A magnet extensometer would be especially useful in evaluating differences in consolidation rates for the subsurface clay layers,
4) The finite difference technique in conjunction with magnet extensometers has been demonstrated to be a useful technique in projecting time of consolidation settlement as field data is obtained, and this location would therefore be an ideal candidate for demonstrating implementation of the previous research results,
5) And other corresponding research in the area will include some drilling and sampling, and this project could potentially "piggy-back" with that project thus saving some of the cost associated with magnet extensometer installation.

2. Describe why this research is important and how it is unique.

Although the finite difference method has been shown to be a useful (and perhaps more accurate) technique in estimating, the author of this proposal has yet to see this method utilized. This particular construction project appears to be an ideal location to field verify the results of the previous study, and to demonstrate the use of this methodology in real time. It is anticipated that this project could be utilized to demonstrate the technique to interested UDOT geotechnical consultants. The previous results have yet to be implemented, and since this construction is already slated to go, this is an opportunity to do so with limited cost.

3. List the research objective(s) to be accomplished:

1. Utilize the finite difference technique to evaluate and project consolidation settlements using magnet extensometer data
2. Demonstrate to UDOT geotechnical consultants the use of the finite difference technique for estimating the time-rate-of-settlement for subsurface clay layers bounded by a magnet extensometer

4. List the major tasks to accomplish the research objective(s):

1. Install a magnet extensometer at the Provo, University Avenue interchange as construction allows
2. Gather regular magnet extensometer readings as subsurface settlements progress
3. Use the finite difference technique to project end-of-primary settlements for subsurface layers
4. Perform a training session with UDOT geotechnical team and consultants to present study results

5. List the deliverable(s) to come to UDOT from this research study:

1. Project report.

6. Describe how the results of this study will be implemented at UDOT.

The UDOT geotechnical team and their associated consultant are the intended direct users of the results of this study. These results can benefit projects associated with large lengthy settlements on soft soil sites (as are common in the valleys along the Wasatch Front) in making accurate end-of-primary estimates. This will further help project personnel more accurately schedule and sequence their projects.

7. Estimated cost - Total: $15,000 **UDOT Share:** $15K **Other/Matching Funds:** $student labor match: NOTE: the cost shown also assumes that a portion of the drilling cost associated with installation of a magnet extensometer is able to take place concurrently with other research going on at this location. Cost of magent installation could escalate the total cost if this is not able to be sequenced accordingly.

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

It is anticipated that this project will take two calendar years to complete (based on current design 18 month settlement projection). Principal costs are associated with installation of magnet extensometer, obtaining readings and analysis, and project report.

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Evaluation of Observational Method in Geotechnical Construction and Design **No. UT-13.04.05**

Submitted By: Clifton Farnsworth **Organization:** Brigham Young University

Email: cfarnsworth@byu.edu **Phone:** 801-422-6494

UDOT Champion (suggested): Darin Sjoblom, Jon Bischoff, Larry Myers

Select a Subject Area

- ☐ Materials/Pavements
- ☐ Maintenance
- ☐ Traffic Mgmt/Safety
- ☒ Geotechnical
- ☐ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

In 1969, Dr. Ralph Peck introduced a presentation entitled "Advantages and Limitations of the Observational Method in Applied Soil Mechanics," and has since become a landmark geotechnical paper. Generally referred to as simply the "observational method," this "learn-as-you-go" approach is based on designing with "whatever information can be secured," making a "detailed inventory of the possible differences between reality and the assumptions," and then computing "various quantities that can be measured in the field." This approach then utilizes the results of the field measurements to "gradually close the gaps in knowledge and if necessary, modify the design during construction." Due to the heterogeneous nature of soil, variability in soil properties, and practical limitations in extensive soil sampling, geotechnical engineering inherently requires the use of assumptions. The level of conservatism should be a direct reflection of the confidence in understanding subsurface soil conditions and properties. Certain types of project delivery methods lend themselves better to the use of the observational method, including design-build and CMGC. Due to the sequential nature of design-bid-build delivery, a true observational approach allowing for "design changes" to be made in the field is difficult. However, this does not mean that certain construction practices cannot benefit from "observational procedures" to verify design and/or align construction processes with field monitoring. Unfortunately, UDOT guidance does not currently contain any detailed guidance in how to properly use the observational method in a broad range of design and construction practice. [Quotations from Peck (1969)].

2. Describe why this research is important and how it is unique.

A fairly high profile UDOT construction project was completed a number of years ago, but recent legal pursuits have brought the design and construction activities associated with this project back to life. In a number of depositional statements, UDOT employees were asked to explain their understanding of the observational method and how it is utilized on UDOT projects. Although unaware by the UDOT employees prior to construction, it appeared that the designer intended to utilize the observational approach to make changes during construction, even though the design-bid-build process made this very cumbersome. This recent string of events has highlighted the need for analyzing the observational approach in UDOT geotechnical design and construction and developing a set of procedures for doing so. Further, this research needs to begin to develop guidelines for better associating risk with geotechnical design and allowing UDOT, designers, and contractors alike to make more informed decisions based on the corresponding risks. An actual project (such as Provo Canyon) could be utilized to develop the risks associated with the project, including the cost associated with savings versus the associated real costs. This research is unique in that these procedures do not currently exist and important in that the results of this research may help prevent (or at least reduce the effects of) similar litigation.

3. List the research objective(s) to be accomplished:

1. Identify various ways that the observational approach is used in UDOT geotechnical design and construction
2. Develop procedures for appropriately using the observational approach in UDOT geotechnical design and construction including corresponding risk assessment of geotechnical features.

4. List the major tasks to accomplish the research objective(s):

1. Perform general literature review of observational techniques utilized in geotechnical design and construction, including surveying other select states with regard to their approach
2. Determine UDOT specific geotechnical design and construction practices that utilize observational technique
3. Analyze current technologies associated with observation method of design and construction and identify advantages and limitations
4. Develop guidelines for utilizing observational method of design and construction for each technology type identified above and for corresponding project delivery methods
5. Develop guidelines for determining and presenting associated geotechnical project risk when using observational approach

5. List the deliverable(s) to come to UDOT from this research study:

1. Project report.

6. Describe how the results of this study will be implemented at UDOT.

The UDOT geotechnical team is the intended direct user of the results of this study. The UDOT Geotechnical Division can then choose to make corresponding modifications in their manual of instruction or other business practices as they deem appropriate. However, these results can ultimately make all UDOT projects with a high degree of geotechnical risk more transparent and less susceptible to problems associated with overaggressive use of the observational approach in design and construction.

7. Estimated cost - Total: $15,000 **UDOT Share:** $15K **Other/Matching Funds:** $student labor match

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

It is anticipated that this project will take one calendar year to complete.

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Effect of Pile Head Geometry on Lateral Resistance **No. UT-13.04.06**

Submitted By: Kyle Rollins **Organization:** Brigham Young University

Email: rollinsk@byu.edu **Phone:** 801 358-1497

UDOT Champion (suggested): Jon Bischoff or Darin Sjoblom

Select a Subject Area

- ☐ Materials/Pavements
- ☐ Maintenance
- ☐ Traffic Mgmt/Safety
- ☒ Geotechnical
- ☐ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

At a number of UDOT bridges, designers have used sleeved piles (piles within corrugated steel pipes or "cans") or plastic sheeting to reduce axial pile-embankment interaction because of dragload, equipment availability, or other issues. Sand or pea gravel is sometimes backfilled in the annular space between the can and the pile. Although these approaches may have been successful in dealing solving the immediate problem, recent testing suggests that they can negatively impact lateral resistance to significant but un-quantified degrees. Few if any test results are available to aid designers in selecting appropriate reduction factors for these conditions. As a result, considerable uncertainty is involved in the selection of appropriate soil parameters for lateral pile analysis in these cases. Side-by-side comparison lateral load tests are necessary to provide guidance for these cases which are becoming more common.

2. Describe why this research is important and how it is unique.

Lateral pile resistance is important for seismic conditions and for thermal expansion and contraction with integral bridge abutments. Designers are currently making recommendations without a firm basis for their assumptions. Little or no information on this issue is available from the technical literature or from comparison tests. No guidance is provided in code language. Comparison field tests will provide ground truth information which can be very useful when this issue is encountered in future projects. Pile tests can be conducted on reaction piles for the "Piles Near MSE Wall" study to reduce overall project cost.

3. List the research objective(s) to be accomplished:

1. Determine lateral resistance of pipe piles in cans with sand and pea gravel backfills.
2. Determine lateral resistance of pipe piles with double plastic sheeting
3. Provide design guidance on realistic soil parameters to account for the measured resistance in LPILE analyses.

4. List the major tasks to accomplish the research objective(s):

1. Instrument test piles for load testing (strain gauges and deflection vs. depth measurements)
2. Conduct comparative lateral load tests (conventional pipe pile, pile in can with sand backfill, pile in can with pea gravel backfill, pile with double plastic sheet wrapping.) to develop lateral load vs. displacement curves and bending moment vs depth curves.
3. Make comparison between tests and perform back-analysis using LPILE to determine appropriate soil parameters and potential composite action.
4. Perform parametric analyses to assess potential variations
5. Develop design recommendations for lateral resistance of piles with these geometries.

5. List the deliverable(s) to come to UDOT from this research study:

1. Test result summary report
2. Design recommendations for LPILE analysis for piles with these geometries

6. Describe how the results of this study will be implemented at UDOT.

The recommendations regarding soil parameters for these conditions in typical UDOT approach fill materials will be included in the UDOT design manual.

7. Estimated cost - Total: $30,000 **UDOT Share:** $ **Other/Matching Funds:** $

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

Lateral load testing could start as early as Summer 2013 but could be delayed until Spring 2014 for second round of lateral load tests at MSE test wall at Geneva Rock Point of the Mountain pit. The anticipate schedule would be as follows:

Instrumentation -1 month
Lateral Load Testing – 1 month
Data Reduction – 1 month
LPILE Back-Analysis and parametric analysis – 1 month
Report preparation – 2 months

Total time – 6 months

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: POOLED FUND: Simplified SPT Performance-Based Assessment of Liquefaction and Effects **No. UT-13.04.07**

Submitted By: Kevin W. Franke **Organization:** Brigham Young University

Email: kevin_franke@byu.edu **Phone:** 801-422-1349

UDOT Champion (suggested): Darin Sjoblum, Jon Bischoff, Jim Higbee, and Grant Gummow

Select a Subject Area

- ☐ Materials/Pavements
- ☐ Maintenance
- ☐ Traffic Mgmt/Safety
- ☒ Geotechnical
- ☐ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

Conventional "pseudoprobabilistic" procedures to evaluate liquefaction triggering and its effects have been shown through recent research to produce estimates of liquefaction factor of safety at inconsistent and often unacceptable levels of risk. These errors are introduced through the incorrect assumption that using probabilistic ground motions in a deterministic liquefaction analysis will yield a probabilistic estimate of liquefaction factor of safety. The inconsistent consideration of liquefaction risk could contribute to undesirable performance or even collapse of various important structures such as bridges or retaining walls in the event of an earthquake. Conversely, the inconsistent consideration of liquefaction risk could also potentially contribute to the unnecessary and expensive over-design of liquefaction mitigation alternatives. Utilization of a fully-probabilistic or performance-based liquefaction triggering procedure, which considers both uncertainty in the seismic loading and the liquefaction triggering relationship, could effectively solve these problems. Furthermore, probabilistic evaluation of liquefaction triggering could potentially be taken into account when considering liquefaction effects such as lateral spreading or free-field liquefaction settlements. However, current performance-based liquefaction procedures (e.g. Kramer & Mayfield 2007) are quite complex and beyond the level of practical application for most practicing engineers.

2. Describe why this research is important and how it is unique.

This research is important because it will result in more consistent evaluation of liquefaction and its effects across different seismic environments. Such consistency is important when targeting a specific hazard level and is necessary to ensure that neither over-design nor under-design occurs when assessing liquefaction. This research builds upon recently published performance-based liquefaction studies in order to develop innovative simplified procedures to closely approximate fully-probabilistic evaluations of liquefaction triggering, lateral spread displacement, free-field liquefaction settlement, and seismic slope displacement. Such simplified procedures would not only address the problem of evaluating liquefaction at consistent and targeted levels of risk at any location within the state, but would also be relatively easy for most engineers to apply in practice. This research is unique because only a relatively small portion of this research has been tested successfully in the state of Washington to date. Therefore, UDOT and its other DOT collaborators would be applying cutting-edge research and helping to pioneer these new procedures to evaluate uniform hazard liquefaction potential and its associated effects.

3. List the research objective(s) to be accomplished:

1. Derive new simplified performance-based procedures for liquefaction triggering (Boulanger and Idriss 2012), lateral spread displacement (Youd et al. 2002), free-field liquefaction settlement (Cetin et al. 2009), and lateral seismic slope displacements (Saygili and Rathje 2008)
2. Develop liquefaction parameter maps associated with each of the hazards listed in objective (1) above at return periods of 475 years, 1,033 years and 2,475 years for each of the states participating in the pooled fund study. The maps will be developed in GIS format.
3. Evaluate the new simplified performance-based liquefaction procedures against conventional liquefaction procedures
4. Develop a site-specific liquefaction design procedure that will envelope performance-based analysis results with deterministic liquefaction results in order to prevent "unrealistic" assessments of liquefaction hazard.

4. List the major tasks to accomplish the research objective(s):

1. Work with graduate and undergraduate student researchers to derive new simplified performance-based procedures for assessing liquefaction triggering, lateral spread displacement, free-field liquefaction settlement, and lateral seismic slope displacement (Year 1)
2. Use existing software (PB LiquefY and EZ-FRISK) to develop liquefaction parameter maps at the return periods of interest for liquefaction triggering and lateral spread displacement (Year 1)
3. Develop new software to perform gridded fully-probabilistic assessments of volumetric strain (for settlement) and lateral seismic slope displacement (Year 1 and 2)
4. Use newly-developed software from Task (3) to create liquefaction parameters maps at the return periods of interest for volumetric strain and lateral seismic slope displacement (Year 2)
5. Develop a user-friendly analysis spreadsheet for designers to use in conjunction with the new liquefaction parameter maps. The spreadsheet will include deterministic analysis options in addition to performance-based analysis options (Year 1 and 2)
6. Select 5-10 sites in each state to analyze with a fictional soil profile in order to compare the new simplified performance-based analysis methods with conventional analysis methods (Year 1 and 2)
7. Work with student researchers to develop a site-specific liquefaction design procedure that will envelope performance-based analysis results with deterministic liquefaction results in order to prevent "unrealistic" assessments of liquefaction hazard. (Year 2)
8. Prepare a technical report to document the results of the research (Year 1 and 2)
9. Hold a workshop at the end of the research project to introduce DOT and invited consulting engineers to the new simplified performance-based liquefaction methods and to answer questions (end of project)

5. List the deliverable(s) to come to UDOT from this research study:

1. A summary technical report describing the results/observations of the research and the recommendations for the implementation of the newly-developed performance-based liquefaction procedures on transportation projects.
2. GIS shapefiles of the liquefaction parameter maps for liquefaction triggering, lateral spread displacement, free-field volumetric strain, and lateral seismic slope displacement at the three return periods of interest.
3. An analysis spreadsheet to be used in conjunction with the liquefaction parameter maps.
4. A workshop for each DOT participant and invited guests to demonstrate/introduce the new simplified performance-based procedures and to answer questions

6. Describe how the results of this study will be implemented at UDOT.

The results of this study could immediately be implemented by UDOT in the liquefaction evaluation of its new embankments, bridges, and retaining structures. Depending on the classification of the structure (e.g. critical, essential, etc.), an engineer would utilize the performance-based liquefaction parameter maps corresponding to the targeted hazard level with site-specific soil boring data to assess liquefaction and its associated effects in terms of uniform hazard.

7. Estimated cost - Total: $120k (over 2 yrs) **UDOT Share:** $15k/yr (with AK, SC, and MT committed to joining study)
Other/Matching Funds: $80k

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

I can start as soon as money becomes available (…pending availability of funds from other participating states). Otherwise:
1/1/14 to 12/31/14 – Tasks 1-2, part of Tasks 3, 5, 6, & 8 (See Section 4 above)
1/1/15 to 12/31/15 – Tasks 4, 7, & 9, remainder of Tasks 3, 5, 6, & 8 (See Section 4 above)

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Evaluation of Cost Savings Associated with CMGC Contracting **No. UT-13.05.01**

Submitted By: Clifton Farnsworth **Organization:** Brigham Young University

Email: cfarnsworth@byu.edu **Phone:** 801-422-6494

UDOT Champion (suggested): Michelle Page or Bryan Adams? (Also John Haynes with FHWA)

Select a Subject Area

- ☐ Materials/Pavements
- ☐ Maintenance
- ☐ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☒ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

In recent years, UDOT has been utilizing CMGC (Construction Management/General Contractor) as an alternative innovative delivery method for several reasons, primarily by reducing and sharing the risk associated with construction by promoting an integrated team approach to problems solving early in the design process and throughout construction. Because CMGC contracting is still so new to the highway construction arena, much remains to be proven about its ability to consistently minimize and allow control over construction risk. Another indicator of CMGC success is the associated cost savings that are claimed to exist. However, these cost savings are still not readily understood. UDOT has been one of the leading state agencies in the nation in using CMGC contracting, and likewise has the most project data available. Individual project reports and annual reports documenting the use of CMGC on UDOT projects have been generated for the past several years, but proof of cost savings has been hard to come by. Part of the problem is simply not having a quick and easy method for monitoring or measuring this. In a recent conversation with a FHWA representative running their initiative to promote the use of CMGC nationally, he indicated that "we think the cost savings are there, be we just can't show proof of the cost savings." He further indicated that a number of other states are interested in what those numbers actually are, and in developing procedures to track them better. This means that this project has the potential to be run as a pooled fund study, ultimately helping better define the appropriate use CMGC in achieving project cost savings and in reaching that result by teaming up with other interested states to perform the research.

2. Describe why this research is important and how it is unique.

UDOT has been putting together an annual report summarizing their evaluation of the CMGC program for the past several years. With the recent approval of CMGC in the SEP-14 process, these reports need no longer be put together. However, since the CMGC process is still relatively new in heavy/highway construction applications, there is still much to be learned about the process in making it more efficient and effective. The purpose of the annual reports was to detail the performance of CMGC projects compared to traditional delivery methods, the best application of CMGC, and to outline UDOT's formal CMGC process. Therefore, UDOT has already begun developing performance measures to validate the assumptions associated with comparing the contractor's price to market prices, tracking innovations, risk, and change orders and overruns. However, the research proposed herein would broaden the previous work performed by UDOT as well as expand the level of knowledge associated with cost savings through the CMGC process. What is lacking in the current body of knowledge is proof of the cost savings. As UDOT has become more sophisticated in the manner in which CMGC is run on the projects, so too has the effectiveness in performing CMGC projects. This research proposes to take a look (starting with the most recent project and working backwards), to better evaluate the project cost savings associated with the CMGC process. It is further anticipated that by teaming up as a pooled fund study, that projects from other states can also be evaluated. UDOT would then benefit by learning from their recent experiences as well.

3. List the research objective(s) to be accomplished:

1. Determine cost savings in CMGC projects
2. Develop a quick and easy method for monitoring and measuring cost savings through CMGC projects

4. List the major tasks to accomplish the research objective(s):

1. General literature review of cost savings associated with CMGC process (also evaluate how cost savings are determined and followed in vertical construction CMGC applications)
2. Evaluate the techniques used for determining cost savings on CMGC projects
3. Work through select recent CMGC projects to determine associated cost savings
4. Provide conclusions and recommendations of findings

5. List the deliverable(s) to come to UDOT from this research study:

1. Final report detailing results of research objectives

6. Describe how the results of this study will be implemented at UDOT.

Results from this study can be implemented directly into the CMGC contracting process. Having a better understanding of cost savings is a direct benefit in reducing construction project cost. Furthermore, the results of this research may help in the project delivery decision process and knowing which projects are best suited for CMGC contracting.

7. Estimated cost - Total: $$25,000 **UDOT Share:** $25K **Other/Matching Funds:** $student labor match

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

The cost and time associated with this project are really a function of how many construction projects (and their associated size) are analyzed. As a pooled fund study, it would make sense to spread this project over two different years, and would then need to include other state matching funds. This in turn could reduce the cost provided by UDOT. As a bare minimum, without a pooled fund, the project would take 1 year and cost $25K. It should be noted that the FHWA representative for CMGC has indicated that he believes this project lends itself well to be a pooled fund study and that other states would be interested in participating.

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Improving UDOT Program Management Business Dynamics **No. UT-13.05.02**

Submitted By: Lori Dabing **Organization:** Project Development

Email: ldabling@utah.gov **Phone:** 801-964-4456

UDOT Champion (suggested): Lori Dabling

Select a Subject Area

- ☐ Materials/Pavements
- ☐ Maintenance
- ☐ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☒ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

There is a lack of consistency in the decisions that are made and implemented by UDOT Project Managers on behalf of UDOT. Project Managers who work directly with contracts and contractual arrangements often negotiate without an understanding or recognition of similar arrangements that have been negotiated in the past or are currently in force. UDOT would benefit from a more rigorous process for gathering and sharing lessons learned, terms and agreements, proven practices, etc. in the interest of improving costs and making decisions consistent with the way UDOT prefers to do business.

2. Describe why this research is important and how it is unique.

When UDOT has brought employees together from various departments/regions for training purposes, there is consistent evidence that the departments are not aware of what other departments/regions have negotiated or proven practices across the organization. Discussions in the classroom show that the employees would benefit from understanding others' terms and agreements. Likewise, UDOT projects and programs would benefit financially from the ability to improve the consistency of terms and leveraging proven practices across the various departments.

3. List the research objective(s) to be accomplished:

1. Understand the current Project Management business culture of UDOT to help understand the dynamic approach that is expected as employees make decisions on behalf of UDOT. The recommended Dynamics model is based on the work of Richard Schneider in "Reengineering Alternative"
2. Understand the existing infrastructure for storing and sharing Agreements, terms and conditions, proven practices, and internal FAQs
3. Discover how the employees of UDOT currently share data between departments
4. Recommend process infrastructure that will:
   a. Improve the availability of UDOT data that should/could be shared across departments
   b. Improve the consumption of UDOT data that should/could be shared across departments for the benefit of UDOT
   c. Support the selection of or modification of tools to support efficient and functional sharing of data between departments

4. List the major tasks to accomplish the research objective(s):

1. Interview UDOT executives to understand the cultural intent of decision making and agreement finalization
2. Interview UDOT department leaders to understand the cultural intent at the department level
3. Identify disparity of cultural intent
4. Identify the existing processes and methods of data resource sharing
5. Examine the options for improved data resource sharing based on the cultural intent of the organization(s)
6. Recommend process improvement (innovation) with the intent to improve the sharing of important data that can improve the operations and financial performance of UDOT

5. List the deliverable(s) to come to UDOT from this research study:

1. Cultural map as intended by leadership
2. Cultural map as practiced and understood in the organization
3. Roadmap to bring the Practiced Culture in line with the Intended Culture
4. Process Map for current data sharing processes, including participants, leaders, owners, and tools
5. Process Map for proposed data sharing processes, including participants, leaders, owners, and tools
6. Proposed plan to migrate the UDOT organization to the Intended Culture and the proposed/approved Process Map

6. Describe how the results of this study will be implemented at UDOT.

The answer to this question #6 is part of the deliverables of the research project listed in item 5 above.

7. Estimated cost - Total: $15,000 **UDOT Share:** $ **Other/Matching Funds:** $

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

Milestones:

July 1, 2013 - Begin initial interviews and organizational research
August 15, 2013 - Begin analysis of information and development of cultural and process maps
October 15, 2013 – Submit draft deliverables for UDOT review
November 15, 2013 – Present research data and propose implementation plan to UDOT senior leaders
January 31, 2014 – Deliverables received by UDOT

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Tacit Knowledge Management **No. UT-13.05.03**

Submitted By: David Stevens **Organization:** UDOT Research Division

Email: davidstevens@utah.gov **Phone:** 801-589-8340

UDOT Champion (suggested):

Select a Subject Area

- ☐ Materials/Pavements
- ☐ Maintenance
- ☐ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☒ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

Transfer of knowledge from experienced staff within UDOT to less experienced staff occurs in various ways. The current plan for UDOT University is for that program to provide access to available training provided by UDOT for its employees, consultants, and contractors. While this allows for transfer of explicit knowledge, required to learn/maintain core functions of an individual or group, the transfer of tacit knowledge is not necessarily addressed in the current program.

Tacit knowledge is defined as knowledge that is not easily transferred to others by verbalizing it or writing it down. An example might be the story behind development of a current construction material specification, known only by a handful of veteran materials engineers long associated with the specification. Prior to the retirement of this knowledgeable few, it would be helpful to new materials engineers in the Department for the veteran engineers to share their background knowledge on the current specification with them, either in live or recorded format. The purpose of this proposed research is to explore existing tacit knowledge management programs in the country, determine which concepts and tools from these would be helpful and feasible to implement at UDOT, try out the concepts and tools as possible on a small scale at UDOT, and explore the potential benefits of implementing knowledge management in most organizations within UDOT.

2. Describe why this research is important and how it is unique.

While formal manuals, policies and procedures, handbooks, specifications, standard drawings, and training on these provide the explicit knowledge for individuals and groups in UDOT to function in their core business areas, capturing and sharing of tacit knowledge is also important to the consistency and efficiency of fulfilling job functions and collaborating across disciplines within the Department. This research would provide a prime opportunity to explore and implement principles of tacit knowledge management on a small scale, to potentially benefit multiple organizations and processes within UDOT. Tacit knowledge would be more likely to be retained and shared as needed, rather than being lost once individuals move on to other positions or retirement. An organized tacit knowledge management process could also enhance or facilitate current efforts within UDOT to have preconstruction, construction, and maintenance teams on a project/corridor work with each other in sharing lessons learned and institutional memory across the various project phases. These lessons learned could then be applied to improving design and construction on subsequent projects.

Virginia and a few other state DOTs have successfully implemented tacit knowledge management, where they have trained various interested groups within their organizations to try out the program and then self-direct their own process based on available knowledge and training needs. UDOT could follow their lead and yet customize a program/process to fit our needs and culture, including being a useful companion to the UDOT University program.

3. List the research objective(s) to be accomplished:

1. Determine which concepts and tools from existing tacit knowledge management programs from across the country would be helpful and feasible to implement at UDOT.
2. Try out the selected concepts and tools on a small scale at UDOT, document the benefits, and make a plan for further implementation.

4. List the major tasks to accomplish the research objective(s):

1. Explore existing tacit knowledge management programs in the country, including literature review and possible visits by UDOT there or by other states' representatives to Utah.
2. Conduct a survey within UDOT on 1) current methods used by UDOT, if any, to capture and share tacit knowledge; and 2) points of view regarding need, desired functionality, and potential benefits of a knowledge management program at UDOT.
3. Determine which concepts and tools from existing programs in the country would be helpful and feasible to implement at UDOT. These may include the following:
    a. Portal/database options for storing and sharing of tacit knowledge (SharePoint, online database, index, etc.).
    b. Defining/establishing "communities of practice" that would benefit from organized sharing of tacit knowledge.
    c. Processes for capturing and sharing of best practices, lessons learned, and available/feasible innovations.
    d. Knowledge stewardship by specific organizations in the Department.
    e. Knowledge mapping to determine who is sharing and how, and which new knowledge networks are needed.
    f. Video/audio clips of tacit knowledge to go with user manuals, etc.
    g. Recorded exit interviews with retiring/moving individuals to capture and share institutional memory.
4. Conduct a pilot study with a few groups within UDOT to try out the selected concepts and tools.
5. Document the benefits to UDOT and lessons learned for those involved in the pilot study.
6. Estimate the potential benefits of implementing knowledge management in most organizations within UDOT, including increased efficiencies and cost savings.
7. Make a plan with UDOT leadership for further implementation, including how this program would fit alongside UDOT University efforts.

5. List the deliverable(s) to come to UDOT from this research study:

1. A research report and executive summary summarizing the results of the study and recommendations for further implementation.
2. Presentations on the research results and proposed implementation plan.

6. Describe how the results of this study will be implemented at UDOT.

Results of the pilot study would be shared with UDOT leadership. A more comprehensive implementation plan would then be prepared based on the pilot study results and with input from UDOT leadership. If resources are available and interest high, then implementation among additional groups within UDOT could proceed. There may be a need for a small group at the UDOT Complex to actively manage the knowledge management program and train groups within UDOT on the process as they show interest.

7. Estimated cost - Total: $10k to 20k **UDOT Share:** $10k to 20k **Other/Matching Funds:** $

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

Approximately 6 to 12 months, starting about July 2013.

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Evaluation of Construction Documentation Procedures **No. (office use): UT-13.05.04**

Submitted By: Clifton Farnsworth **Organization:** Brigham Young University

Email: cfarnsworth@byu.edu **Phone:** 801-422-6494

UDOT Champion (suggested): Larry Myers, Other?

Select a Subject Area

- ☐ Materials/Pavements
- ☐ Maintenance
- ☐ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☒ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

A fairly high profile UDOT construction project was completed a number of years ago, but recent legal pursuits have brought the design and construction activities associated with this project back to life. Although "hindsight is said to be 20-20," one of the key features One of the key observations in readings depositional statements from project personnel is that there seemed to be a lack of training associated with construction documentation and whether or not adequate documentation was performed. For certain projects with a high degree of associated risk, additional documentation beyond the norm may even be warranted. An associated dilemma with construction documentation is staying apprised of technology advancements and utilizing the ever increasing technology tools for adequate documentation. This research proposes aims to evaluate the current practices associated with construction documentation, training procedures and techniques utilized, and then perform project specific analysis to evaluate the level of construction documentation taking place.

2. Describe why this research is important and how it is unique.

Construction documentation is important for a number of reasons, including verification of work performed, quantities utilized, means and methods associated with construction, and in general making an accurate record of how construction occurred. Further, construction documentation is highly invaluable when litigation on a construction project occurs. This research will evaluate the use of modern tools in construction documentation with appropriate documentation practices. A third-party review in determining how well documentation procedures are currently be followed will also allow the department to better understand the adequacy and effectiveness of their current procedures and practices.

3. List the research objective(s) to be accomplished:

1. Identify and evaluate documentation techniques used by other state highway agencies
2. Determine effectiveness of UDOT practices in procedure, training, and actual construction documentation
3. Develop hierarchy of documentation procedures based on associated project risk

4. List the major tasks to accomplish the research objective(s):

1. Perform general literature review of construction documentation techniques utilized in heavy/civil/highway construction
2. Determine documentation practices followed by other state highway agencies
3. Evaluate current UDOT construction documentation training procedures
4. Analyze select UDOT projects to evaluate documentation taken
5. Perform survey of current construction projects and evaluate construction documentation
6. Compare results of actual documentation with corresponding UDOT standards
7. Make recommendations as appropriate

5. List the deliverable(s) to come to UDOT from this research study:

1. Project report.

6. Describe how the results of this study will be implemented at UDOT.

The UDOT central construction team and associated region construction teams are the primary users of this research. These results can benefit general construction practices, support UDOT's role in providing effective and efficient construction projects, and potentially strengthen the department's involvement in higher risk projects. Ultimately, these results can provide a level of measure of current documentation practices and improve the construction process.

7. Estimated cost - Total: $15,000 **UDOT Share:** $15K **Other/Matching Funds:** $student labor match

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

It is anticipated that this project will take one calendar year to complete.

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Knowledge Management by Peer Exchange **No. UT-13.05.05**

Submitted By: Jeannine Wirth **Organization:** RiversQuest Consulting

Email: jwirth@riversquest.com **Phone:** 406-260-5037

UDOT Champion (suggested): Cameron Kergaye

Select a Subject Area

- ☐ Materials/Pavements
- ☐ Maintenance
- ☐ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☒ Preconstruction
- ☐ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

One of the most effective and efficient sources of sharing knowledge is a peer network. Travel opportunities, especially for technical level staff, have been severely limited to conserve state and federal budgets. Technology is now readily available to facilitate conversations and knowledge sharing across state boundaries without travel. New networks and programs need to be established to support and facilitate sharing of lessons learned, innovative techniques in progress and other valuable knowledge continually being developed by state DOTs. A peer knowledge exchange network between several states is an essential tool for keeping up with rapidly changing technology and processes.

2. Describe why this research is important and how it is unique.

Sharing knowledge and innovations is a powerful method to leverage limited resources and avoid duplication of effort. We will use existing technology to inexpensively gain knowledge and avoid failures and pitfalls discovered by others. Peer knowledge sharing is a unique and efficient way to maximize the use of public funds and strengthen cooperation and collaboration between states. Peer cooperation and collaboration will help state personnel increase their efficiency at little extra cost. Every state has processes, materials and technology use that is applicable to other states. Sharing this information through presentations by the subject area experts with other participating states would reduce duplication of effort and inspire further innovation.

3. List the research objective(s) to be accomplished:

1. Establish peer knowledge management and exchange on a variety of technical innovation topics
2. Create a low-cost information exchange program that can be replicated and expanded across state and federal boundaries.
3. Leverage limited resources by sharing knowledge with peers and technical experts.

4. List the major tasks to accomplish the research objective(s):

1. Obtain participation of 6-10 western state DOTs.
2. Establish preliminary list of 5-10 discussion topics.
3. Set agenda for first four quarterly meetings of two year process.
4. Research current topics of interest and find subject matter experts able to present valuable information to participants.
5. Develop, post and advertise agenda and calendar for knowledge exchange discussions.
6. Gain commitments from subject matter experts to present each topic and invite key people to participate.
7. Moderate each event to stimulate active discussion, record key information and disseminate it to network members.

5. List the deliverable(s) to come to UDOT from this research study:

1. Membership in a valuable knowledge sharing peer network.
2. Tested innovations from other states to incorporate into projects and processes.
3. Recognition for innovations and enhanced cooperation with other agencies.
4. Knowledge management system for technical innovations.

6. Describe how the results of this study will be implemented at UDOT.

Identify innovations to adopt in UDOT processes or project
Have conversations with representatives from 6-10 other states about current innovations

7. Estimated cost - Total: $72,000 **UDOT Share:** $$12,000 **Other/Matching Funds:** $$60,000

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

June - August, 2013: Research innovation topics and subject matter experts for group conversations. Enlist states to participate and provide their share of funding. Set first year schedule and agendas.

September 2013 - First quarterly two-hour meeting (virtual) for peer exchange

December 2013- Second quarterly meeting (virtual)

March 2014 - In-person meeting to strengthen relationships and knowledge exchange between peers including a site visit of the current discussion topic

June 2014- Fourth quarterly meeting (virtual)

September 2014 - Fifth quarterly meeting (virtual)

December 2014 - Sixth quarterly meeting (virtual)

March 2015 - Second in-person meeting

June 2015 - Virtual meeting to discuss a current innovation and next phase for the project.

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Developing a Rubric and Best Practices for Conducting Bicycle Counts **No. : UT-13.06.01**

Submitted By: Shaunna K. Burbidge, PhD **Organization:** Active Planning

Email: burbidge@walkbikeplan.com **Phone:** 801-336-7991

UDOT Champion (suggested): Evelyn Tuddenham

Select a Subject Area

- ☐ Materials/Pavements
- ☐ Maintenance
- ☒ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☐ Preconstruction
- ☒ Planning/Asset Mgmt
- ☒ Transportation Innovation

1. Describe the problem to be addressed.

Recent local research has identified an increase in both the use of bicycles for transportation as well as demand for bicycle friendly infrastructure. However, UDOT does not have current reliable data identifying the most popular cycling routes or cyclist volumes along those routes. Additionally, it is not clear which tools/methods would be most effective to gather this data and present it in a way that would be meaningful and would allow UDOT to improved bicycle planning.

2. Describe why this research is important and how it is unique.

This research will identify industry best practices for conducting bicycle counts including which technologies would be most appropriate for conducting bicycle counts across Utah's diverse urban and rural environments. By examining which tools and methods have been effective elsewhere and testing them locally, this research will develop a rubric for conducting bicycle counts as well as guidelines for analyzing the resulting data to provide meaningful results for UDOT planners.

3. List the research objective(s) to be accomplished:

1. Identify industry best practices for conducting bicycle counts including methods and technologies
2. Perform experimental case studies of various locations to determine which methods are most appropriate for each environment
3. Identify locally effective methods
4. Create a rubric to guide regions in conducting bicycle counts; including guidelines for interpreting and using outputs

4. List the major tasks to accomplish the research objective(s):

1. Create an inventory of existing methods for conducting bicycle counts in urban and rural areas and classify their appropriateness and applicability in Utah
2. Interview local agencies who have previously conducted bicycle counts to discuss the pros and cons of the methods they employed

3. Select the top 3 most appropriate methods from Task 1and select local test sites based on input from UDOT
4. Conduct bicycle counts at each test site and review output/data; determine which methods were the most effective
5. Create a rubric and guidelines to assist UDOT in conducting and utilizing data from bicycle counts

5. List the deliverable(s) to come to UDOT from this research study:

1. List of appropriate methods/tools for conducting bicycle counts in Utah
2. Output/count data for specific test sites
3. Detailed guidelines for conducting bicycle counts and interpreting data

6. Describe how the results of this study will be implemented at UDOT.

Each of the UDOT regions will be able to use the guidelines resulting from this research to identify appropriate locations for conducting bicycle counts as well as which tools/methods should be used at each site type. Additionally, the guidelines will outline what the output data will look like and how it can be analyzed and packaged to be useful in informing future planning.

7. Estimated cost - Total: $40,000* **UDOT Share:** $30,000 **Other/Matching Funds:** $10,000

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

Study Start Date: July 1, 2013

Study Duration: 15 moths

Research Schedule

July 2013- Notice to Proceed granted from UDOT

Aug-Oct 2013- Conduct literature review and analysis of existing bicycle count tools and methods. Determine which methods would be most useful for UDOT based on Utah's diverse transportation environments.

-Interview local agencies, municipalities, or interest groups who have used existing technologies to conduct counts and identify the pros and cons they encountered with each method.

Oct-Dec 2013- Identify test sites with input from UDOT and purchase/secure necessary equipment* to conduct counts

Jan-Feb 2014- Conduct counts in Southern Utah (if identified as test sites by UDOT)

Mar-May 2014- Conduct bicycle counts in Northern Utah

Jun-Jul 2014- Conduct additional counts as needed (if utilizing rolling count dates due to limitations on equipment)

Aug-Sept- Compile count data and identify which methods were the most effective based on local conditions; Draft guidelines for conducting counts, based on equipment specifications and data outputs; Create guidelines for interpreting and utilizing final data outputs.

Oct 2014- Submit and present final report and guidelines to UDOT

*The budget for this project only includes the research time and expenses associated with this project and does not include purchasing the equipment to conduct the bicycle counts. Depending on the costs of the tools /methods identified in Task 1, an appropriate budget will need to be identified to secure equipment to conduct the counts at each test sites. This may include purchasing/securing a small number of counters/etc. and conducting the test site counts on a rolling basis in order to limit the initial investment while still acquiring meaningful data. There is also potential to borrow or rent equipment from other jurisdictions for pilot testing on an evaluative basis.

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Asset Management 5 Year Plan **No. UT-13.06.02**

Submitted By: Stan Burns **Organization:** UDOT - Asset Management

Email: sburns@utah.gov **Phone:** 801 6336221

UDOT Champion (suggested): Stan Burns

Select a Subject Area

- ☐ Materials/Pavements
- ☐ Maintenance
- ☐ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☐ Preconstruction
- ☒ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

UDOT has a robust asset management program. The program includes state of the art data collection, pavement and bridge optimization analysis programs. Development of Asset Management at UDOT up to this time has been guided by the 2002 Gap Analysis and by the quarterly Transmat Steering Committee chaired by the Deputy Director.

In order to build on past success the division should develop new 5 year plan. The roadmap should determine the state of the practice; develop a strategic direction with values and goals. The road map would also include 3 and 5 year implementation plan with milestones and performance measures

2. Describe why this research is important and how it is unique.

The Department has approximately 30 billion dollars in assets. It has the responsibility maintain and extend the life of these assets at the lowest possible cost. Achieving the goal requires many different elements with just one being a long term strategic roadmap

3. List the research objective(s) to be accomplished:

1. Research the state of the practice, i.e. research other possible 5 year plans
2. Conduct interviews with industry, universities, and with both FHWA and UDOT
3. Conduct stakeholder meetings to help develop a 5 year plan
4. Consider conducting a second Gap Analysis with stakeholders
5. Establish a strategic direction
6. Develop and articulate core goals and values
7. Develop a plan for the next 3 and 5 years
8. Develop a realistic implementation plan with schedule.
9. Performance measures should be included with the roadmap

4. List the major tasks to accomplish the research objective(s):

1. See item # 3
2.
3.

5. List the deliverable(s) to come to UDOT from this research study:

1. See item # 3

6. Describe how the results of this study will be implemented at UDOT.

The purpose of the Plan is by its very nature to create a product that is implementable.

7. Estimated cost - Total: $60K **UDOT Share:** $30K research **Other/Matching Funds:** $30K asset management

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

Interviews	Early summer 2013
Selection	Early summer 2013
Contract Scope	Mid summer 2013
Kickoff Meeting	Late summer 2013
Discovery Phase	Early autumn 2013
Round Table	
Discussion	Autumn 2013
Interviews	Autumn
Draft Report	Early Winter 2013
Final Report	Winter 2013

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Understanding UDOT's Role in Utah's Air Quality Challenges **No. :UT-13.06.03**

Submitted By: Matt Riffkin, P.E. **Organization:** InterPlan

Email: matt@interplanco.com **Phone:** 801-307-3400

UDOT Champion (suggested): Angelo Papastamos

Select a Subject Area

- ☐ Materials/Pavements
- ☐ Maintenance
- ☐ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☐ Preconstruction
- ☒ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

During northern Utah's recent winter inversion, when air pollution in several Utah counties were among the worst in the nation, many were pointing to the transportation system as both the cause for bad air and a likely place to find the solution. This research will frame northern Utah's air quality problem and examine the magnitude of change possible from aggressive, but reasonable, changes in transportation during air quality episodes.

2. Describe why this research is important and how it is unique.

Air pollution issues are framed in a highly regulatory process involving the State DOT, Division of Air Quality, and Metropolitan Planning Organizations. Due to the complexity of the regulations and the potency of the penalties for non-compliance, strategies are viewed in isolation with rigorous cost-benefit comparisons and a comprehensive vision is not articulated. Since no single strategy can solve the complexity of the problems, the issues become contentious, adversarial, and clouded with jargon and federal acceptance. This research would allow UDOT to consider various "what if" questions about transportation's role in air pollution so that the department is in a better position to help tax payers and constituents achieve their long term goal of clean air and a strong transportation system.

3. List the research objective(s) to be accomplished:

1.Serve as a "sand box" for developing new ideas and concept s into the TravelWise program, the Traffic Operations Center, and other UDOT programs that might have an impact on air quality

2.Allow UDOT to take a proactive role in establishing a transportation vision that is compatible with clean air and is seen as fostering a strengthened economy on several fronts.

4. List the major tasks to accomplish the research objective(s):

1.Develop up to three packages of aggressive but reasonable transportation solutions to air pollution involving TravelWise, traffic operations, and other transportation programs and ideas.

2.Measure the effectiveness of each package of transportation solutions as short-term ("emergency") concepts during air pollution episodes.

3.Help develop talking points for UDOT leadership regarding transportation's role in air pollution episodes and the effect that various choices made by transportation users have on air pollution

5. List the deliverable(s) to come to UDOT from this research study:

1. At the end of this research, UDOT will obtain a comprehensive list of various transportation strategies and their range of effectiveness on the air pollution problems during temperature inversion episodes.
2. UDOT leadership will receive an incubated analysis of possible transportation visions and how those visions relate to clean air, user mobility options, economic vitality, and other goals of the department.

6. Describe how the results of this study will be implemented at UDOT.

The science and technology of transportation and air quality modeling is well advanced. While UDOT is involved in the regulatory process of air quality plans and transportation conformity, the Department is not proactive in explaining the air quality benefits of various UDOT projects and programs. This research will look specifically at the air quality benefits of various department controlled transportation projects, policies, and programs and measure the magnitude of air pollution benefit of various actions. The net result will allow UDOT leadership to assist policy leaders in developing a vision for transportation, air quality, and ultimately a long-term strong economy and quality of life. Funding this effort through research will allow the Department to evaluate a broad range of transportation related air quality strategies on an experimental or fact-finding basis.

7. Estimated cost - Total: $50,000 **UDOT Share:** $50,000 **Other/Matching Funds:** $

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

This work can start immediately and results can be ready by the July/August summer air pollution season. The following schedule is proposed:

Mid-April 2013- Project Notice to Proceed

Late April 2013 - Background summary of air pollution problems including transportation (mobile source) share of problems both historically and in present day.

Early May 2013 - Convene a committee of air quality and transportation experts and advocates to brainstorm packages of transportation programs, projects, advisories, restrictions that can be implemented during air pollution episodes.

Late May 2013 - Finalize discrete packages of transportation programs etc. and determine travel demand modeling assumptions that best simulate the transportation packages.

Late June 2013 - Compile travel model results and input into TRIMS 3.0 air quality model to develop emissions estimates consistent with MOVES mobile model emission rates used by Utah DAQ and others.

Mid- July 2013 - Summarize results and present results to UDOT.

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Algorithm Development for QA/QC of Asset Management Data and Forcasting of Sign Deterioration **No. :UT-13.06.04**

Submitted By: Kevin Heaslip **Organization:** Utah State University

Email: kevin.heaslip@usu.edu **Phone:** 435-797-8289

UDOT Champion (suggested): Stan Burns, UDOT Asset Management

Select a Subject Area

- ☐ Materials/Pavements
- ☐ Maintenance
- ☐ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☐ Preconstruction
- ☒ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

Since the establishment of the first minimum retroreflectivity levels in 1993, agencies and researchers have focused on determining the service life of different sheeting type and color combinations. While deterioration curves and measured retroreflectivity are viable methods for maintaining retroreflectivity compliance, they do not ensure the ability of the traffic sign to convey its intended message. Retroreflectivity efficiency only ensures visibility but does not properly describe the legibility of the sign. Therefore, while agencies across the nation are developing and implementing traffic sign maintenance plans, the emphasis should not be solely placed on visibility.

In order to evaluate the performance of UDOT's traffic signs, a sample sign population was collected across all four of UDOT's maintenance regions. Analysis on this sample set not only determined the current rate of compliance, but it also identified several issues seen throughout the population. Signs under UDOT's jurisdiction are four times more likely to have substantial damage to the sign face than to fail to meet the minimum retroreflectivity levels. Analysis was conducted on determining contributing factors damage rates and it was determined that precipitation, elevation, seasonal temperature swing, and exposure of the sign all contributed to higher rates of damage. Additional analysis was conducted on determining the service life of different type and sheeting combinations. Hindered by the lack of known installation information, the analysis only identified service life as a significant contributor to sheeting deterioration.

The addition of mobile asset management data collection from Mandli will provide opportunities and challenges in the quality control of asset management and in the proper budgeting for sign management.

2. Describe why this research is important and how it is unique.

This research is important to utilize the data collected by UDOT in the most efficient manner possible. The significant effort to collect data shows a concerted effort to improve asset management in the state and the research proposed will be applied to create value added analysis of the data to support funding and decision making, ultimately saving the department money in the future.

3. List the research objective(s) to be accomplished:

1. Provide QA/QC for the data collected from Mandli
2. Create a living database of assets that can be updated and used for forecasting of deterioration
3. Development of algorithms for QA/QC and sign deterioration that can be attached to OMS

4. List the major tasks to accomplish the research objective(s):

1. Continue to work with the Industry Workgroup on asset management.
2. Conduct QA/QC on the Mandli Data using the database of collected signs from the previous USU research
3. Implement Policy which will Manage Data from Mandli and Create a Dynamic Database
4. Implement a predictive tool to forecast sign degradation over a 5 year timeframe
5. Implement a mobile application to collect data on new sign installations
6. Implement a budget planning tool, which will support changing levels of funding for sign management and will support several different maintenance goals.

5. List the deliverable(s) to come to UDOT from this research study:

1. Report on the QA/QC findings
2. Report on the sign management deterioration curves
3. Implementation of Policy that supports asset management decision-making over time.

6. Describe how the results of this study will be implemented at UDOT.

UDOT will use this research to implement practical informed policy in the area of asset management.

7. Estimated cost - Total: $150,000 **UDOT Share:** $75,000 **Other/Matching Funds:** $75,000

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

The following schedule is proposed for this study. The study is scheduled for 18 months.

- Start Date: June 1, 2013
- QA/QC Report: December 1, 2013
- Algorithms for Sign Deterioration: May 31, 2014
- Predictive Tool for OMS: September 3, 2014
- Final Report: December 31, 2014

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Innovative Display of Transportation Analysis and Results **No. :UT-13.06.05**

Submitted By: Grant G. Schultz and Daniel P. Ames **Organization:** Brigham Young University

Email: gschultz@byu.edu; dan.ames@byu.edu **Phone:** 801-422-6332; 801-422-3620

UDOT Champion (suggested): John Thomas

Select a Subject Area

- ☐ Materials/Pavements
- ☐ Maintenance
- ☐ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☐ Preconstruction
- ☒ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

The mission of the Utah Department of Transportation (UDOT) is to preserve infrastructure, optimize mobility, improve safety (zero fatalities), and strengthen the economy. To help meet the mission of the department and to improve the quality of life and economic vitality of the state, the Systems Planning and Programming Division helps to (among other things) identify important transportation needs and establish transportation plans that will provide solutions to these needs. This is primarily accomplished through the Long-range Plan (LRP) and Statewide Transportation Improvement Program (STIP). One of the challenges with developing and implementing the plans is communicating to both internal (UDOT) and external (public) stakeholders the transportation analysis and plan results. The purpose of this research is to identify ways and develop a tool to communicate through Graphical Information Systems (GIS) and other graphical interfaces the needs of the state (e.g., congested areas, safety concerns), how the LRP addresses these needs, and how the STIP implements the solutions. The primary reasons to develop such a tool would be to make project delivery more efficient and to better communicate transportation problems, solutions, and implementation to the number one client of UDOT; the public.

2. Describe why this research is important and how it is unique.

UDOT will benefit from this project by better communicating transportation needs and proposed solutions. One of the challenges that face transportation professionals, particularly transportation planners, is the ability to communicate the needs and proposed solutions to transportation projects to stakeholders internal and external to the agency. This will provide UDOT with a tool to address this need.

3. List the research objective(s) to be accomplished:

1. Identify methods to communicate graphically the transportation needs of the state.
2. Develop a GIS interface tool to help communicate these needs.
3. Coordinate with UDOT Planning the integration of the interface.

4. List the major tasks to accomplish the research objective(s):

1. Develop a project scope of work and detailed estimate.
2. Perform literature review on graphical communication of transportation solutions.
3. Explore and evaluate data to interface with the tool.
4. Identify ways to integrate the proposed tool through UPlan.
5. Make recommendations on the tool and provide a prototype GIS tool.
6. Report results to UDOT in the form of a written report.

5. List the deliverable(s) to come to UDOT from this research study:

1. Engineering report documenting the literature review and research results.
2. Prototype GIS tool to graphically communicate transportation needs and solutions.

6. Describe how the results of this study will be implemented at UDOT.

This research would be implemented by the UDOT Planning Division to communicate the needs and solutions for transportation projects. The results of the research would assist UDOT in better communicating to both internal (UDOT) and external (public) stakeholders the proposed solutions to transportation needs and ultimately to help meet the mission of UDOT.

7. Estimated cost - Total: $60,000 **UDOT Share:** $60,000 **Other/Matching Funds:** $

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

It is recommended that this project begin in later summer or early Fall 2013 with the initial tasks of the project scope of work and detailed estimate, followed with the literature review. The work will continue according to the tasks outlined previously. It is anticipated that the project would take 12-16 months.

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: SMA Friction Values **No. :UT-13.06.06**

Submitted By: Mike Miles **Organization:** R4 Materials

Email: mmiles@utah.gov **Phone:** 4358960713

UDOT Champion (suggested):

Select a Subject Area

- ☐ Materials/Pavements
- ☐ Maintenance
- ☐ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☐ Preconstruction
- ☒ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

We have been seeing some skids tests on our SMA surface that has given us some cause for concern. New pavements with low numbers and old pavements with high numbers and visa versa. We would like to see if we have a cause for concern because the SMA may be wearing too fast.

2. Describe why this research is important and how it is unique.

SMA is a surface treatment that we use a lot because of its toughness and durability. As of late, we have seen some skid test data that may indicate that some of our SMA is not performing as advertised. In order to assess the condition of our SMA, we would like to do some in depth skid testing and make a comparison of the old to the new and see if we do have a problem.

3. List the research objective(s) to be accomplished:

1. Is our SMA wearing too fast?
2. Are we placing the SMA properly?
3. Are there recent placements that need to be fixed?

4. List the major tasks to accomplish the research objective(s):

1. Do skid testing on all of our SMA placements and compare the data.
2. Determine if we do have some places that need improvement.
3. Compare placement methods to see if they may be a potential cause for any problems

5. List the deliverable(s) to come to UDOT from this research study:

1. Skid data for all SMA placements
2. A map of all SMA placements
3. Dates of all placements

6. Describe how the results of this study will be implemented at UDOT.

Information will be used to affirm our use of SMA and make corrections or repairs where necessary, in addition to giving us a clearer picture of the condition of our pavements.

7. Estimated cost - Total: $30,000 **UDOT Share:** $ **Other/Matching Funds:** $

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Route Advisory For Multi-Modal Routing and Emission Cost Estimation through TravelWise **No. : UT-13.06.07**

Submitted By: Milan Zlatkovic and Xuesong Zhou **Organization:** University of Utah

Email: milan@trafficlab.utah.edu; zhou@eng.utah.edu **Phone:** 801-819-5925; 801-585-6590

UDOT Champion (suggested): Angelo Papastamos (apapastamos@utah.gov)

Select a Subject Area

- ☐ Materials/Pavements
- ☐ Maintenance
- ☐ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☐ Preconstruction
- ☒ Planning/Asset Mgmt
- ☐ Transportation Innovation

1. Describe the problem to be addressed.

TravelWise is a set of strategies developed by UDOT to encourage the traveling public to use alternative transportation modes (such as transit, walk and bike) to driving alone. The goals of the TravelWise program are to reduce energy consumption, optimize mobility, reduce traffic congestion and improve air quality. In order to achieve these goals, TravelWise aims to provide a coordinated transportation program to support alternative transportation modes, especially for converting short-distance driving alone trips to walk or bike trips.

The purpose of this research is to develop methodologies for multi-modal routing and emission cost estimation that can be implemented through TravelWise, to help enable effective transportation demand management and provide much needed information on emission costs and biking safety. Currently, emission cost estimation in standard planning practice is based on traveling distance only, not sensitive to prevailing traffic conditions, so additional methodologies are needed to include live traffic data. The current tools for route suggesting show traffic information on network and corridor levels, but not for the route level. Suggesting safe and reliable multi-modal routes is critical for encouraging mode switch and to reduce the overall emission impact of traveling activities.

This study proposes to review and evaluate available tools for route selection and analyzing regional emissions caused by transportation activities, and further provide recommendations on route selection and/or adaptation of traffic emission analysis tools.

2. Describe why this research is important and how it is unique.

This research will introduce the following approaches:

(1) Development of a data hub, integrated with different data sources (from UDOT, UTA) and latest research results related to multi-modal route choice behavior.
(2) Work with UDOT to enhance the data content and provide rich and relevant multi-modal information for TravelWise.
(3) Provide emission cost estimates which are critical to enable effective traffic demand management strategies for attaining air quality standards.
(4) Produce route-based emission curves as a function of travel speed
(5) This research project is expected to help TravelWise to better understand and evaluate variant emission analysis tools toward their own modeling requirements.
(6) The proposed research product will be a proof of concept, and will be hosted in a cloud computing facility (e.g. Microsoft Cloud Service) outside UDOT.

3. List the research objective(s) to be accomplished:

1. Work with UDOT and UTA to review available data sources on multi-modal routing advisory and transportation related emission cost estimation.
2. Develop criteria and procedures on evaluating dynamic routing engines and emission cost tools for transportation demand management applications.
3. Evaluate modeling methods and procedures for dynamic routing and quantifying emission impact of different transportation improvement strategies.
4. Recommend additional data needed for enabling accurate multi-modal routing provision and impact assessment for UDOT

4. List the major tasks to accomplish the research objective(s):

1. Review available tools on multi-modal routing and transportation related emission estimation. A wide variety of tools are available for emissions analysis. Generally, two categories of applications are used for transportation related emission estimation: transportation planning models and emission models. The transportation planning models analyze vehicle activities based on the traffic demands, supplies and management strategies, while the emission models examine the fuel consumption and greenhouse gas production from vehicles. This task will review variant tools on both categories and cross-compare their functionalities.
2. Meet with UDOT and UTA personal to specify detailed data and functional requirements for the required tools.
3. Develop evaluation criteria and procedures. A set of evaluation criteria will be developed to compare the performance of different routing algorithms with different data needs. An evaluation procedure will also be constructed to help agencies on making decisions on the selection of multimodal routing system design.
4. Discuss transportation improvement strategies on mode switches and emissions reduction, with the focus on multi-modal transportation.
5. Collect datasets in calibrating and validating dynamic routing and emissions analysis tools used in transportation planning applications.
6. Implement multi-modal routing and traffic emission analysis tools for UDOT. Write a draft report and final report.

5. List the deliverable(s) to come to UDOT from this research study:

1. Literature review on available dynamic routing engines with emphasis on multi-modal transportation, and emission cost analysis tools.
2. Proposed dynamic routing and emission cost estimation engines developed by the research team.
3. Methodology for integrating dynamic routing and emission cost estimation results within TravelWise.
4. Final report with all analysis, methodologies, tools and recommendations

6. Describe how the results of this study will be implemented at UDOT.

Multi-modal Route Advisory results can be used in the following ways:
(1) Provide travelers with more transportation options that can avoid traffic jams and reduce commuting delays through mode, route and departure times changes.
(2) Provide traffic operators with more information for route-level decision support.
(3) Encourage both transportation system users and managers to make better informed decisions.
(4) Focus on reducing short motorized trips (less than two miles)
(5) Build up toward Transit Oriented Development (TOD) initiatives
(6) Build up toward the overall goal in motorized trip reduction

7. Estimated cost - Total: $100,000 **UDOT Share:** $50,000 **Other/Matching Funds:** $50,000

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

Performance period for this project is 18 months, with an expected start on 07/01/2013 and end on 12/31/2014
Phase I (6 months): Literature review, data collection, tools evaluation
Phase II (6 months): Development and testing of Dynamic Route Advisory and emission cost estimation models
Phase III (6 months): Additional improvements and implementation of the models, and writing the final report

2013 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 25, 2013. Submit statements to Steve Bagley at sbagley@utah.gov ******

Problem Title: Precast Concrete Pavements for Urban Intersection Reconstruction **No. UT-13.07.03**

Submitted By: David Stevensss **Organization:** UDOT Research Division

Email: davidstevens@utah.gov **Phone:** 801-589-8340

UDOT Champion (suggested):

Select a Subject Area

- ☐ Materials/Pavements
- ☐ Maintenance
- ☐ Traffic Mgmt/Safety
- ☐ Geotechnical
- ☐ Preconstruction
- ☐ Planning/Asset Mgmt
- ☒ Transportation Innovation

1. Describe the problem to be addressed.

Reconstruction of pavements at busy urban intersections can involve significant delays to the traveling public due to reduction of lanes during construction. One way to potentially reduce traffic delays during intersection reconstruction is to use precast concrete pavement panels, placed mainly at night during low traffic volumes, thereby accelerating the reconstruction and having minimal impact on the intersection traffic. Research involvement in UDOT's first precast intersection would be to document lessons learned and help set the stage for streamlining the process and reducing cost on future precast intersection projects.

2. Describe why this research is important and how it is unique.

A flagship precast intersection reconstruction project at UDOT could potentially reduce traffic delays through the intersection during reconstruction, and the associated lessons-learned research could aid future intersection reconstruction projects considering the precast pavement option. UDOT has had success in recent years with various precast concrete pavement designs for intermittent replacement of distressed pavement panels on freeways. Application of precast pavements to an intersection poses some unique challenges, including multiple streets and turning movements and the required ability of designers and precasters to account for the base grading, utility access/manholes, and surface drainage in the precast panels during their design and precast activities. With time and additional projects, designers and precasters could improve the process and the cost might come down.

3. List the research objective(s) to be accomplished:

1. Explore options for supplemental funding to enable a planned UDOT project to implement a precast concrete intersection.
2. Facilitate a lessons learned effort during the preconstruction and construction phases of the precast concrete intersection project.

4. List the major tasks to accomplish the research objective(s):

1. Conduct a literature and project review across the country for precast intersection projects and technologies.
2. Possibly assemble a scanning tour group from UDOT, designers, and contractors to travel and learn from a few states where precast intersections have been used successfully. At a minimum, identify current barriers to implementation at UDOT and field questions to experienced states to help us overcome the barriers and plan our project.
3. Evaluate the potential traffic delay (user cost) reduction from implementing a precast intersection during a UDOT intersection reconstruction project.
4. Select a UDOT project on which to implement a precast concrete intersection, and secure supplemental funding to assist in paying the extra preconstruction and construction costs.
5. Facilitate design/construction methodology selection and associated precast trials.
6. Document lessons learned in preconstruction and construction phases.
7. Prepare a lessons learned report and share with UDOT, designers, and contractors to help on future precast intersections.

5. List the deliverable(s) to come to UDOT from this research study:

1. Lessons learned report and presentations.

6. Describe how the results of this study will be implemented at UDOT.

Lessons learned from the initial precast intersection project could help to streamline the process and bring down the cost for future precast intersection projects.

7. Estimated cost - Total: $Large - TBD **UDOT Share:** $Large - TBD **Other/Matching Funds:** $

8. Outline the proposed schedule for this study, including estimated start date, duration, and major event dates.

Estimated 1 to 2 year process to identify project and funding and to implement a chosen design and construction process on one project.

2013 UDOT Research Workshop (UTRAC)

Group 7: Transportation Innovation: *Brainstorm Ideas*

Precast Intersections

(See the submitted Problem Statement UT-13.07.03)

Precast all pavement for an intersection and place it rapidly (overnight or over a weekend). Suggestion was made for 5400 S. @ 5600 W., a project which is coming up.

Idea: Could the grade be set 2-3 inches low and then a bed of grout be placed over the entire area and then the panels set on the grout, like tiles being set in mortar? If need be, relief ports could be provided in the panels for the grout to ooze out as the panel is set to grade.

Pro	Con
Minimize impacts to public	Accommodating utilities (block outs, etc.)
Minimize impacts to local businesses	Tolerances for fitting up the panels, casting accuracy
Higher quality concrete	Vertical grade control, how to adjust panels vertically to provide smooth ride.
Safety (less exposure for workers and less impact to traffic)	Differential settlement
Public support for "Get in, Get out, Stay out"	Complex design details
	Cost?

Votes: 5

Digital Construction Site

A single electronic site where all data related to a project will be stored and accessible. This would include Electronic Plans, Design Data, Testing Information, Documentation, etc. The site would be cloud based and accessible to contractors and UDOT staff. This idea also encompasses the idea of electronic plans, i.e. not publishing paper plans but only electronic plans, design data, specs, etc.

Pro	Con
Increased efficiency	Fear of losing information
Transparency	Security
Information tracking	Liability?
Reduced errors	Fear of market shift
	QC/QA process undefined

It was noted that there are not currently industry standards for such a sight. Data formats, etc. need to be standardized.

Votes: 5

Laser Striping

The idea is that instead of painting lines on the road, the striping could be projected from overhead using lasers. The delineation could then be actively managed just like and remotely modified much like signal timing, etc. Also, the striping could be animated to help provide active guidance for drivers, for example, through complex intersections.

Pro	Con
Flexibility	Amount of energy used?
Communicate more information to drivers	Power backup
Manage the resource of pavement more effectively	How will it work in bright sun? Rain and Snow?
Driver expectation	Driver expectation

Votes: 4

Modular Embankment

The idea is to use old shipping containers to create embankments. Used containers are readily available at very low prices (approx. $2000 to $3000 each). They are easily transported and can be rapidly stacked. They are very strong and can easily withstand the weight of several layers along with highway loads. Because they enclose such a large volume of empty space, they are equivalent to lightweight fill or even geofoam. They could be used as either temporary embankment, in which case they are easy to disassemble and remove, or permanent embankment. If they will be permanent we would need to develop a way to prevent corrosion (perhaps spray galvanizing?).

Pro	Con
Rapid construction	Long term durability Rust ?
Light weight	Would need a load distribution slab.
Green	
Reusable	

Votes: 3

Drones

Could Unmanned Aerial Vehicles (UAVs or Drones) be used to collect real time traffic data? During Construction they could provide real time status of queuing, etc. They could also be used by the TOC to monitor traffic during events; provide real time feedback as changes are made to signal timing, etc.

Could UAVs be used for avalanche control?

One of the leading vendors of this technology is right here in Utah (L3).

Pro	Con
Real time data	Privacy concerns
Flexibility	Potential airspace issues
Low cost	
Safety (By improving operations and by keeping workers out of dangerous situations)	

Votes Received: 2

Workers' Safety

Are there technologies available to create safer work zones?

With cars becoming smarter is there a way to communicate the presence of workers to the drivers?

In other industries there is a movement to "Design for Safety". Is this applicable to our industry?

Should a Safety Officer be involved in the design of projects? Review plans before they are advertised?

Should we review all phases of the Project Lifecycle (Design, Construction, Operation, and Maintenance) and identify the top 5 causes of accidents in each phase? Then we could develop mitigation for each.

Pro	Con

Votes received: 1

In Place Recycling

This idea is more than just in place recycling of asphalt. It includes a complete re-working of sub-grade materials as well. For example, could a machine be developed that would grind up all of the pavement and sub-grade, sort the material, processes the various materials (by adding any materials required bring the material up to spec.) and replacing the material.

Pro	Con
Re-use materials on site	The technology doesn't currently exist
Saves time	Would our current specs allow?
Increased quality?	
Saving costs and fuel	
Increased safety	
Green	

Votes: 0

Better Base for Precast Pavement Slabs

There is a need to develop a better method of setting precast pavement slabs rapidly. One thought was to use a bed of grout which would allow the pavement panels to be set much like tiles in a bed of mortar. Another thought was to use Grout Bags, basically sealed fabric bags of grout which would be placed on the grade and then the panel would be set. The bags would then "squish" under the panel and conform to the sub-grade and the bottom of the panel.

Pro	Con
Rapid construction of pavement	Requires skilled labor for placement
Uniform load distribution	Cost?
Better quality	Learning curve

Votes: 0

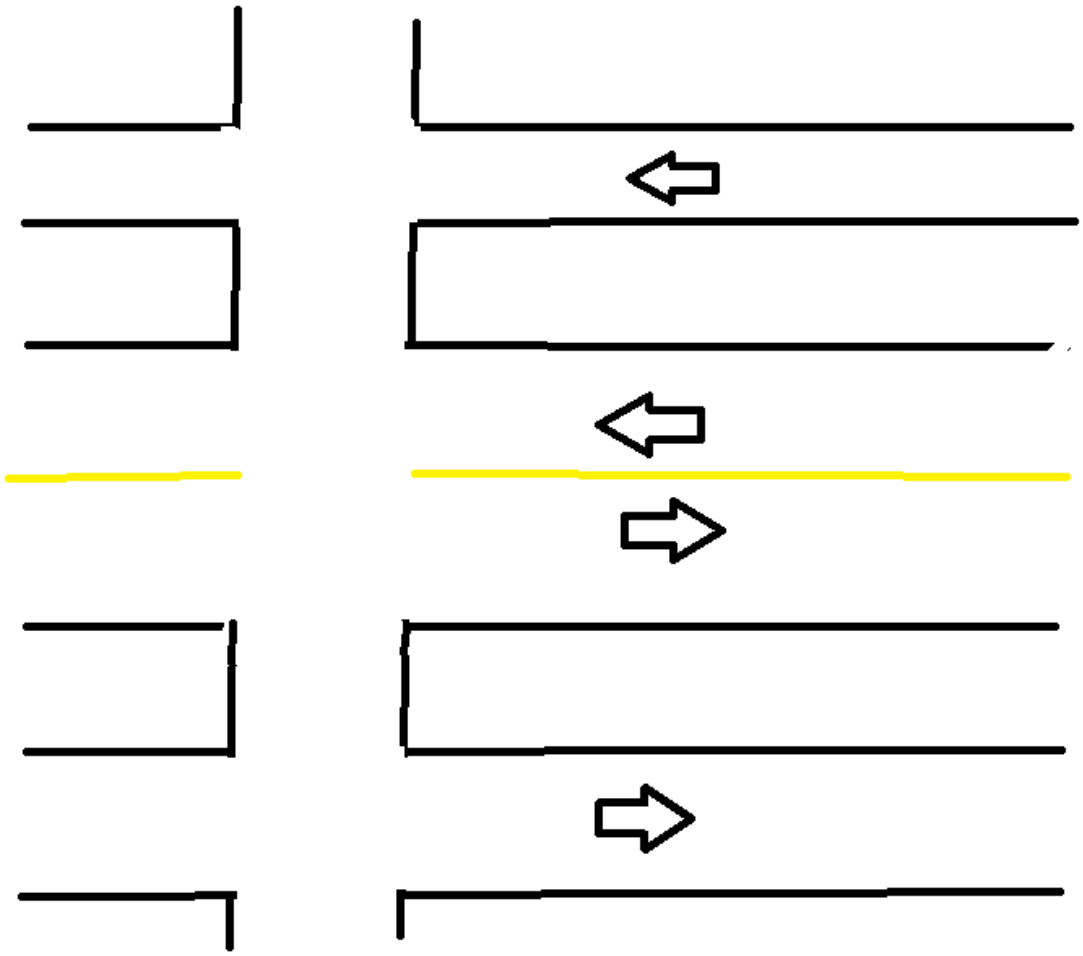
Utility installation

Is there a way to install utilities in existing roads (pipes, etc.) without trenching but cheaper than current boring techniques? Another thought was to install utility corridors (box culverts) during initial construction or re-construction that allow utility companies to install their facilities in the corridor without tearing up the road.

Pro	Con

Votes: 0

Multi-way Roadway



The idea is a new type of urban roadway. The main flow of traffic is carried in the center lanes which have limited access points. To the outside of corridor are frontage roads which allow access to properties along the roadway. There are limited places where the main traffic can move into and out of the frontage roads. This idea is being considered by at least one local city but there are not currently any tools or procedures to model this configuration.

Pro	Con
Maximize use of current ROW width	Unfamiliar
Balances access with mobility	Economics?
Currently used in other countries (Mexico)	Perceptions of property owners, drivers

Votes: 0

Risk Communication

How do we effectively communicate risk to the public? This includes both our risks and the public's risks.

For example, how do we communicate the true risks of distracted driving in an effective, persuasive way? How do we let the public know about the vagaries of highway construction? There are people that are expert at communicating risk such as the Society for Risk Assessment. Could we partner with them to improve our communications with the public?

Pro	Con
Effective education	Privacy issues
Make it personal	Cost?
Similar to Behavior Based Safety	

Votes: 0

Temporary Construction Striping

Are there new technologies for creating temporary striping that can be removed without damaging the pavement? Tape that has an adhesive that releases with heat? Paint that reacts with certain wavelengths of light to disappear (maybe use a laser to remove)?

Pro	Con
Doesn't scar the pavement	Technology not yet developed
Increase safety by eliminating conflicting ghost lines	
Increased flexibility by using more phases of construction because we're not worried about scaring the pavement	

Votes: 0

Ideas from Europe

What are they doing in Europe that we could use here to increase durability or reduce impacts of our projects?

No pro's or con's identified

Votes: 1 (I think they just wanted a trip to Europe)

Large Helical Piles

Currently the Department uses either Pipe Piles or, rarely, H Piles. We also use Drilled Shafts where a vertical shaft is excavated then filled with reinforced concrete. There is a different type of pile used in other industries that may be applicable to bridges. These are Helical Piles, which are like giant screws that are twisted into the ground.

Pro	Con
Reduced spoils compared to Drilled Shafts.	Currently not approved by AASHTO
Good for contaminated sites where disposal of spoils would be a problem	No design criteria for bridges with seismic loading
They are not driven (pounded) like traditional piles so the noise and vibration impacts are greatly reduced.	

Votes: 1

Going Vertical

Are there places where building additional roadway capacity is not the answer but instead we could install an alternative transportation mode over our existing corridors? For example, gondolas or trams?

There is a company here in Utah that specializes in these types of systems. The name is Dopplemyer.

Pro	Con
Maximize use of current ROW width	Unfamiliar
Transportation in modes other that cars	Economics?
	Public Acceptance

Votes: 1

Missouri Bridge Program

Could we do something similar to the way that Missouri did their bridge program? Basically they let a contract to (I believe) Design Build Finance a large number of bridge replacements over a large area of the state. We do not need to do this for bridges but is there some other aspect of our system that would benefit from this? We are doing something similar with the striping warrantee project and have looked at a Structures preservation project.

Before Pro's and Con's can be identified we need to contact Missouri and see how it worked for them.

Votes: 0

Reflective Pavement Markers

Other states use reflective pavement markers which provide very visible delineation at night and during wet weather. UDOT, and other snow states, have not adopted them because of their problems with snow removal. Even the so-called plowable markers are not durable and cause problems with the plows. Some states have recessed the reflective markers by grinding a small trench for them to sit in. This leads to a concern with pavement distress due to freeze-thaw.

Is there a better way to install reflective markers to minimize these issues?

No pro's or con's developed.

Votes: 0

Adapting New Technology

Can we adapt current New Technology for uses not currently identified? For example, could Lidar be used to monitor settlement instead of settlement platforms? Would this be any cheaper? What would the accuracy be? There are currently projects in the Middle East that are using satellite imaging to monitor settlement. The same questions apply.

No pro's or con's developed.

Votes: 0

Pre-Formed CMGC Teams

This is the idea that, when the Department wants to let a CMGC project, they would put out a notification and allow Contractors to team with Design Consultants. The Department would then go through a qualifications based selection of the teams. However, the Department would enter into separate contracts with the Designer and the Contractor; that way we still have control over the design. The advantage is that we are not forcing a marriage between the designer and the contractor.

Pro	Con
More innovation	Unsure of legal implications (procurement laws)
Quicker procurement	What about the Best Value requirements?
Better collaboration	

Votes: 1

Split Pipe Diaphragm

In other places they are starting to use a split pipe for the stiffener at diaphragm locations. This means that a simple tab can be welded at any angel to the pipe and unique bend connectors are not required for each situation. This saves time during fabrication and reduces the opportunities for errors.

No pro's or con's developed

Votes: 0

Permanent Deck

It was suggested that by using stainless steel reinforcing along with post-tensioning, a deck which lasts the life of the bridge could be accomplished. Although the up-front costs would be higher it was felt that the Life-Cycle costs would be significantly less. This would require more investigation.

No pro's or con's developed.

Votes: 0