

Culvert Risk Mitigation Planning

Lizzie Kemp, CDOT Resiliency Program Manager June 29, 2020 AASHTO Webinar - Climate Resilience



COLORADO Department of Transportation





- 1. Background CDOT Resiliency Program
- 2. Tools for quantifying vulnerability and risk
- 3. Using risk data in decision-making
 - * Culvert mitigation planning

CDOT Resiliency Program





Lessons Learned

1976 and 2013 floods destroyed many of the same facilities



US 34 1976



US 34 2013



What can we do now



... To avoid this in the future?



AASHTO Adopted Definition

Resiliency:

"The ability to prepare and plan for, absorb, recover from, or more successfully adapt to adverse events."



CDOT Resiliency Program

- Created in 2018, with Policy Directive 1905.0 - the vision for resilience at CDOT
- Works to integrate resilience in CDOT functions
- Coordinates resilience activities at CDOT
- Conducts research to support resilience
- Provides resilience knowledge and resources to CDOT staff

CDOT Tools – Measuring Vulnerability and Risk





Asset Criticality – Some Roadways are More Critical Than Others

Variables in CDOT's Criticality Measure

- <u>Usage</u>: AADT + Roadway Classification
- <u>Economic Impact</u>: Freight value (\$) + Tourism value (\$)
- <u>Social Impact</u>: SoVI
- <u>System Impact</u>: System Redundancy

Equal weight assigned to each of the six selected variables.

$$\checkmark$$
 \checkmark \checkmark

SOCIAL ENVIRO ECON



Criticality Map for System Resilience



AADT	16.7%
ASHTO Road Classification	16.7%
Freight \$ (County)	16.7%
Tourism \$ (County)	16.7%
SoVI	16.7%
Redundancy	16.7%



Reminder: Criticality reflects the importance of each asset to overall operations within CDOT's network as related to *system resilience only*. Criticality is part of Step 1 in a 7-step Risk and Resilience Analysis process.



Risk and Resiliency Standard - Manual

- To be published summer 2020
- Standardizes the data, assumptions, and methodology for conducting risk assessment
- Step by step "Cookbook" on how to calculate risk



2020

aem



Risk and Resiliency Standard - Manual

- Based on RAMCAP 7 step process
 - What is the *asset of concern*?
 - Location, value, condition, criticality
 - What are relevant *physical threats*?
 - Likelihood and location
 - What is the *impact* on our system?
 - Consequences and vulnerability
 - What are the *optimal investments* we can make now to improve resiliency in advance of future events?





Results – Annualized Risk (\$ per threat-asset pair)

Given the worst reasonable event, what are the consequences? (\$)

Owner Cost

 Asset Replacement Cost

<u>User Cost</u>

 Value of time (delay/detour)







Excel Templates – Based on Standard Model and Assumptions

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Using the Tools to Make Decisions --Prioritizing Which Risks to Mitigate





I-70 Corridor Risk & Resiliency Pilot

- Analysis of risk potential from physical threats on I-70 from Kansas to Utah
- Looked at
 - all assets roads, bridges, culverts, etc.
 - Wide range of threats flood, avalanche, rockfall, etc.
- Proactive look <u>at optimal investments</u> we can make now, in advance of <u>future events</u>, to improve system resilience





I 70 Pilot Results





Decision – Focus on minor culverts



Culvert Mitigation Planning





What can we do now



... To avoid this in the future?



Lessons Learned

• Culvert failure can come in many ways...





June 29, 2020

Integrating Resiliency at CDOT: Maintenance & Operations



Prioritizing At Risk Culverts

- With over <u>60,000</u> culverts under 4 feet across the state, which subset should we focus on first?
- Proposal: Focus first on culverts in poor condition that are also on critical routes --- <u>1,000</u> culverts statewide

Criticality Map for System Resilience





Proposed Culvert Mitigation Plans

Step 1: complete an inspection of identified high-risk culverts (update condition in database)

Step 2: identify and document specific proposed mitigation action for each culvert based on inspection

Capital improvement

* e.g. replace culvert, slip line, etc.

Operational fix

* e.g. increased cleanout frequency, install technology to monitor flows, etc.

Step 3: Run risk calculation for both base condition (as is) and mitigated condition – to determine potential risk reduction. Calculate Benefit /Cost.



Propose Culvert Improvements

GOAL: based on solid data, recommend a project list and funding for culvert improvements that meet a justifiable benefit cost (B/C) in order to reduce CDOT risk.

Extra slides



Colorado Resiliency Framework

Created by the Colorado Resiliency Office (DOLA) Defines <u>re·sil·ience</u> for Colorado

"The ability of communities to rebound, positively adapt to, or thrive amidst changing conditions or challenges—including human-caused and natural disasters—and to maintain quality of life, healthy growth, durable systems, economic vitality, and conservation of resources for present and future generations."

