COLORADO
Department of Transportation

Defining Resiliency for Colorado Communities

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What is resiliency to CDOT?

- ***"Build Back better than Before"***
- Partnerships & Long-term Relationships
- Coordinated Recovery Efforts
  - Hydrology Studies
  - Repair Philosophy
  - Stream Restoration
- Risk and Resiliency Analysis
- Colorado Resiliency Framework
- Risk based Asset Management

Hydrology Team & Partners

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Colorado Water Conservation Board
Department of Natural Resources

FEMA

U.S. Department of Transportation
Federal Highway Administration

ch2m

JACOBS

AECOM

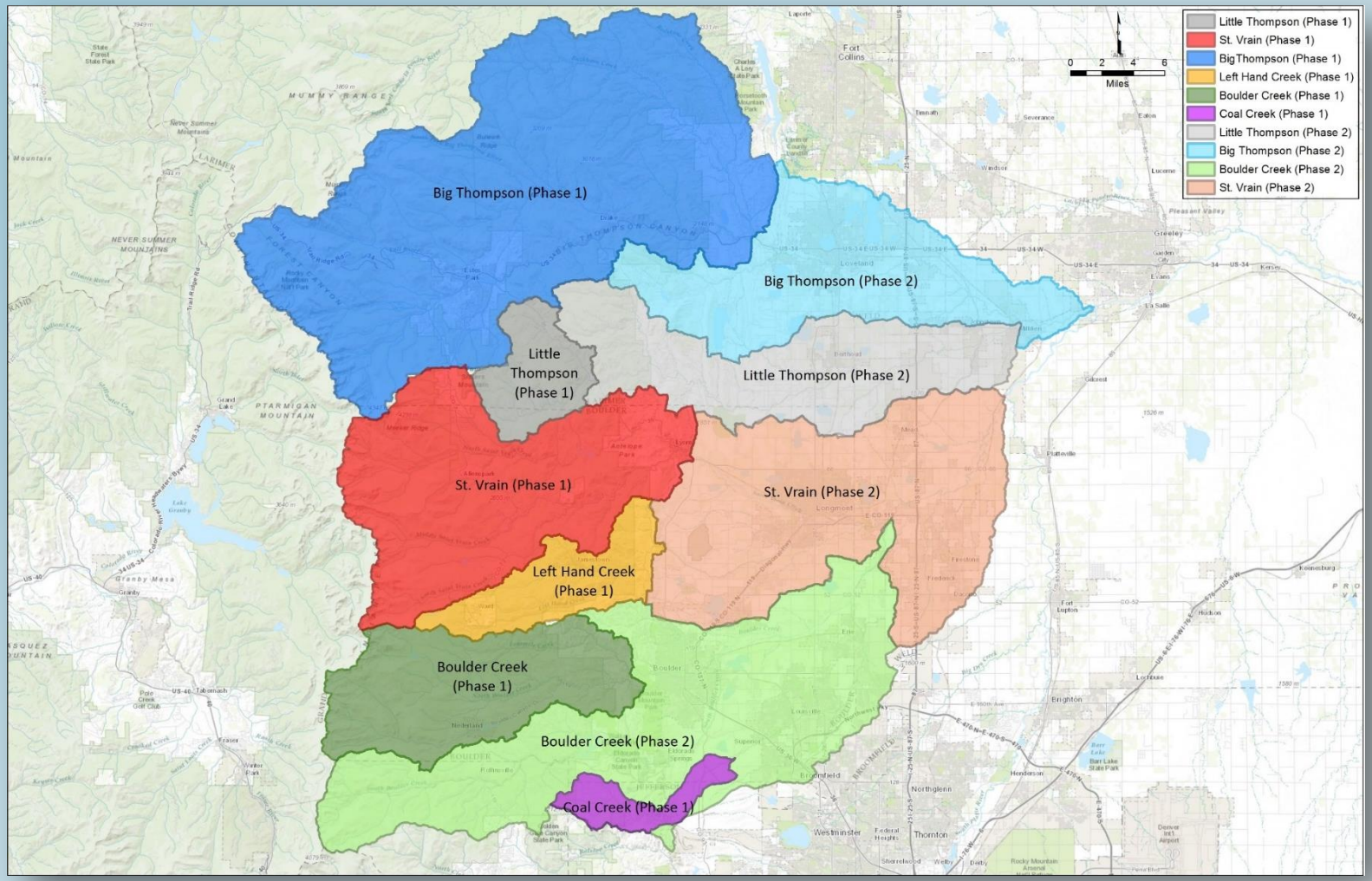
AYRES ASSOCIATES

MULLER ENGINEERING COMPANY

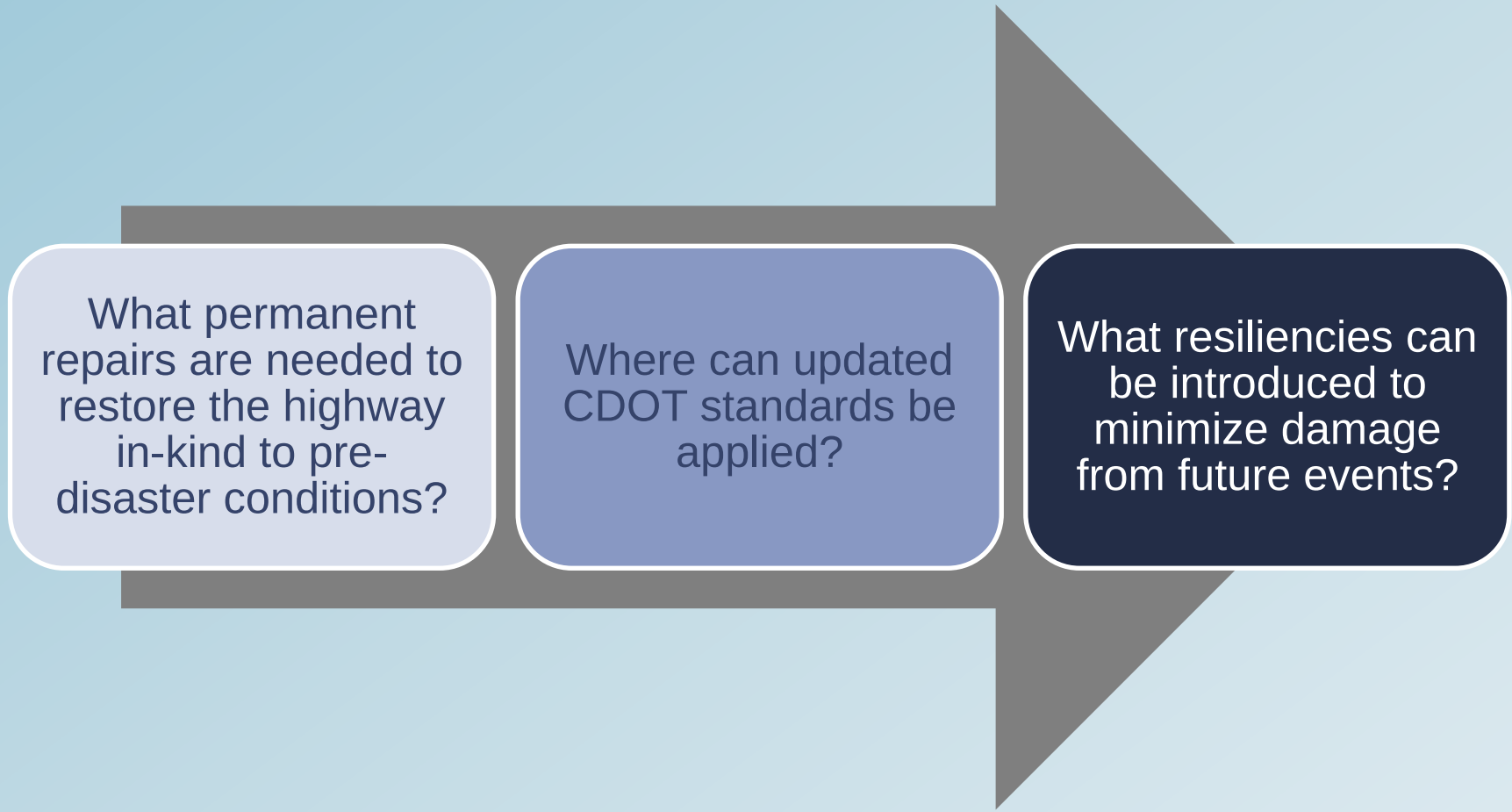
Applied Weather Associates

PARSONS BRINCKERHOFF

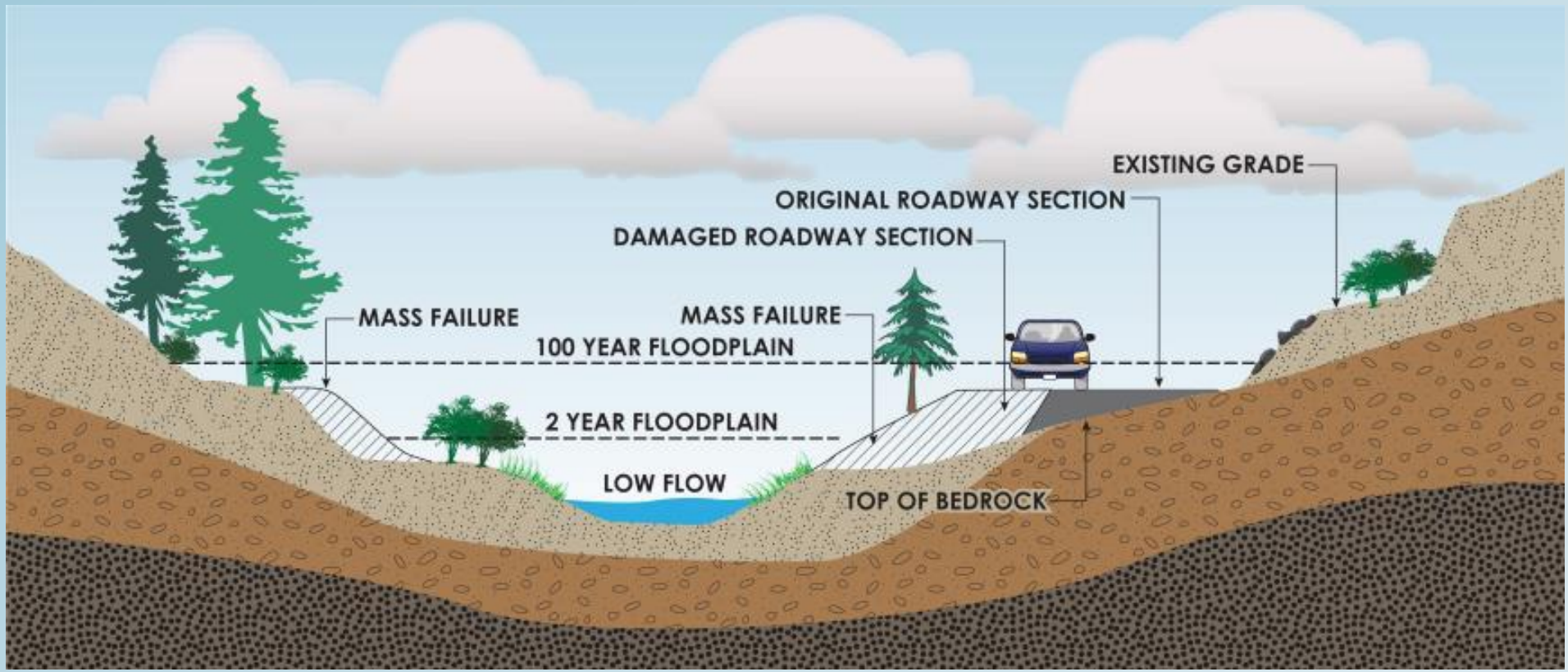
CDOT & CWCB Hydrology Studies



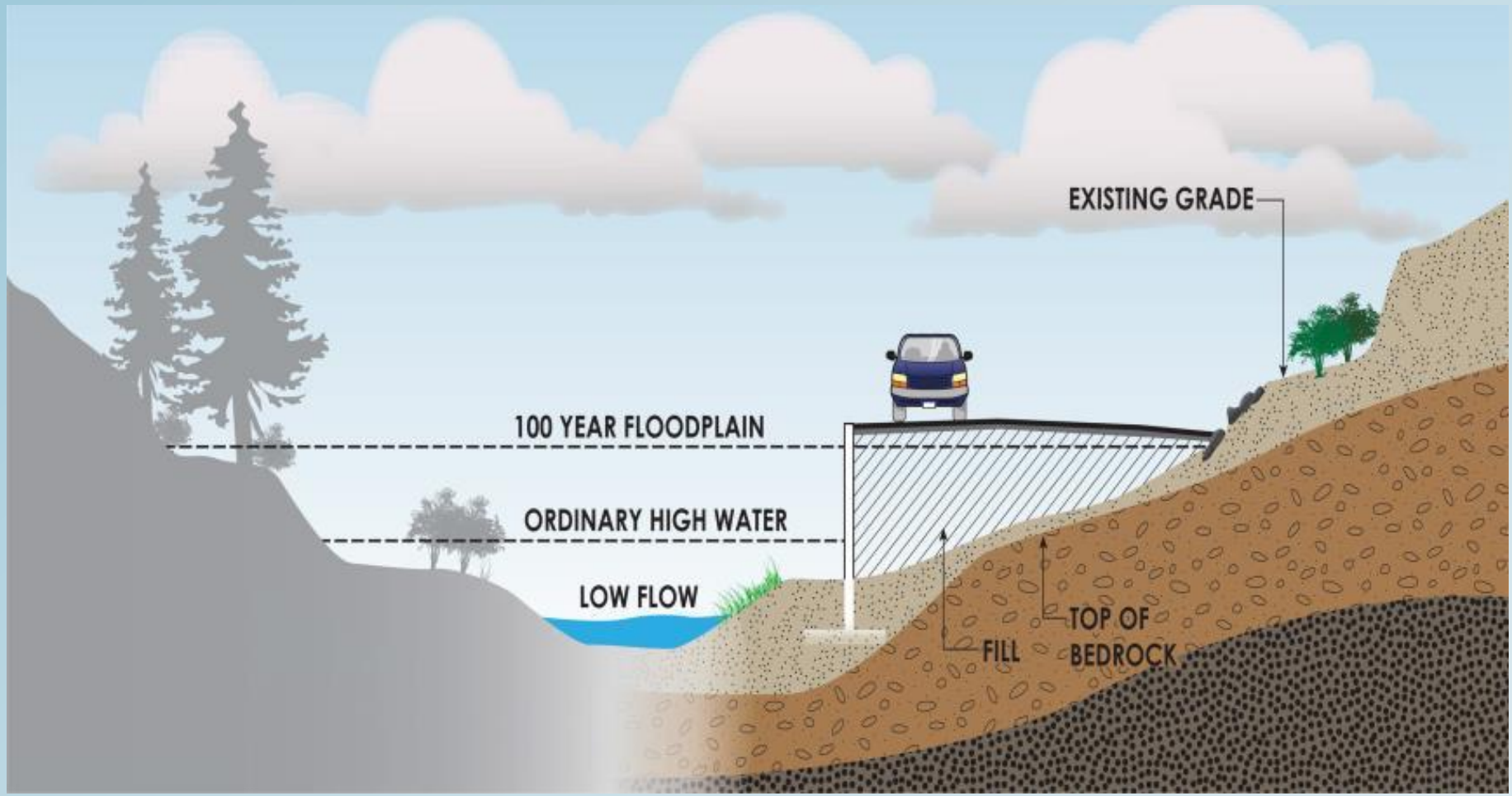
Federal Highway – ER Funding



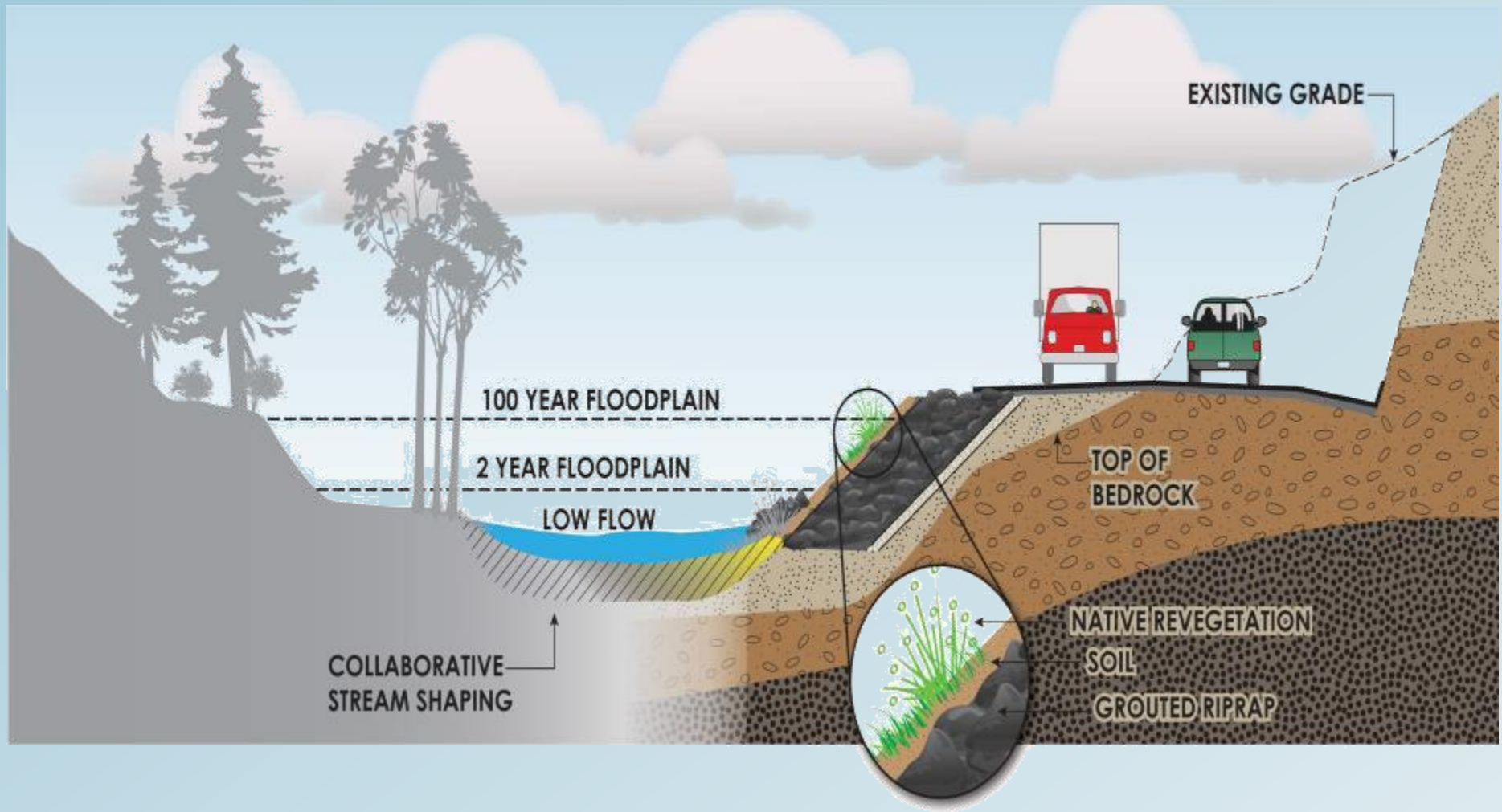
Repair Philosophy



Typical Repair

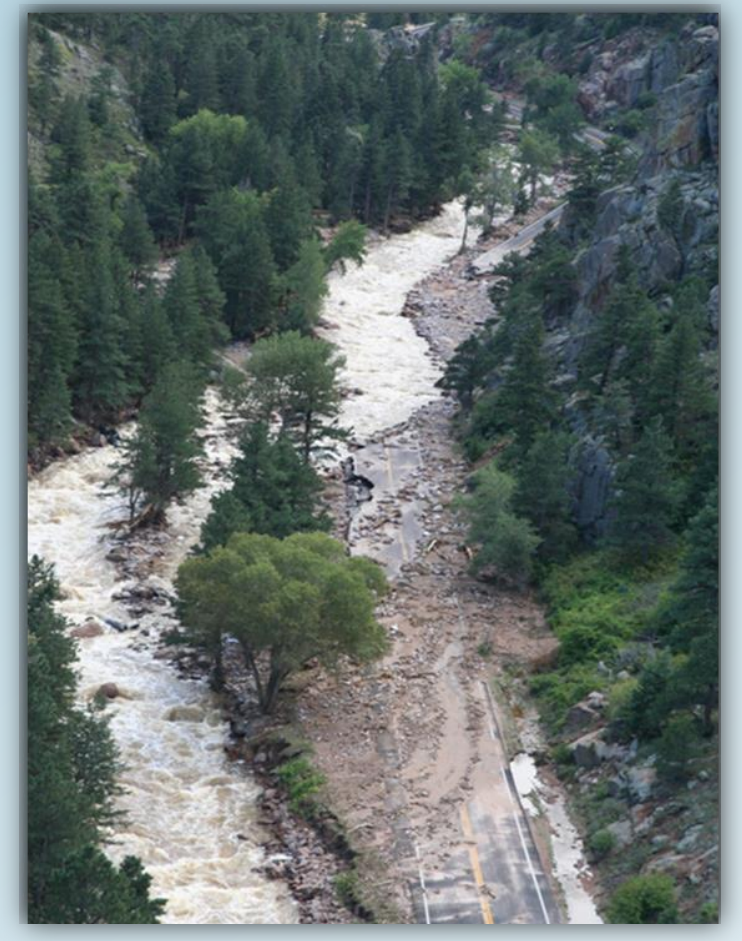


Resilient Concept



FHWA and CDOT
Risk and Resiliency Pilot

- Assess risk
- Assess vulnerability of assets
- Estimate consequences
- Criticality Score
- Design alternatives



Criticality Score

- Provides context: What effect a particular asset or facility has on the public and overall agency performance
- Assets scored on a five-point scale (1=Very Low Impact; 5=Very High Impact)

	Score				
	1 Very Low Impact	2 Low Impact	3 Moderate Impact	4 High Impact	5 Very High Impact
Road Classification	Rural Major Collector	Urban Collector (Major or Minor)	Minor Arterial	Primary Arterial	Interstate Freeway Expressway
Need for Access by Essential Traffic	Facility Open to Essential Traffic More Than 48 Hours After Event Multiple-Redundant Routes Available with No/Minimal Loss of Capacity	Facility Open to Essential Traffic Within 48 Hours of Event Single Redundant Route Available with No/Minimal Loss of Capacity	Facility Open to Essential Traffic Within 12 Hours of Event Multiple Redundant Routes Available with Some Loss of Capacity	Facility Open to Essential Traffic Within 2 Hours of Event Single Redundant Route Available with Significant Loss of Capacity	Facility Open to Essential Traffic Immediately Following Event Single Point of Failure
Route Designation	Truck % under 10%	HAZMAT Route	Truck % over 10%	Defense Route	Evacuation Route
Capital Cost of Damaged Site (per Lane Mile)	< $5 million/lane mile	$5 - $10 million/lane mile	$10 - $20 million/lane mile	$20 - $30 million/lane mile	> $30 million/lane mile

Resilience Index (RI)

- RI is based on the Criticality Score of the asset
- RI reflects the critical nature of the asset within CDOT's overall system
- RI reflects the typical annual construction investment by CDOT and FHWA to specific types of facilities

Criticality Score	Criticality Level	RI
4 to 10	Low	1.0
11 to 15	Moderate	2.0
16 to 20	High	3.0

Risk and Resiliency Calculations

Analysis Objectives	Formulas
Risk from Natural Threats	$Risk = C \times V \times T$ Where: R = annual monetary risk due to natural threats ($) C = consequences ($) V = vulnerability to identified consequences under a specific threat (probability) T = specific threat likelihood (probability)
Resilience from Natural Threats	$Resilience = AADT \times \%AADT\ Not\ Serviced \times Days\ Out\ of\ Service \times V \times T$
Benefit to Cost Ratios	B/C_{Risk} - Reflects the reduced annualized monetary risk to the asset only as compared to the annualized cost of the design
	B/C_{RnR} – Reflects the reduced risk as well as the resilience of the design provided to the overall CDOT system

Colorado Resiliency Framework

- Sector Overview
- Shocks and Stresses
- Problem Statements
- Strategies and Goals
- Cross-Sector Integration

CDOT Risk and Resiliency

How is CDOT going to incorporate resiliency into day to day operations?

- Risk and Resiliency Analysis Tool
- Asset Management
- Project Management

CDOT and Relevant Risk Efforts and Tools May 2015