
 **COLORADO**  
Department of  
Transportation

**Risk Based Cost Estimating Peer Exchange**

 **Peer Exchange Overview**

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- Risk Based Estimating Purpose and Need
- What is Risk?
- CDOT Structure and Organization
- CDOT Project Estimating Process
- CDOT Risk Management Process
- CDOT Risk Management Tools
- Projects using Risk Based Estimating at CDOT
- Question and Answer Session



## Purpose of the Peer Exchange

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Why are we here?  
Why is this so important?  
Why establish a program?



## What is Risk?

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Who can define what risk is on a  
transportation project?



## What is Risk?

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What is risk?  
Is it positive or negative?



## What is Risk?

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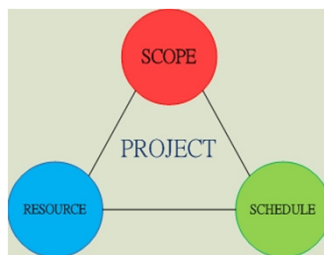
Who here feels comfortable  
talking about risks with  
management?



## What is Risk?



“an uncertain event or condition, if it occurs, has a positive or negative effect on the project’s objectives such as scope, schedule, cost, and quality.” (Project Management Institute)



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## What is Risk?

### Risk -Defining and Understanding Risk is Critical

- Risk is widely misunderstood, overestimated, underestimated, and taken for granted. It is overstated and understated depending on project goals and timelines.
- For example, risk can be understated if the goal is to keep the project alive or on its current track.
- Risk can be overstated to change the scope or timeline of the project.
- Risks can build upon each other if not understood or identified.
- Risks can be good or bad depending on the project or situation.



## What is Risk?

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### Risk -Defining and Understanding Risk is Critical

- Every project is different and similar designs can have different risks.
- The risks may be similar but the context of those risks are different.
- How do we know? Experience, context, plans, as-builts, records, lessons learned, bid data, learning from watching others, etc.



## Budgeting

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Who here feels like once a planning budget is established, it puts challenging constraints on a project?



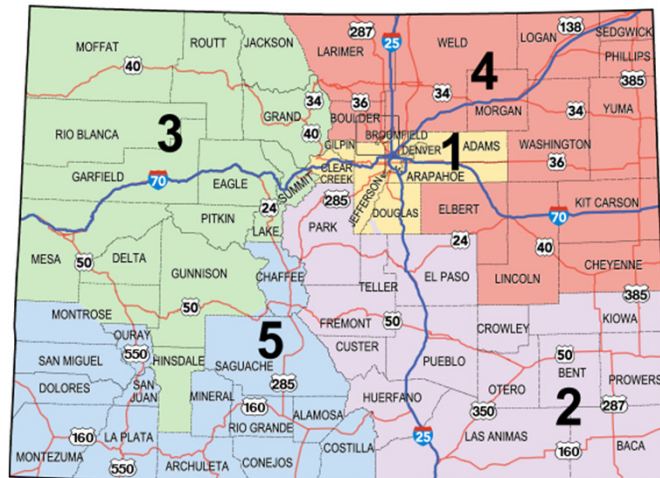
## Why is Risk-Based Cost Estimation Important

- Embracing risk and making calculated strategic decisions based on analysis has helped Utah, Texas, Minnesota, Washington, and Nevada receive more state funding and trust from stakeholders.
- Ranges of estimates and schedules.
- Scoping a project then establishing a schedule and budget.



## CDOT Structure and Organization

- CDOT Organizational Structure





## CDOT Information

- The 5 Regions Deliver The Projects in Design and Construction
- Decentralized Region Components
  - Materials Testing
  - Environmental
  - Right-Of-Way/Survey
  - Utilities
  - Hydraulics
- Centralize Headquarters Components
  - Cost Estimating
  - Structures/Bridges
  - Geotechnical
  - Bike and Pedestrian



## CDOT Project Estimating Process

- **Cost Estimating and Risk Culture**
  - Currently CDOT Talks about Cost Estimates in terms of Point Estimates vs. Probabilistic or Range Estimates
  - Based mainly on production based spreadsheets, market info, and historical bid prices.
  - 30% contingency is the standard for use in planning estimates





## CDOT Risk Management Process

- CDOT has Developed a process that roughly follows the Project Management Body of Knowledge (PMBOK)
- CDOT Has created guidance which contains the following key components:
  - Risk Flow Chart
  - Risk Assessment Worksheet
  - Risk ID Worksheet



## CDOT Risk Management Tools

- Risk Assessment Worksheet - To Provide a Summary Level of Risk Early in the Planning / Scoping Phase

<b>1. Experience of the Project Delivery Team</b>
Weight of Risk = 15%
Score = 6
Experienced (0 pt)
6 <input type="text"/> Somewhat Experienced (1-14 pt)
Not Experienced (15 pt)

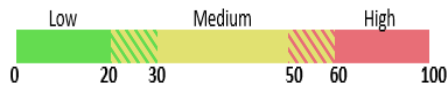
<b>2. Total Project Cost</b>
Weight of Risk = 10%
Score = 5
≤\$2M of funding (0 pt)
5 <input type="text"/> \$2M to \$15M of funding (1-9 pt)
> \$15M of funding (10 pt)

<b>3. Stakeholders/Partners</b>
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<b>6. Primary Project Type</b>
Weight of Risk = 10%
Score = 10 *Max of 10 pts
-- <input type="text"/> Structure (4-10 pt)
5 <input type="text"/> Widening (4-10 pt)
10 <input type="text"/> Interchange (8-10 pt)
-- <input type="text"/> Surface Treatment (3-7 pt)
7 <input type="text"/> Signal/Intersection (2-7 pt)
2 <input type="text"/> Traffic Operations (1-3 pt)
<input type="checkbox"/> Rockfall (4 pt)
6 <input type="text"/> Miscellaneous (1-10 pts)

<b>7. Pre-Construction Delivery Timeline</b>
Weight of Risk = 20%
Score = <b>Select</b>

Output is a Project Risk Score







## CDOT Risk Management Tools

- Risk Id Sheet - A Tool to Gather Risks from Stakeholders during key Meetings

Risk ID Worksheet						
Risk Category (ROW, Utility, Env, EEO, etc.)	Brief Title for Risk	Description: What is the Potential Risk? When will you know if it is an issue? Can it be avoided? What are the options if it occurs?	Risk Impact: Ad Date (Ad) Cost Constructibility (CN)	Probability 1 to 5 1=low 5=high	Impact 1 to 5 1=low 5=high	Risk Score (Col E X Col F)
Utility	Utility Conflict	There are Overhead Lines that may conflict with project features. Consider this issue as project features are designed; exact conflicts will be determined at 30% design. Try to avoid the conflict.	Ad Date, Cost, and CN	3	4	12
						0



## CDOT Risk Management Tools

- Risk Register - Follow a Risk Breakdown Structure Which Matches Other Major Elements of CDOT.

G15 : Structure replacement required

Risk Identification										Qualitative Analysis
Add Risk	ID	Date Identified / Project Phase	Risk Event (Threat/Opportunity)	Risk Description (SMART)	Risk Trigger	Phase Impacted	Probability / Impacts	Weighted Schedule Impact		
<b>Active</b> - actively monitored & controlled <b>Dormant</b> - risk is not currently a high priority, but may become active in the future <b>Retired</b> - no longer a threat to project objectives		E.g. 9/7/15 Scoping	<b>Risk</b> - an uncertain event or condition that, if it occurs, has a positive (opportunity) or negative (threat) impact on the project	Detailed description of the risk. Include information on the risk that is <b>Specific, Measurable, Attributable, Relevant, and Timebound.</b>  Describe the consequences of the risk to scope, schedule, budget or quality.	Triggers - indication that a risk has occurred or is about to occur. Used to determine when to implement the Risk Response Strategy	Which phase will be modified as part of the response strategy?	<b>Probability</b> - How likely is the risk to occur  <b>Impact</b> - How severe is the impact on the project's objectives			
Active	Safety Assessment Review Required	9/29/2018 Scoping	Threat  4.02-Request and Analyze Crash Data	Time needed in the schedule for request, generation, and delivery of the Safety Assessment Review. Some reports take up to 6 months to generate.	Project identified as a 3R project.	D - Design	Probability VH 5 Cost Impact VL 1 Schedule Impact L 2	10		



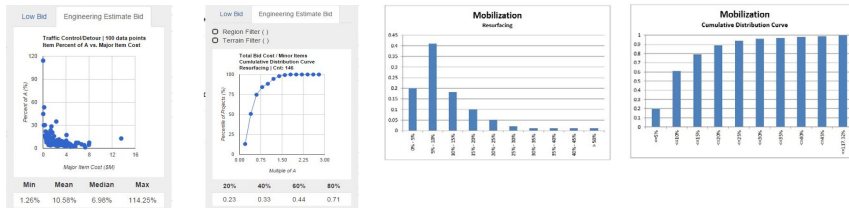
## Planning and Scoping Cost Estimating Tool

- CDOT Cost Planner Tool

Standardize estimating procedures and templates across CDOT Regions

Provide historic data in a format useful for scoping and planning level estimates

Provide statistical distributions to past project costs to tie into risk identification procedures



## Examples of Risk Based Cost Estimating Used

- US 36 - Phased EIS Estimate, FHWA Cost Estimate Review
- C470 - CER Estimate
- North I-25 - Phased EIS Estimate, FHWA Cost Estimate Review
- Westbound Twin Tunnels



## Past Use of Risk Based Cost Estimating

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### Westbound Twin Tunnels

- What the team had in base data:
  - Eastbound Twin Tunnels GMP Prices, Corridor Historical Prices
  - Kraemer Unofficial Proposal for Westbound Twin Tunnels



## Past Use of Risk Based Cost Estimating

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### Westbound Twin Tunnels

- What the team had:
  - Created a base estimate with line items, all risk and opportunity costs were removed.
  - Unit items used bid histories, recent projects, and eastbound/westbound twin tunnels pricing/proposals
  - Base risk register, base costs, project experience, lessons learned.
  - Assumed same team, CDOT, consultant, contractor



## Past Use of Risk Based Cost Estimating

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### Westbound Twin Tunnels

- What the team had: Risk Register
  - Uncertainty in geotechnical (tunnel)
  - Uncertainty in geotechnical (rock excavation)
  - Traffic control and phasing
  - Contracting and Schedule Risk
  - Market Uncertainty - materials, equipment, etc.



## Past Use of Risk Based Cost Estimating

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### Westbound Twin Tunnels

#### The Base Estimate and Schedule

- Created an excel spreadsheet with all base costs.
- Used estimated costs instead of percentages for mobilization, traffic control, erosion control, utilities, etc. teaming with construction staff
- Created a base construction schedule (rough) based on March 2014 start and December 2014 opening of westbound tunnel.



## Past Use of Risk Based Cost Estimating

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### Westbound Twin Tunnels

#### The Risk Based Estimate

- Base Estimate was \$47 million with CE/Indirects and design engineering.
- Base Schedule was 9 months (March to November)
- Major risks were tunnel geotechnical, rock excavation geotechnical, traffic impacts affecting productivity.
- Eliminated risks were market uncertainty - March bidding, market was stable, materials were stable



## Past Use of Risk Based Cost Estimating

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### Westbound Twin Tunnels

#### The Risk Analysis

- Tunnel Geotechnical - Low Risk with a High Impact
  - 25% chance of impact, 100% risk of high impact to schedule and cost
  - Savings from lessons learned were cut by 10% due to risk of change in site conditions.
- Rock Excavation - High Risk with High Impact
  - 75% chance of impact, 100% risk of high impact to schedule and cost. 100' in length moving to 500' in length, 120' tall, needs high productivity, impacts tunnel and roadway construction
  - \$2 million dollar total cost went to \$7.2 million in total cost. Schedule for rock ex went from 1.5 months to 5 months.



## Past Use of Risk Based Cost Estimating

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### Westbound Twin Tunnels

So how did we do?

- \$55 million total project estimate
- \$53.8 million expended during construction or 97.8%
- Construction complete by December 20, 2014 after one month delay due to political pressure (ski season).
- Rock excavation turned out to be the biggest realized threat to the project nearly delaying the project into 2015.



## Past Use of Risk Based Cost Estimating

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## Question and Answer Session

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## Contacts and Thank you!

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