

# ***Risk Analysis Process Training for Project Managers***



Presented by:  
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# Presentation Format

- **Introduction and Pre-Workshop Activities**

Greg Davis, P.E.

State Estimates Engineer

- **Risk Analysis Workshop**

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- **Project Case Studies**

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# ***Introduction***



# What is Risk?

❖ Project Management Institute (PMI) Says:

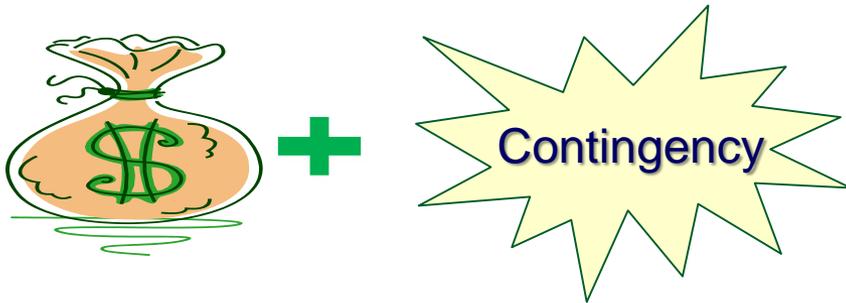
“An uncertain event or condition that, if it occurs, has a positive or negative effect on the project’s objectives.”



# What is Risk Analysis?

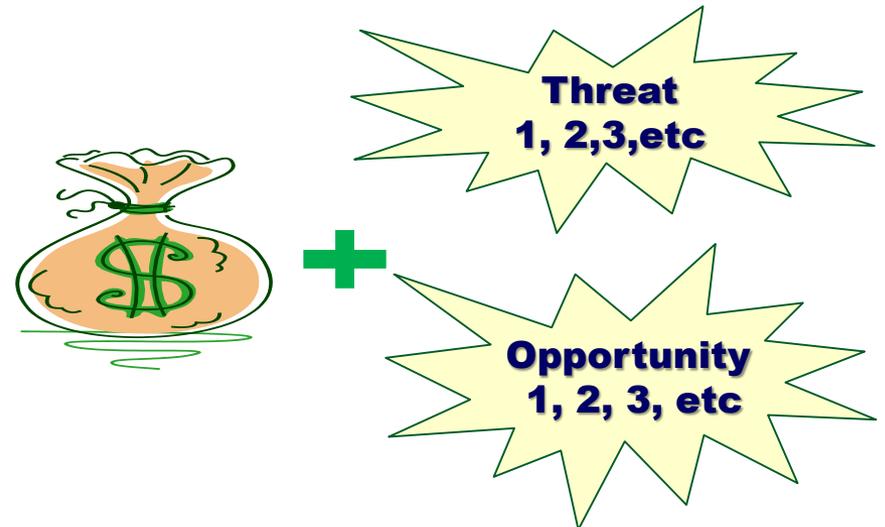
## Traditional Estimating

- ◆ Contingency is intended to include all risk known/unknown
- ◆ Little control of cost and schedule
- ◆ Reactive



## Risk-Based Estimating

- ◆ Risk are clearly identified and quantified in estimate
- ◆ Reasonable control of cost and schedule
- ◆ Proactive

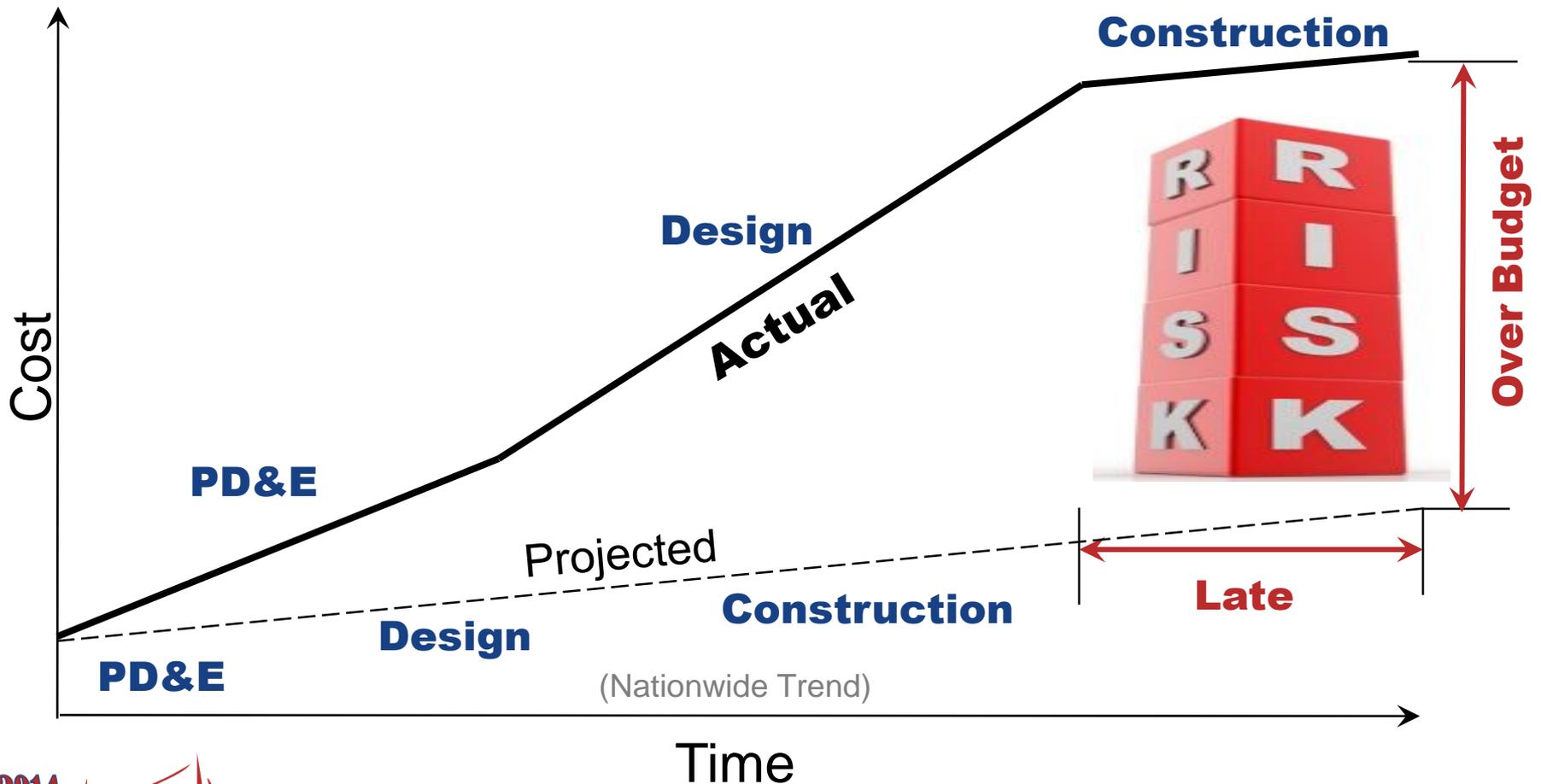


# Why Risk Analysis?

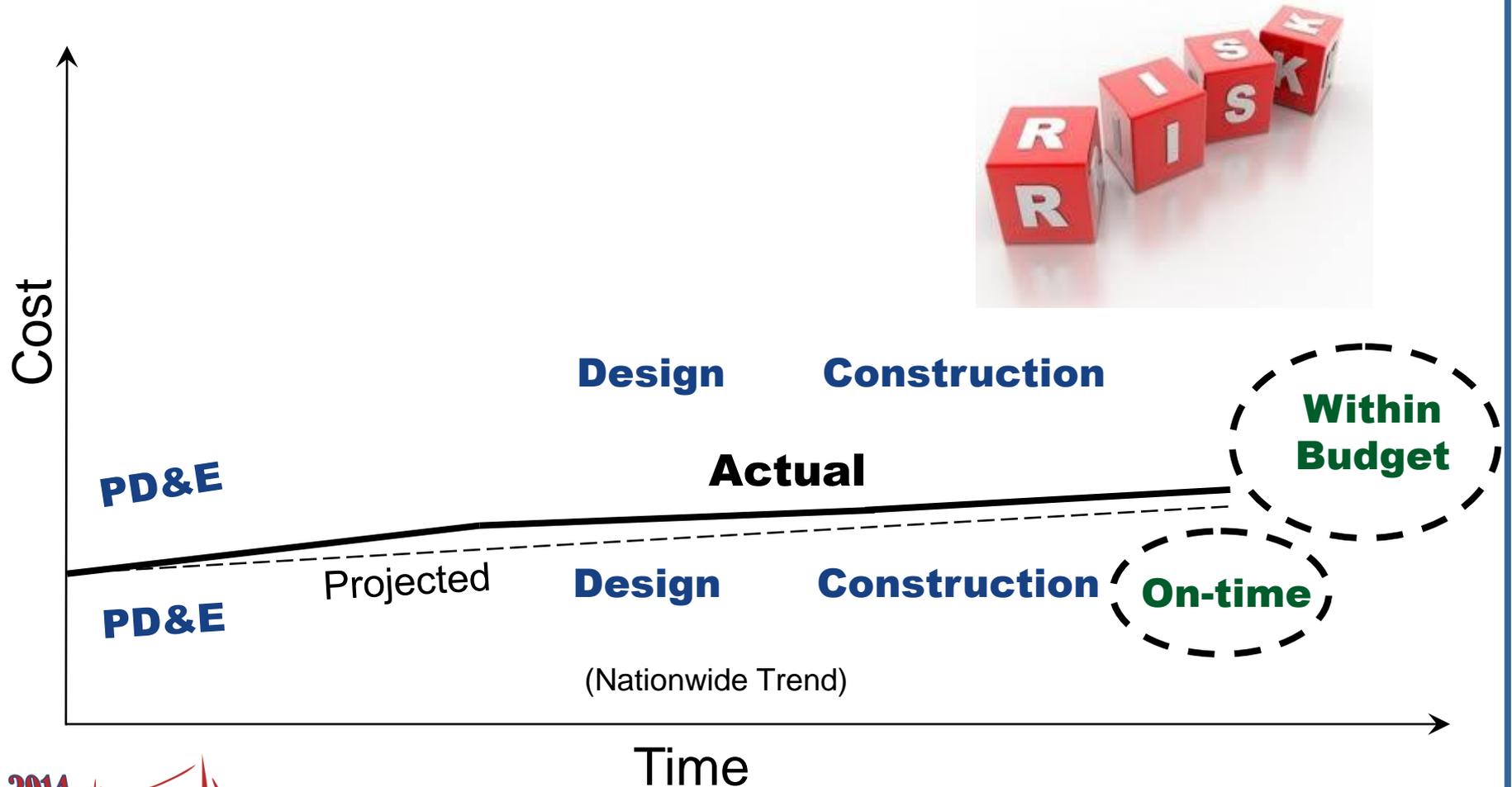
- ◆ Stabilize & Support Work Program with better cost estimates and schedules
  - Validate cost & schedule for accurate project delivery
  - Replace general project contingency with risk-based cost
- ◆ Enhance Risk Assessment/Mitigation activities in Project Management
- ◆ Support FHWA requirement for financial plans on major projects by providing risk-based cost estimates

**Maximizes the Likelihood of Meeting Time & Budget Goals**

# Typical Project Scenario without Risk Analysis



# Typical Project Scenario with Risk Analysis



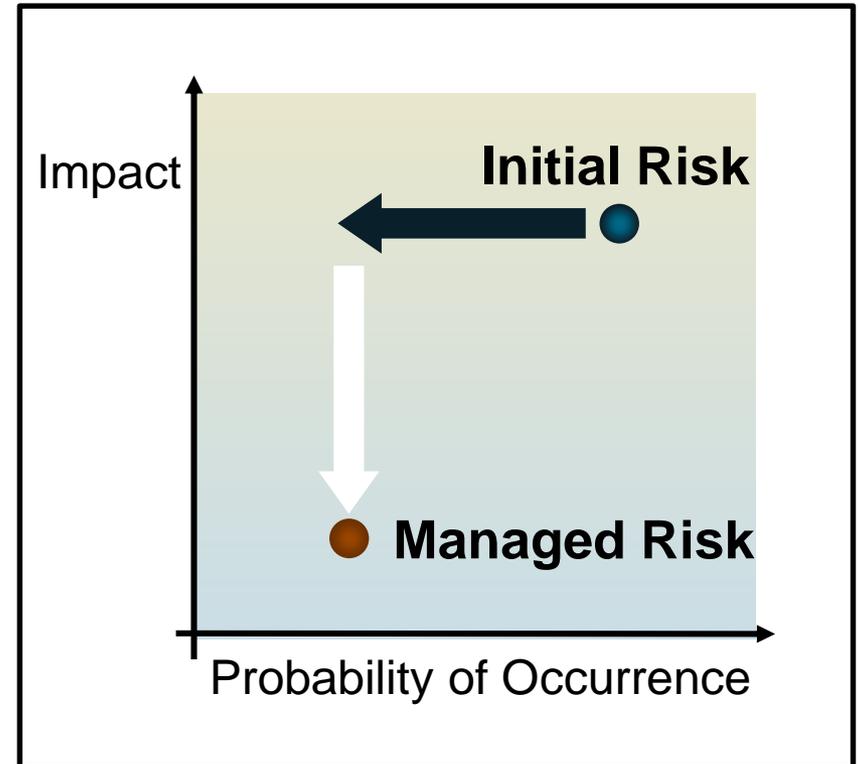
# Risk Management Overview

Risk Management is the systematic process of identifying, assessing, and responding to risks in order to manage or reduce potential adverse effects on the achievement of program and project goals.



# Goal of Risk Management

- ◆ Risk Assessment's aim is to assess potential impact of various scope, event, and budget risks on the project's cost and schedule.
- ◆ Risk Management's aim is to identify opportunities and mitigation strategies to reduce both the likelihood of an event occurrence and the potential effect if it occurs.



# Risk Management Objectives

- ◆ Decrease the probability and impact of negative risk events
- ◆ Increase the probability and impact of positive risk event
- ◆ Make better decisions
- ◆ Allocate risks to those who can best control them
- ◆ Increase agency credibility
- ◆ Foster good relationships with project stakeholders



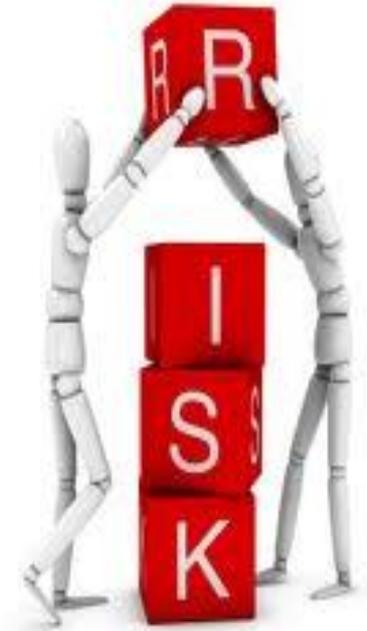
# Risk Management Outcomes

- ◆ Validation of Project Cost and Schedule
- ◆ Managed Risk Response Plan
  - ✓ Identification of high cost and schedule risk drivers
  - ✓ Reduced Contingency as project evolves
- ◆ Understand and Communicate Cash Flow Requirements in Financial Plans



# When to Use Risk Management

- ◆ Early planning and budgeting
- ◆ Evaluation of project delivery alternatives
- ◆ Financial Planning Support
- ◆ Establishing Risk Allocation between parties
- ◆ Preparation of project contract documents
- ◆ **Throughout Project Delivery Lifecycle**



# Benefits of Risk Management

- ◆ Meets FHWA guidelines for risk-based cost estimation
- ◆ Risk management is a component the Project Management Plan
- ◆ Outputs are utilized in financial planning
- ◆ Helps in delivery methods and risk allocation
- ◆ Development of targeted risk management strategies

# Risk Management



“Hope is not a Strategy”

# *Pre-Workshop Activities*



# Before the Workshop...

- ◆ **Preparation Session** with the project team to:
  - Educate
  - Plan
  - Set the stage
  - Build expectations with the project team.



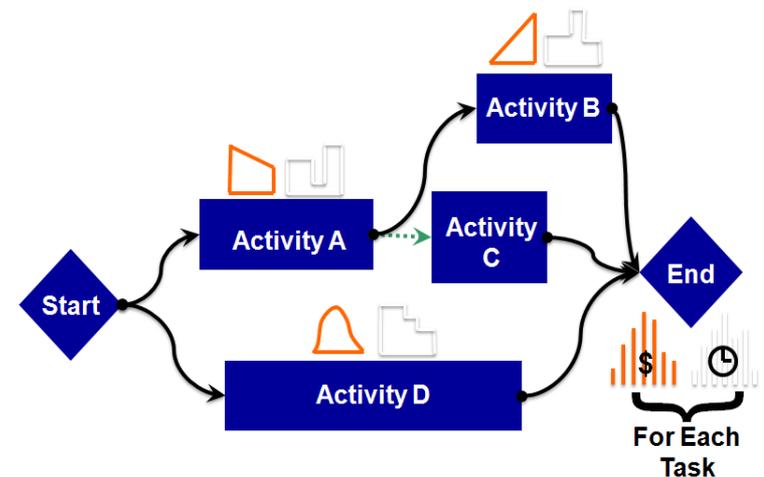
# Preparation Session Agenda

- ◆ Risk Analysis Process Overview
- ◆ Project Overview & Identify Risk Areas
- ◆ Develop Project Starter Risk List
- ◆ Create a flowchart of the project schedule
- ◆ Review Base Cost Estimate
- ◆ Assign tasks to the project team
- ◆ Set the agenda for the workshop

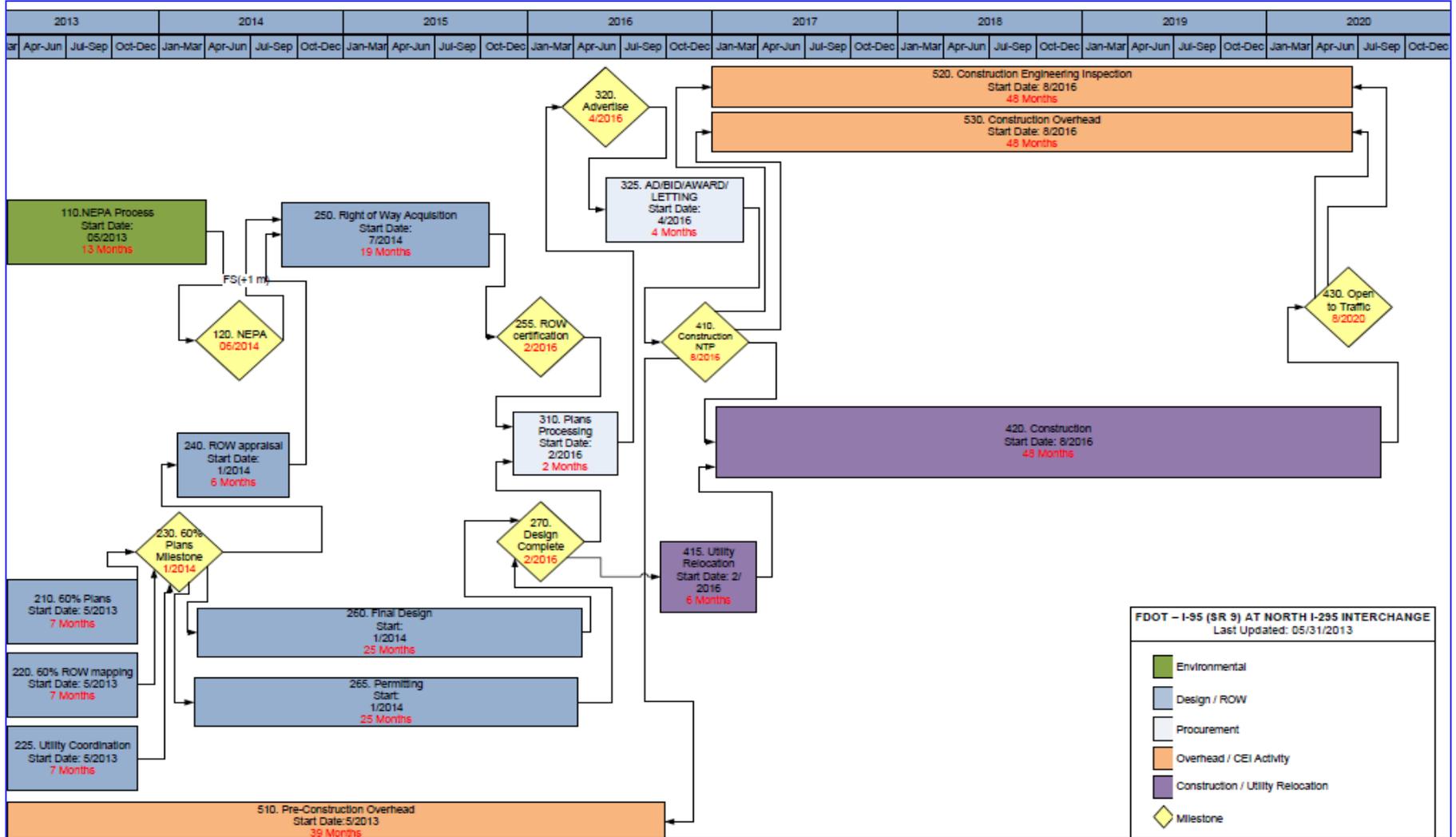


# Baseline for Risk Assessment

- ◆ Define purpose & need of project
- ◆ Establish scope of work
- ◆ Validate base cost estimate
- ◆ Develop project flowchart



# Project Schedule Review



# Base Cost Variability Review

## Common Terminology

### Base Costs

#### Base Cost Estimate:

The Base Cost represents the cost which can **reasonably be expected if the project materializes as planned**. Base Costs are initially estimated by the Project Team and reviewed and validated during the Risk Workshop by the Cost Team and Subject Matter Experts.

#### Base Cost Uncertainty:

An estimate of the error or tolerance within the quantity or unit price of an item. The level of uncertainty is directly related to its position in the project life cycle: the earlier in the project development process, the greater the uncertainty; the closer to completion, the less uncertainty.

Cost Category	Activity	Base	Low	High
Hard Costs	<b>DB Construction</b>	<b>\$229.08</b>	<b>-14%</b>	<b>7%</b>
	Lift Bridge Structural W/ Fenders	\$134.80	-14%	5%
	APPROACH SPANS - Substructure	\$9.46	-15%	5%
	APPROACH SPANS - Substructure	\$21.10	-11%	9%
	Lift Bridge Mechanical	\$24.59	-10%	10%
	Demolition	\$11.00	-20%	5%
	CIVIL - 25 percent Highway	\$5.02	-15%	5%
	Electrical	\$9.00	-10%	10%
	Architectural (Control Room/Machine Room)	\$6.22	-10%	10%
	Architectural Treatments	\$4.00	-10%	10%
	Architectural Lighting	\$0.81	-10%	10%
	Other (Hozmat, Water Control, Flexi-float,	\$1.56	-10%	10%
	Traffic Police Allotment	\$0.54	-5%	10%
	Misc. (Field Office & Equipment, Public Involvement, Maintenance & Operation, etc.)	\$1.01	-10%	10%
	Utility Relocation (Utility Estimate Cost)	\$0.00		
	Mobilization (3 percent)(Construction Items	\$6.87	-14%	7%
	DesignBuild Engineering (4 percent of CN \$)	\$9.44	-10%	10%
	Escrow Warranty (1.5 percent CN Costs)	\$3.54	-10%	10%
	Construction Inspection	\$2.00	0%	75%
	Construction QC	\$3.00	0%	75%
	<b>Total DB Contract (Hard Costs)</b>	<b>\$253.97</b>	<b>-13%</b>	<b>8%</b>
Soft Costs	Preliminary Engineering Design (RFP Development for Design-Build)	\$3.00	-10%	0%
	District Construction RE Services and Eng	\$1.30	0%	50%
	Owner's Rep	\$0.30	-10%	10%
	Construction Phase Services (2 percent)	\$5.08	-10%	10%
	<b>Total Engineering - non-DB (Soft Costs)</b>	<b>\$9.68</b>	<b>-9%</b>	<b>12%</b>
<b>Project Sub Total Project Costs</b>		<b>\$263.65</b>	<b>-13%</b>	<b>8%</b>

# *Workshop Details*



# Objectives of the Workshops

- ◆ Identify the project risk to account for uncertainty surrounding scope, cost and schedule;
- ◆ Assess the project risks by quantifying the affects on the cost and schedule:
  - ✓ Likelihood of occurrence
  - ✓ Impact
- ◆ Analyze the project risks through modeling to develop a baseline risk assessment.
- ◆ Produce a Risk Register for future monitoring of identified project risks.

# Project Team Roles

- ◆ Provide Project Information:
  - ✓ Project location maps, overheads, etc.
  - ✓ Project cost estimate and backup
  - ✓ Design and construction schedule or flow chart
  - ✓ Develop comprehensive list of risks, typically using starter risk list
  
- ◆ Workshop Support:
  - ✓ Provide input on risk identifying, quantification and mitigate
  - ✓ Provide information on project history and key decisions as these items come up in discussion

# Who Should Attend Workshop

- ◆ Project Manager
- ◆ External Subject Matter Experts
- ◆ Internal and External Stakeholders



- ◆ Disciplines
  - ✓ Construction
  - ✓ Bridge & Structures
  - ✓ Environmental
  - ✓ Right of Way
  - ✓ Geotechnical
  - ✓ Construction
  - ✓ Utilities
  - ✓ Local agencies
  - ✓ Others depending on project scope

# Workshop Approach

- ◆ Collaborative team approach
- ◆ 2 to 3 day structured workshop
- ◆ Identify & quantify threats and opportunities
- ◆ Identify risk management strategies



# Workshop

- ◆ Risk Lead presents a CRA process Overview
- ◆ Project Team presents the project
- ◆ Base cost presented to and validated by the group
- ◆ Base schedule presented to and validated by group

# Workshop

- ◆ Sessions by Functional Area
  - ✓ Identify Risks
  - ✓ Quantify Risks
  - ✓ Discuss possible Mitigation
- ◆ Build Consensus of various stakeholders
- ◆ Engage the Internal and External Subject Matter Experts
- ◆ Workshop Wrap-up

# Workshop

- ◆ Typical Functional Sessions
  - ✓ Structures/Geotechnical
  - ✓ Roadway Design
  - ✓ Drainage
  - ✓ Environmental
  - ✓ Right-of- Way
  - ✓ Utilities
  - ✓ Construction
  - ✓ Maintenance of Traffic
  - ✓ Management, Funding & Market Conditions



# Type of Risks

- ◆ **Budget Risks** (base cost uncertainty)

- *Risk that budget elements will deviate from the estimate.*

Examples: deviations in unit prices, deviations in quantities.

- ◆ **Event Risks**

- *Risk of internal or external events that force the project team to work beyond the estimate just to meet the Project Scope and SOW.*

Examples: Extreme weather, contractor non-performance.

- ◆ **Scope Risks**

- *Risk of significant changes to project scope due to external pressures.*

Examples: community pressures for changes in alignment.

# Risk Register: Risk Identification

Risk Register for I-4						Initial Risk Quantification												
Risk Information						Cost Risk Information (Millions \$)						Schedule Risk Information (Months)						
Record #	Risk ID	Risk Agenda Category	Activity Impacted	Risk Name	Description	Initial Probability of Occurrence (%)	Initial Low Cost	Initial Most Likely Cost	Initial High Cost	Initial P(L) Cost	Initial P(M) Cost	Initial P(H) Cost	Initial Low Schedule	Initial Most Likely Schedule	Initial High Schedule	Initial P(L) Schedule	Initial P(M) Schedule	Initial P(H) Schedule
1	DES 01	Design, Structures, and Geotech Risks	118	Add South Street Modification	Need mod to make plan work. Additional construction cost. Related ROW is being purchased separately. From URS estimate, \$93.4M plus ROW (which is already captured in the base ROW numbers). Includes related utility risk (FDOT is paying, so unlikely to significantly affect schedule).	100%	\$93.40	\$93.40	\$93.40				0	0	0			

## Risk Register for I-4

### Risk Information

Record #	Risk ID	Risk Agenda Category	Activity Impacted	Risk Name	Description
1	18	21	22	23	24
1	DES 01	Design, Structures, and Geotech Risks	118	Add South Street Modification	Need mod to make plan work. Additional construction cost. Related ROW is being purchased separately. From URS estimate, \$93.4M plus ROW (which is already captured in the base ROW numbers). Includes related utility risk (FDOT is paying, so unlikely to significantly affect schedule).

# Risk Register: Risk

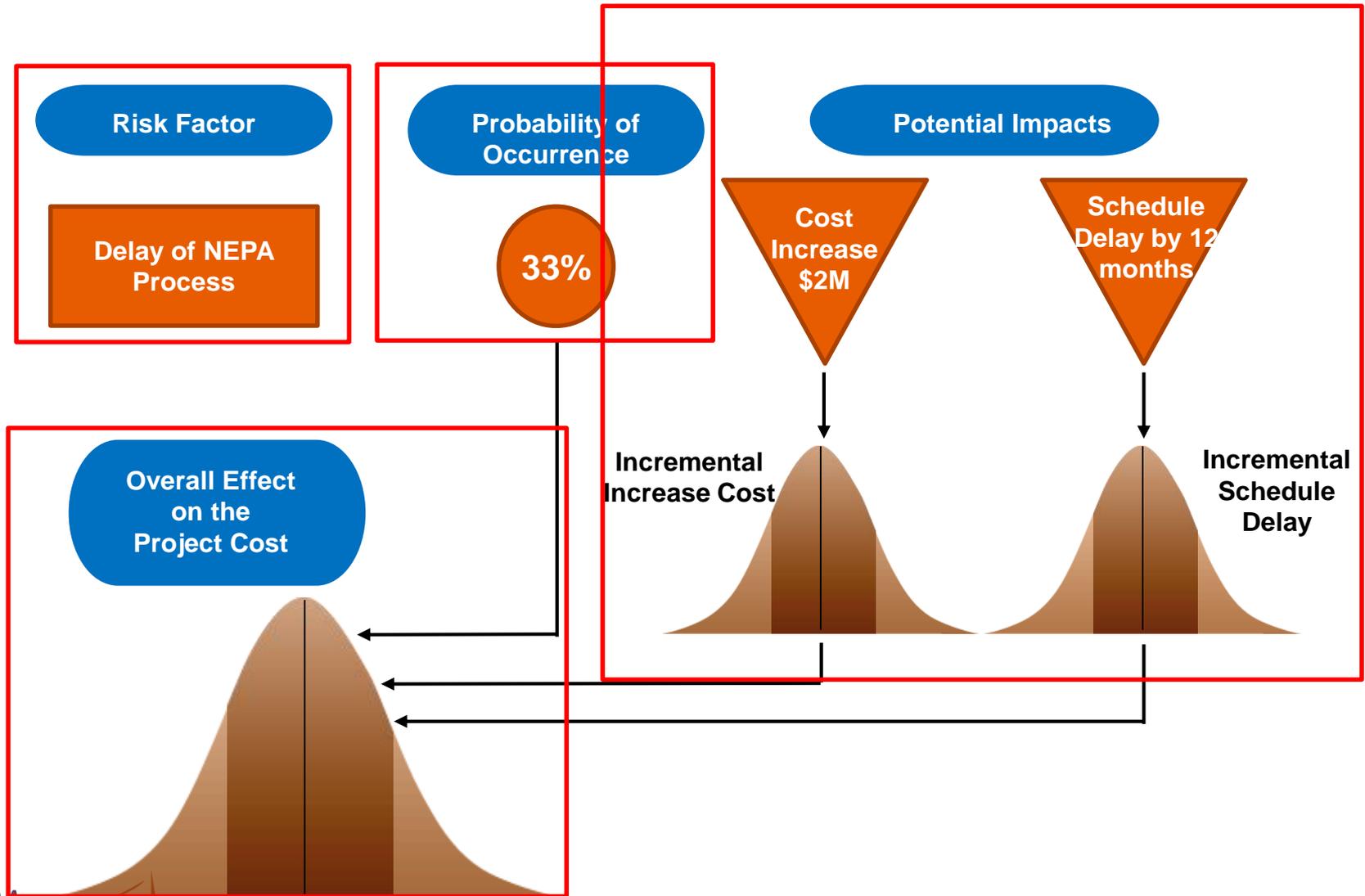
Risk Register for I-4						Initial Risk Quantification												
Risk Information						Cost Risk Information (Millions \$)			Schedule Risk Information (Months)									
Item #	RIS ID	Risk Agenda Category	Activity Impacted	Risk Name	Description	Initial Probability of Occurrence (%)	Initial Low Cost	Initial Most Likely Cost	Initial High Cost	Initial P(L) Cost	Initial P(M) Cost	Initial P(H) Cost	Initial Low Schedule	Initial Most Likely Schedule	Initial High Schedule	Initial P(L) Schedule	Initial P(M) Schedule	Initial P(H) Schedule
1	DES 01	Design, Structures, and Geotech Risks	118	Add South Street Modification	Need road to make plan work. Additional construction cost. Related ROW is being purchased separately. From URS estimate, \$93.4M plus ROW (which is already captured in the base ROW numbers). Includes related utility risk (FOOT is paying, so unlikely to significantly affect schedule).  Could require increased signing at "major" interchanges (e.g.,	100%	\$93.40	\$93.40	\$93.40				0	0	0			

Initial Risk Quantification												
Initial Probability of Occurrence (%)	Cost Risk Information (Millions \$)						Schedule Risk Information (Months)					
	Initial Low Cost	Initial Most Likely Cost	Initial High Cost	Initial P(L) Cost	Initial P(M) Cost	Initial P(H) Cost	Initial Low Schedule	Initial Most Likely Schedule	Initial High Schedule	Initial P(L) Schedule	Initial P(M) Schedule	Initial P(H) Schedule
29	30	31	32	34	35	36	38	39	40	42	43	44
100%	\$93.40	\$93.40	\$93.40				0	0	0			

12	PS-A	Design, Structures, and Geotech Risks	115, 116, 117, 118, 119 (Cost), 104 (Schedule)	Delay in obtaining agreements with local governments (A)	arena, Grand National overpass, South St/Anderson, which are captured separately). Delay in procurement to achieve agreement, and/or save costs if no agreement (down to 1% of construction costs). Potential (mutually exclusive) scenarios: A, as planned B, no agreement (save costs) and no delay C, delay in agreement D, delay and then no agreement (save costs)	85%	\$0.00	\$0.00	\$0.00				0	0	0			
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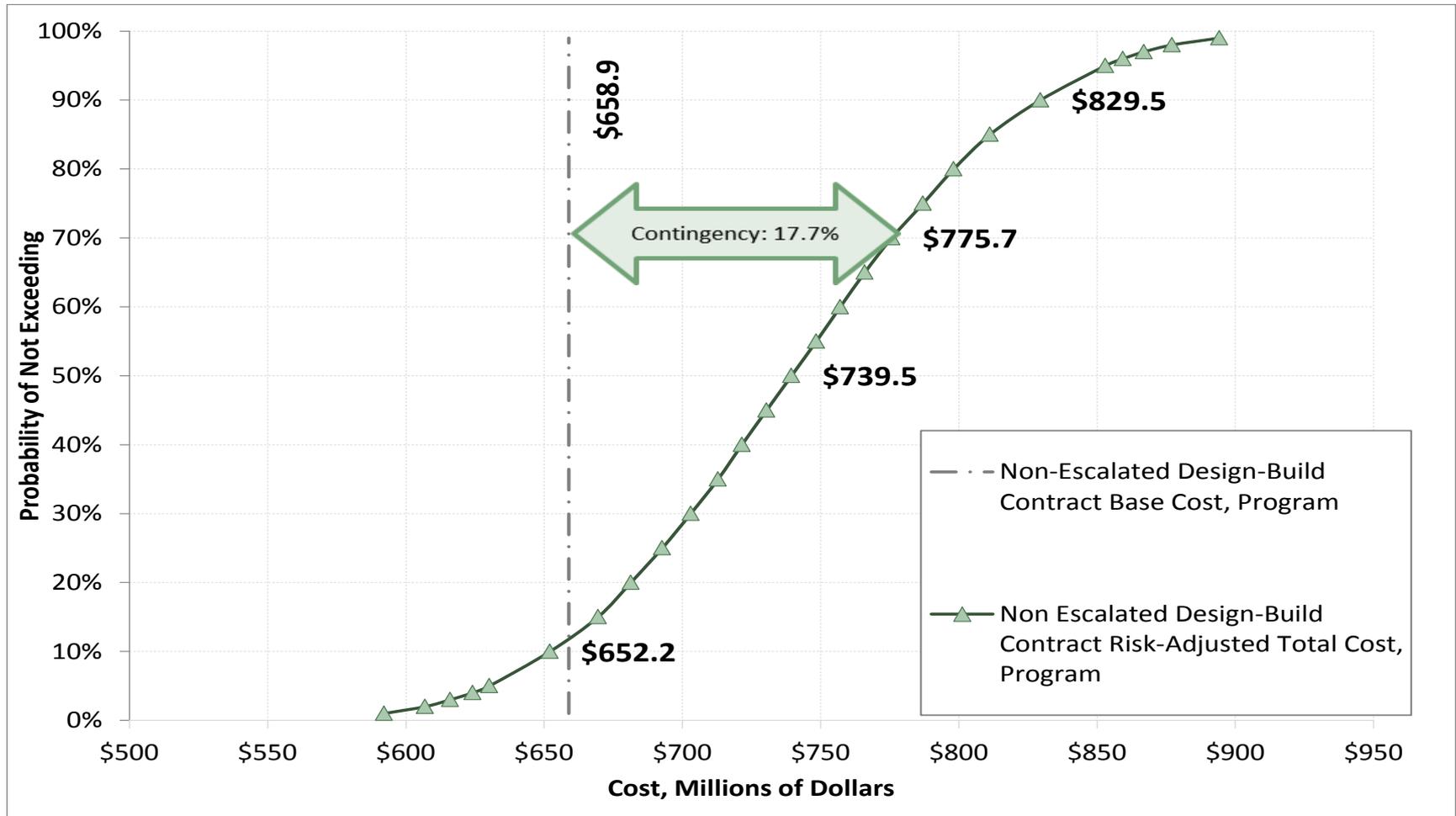
# Quantifying Individual Risks



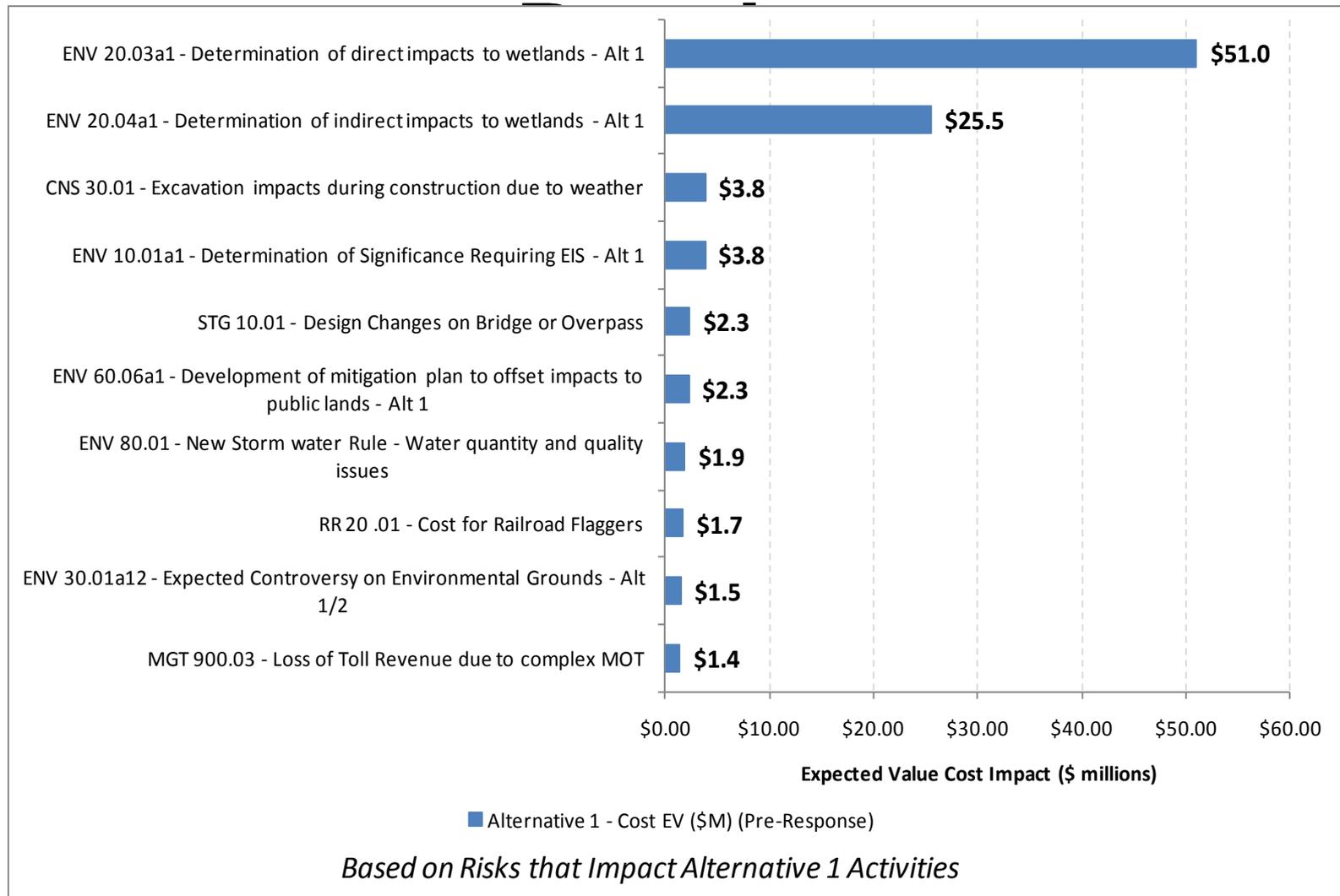
# Modeling and Presentation

- ◆ Preliminary results are generated and presented to project team for feedback & review.
- ◆ Results are finalized and presented to management
  - Risk based cost and schedule estimates
  - Ranking of key drivers of risks

# Baseline Risk Assessment Results



# Baseline Risk Assessment



# Workshop Deliverables

- ◆ Final report detailing the results of the workshop
- ◆ Final Risk Register for Project Manager to use managing the identified risks



# Applications of Risk Management



# Project Case Studies

## ◆ Sisters Creek Bridge Replacement



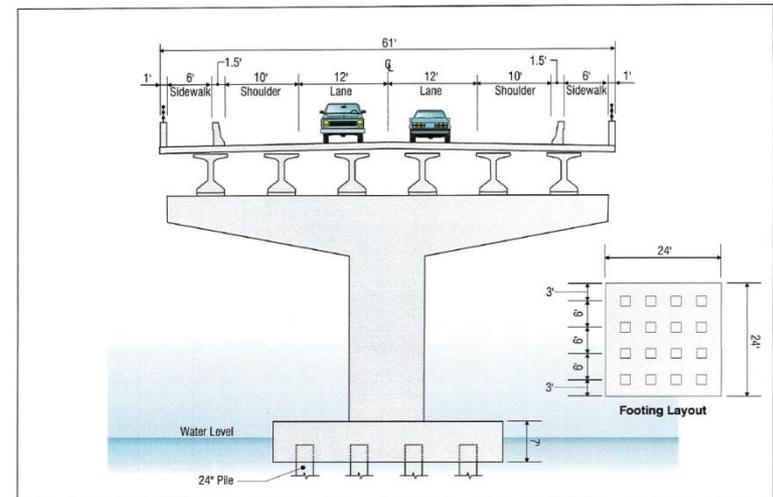
## ◆ I-95 Overland Bridge



# Sisters Creek Bridge Replacement

## ◆ Project Overview

- ✓ Located on SR 105, northeast of Jacksonville
- ✓ The proposed project will:
  - Replace a movable bridge with a fixed span, high level bridge
  - Be built offset to existing bridge, on a new alignment, and tie into existing roadway
  - Use existing FDOT right-of-way for new alignment



SR 105 Over Sisters Creek  
Duval County  
FP ID No. 209607 1 22 01  
Section No. 72250



PROPOSED BRIDGE TYPICAL SECTION

FIGURE  
8-3

# Sisters Creek Bridge Replacement

## ◆ Objectives

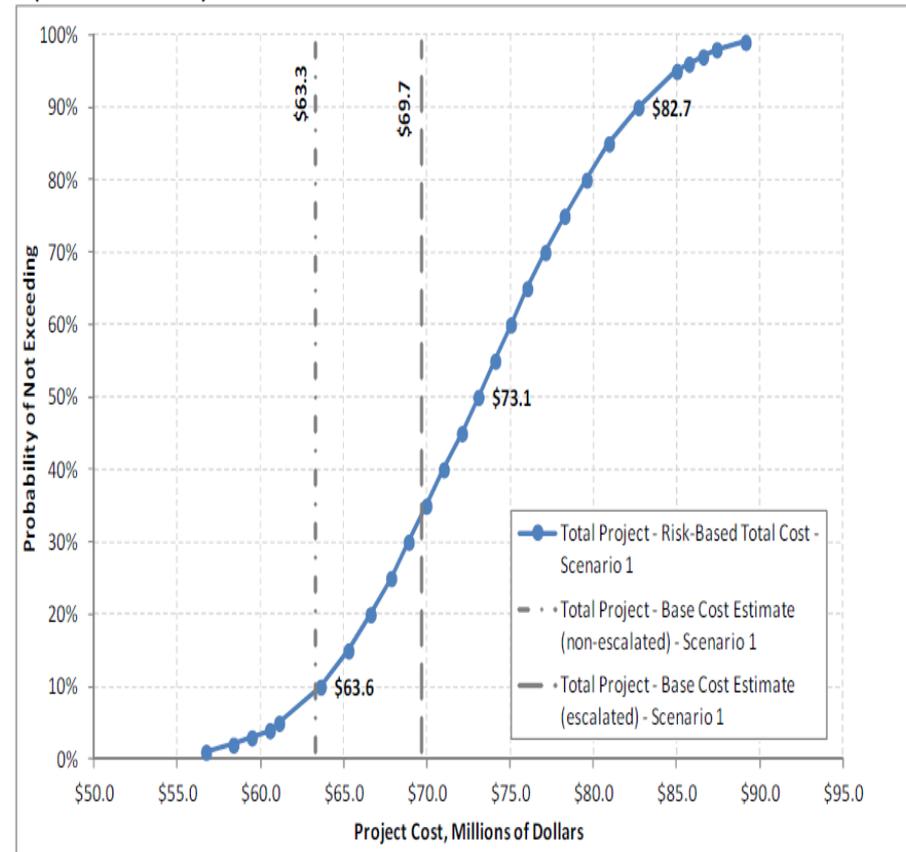
- ✓ Validated Cost Estimate
- ✓ Identify and quantify risks to project cost and schedule
- ✓ Assess likelihood of meeting aggressive delivery schedule
- ✓ Estimate implications of potential funding delay on project costs
- ✓ Identified and quantified critical cost items not listed in LRE
- ✓ Developed a risk management plan for project team
- ✓ Quantified cost of funding delay to inform FDOT management decision making

# Sisters Creek Bridge Replacement

## ◆ Cost Estimate

- ✓ Base Cost (inflated)  
= \$69.7M
- ✓ Risk-based Cost (70%)  
= \$77.0M
- ✓ Cost Range  
= \$63.6 M- \$82.7M

Figure 13: Escalated Risk-Adjusted Total Cost Probability Distribution – Scenario 1 (in YOE dollars)

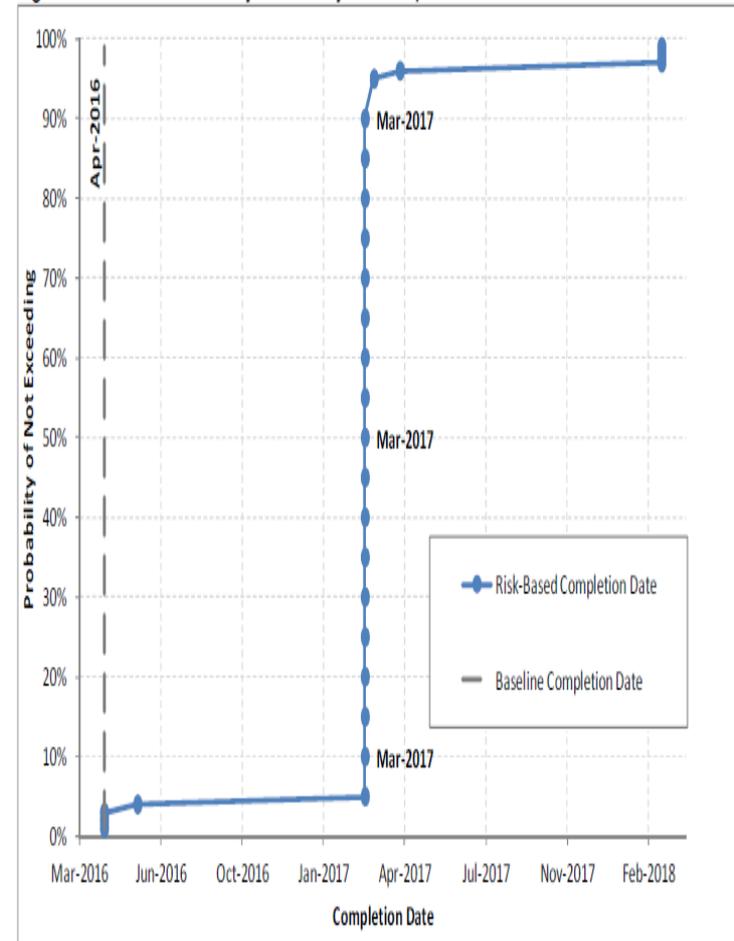


# Sisters Creek Bridge Replacement

## ◆ Schedule

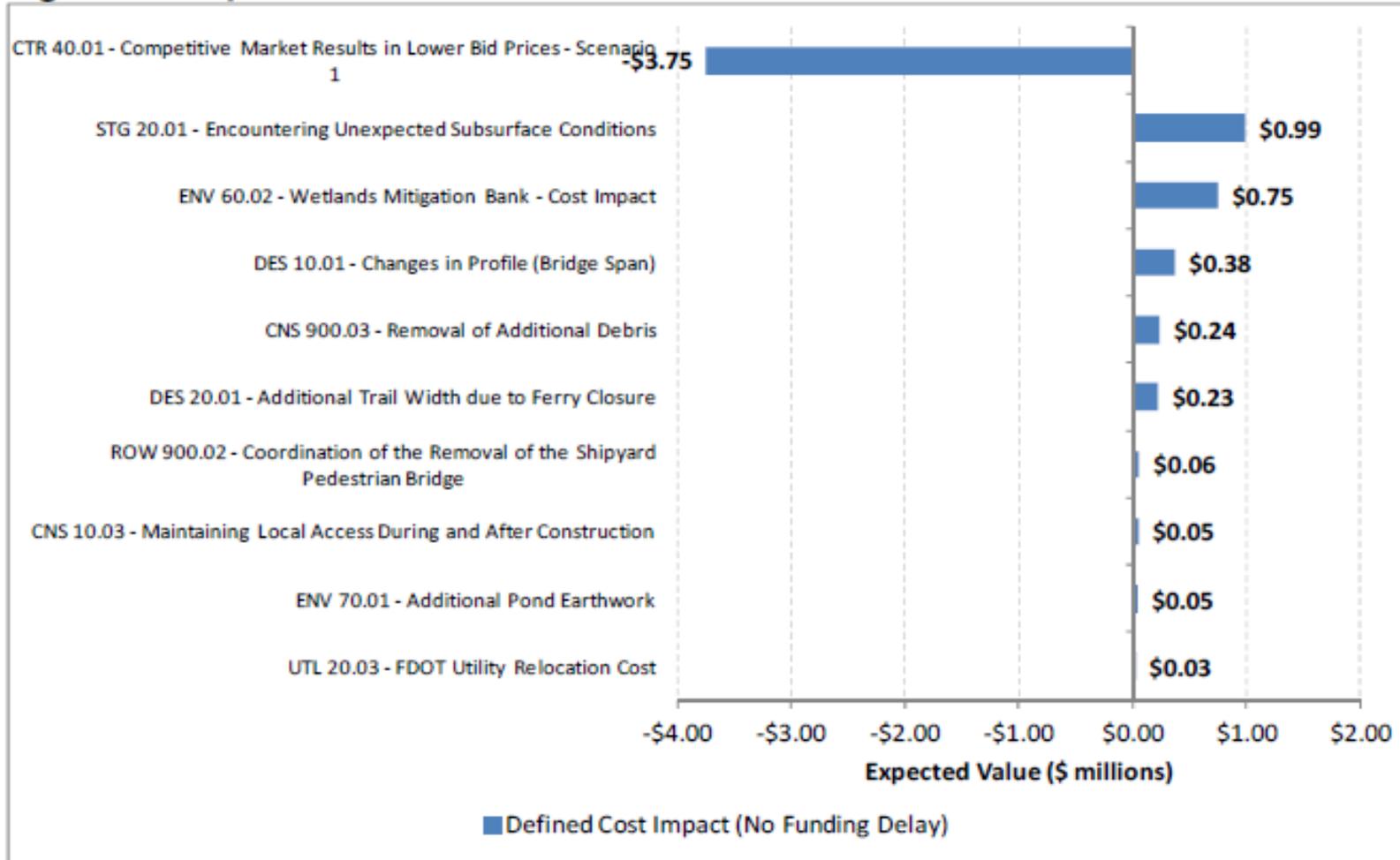
- ✓ Base Time  
= Apr 2016
- ✓ Risk-based Time (70%)  
= Mar 2017
- ✓ Time Range  
= Mar 2017 – Mar 2017

Figure 17: Overall Risk-Adjusted Project Completion Date – Scenario 1



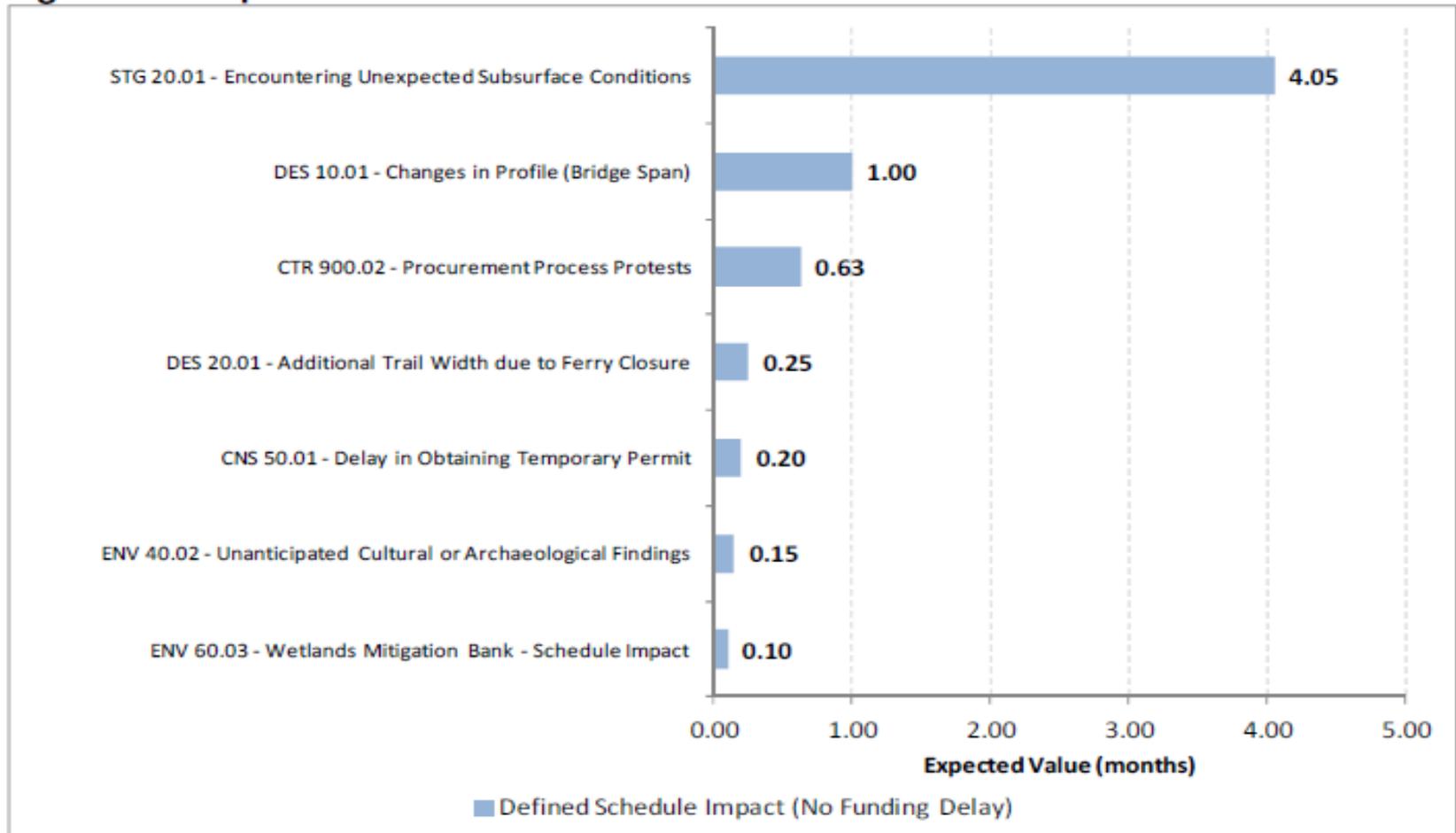
# Sisters Creek Bridge Replacement

Figure 9: Top Cost Risks – Scenario 1



# Sisters Creek Bridge Replacement

Figure 10: Top Schedule Risks – Scenario 1



# Sisters Creek Bridge Replacement

## ◆ Risk Mitigation

- ✓ Extensive Geotech Survey in RFP
- ✓ Bathymetric survey of river bottom debris & composition
- ✓ Maximum budget requirement

## ◆ Procurement Information

- ✓ Award Cost = \$44.2M (Dec 13)
- ✓ Bid Range = \$39.0M - \$45.9M
- ✓ Awarded Time = 800 days
- ✓ Completion Date = Apr 2016
- ✓ Time Range = 800-850 days

Figure 16: Non-Escalated Risk-Based Design-Build Contract Cost – Scenario 1 (in \$2012 dollars)

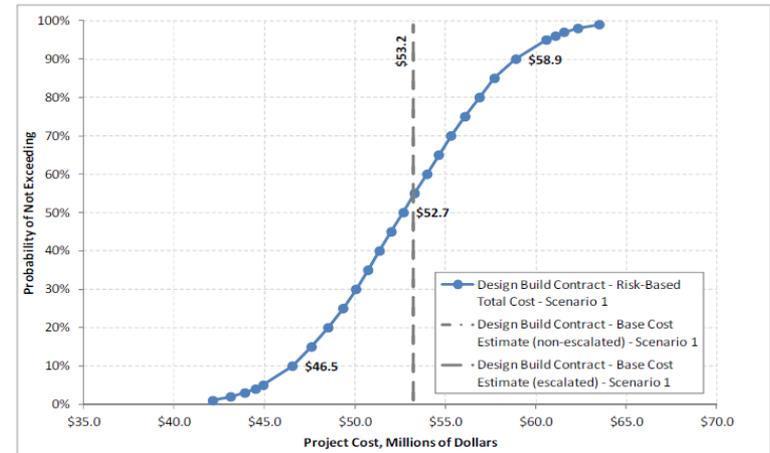
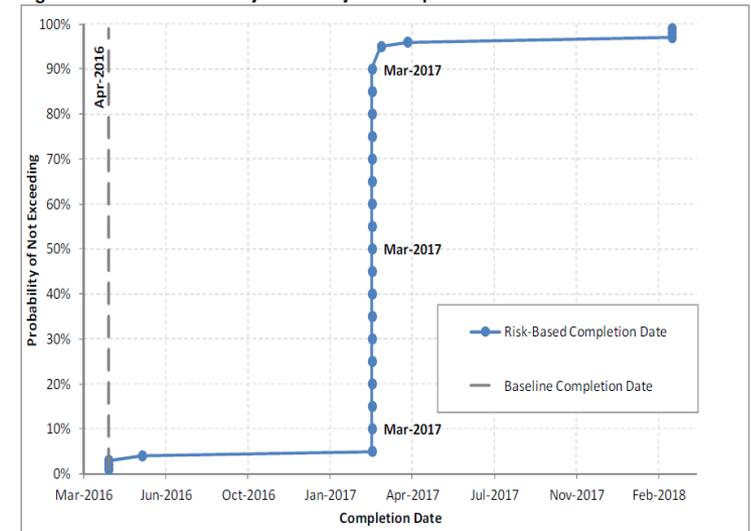


Figure 17: Overall Risk-Adjusted Project Completion Date – Scenario 1



# I-95 Overland Bridge

The proposed project will:

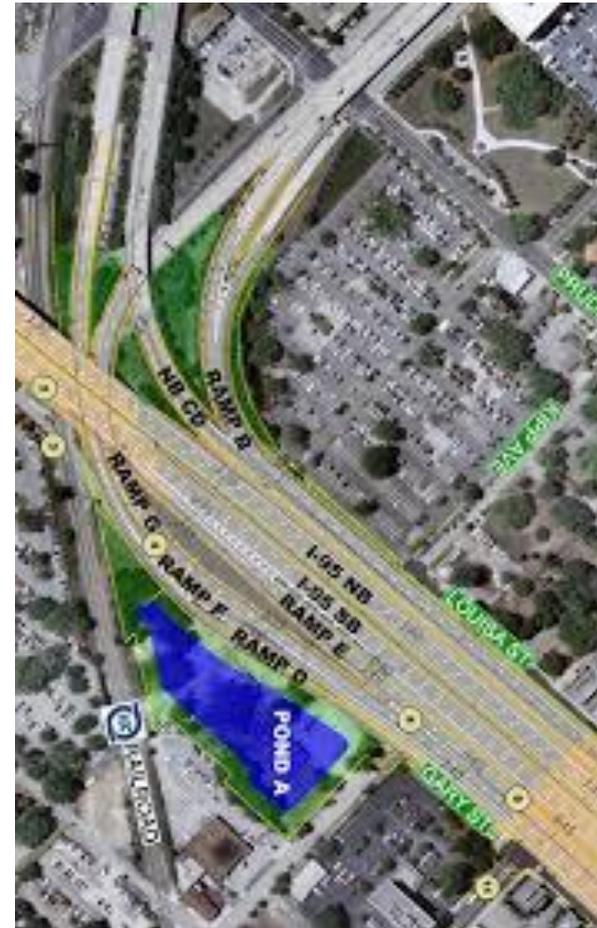
- ◆ Replace the single bridge with two shorter bridges and a fill section of MSE in between the two
- ◆ Widen southbound mainline of I-95 to create 3 continuous travel lanes to improve traffic flow and eliminate dangerous weaving.
- ◆ Modify and widen the southbound collector/distributor road
- ◆ Build a new northbound collector/distributor road  
Modify Atlantic Blvd and Philips Hwy areas for additional access points to I-95.



# I-95 Overland Bridge

## Summary of Key Findings

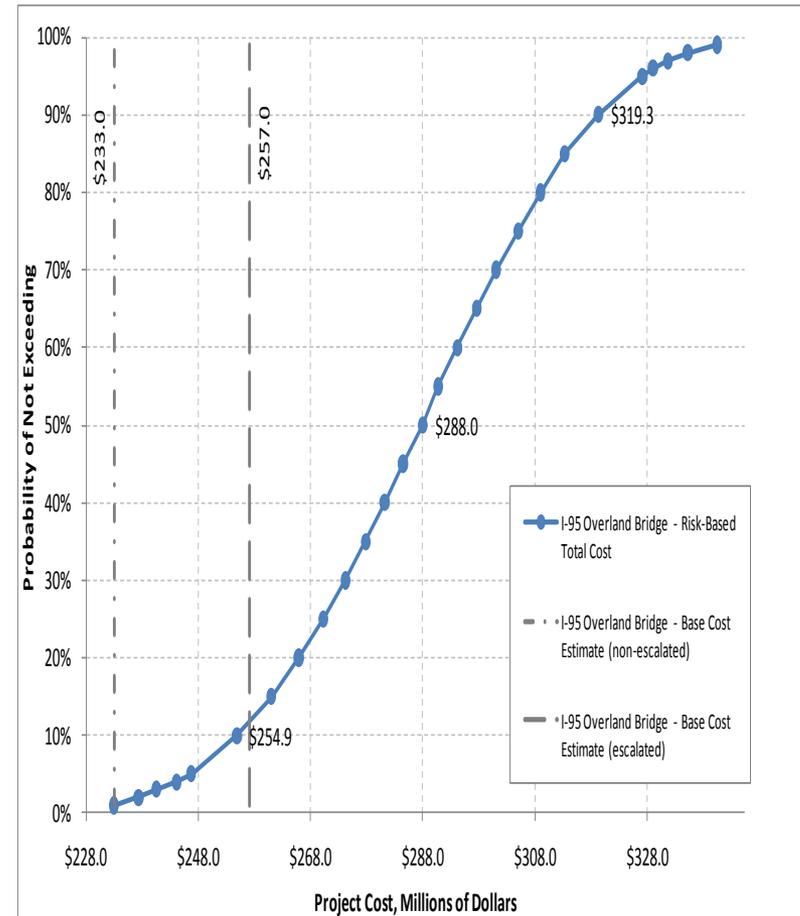
- ◆ Conducted risk assessment prior to RFP development
- ◆ Identified critical elements to include and specify within the RFP
- ◆ Identified need for railroad agreement in CRA workshop – critical element needed for a utility relocation
- ◆ Determined need for contractor to provide temporary drainage to assure that the project didn't cause any extra water runoff



# I-95 Overland Bridge

## ◆ Cost Estimate

- ✓ Base Cost (inflated)  
= \$257.0 million
- ✓ Risk-based Cost (70%)  
= \$254.9 million
- ✓ Cost Range  
= \$254.9-\$319.3 million

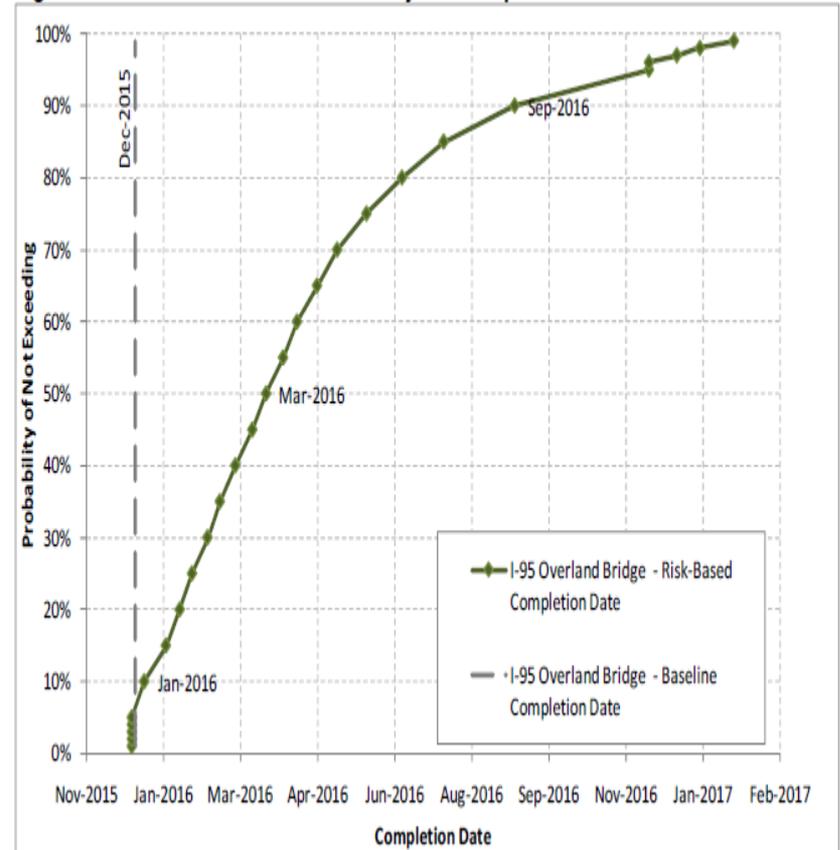


# I-95 Overland Bridge

## ◆ Schedule

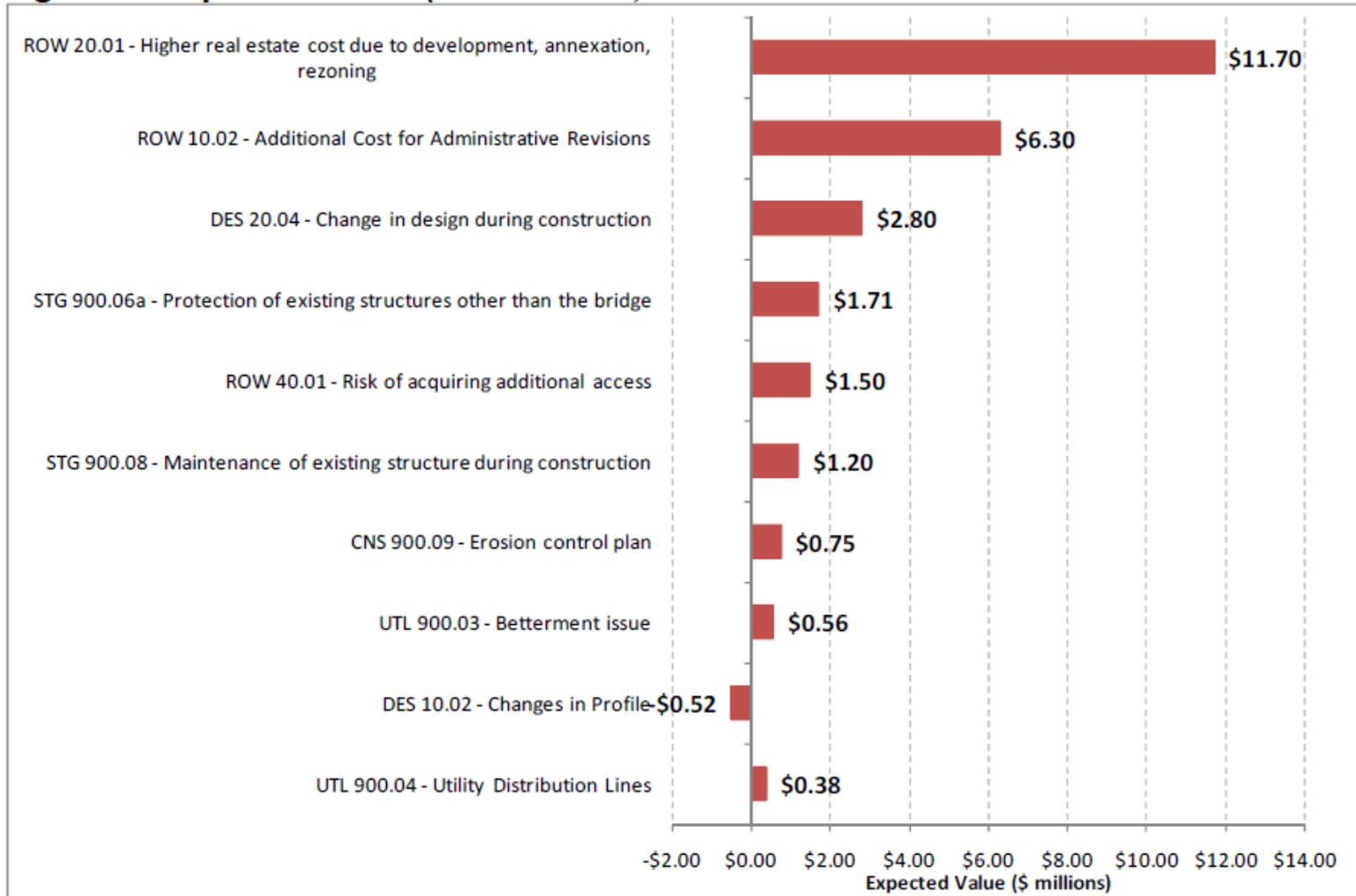
- ✓ Base Time  
= Dec 2015
- ✓ Risk-based Time (70%)  
= May 2016
- ✓ Time Range  
= Jan 2016 - Sep 2016

Figure ES-2: Risk-Based Overall Project Completion



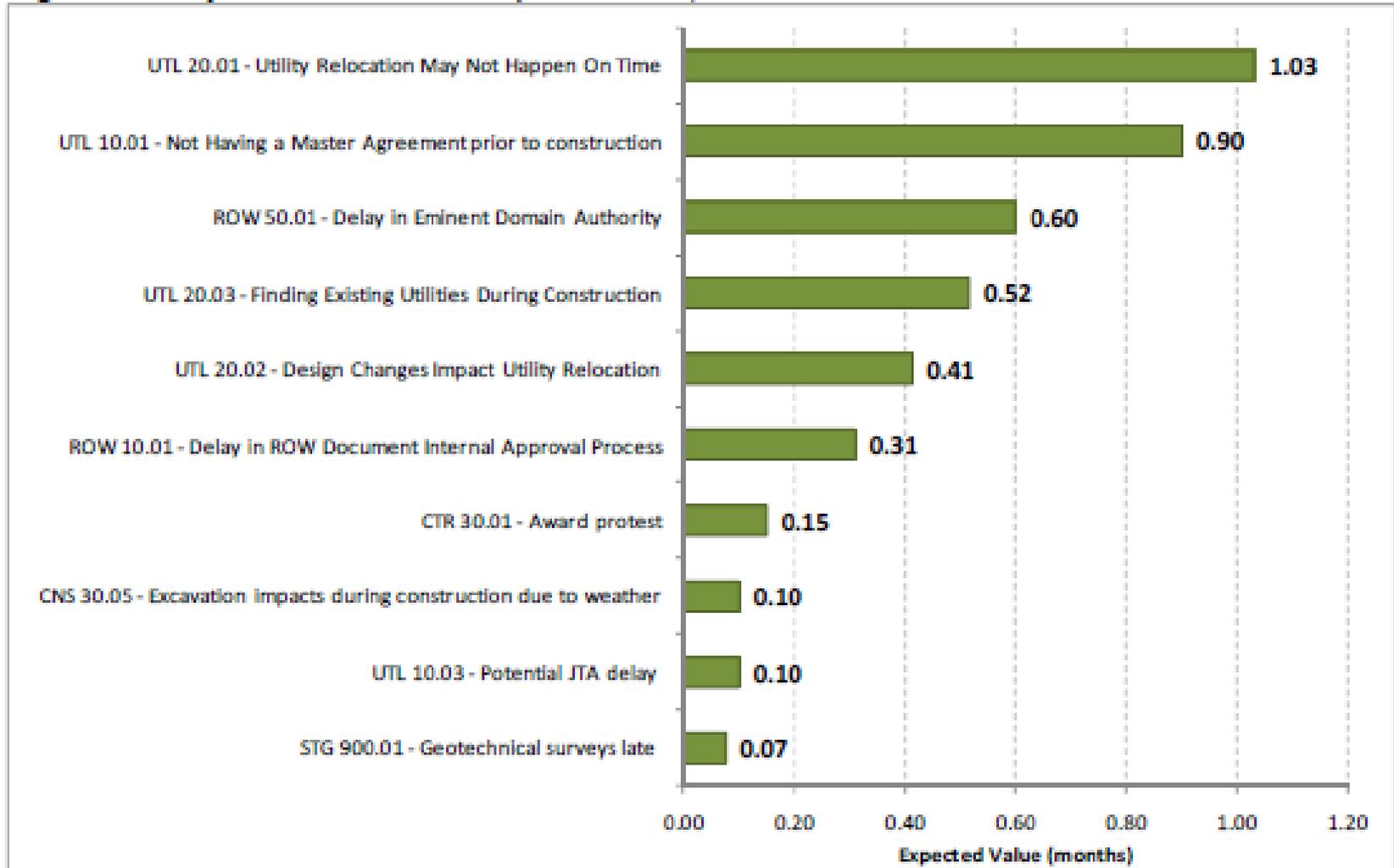
# I-95 Overland Bridge

Figure 4: Top Cost Risks (in \$ Millions)



# I-95 Overland Bridge

Figure 5: Top Schedule Risks (in Months)



# I-95 Overland Bridge

## ◆ Risk Mitigation

- ✓ RFP eliminated access areas
- ✓ VE Study on draft RFP
- ✓ Design Build Team proposed alternative alignment

## ◆ Procurement Information

- ✓ Award Cost = \$148.8M (May 2012)
- ✓ Bid Range = \$148.8M - \$156.7M
- ✓ Awarded Time = 1,165 days
- ✓ Completion Date = Oct 2015
- ✓ Time Range = 1,085-1,165 days

Figure 16: Non-Escalated Risk-Based Design-Build Contract Cost – Scenario 1 (in \$2012 dollars)

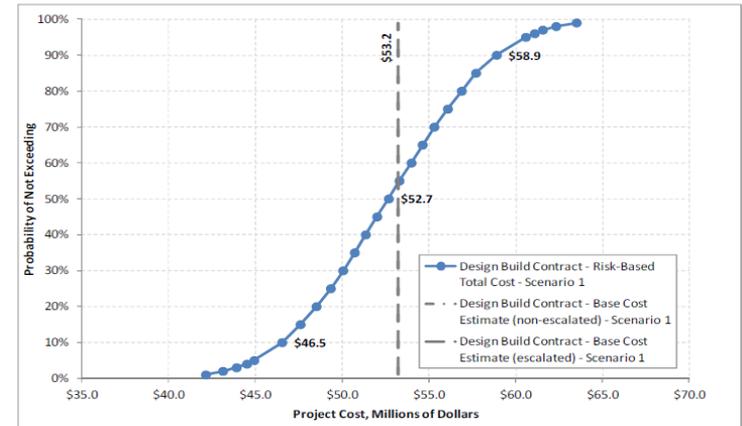
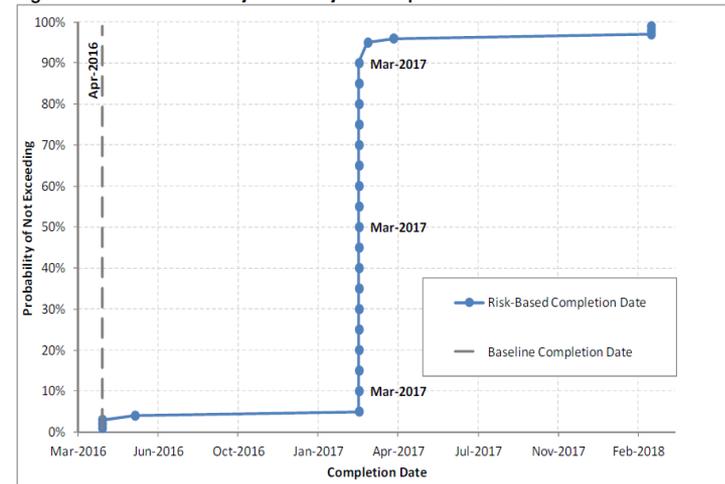


Figure 17: Overall Risk-Adjusted Project Completion Date – Scenario 1



# References

- ◆ Project Management Handbook Chapter 19

<http://www.dot.state.fl.us/projectmanagementoffice/PMHandbook/pmhandbookindex.shtm>

- ◆ Washington State Department of Transportation

<http://www.wsdot.wa.gov/Projects/ProjectMgmt/RiskAssessment/>

- ◆ FHWA Risk Assessment

<http://international.fhwa.dot.gov/riskassess/index.cfm>

[http://www.fhwa.dot.gov/ipd/project\\_delivery/resources/risk\\_management/](http://www.fhwa.dot.gov/ipd/project_delivery/resources/risk_management/)

# Thank You! / Questions?

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