

DATE: September 14, 2016

TO: Transportation Commission Resiliency Subcommittee

FROM: Lizzie Kemp and Heather Paddock, Co-Project Managers and Joshua Laipply, P.E. Chief Engineer

SUBJECT: I-70 Risk and Resiliency Assessment Pilot

Purpose

Briefing on the upcoming I-70 Risk and Resiliency Pilot project. The goal of the pilot is to quantify and improve system resilience in advance of future events to better prepare CDOT and reduce future losses. Moving Ahead for Progress in the 21st Century (MAP-21 §1106; 23 USC 119) legislation mandates transportation agencies develop and apply risk-based asset management processes to preserve or improve the performance of the road systems they own. This project will assist CDOT to advance how it complies with the directive and also help inform future maintenance and project selection processes.

Action

CDOT is requesting Subcommittee review and comment on the scope, schedule, process and proposed Subcommittee engagement plan.

Background

This fall, CDOT will begin work on a pilot project to assess risk and resiliency of its transportation assets on Interstate 70 from the Kansas to Utah borders with funding approved by the Commission in July. Recently, CDOT's system has suffered significant damage from floods, fire, rockfall and other physical events. Recovering from those events has been challenging, time-consuming, financially and economically expensive to the agency. In addition to reconstruction cost, these events have significant social, economic and environmental impact. The I-70 Pilot will demonstrate an established, probabilistic approach for evaluating risk and improving resiliency of the State's transportation assets. The method utilized for the Pilot has been developed as part of the Flood Recovery Program and most recently utilized on the Glenwood Springs rockfall event to analyze potential mitigation measures to harden the corridor from future rockfall events. The Pilot is a demonstration project to more fully understand and better manage the threats posed by physical events.

Details

Applied Engineering Management (AEM) Corporation has worked with CDOT to develop the analysis approach and is under contract to assist in this 12-month effort. The Pilot does not propose new funding for improvements recommended by the analysis, but will provide quantified risk and resilience information for assets on I-70 to assist in prioritizing projects at key locations where risk is high and resilience is low. If successful, the Pilot process can be applied to future asset management, project prioritization and maintenance practices in critical corridors throughout the state.

- I-70 has been selected as the test corridor for this Pilot due to the diversity of terrain, environmental constraints, statewide significance and wide range of rural, recreational and urban character.
- The Pilot builds on CDOT's 2013 Transportation Asset Management Plan (TAMP), and methods utilized through the Flood Recovery Program. Specifically, the method builds upon a framework referred to as

RAMCAP+ (*Risk Analysis and Management for Critical Asset Protection*). CDOT and consultants AEM Corporation successfully utilized this approach to support, where appropriate, funding betterments to our facilities as part of recent emergency reconstruction projects.

- The project team will inventory assets, calculate the probability of events occurring that could compromise those assets, estimate the resulting damage, identify which assets are most critical to system operations, and suggest alternative approaches for maintenance or improvement of those assets to improve resiliency and redundancy of our system in a way that is more cost-effective over the long term.
- Key CDOT staff from around the state with special subject matter expertise have been identified to serve on the Project Working Group. A series of four all-day workshops will be the primary vehicle for developing and implementing the project. Formal regular communications with the I-70 Pilot Executive Oversight Committee and the newly formed Commission Resiliency Subcommittee will further serve to ensure CDOT's goals and objectives are integral to the project. (see attached project organization chart)
- The number and types of assets and hazards to be evaluated in the Pilot is limited to ensure completion of the project within 12 months. While no new data is required for the Pilot, the team will engage key data and subject matter experts on staff (the Data Advisory Team) to ensure that a full-scaled statewide R&R analysis will be feasible if the Commission chooses to pursue this approach in the future.
- Up to five criteria will be applied to determine the most critical assets/segments of the I-70 corridor. Criticality measures will include socioeconomic factors, use and operational characteristics, and health in the community. The selection of criteria and weight of each will be established by the CDOT I-70 Pilot R&R Project Working Group through the workshops.
- After a corridor wide screening and prioritization of assets based on annualized risk, four sites will be assessed in detail, determining potential risk reduction/resilience increase provided by potential maintenance and design improvements.
- A final report will provide CDOT the results of the R&R analysis, and propose steps for implementing and institutionalizing the process across the state.
- The results of the I-70 Pilot R&R analysis will be presented to the CDOT I-70 Pilot R&R Working Group, the Executive Oversight Committee, and the Commission Resiliency Subcommittee

Key Benefits

The I-70 R&R Pilot is a collaborative effort to develop and evaluate the annualized risk to assets on I-70 from physical threats. The results will permit CDOT to evaluate the utility of such R&R analysis for internal use in pro-actively managing Colorado's road transportation network and its applicable physical threats in the future. If successful, the results will inform and improve CDOT's current asset management, project prioritization and maintenance practices.

Next Steps

The first of four all-day workshops with the Project Working Group is scheduled for September 27, 2016. The team proposes to return to the Resiliency Subcommittee quarterly over the next twelve months to report on progress and request guidance and feedback. The Subcommittee will report to the full Commission with thoughts about whether this process should be pursued on other key corridors statewide.

Attachments

Project Scope Overview

Project Organization Chart

Project Schedule and Milestones



I-70 Pilot Risk and Resilience (R&R) Assessment Overview

Introduction

Two recent natural disasters have highlighted the physical threats facing Colorado's highway transportation system, underscoring CDOT's strategic imperative to move to a holistic approach to data-driven decisions. The first of these was the magnitude of the physical, social, and economic damage sustained following the September 2013 floods along the Front Range. The second event was the February 2016 Glenwood Canyon rock fall on I-70, resulting in approximately \$16 million in road-user costs, and additional millions more in economic losses from disruptions to businesses and government operations. These two events reinforce the necessity for implementing a rigorous and systematic methodology for identifying the physical hazards threatening Colorado's highway network.

Discussion

Background

- Moving Ahead for Progress in the 21st Century (MAP-21 §1106; 23 USC 119) legislation mandates transportation agencies develop and apply risk-based asset management processes to preserve or improve the performance of the road systems they own.
- The FHWA Gulf Coast (GC) studies and Climate Change (Climate) Pilots represent the leading edge of national efforts exploring development of an asset criticality and threat assessment frameworks for transportation.
 - However, the results of these studies have yet to result in standard and widely adopted asset criticality criteria and a threat evaluation framework for transportation.
- The R&R management framework for analyzing physical threats to CDOT's highway transportation systems and assets adopted by CDOT following the 2013 floods is the American Society of Mechanical Engineer's (ASME) Risk and Resilience Analysis and Management for Critical Asset Protection (RAMCAP PlusTM).
 - RAMCAP Plus was developed in response to the terrorist attacks of September 11, 2001.
 - Initially focused on terrorist or directed threats, it has evolved to include all physical threats, including those related to natural threats such as weather-related hazards and seismologic events.
 - Since 2002 many hundreds of nationally recognized experts, scientists, engineers, industry leaders, academics, and federal, state and local government officials have been involved in developing the RAMCAP Plus R&R framework (7).
 - RAMCAP Plus has more than a decade's worth of application across seven sectors of the U.S. economy, including Transportation, (6) (7) and is well known among federal agencies.

Objective of the Pilot

- The objective of the Pilot is for CDOT to develop, apply, and evaluate an R&R tool that can be used to improve its stewardship of 23,000 lane miles of roadways and some 3,445

bridges supporting travel and mobility related services throughout the state. The Pilot is a demonstration project to more fully understand and better manage the threats posed by physical threats.

- Benefits of the Pilot include:
 - Identification of those I-70 segments most at risk from physical threats
 - The anticipated damage to I-70 from these potential threats
 - An understanding of the system's ability to recover from physical threats (i.e., a measure of resilience for those segments most at risk and for alternative routes).
 - Further analysis of critical segments of I-70, capturing the benefits of mitigation measures ranging from maintenance, operating contingencies to improved assets.

Pilot Scope

- AEM Corporation (AEM) will be contracted to lead CDOT in developing and implementing the R&R process for the Pilot.
 - Period of performance is 12 months
- AEM will maintain formal, regular communications with the Colorado Transportation Commission R&R subcommittee, and the I-70 Pilot Executive Oversight Committee (EOC) to ensure CDOT's goals and objectives are integral to the project.
- AEM will work with key CDOT staff (i.e., the Working Group) to apply the RAMCAP Plus R&R framework to the I-70 corridor from border to border within Colorado.
- The Working Group will provide input to the R&R.
 - AEM will facilitate a series of four workshops have been developed as the primary vehicle for this collaboration.
 - AEM will lead the Working Group in developing five criticality measures, used to determine the most critical assets/portions of the I-70 corridor.
 - Criticality measures will likely include highway use and operational characteristics, socioeconomic factors, and community resilience.
 - The Working Group will finalize a limited number of asset classes to be studied. Potential assets include:
 - Pavements
 - Bridges
 - Culverts
 - Walls
 - Geotechnical
 - The Working Group will finalize a limited number of limited set of physical threats to be studied. Potential threats include:
 - Flooding
 - Rockfall and rockslide
 - Avalanche
 - Earthquake
 - Wildfire
 - Tornado

- Limited assets and threats will be evaluated to ensure completion of the Pilot within the allotted budget and 12-month time frame.
- Following the R&R screening and prioritization of assets based on annualized risk, four sites will be assessed in detail, determining potential risk reduction/resilience increases provided by maintenance activities and design.

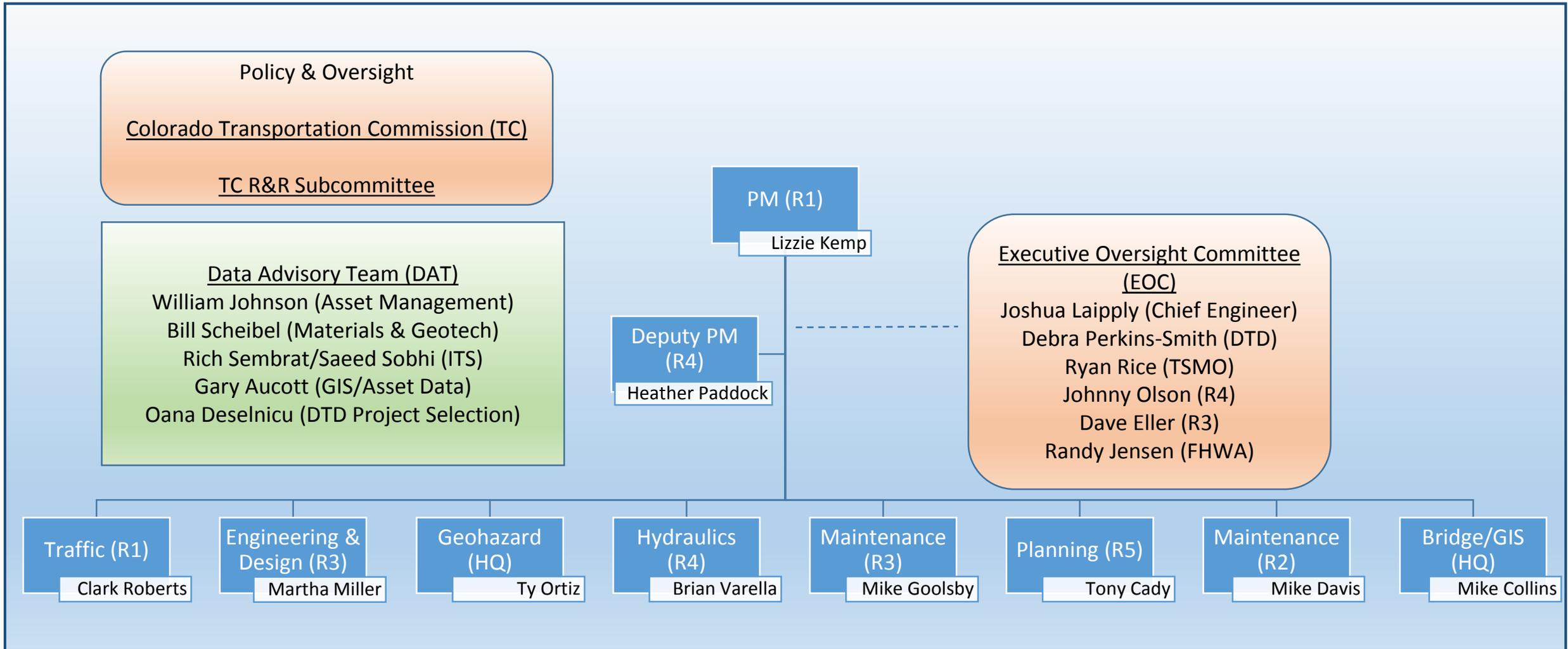
Pilot Outcomes

- CDOT has initiated a probability-based framework to quantify the risk posed by physical threats to highway assets.
 - Benefit-cost analysis of specific mitigation strategies to increase system resilience to these threats is a key product of this analytical framework, supporting both immediate and long-range infrastructure planning.
 - Outcomes of the pilot will assist CDOT in further developing an objective methodology by which to prioritize critical assets and corridors in light of the organization's mission.
- While no new data is required for the Pilot, the project will identify key data and subject matter experts required to fully realize the potential of an R&R analysis scaled state-wide.
- Workshop materials, data related to the Pilot, R&R analysis results and other related information will be provided to CDOT prior to closing the project.
- A final report will provide CDOT the results of the R&R analysis, and propose steps for implementing and institutionalizing the process across the state.

Conclusion

The I-70 R&R Pilot is CDOT's collaborative effort to develop and evaluate the annualized risk to assets on I-70 from physical threats. The results will permit CDOT to evaluate the utility of such R&R analysis for internal use in pro-actively managing Colorado's road transportation network in light of current and anticipated physical threats. The Pilot also furthers implementation of CDOT's strategic business process initiatives.

I-70 Corridor R&R Pilot Project Team



a/o 31 Aug 2016

I-70 Corridor Pilot Project Schedule

	2016					2017							
Event	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
NTP	11												
TC													17
TC R&R		14		16		18			19			19	
EOC	16			16		18			19			19	
DAT		28					15					18	
WG	16	27			6			23			6		

NTP: Notice to Proceed (instant contract in place)

TC: Transportation Commission

TC R&R: Colorado Transportation Commission Risk & Resilience subcommittee

EOC: Executive Oversight Committee (Josh Laipply, chairman)

DAT: Data Advisory Team

WG: R&R workshop (working group)

Schedule subject to change based on availability of CTC/CDOT personnel