APPENDIX Q-2

FHWA Cost Estimate Review Final Report

INDOT / KYTC

I-69 OHIO RIVER CROSSING

ORX 69 OHIO RIVER CROSSING

Henderson, KY – Evansville, IN

FHWA Cost Estimate Review
March 2021
Final Report

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EXECUTIVE SUMMARY

A review team consisting of the Federal Highway Administration (FHWA), the Indiana Department of Transportation (INDOT), the Kentucky Transportation Cabinet (KYTC) and their consultants conducted a Cost Estimate Review (CER) risk workshop to review the cost and schedule estimates for the I-69 Ohio River Crossing (ORX) project between the cities of Henderson, Kentucky and Evansville, Indiana. The CER workshop was held virtually on Microsoft Teams from March 23 through March 26, 2021, with the virtual arrangement related to the worldwide Coronavirus pandemic.

The object of the review was to verify the accuracy and reasonableness of the project estimate and schedule and to develop a probability range for the cost estimate that represents the project's current stage of development.

The project description as summarized from the Draft Environmental Impact Statement (DEIS) is the following: The project is part of the National I-69 Corridor that extends between Mexico and Canada, and the development of an interstate highway across the Ohio River that would connect the southern terminus of I-69 in Indiana with the northern terminus of I-69 in Kentucky. Currently, I-69 does not cross the Ohio River and the only cross-river access between Evansville and Henderson is via US 41, which is classified as a principal arterial and does not meet current interstate design standards.

The project area for the I-69 ORX DEIS extends from I-69 (formerly I-164) in Indiana on the south side of Evansville (i.e., northern terminus) across the Ohio River to I-69 at the KY 425 interchange southeast of Henderson, KY (i.e., southern terminus). The project has been divided into two sections that are planned as separate contracts, including:

- Section 1: from Southern Terminus at KY 425 Interchange to proposed US 60 Interchange (all in Kentucky). This section is currently funded
- Section 2: from proposed US 60 Interchange in Kentucky with new 4-lane Ohio River bridge to the Northern Terminus at the proposed Veterans Memorial Parkway Interchange in Indiana. This section is currently unfunded.

Graphics of the project sections are included in Chapter 2, Figures 1 and 2.

Prior to the CER workshop, the total project cost was estimated at $1,001 million in current year (CY) 2021 dollars and $1,175 million in Year of Expenditure (YOE) dollars with inflation. The overall project completion date was scheduled for June 1, 2032, with the Section 1 contract scheduled for completion on November 27, 2024.

The CER process confirms the base estimate and removes project contingencies from the base estimate includes removing project contingencies from the base estimate and replacing with cost and schedule risks identified, quantified, and then added to the estimate. Risks (both threats and opportunities) were added to this estimate and inflation rates were utilized to escalate costs to the midpoints of expenditure based on the projected schedule. Additionally, the base estimate Right-of-Way (ROW) acquisition costs were increased approximately $4 million, based on an updated cost estimate from the project at the CER.

Along with the risks identified, base variability and market conditions were added in the Monte Carlo simulation run for the Project. This simulation resulted in a 70% confidence level that this project will cost in the range of $1,253 million in Year of Expenditure (YOE) costs with a minimum of $1,029 million and maximum of $1,388 million. The 70% confidence level in YOE is typically identified in the project's Initial Financial Plan (IFP) to show that adequate funding is available to construct the project. This 70% YOE result is approximately 7% higher than the pre-CER YOE value of $1,175 million, primarily a result of some high cost and schedule risks for Section 2 such as concern with the cost of access to construct the new bridges, the costs of meeting seismic requirements for the bridges, and the potential for excessive flooding of the river that could impact construction. The review team also had a concern with potentially high market conditions for Section 2. The model resulted, with 70% confidence, with a potential project completion date of December 9, 2032, approximately 6.5 months later than the Pre-CER schedule of June 1, 2032. The breakdown of these results into Section is in Table 1.

#	Description	$ in Millions (*) Pre-CER Estimate (YOE)	$ in Millions (*) CER 70% Result (YOE) **	% Cost Delta	Pre-CER Project Scheduled Completion Date	CER 70% Completion Date	Sch. Delta (mos.)
1	Section 1	$254.1	$259.5	+2%	Nov. 27, 2024	Sep. 14, 2025	10.5
2	Section 2	$920.4	$997.3	+8%	June 1, 2032	Dec. 9, 2032	6.5
	Total Project	**$1,174.5**	**$1,252.6**	**+7%**	**June 1, 2032**	**Dec. 9, 2032**	**6.5**

Notes (*) The result values include approximately $21 million in prior and fixed costs with Section 1
(**) 70% Results do not add due to the Monte Carlo simulation process

Table 1: Total Project Cost and Schedule Summary ($ in Millions)

These estimates and resulting CER are a snapshot in time that corresponds with the current level of project development. As project development advances, such as design criteria refinement,

final design, procurement activities, and future funding and scheduling decisions, this estimate will likely change. The IFP should be prepared to reflect this validated cost estimate and future updates should detail any changes in the project estimate.

The Workshop observations are as follows:

- The Project Team and SMEs have an excellent grasp of the project's scope and schedule, and the estimates are sufficiently developed based on the current level of design, including geological and hydrologic challenges of the project, to conduct a good workshop.
- At the CER, there was good and open discussion by all parties while reviewing the risk register to determine risk attributes
- Project Personnel, INDOT and KYTC have a good understanding of potential mitigation activities that could reduce risk and are actively thinking of more.
- SME participation was critical to the success of the CER workshop.
- The Project Team brought forth additional risks during the course of the review that were instrumental in the review's outcome.

The following recommendations are provided based on this Workshop:

- Update the project estimate, schedule and risk register to reflect adjustments made during the review.
- Continue to evaluate and maintain the risk register for opportunities to reduce or mitigate risk such as advancing ROW acquisition, and to allocate risk in the future design build contracts.
- A second CER may be advisable and/or necessary to inform future FPAs when funding becomes available for Section 2.
  - Reduction of risk uncertainty will affect forecast values
  - Capture changes in market conditions, pricing and industry capacity and accurately reflect those in future dollars.
- Use a cost forecast range based on the CER's 70% confidence level in the pending FEIS/ROD to inform the public of the cost uncertainty based on the complexity and design development.
- Use the CER 70% YOE amount in setting the project's baseline cost in the IFP. If significant cost changes occur prior to the IFP submittal, they can be accounted for as adjustments to the CER 70% YOE amount in establishing the baseline cost in the IFP.
  - Changes between the CER Final Report and the IFP must be documented in the IFP.
- The CER 70% schedule completion forecast date should be used when setting the project's baseline completion date in the IFP.
  - Additional information is also found in FHWA's guidance on Estimating Schedule for FHWA Major Projects: https://fhwatest.fhwa.dot.gov/majorprojects/schedule_estimating/

CHAPTER 1 – REVIEW PROCESS

A review team consisting of the Federal Highway Administration (FHWA), the Indiana Department of Transportation (INDOT), the Kentucky Transportation Cabinet (KYTC) and their consultants conducted a Cost Estimate Review (CER) risk workshop to review the cost and schedule estimates for the I-69 Ohio River Crossing (ORX) project between the cities of Henderson, Kentucky and Evansville, Indiana. CER workshops are usually held in person to facilitate collaboration, however because of the worldwide Coronavirus pandemic, this CER was held virtually on Microsoft Teams from March 23 through March 26, 2021

The purpose of this chapter is to provide a general overview of the CER process. This chapter includes a discussion of the review objective, team, documentation provided and methodology.

REVIEW OBJECTIVE

The objective of the CER was to conduct an unbiased risk-based review to verify the accuracy and reasonableness of the current total cost estimate to complete the Project and to develop a probability range for the cost estimate that represents the current stage of Project design. The review team also reviewed the proposed Project schedule to determine potential schedule impact on the Project cost.

BASIS OF REVIEW

The Moving Ahead for Progress in the 21st Century Act (MAP-21) required the financial plan for all Federal-aid projects with an estimated total cost of $500 million or more to be approved by the U.S. Department of Transportation Secretary (i.e. FHWA) based on reasonable assumptions. This requirement has remained in place with the current Fixing America's Surface Transportation (FAST) Act. The $500 million threshold includes all project costs, such as engineering, construction, ROW, utilities, construction engineering, and inflation. The FHWA has interpreted 'reasonable assumptions' to be a probabilistic risk-based analysis. The cost estimate review provides this risk-based assessment and is used in the approval of the financial plan. This is an independent review but does not use an independent FHWA estimate. The review team used an estimate provided by the INDOT / KYTC consultant project team.

REVIEW TEAM

The review team was selected with the intent of having individuals with a strong knowledge of the Project and/or of Major Project work and expertise in specific disciplines of the Project. This team participated together throughout the workshop, and individuals with specific Project expertise briefed the review team on portions of the Project or estimate development processes.

The review team also discussed the development of the Project cost estimate quantities, unit prices, assumptions, opportunities, and threats. Lists of those who attended each session of the workshop are provided in the Appendices.

The review team was comprised of members of the following organizations:

- FHWA
  - Division Offices – IN and KY
  - CER Cadre Team- FHWA HQ
- INDOT / KYTC representatives
- Consultants

- Also attending as observers: FHWA Volpe staff

DOCUMENTS REVIEWED

Documents provided by the INDOT / KYTC team and their consultant team for review prior to and during the workshop included:

- Project Cost Estimate
- Project Schedule
- Draft Risk Register
- Project website, including the Draft Environmental Impact Statement (DEIS)

METHODOLOGY

The methodology for this cost estimate review is outlined as follows:

- Verify accuracy of cost estimate
  - Understand project scope and cost estimate development process
  - Discuss assumptions for contingencies and projected inflation rates
  - Review major cost elements
  - Identify threats and opportunities (Risks)
- Model uncertainties
  - Establish base estimate variability
  - Model variation of inflation
  - Determine probability of occurrence and schedule and cost impacts for significant project threats and opportunities
  - Model anticipated market conditions at the time of procurement
- Perform Monte Carlo simulation to model variability and risks and generate likely range of project cost and schedule
- Communicate results

- Report methodology and results in a close-out presentation
- Document review in a final report that will be used to inform the public and develop the Initial Financial Plan (IFP)

The following discussion provides more detail about the concepts utilized during the review.

Verify Accuracy of Cost Estimate

The review team was provided an overview of the estimation process used to develop the project's estimate. This overview included a discussion on the scope of the project, stage of design, and assumptions used to develop the estimate. The review team interviewed the project team and discussed the accuracy of each major cost element.

Model Uncertainties

In general, uncertainties in the estimate can be described as those relating to base variability, market conditions, and cost and schedule risk events. Each of these are discussed and modeled to reflect the total uncertainty.

Base variability is a measure of uncertainty applied to the base estimate that represents the inherent randomness associated with the estimating process. Base variability is a function of the project's current level of design and the process used to develop the estimate. This may be demonstrated by the fact that two estimators using the same data source and following the same general estimate development guidance will generate different estimates. Additionally, the lack of details about the project and assumptions that should be used to develop the estimate would cause more uncertainty and variability in the estimate. This base variation is a function of the system (i.e. assumptions and data sources used to define the estimate). Base variability is applied to the base estimate exclusive of risks. Contingencies that include risks are removed from the base estimate to avoid double counting risks identified in the risk register. Allowances and expected construction change order costs typically remain in the base estimate.

Market conditions at the time of advertisement are modeled to reflect the future competitive bidding environment. Three scenarios are evaluated including worse than planned, as planned, and better than planned. Each scenario is assigned a likelihood of occurrence and range of associated costs. In addition to market conditions, inflationary risk is also modeled and used to project current year dollars to year of expenditure.

A risk register was developed by interviewing the project team and its consultants and then used to define the components of contingency and establish both cost and schedule risks. The risk register includes the event risk name, a description of the event, a probability measure of the

likelihood the event will occur, as well as a probability distribution of costs if the event were to occur. The register also identifies if the risk event is a threat or opportunity for cost/schedule. Risk threats increase costs/schedule and opportunities decrease cost/schedule. A very important feature of the risk register is to establish the relationship of risk events. For example, some risks are mutually inclusive or mutually exclusive. Mutually inclusive means the risk event can only occur if the prior risk event occurs. Conversely, for a risk event to be mutually exclusive means that it can only occur if the prior risk event does not occur. Risk events can also be independent in which case the probability of occurrence is not dependent on any other risk event. Correlation determines how one risk event will sample relative to another risk event. Correlation should only be established when there is reason to suspect that a relationship exists and needs to be accounted for in the simulation.

After models are developed for market conditions, base variability, and risk events, the review team utilized a Monte Carlo simulation to generate a probability-based estimate of YOE Total Project Costs. A simulation is essentially a rigorous extension of a "what-if" statement, or sensitivity analysis, which uses randomly selected sets of values from the probability distributions representing uncertainty to calculate separate and discrete results. A single iteration within a simulation is the process of sampling from all input distributions and performing a single calculation to produce a deterministic result. It is important that each iteration represent a scenario, or outcome, that is logically possible. It is for this reason that the simulation outcomes be reviewed to ensure accuracy. The process of sampling from a probability distribution is repeated until the specified number of computer iterations is completed or until the simulation process converges. Simulation convergence is that point at which additional iterations do not significantly change the shape of the output distribution. The results of the simulation are arrayed in the form of a distribution covering all possible outcomes. The key benefit of this process is that probability is associated with costs.

Communicate Results

The last part of the review is to communicate the review results by providing a closeout presentation and final report. At the end of the review the review team provides a closeout presentation that summarizes the review findings. The presentation identifies the review objectives and agenda, discusses the methodology, and highlights the results of the review including the pre/post workshop estimate results and any estimate adjustments made during the review. The closeout presentation also identifies any significant cost and schedule risks and provides a brief overview of recommendations by the review team. The close-out presentation for this review was held on March 26, 2021 and is included in the Appendices of this report.

The estimate review is a snapshot in time, and as additional information becomes available, it is expected that the estimate will change and be updated. Following the review if errors or omissions are identified and confirmed with the project sponsor these modifications will be incorporated into the final report. The final report communicates all findings of the review to the project sponsor and Division and serves as the official document for the cost estimate review. Cost estimate review reports are maintained by the FHWA Office of Stewardship, Oversight and Management's Major Project's Team.

CHAPTER 2– REVIEW SUMMARY

PROJECT BACKGROUND & SCOPE

The project description as summarized from the Draft Environmental Impact Statement (DEIS) is the following: The project is part of the National I-69 Corridor that extends between Mexico and Canada, and the development of an interstate highway across the Ohio River that would connect the southern terminus of I-69 in Indiana with the northern terminus of I-69 in Kentucky. Currently, I-69 does not cross the Ohio River and the only cross-river access between Evansville and Henderson is via US 41, which is classified as a principal arterial and does not meet current interstate design standards.

The project area for the I-69 ORX DEIS extends from I-69 (formerly I-164) in Indiana on the south side of Evansville (i.e., northern terminus) across the Ohio River to I-69 at the KY 425 interchange southeast of Henderson, KY (i.e., southern terminus). The project has been divided into two sections that are planned as separate contracts, with limits in Figures 1 and 2:

Figure 1: Section 1 from KY 425 to US 60 Interchange

Figure 2: Section 2 from US 60 Interchange (KY) to Veterans Memorial Parkway Interchange (IN)

ENVIRONMENTAL PROCESS

The Draft Environmental Impact Statement (DEIS) for the project is in the review stage, and it is anticipated that the process can be completed for a Final Environmental Impact Statement (FEIS) by early Fall of 2021.

PROJECT PROCUREMENT

Section 1 of the project is being procured using a design-build (DB) delivery method. The procurement is currently on track to begin in April 2021 and a scheduled start of the DB contract in late 2021.

PROJECT SCHEDULE

Table 2 shows the dates that were utilized in the workshop and the model.

Section	Phase	Start	End
Section 1 - KY interchanges and south end	Mitigation	1/1/2022	12/31/2024
	Preliminary Engineering	4/15/2021	7/7/2021
	Procurement	4/1/2021	12/27/2021
	Construction	12/27/2021	11/27/2024
	Right-of-Way & Utilities	4/1/2021	12/31/2022
Section 2 - Ohio River Bridge and Approaches	Mitigation	1/1/2025	12/31/2031
	Preliminary Engineering	5/15/2025	5/13/2026
	Procurement	5/15/2025	12/31/2026
	Construction	1/1/2027	6/1/2032
	Right-of-Way & Utilities	1/1/2025	12/31/2030

Table 2 - Project Schedule

Note that the project team is focused on completing the Section 1 procurement phase in 2021 and having that Design-Build contract completed by the end of 2024, and then beginning the Section 2 contract procurement in 2025.

COST ESTIMATE

Prior to the CER workshop, the project cost was estimated at $1,001.5 million in current year (CY) dollars. An estimate update during the CER increased the Section 1 Right-of-Way cost estimate by $3.6 million from $16.9 million to $20.5 million, increasing the project CY cost to $1,005.1 million as shown in Table 3.

Section	Phase	Cost Estimate in Millions CY $	Totals by Section ($ in Millions)
Section 1 - KY interchanges and south end	Mitigation	$0.9	**$221.9**
	Preliminary Engineering	$3.1	
	Procurement	$1.5	
	Construction	$195.9	
	Right-of-Way & Utilities	$20.5	
Section 2 - Ohio River Bridge and Approaches	Mitigation	$1.8	**$760.4**
	Preliminary Engineering	$12.2	
	Procurement	$9.2	
	Construction	$697.2	
	Right-of-Way & Utilities	$40.0	
Subtotal		**$982.3**	**$982.3**
Prior and Fixed Costs		$22.8	$22.8
Total		**$1,005.1**	**$1,005.1**

Table 3 - Project Costs (Current Year)

The CY cost estimate included $22.8 million of prior and fixed costs that were all included in the Section 1 portion of the estimate in the CER results. The pre-workshop estimate with inflation was $1,174.5 million, that is used in comparison in the report to the CER results. The CER model excluded contingencies from the CY estimate before applying base variation, market conditions, risk and inflation.

REVIEW FINDINGS / OBSERVATIONS

The Workshop observations are as follows:

- The Project Team and SMEs have an excellent grasp of the project's scope and schedule, and the estimates are sufficiently developed based on the current level of design, including geological and hydrologic challenges of the project, to conduct a good workshop.
- At the CER, there was good and open discussion by all parties while reviewing the risk register to determine risk attributes
- Project Personnel, INDOT and KYTC have a good understanding of potential mitigation activities that could reduce risk and are actively thinking of more.
- SME participation was critical to the success of the CER workshop.
- The Project Team brought forth additional risks during the course of the review that were instrumental in the review's outcome.

REVIEW RECOMMENDATIONS

The following recommendations are provided based on this Workshop:

- Update the project estimate, schedule and risk register to reflect adjustments made during the review.
- Continue to evaluate and maintain the risk register for opportunities to reduce or mitigate risk such as advancing ROW acquisition, and to allocate risk in the future design build contracts.
- A second CER may be advisable and/or necessary to inform future FPAs when funding becomes available for Section 2.
- Reduction of risk uncertainty will affect forecast values
- Capture changes in market conditions, pricing and industry capacity and accurately reflect those in future dollars.
- Use a cost forecast range based on the CER's 70% confidence level in the pending FEIS/ROD to inform the public of the cost uncertainty based on the complexity and design development.
- Use the CER 70% YOE amount in setting the project's baseline cost in the IFP. If significant cost changes occur prior to the IFP submittal, they can be accounted for as adjustments to the CER 70% YOE amount in establishing the baseline cost in the IFP.
- Changes between the CER Final Report and the IFP must be documented in the IFP.
- The CER 70% schedule completion forecast date should be used when setting the project's baseline completion date in the IFP.

- Additional information is also found in FHWA's guidance on Estimating Schedule for FHWA Major Projects: https://fhwatest.fhwa.dot.gov/majorprojects/schedule_estimating/

CHAPTER 3 – RISK ANALYSIS

Cost estimates, especially those for Major Projects, contain a degree of uncertainty due to unknowns and risks associated with the level of detail design completed. For this reason, it is logical to use a probabilistic approach and express the estimate as a range rather than a point value. During the CER, uncertainties in the project estimate such as base variability, inflation, market conditions, and risk events were modeled by the review team to reflect the opinions of the subject matter experts interviewed. Then a Monte-Carlo simulation was used to incorporate the uncertainties into forecast curves that represent a range of costs and completion dates for the Project.

FORECAST RESULTS FOR TOTAL PROJECT COSTS

Figure 3 depicts the Monte Carlo simulation forecast curve for the Total Project Cost in year of expenditure (YOE) dollars for the total project. The 70th percentile level of confidence that the estimate will not exceed $1,253 million is shown by the blue shaded area. Alternatively, these results predict a 30% probability that total project costs could exceed this value as in the red shaded area. The 70% result is 7% higher than the pre-CER YOE estimate of $1,175 million.

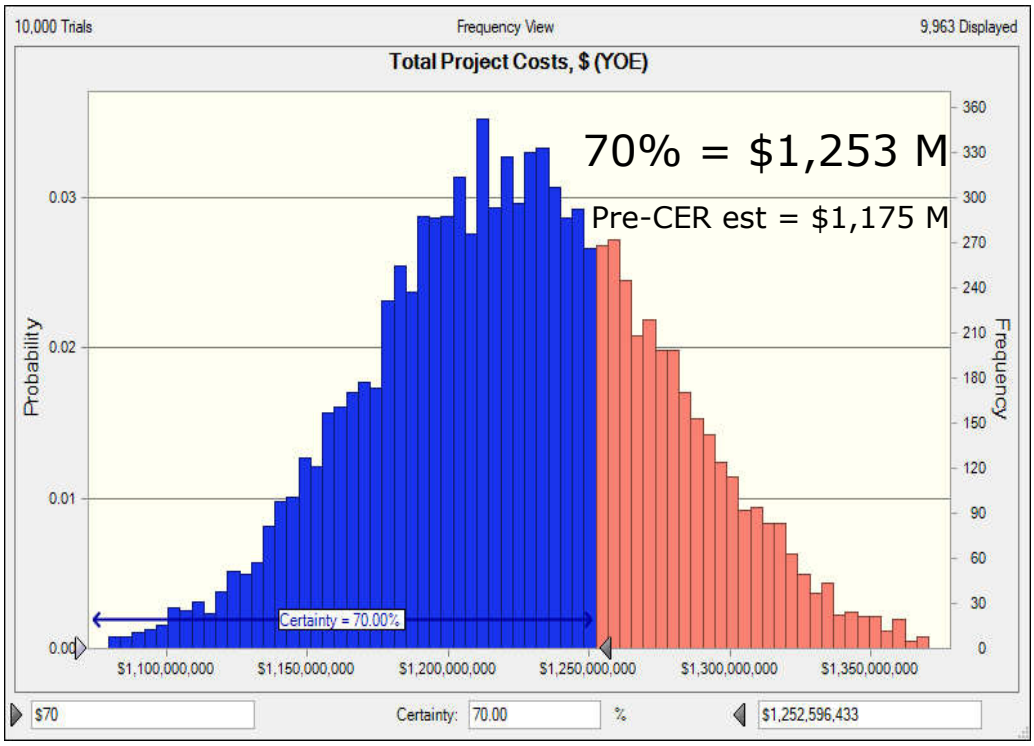

Figure 3: Probable Range of Total Project Costs Year of Expenditure (YOE dollars)

The 7% delta is the result of some high cost and schedule potential risks identified and the concern with high market conditions for Section 2 Ohio River Bridge portion of the project as further described in this Chapter. The Figure 3 results and the pre-CER estimate include the prior project expenditures to date of approximately $18.4 million plus $4.4 million of fixed costs (contracted), which are for the work preparing the DEIS and preliminary engineering.

Table 4 demonstrates the YOE results of Figure 2 in a tabular range, showing that the project cost could range from $1,029 million to $1,388 million, although the lower and higher ends of the variance are unlikely. The higher end at the 100% percentile reflects occurrences where all significant threats identified during the review will be realized, including those with a relatively low likelihood, while opportunities would not be realized. This broad variance in the YOE results demonstrates the project team's uncertainty in future market conditions for the higher cost and more complex Section 2 of the project that is projected to begin in 2025.

Percentile	Total Project Costs Forecast values
0%	$1,029,007,198
10%	$1,158,180,873
20%	$1,181,354,915
30%	$1,197,137,161
40%	$1,211,382,682
50%	$1,224,482,645
60%	$1,238,057,164
70%	**$1,252,596,433**
80%	$1,269,722,154
90%	$1,292,706,565
100%	$1,387,933,581

Table 4: Percentile Rankings of Total Project Costs in YOE Dollars

The Figure 4 Project Completion Date demonstrates the potential project schedule delay, with the 70% result in December 2032 versus a pre-CER schedule of June 2032, approximately a 6-month potential delay due to risk. Note that the variance beyond the 70% extends another 6-months beyond, well into 2033.

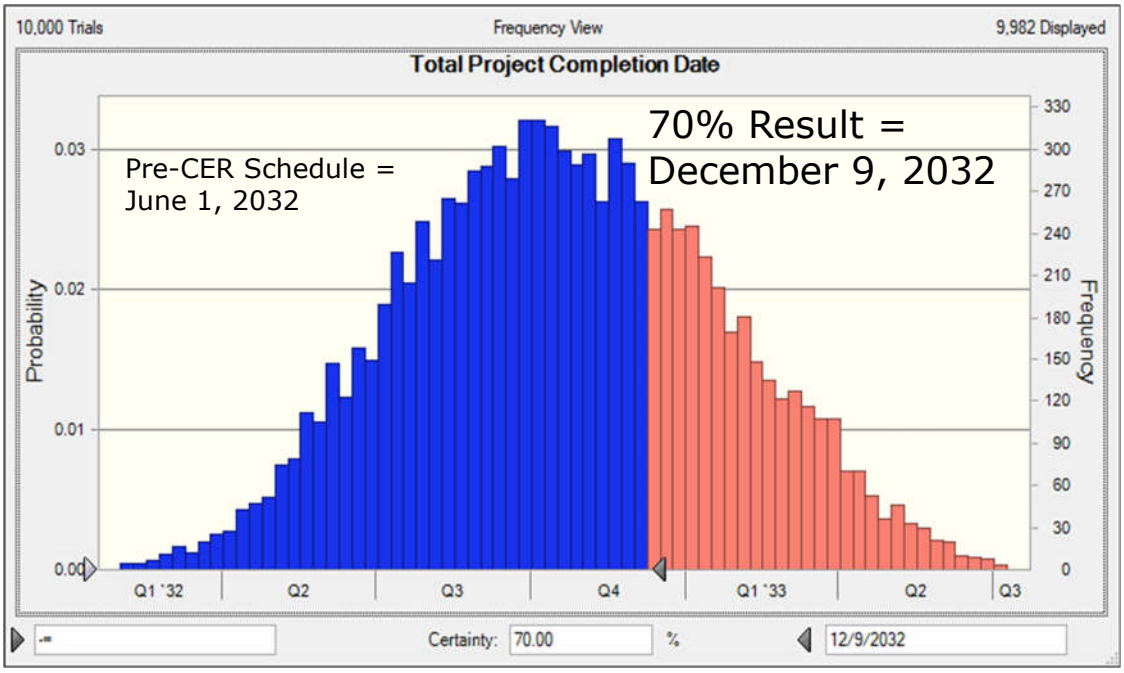

Figure 4: Project Completion Date

FORECAST RESULTS for SECTION 1 Funded portion of the Project

The following results are the Section 1 funded portion of the total project:

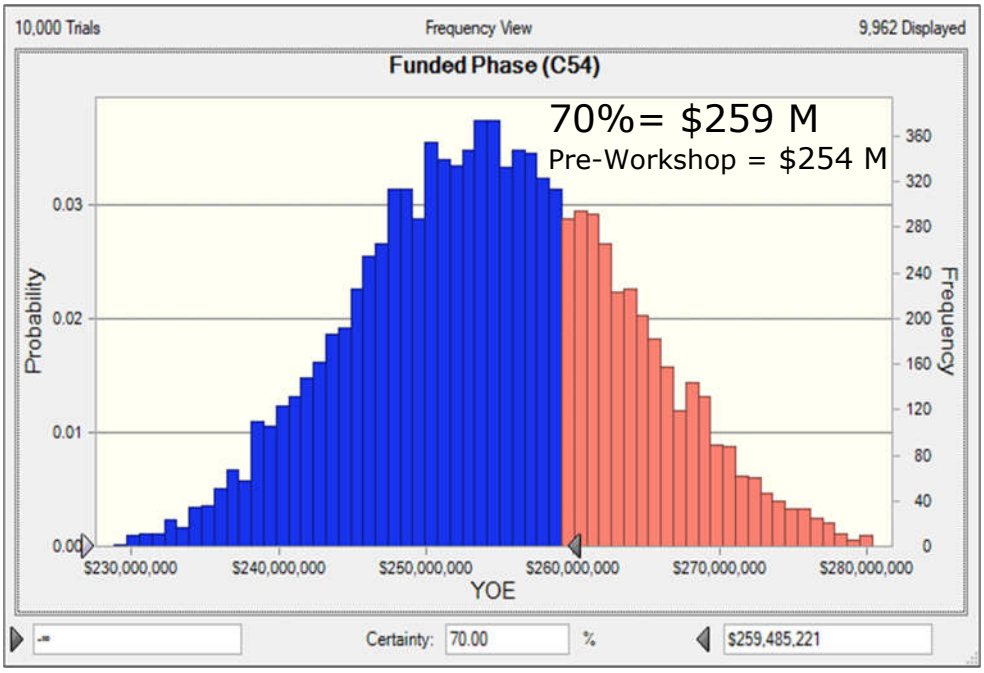

Figure 5: Section 1 YOE Results

Percentile	Total Project Costs Forecast values
0%	$224,829,613
10%	$242,660,438
20%	$246,722,718
30%	$249,550,852
40%	$252,058,660
50%	$254,430,013
60%	$256,845,973
70%	**$259,485,221**
80%	$262,426,813
90%	$266,568,651
100%	$288,318,996

Figure 6: Section 1 YOE Results

Figures 5 and 6 show the YOE results for the Section 1 (Kentucky Interchanges and South End) currently funded portion of the project, with a 70% YOE result of $259 million. This result is within 2% of the pre-CER YOE estimate of $254 million for this Section. This demonstrates that the current Section 1 estimate contingencies appear to adequately cover the risks for this portion of the project. With the project being priced by the design-build teams during 2021, the range of variation between the 10% ($242 million) and 90% ($266 million) confidence level results are relatively narrow within a 10% variance.

Figure 7 shows the schedule result for Section 1, with the 70% confidence level showing a completion in September of 2025, approximately 10 months later than the pre-CER schedule date of November 2024, indicating the high schedule threats that the project team foresees for Section 1.

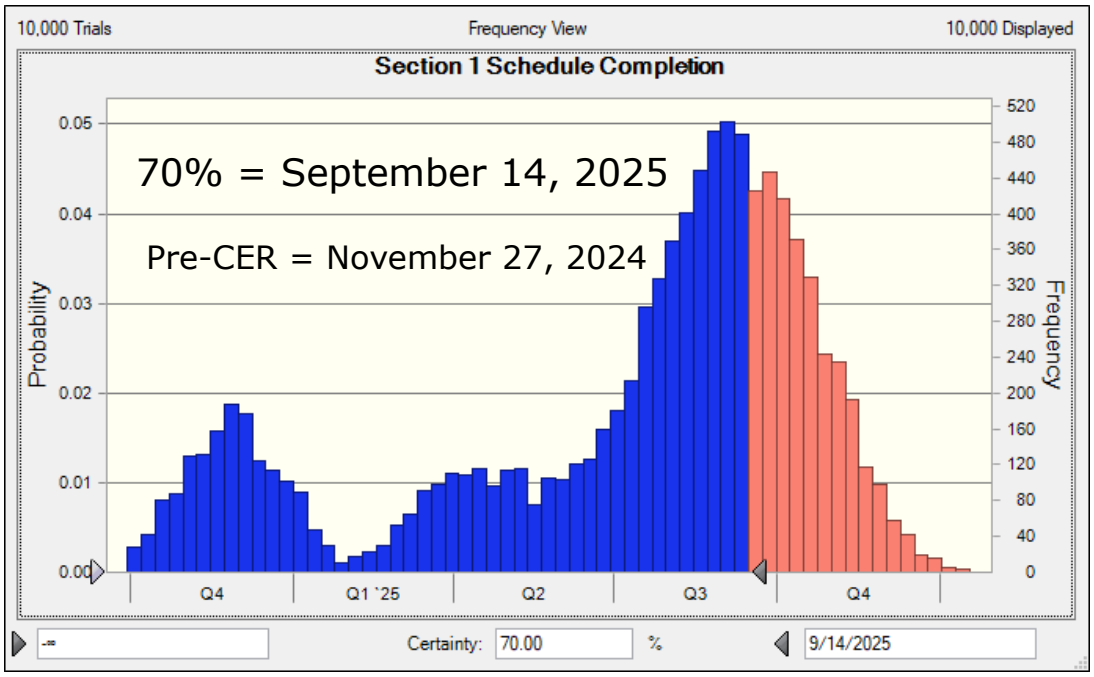

Figure 7: Section 1 Schedule Results

FORECAST RESULTS for SECTION 2 Unfunded portion of the Project

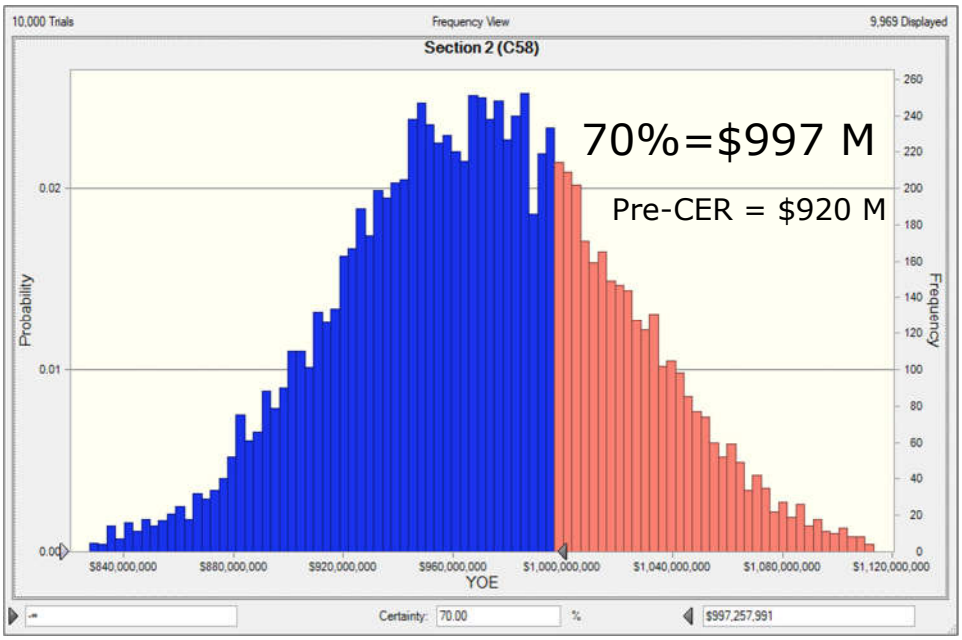

Figure 8: Section 2 YOE Result

Percentile	Total Project Costs Forecast values
0%	$771,368,462
10%	$905,050,429
20%	$927,286,140
30%	$943,304,775
40%	$956,613,081
50%	$970,251,730
60%	$983,336,722
70%	**$997,257,991**
80%	$1,013,785,895
90%	$1,036,845,760
100%	$1,135,558,975

Figure 9: Section 2 YOE Result Tabular Results

Figures 8 and 9 show the YOE results for the Section 2 (Ohio River Bridge and Approaches) currently unfunded portion of the project, with a 70% YOE result of $997 million. This result is 9% greater than the pre-CER YOE estimate of $920 million for this Section. This demonstrates that the current Section 2 estimate contingencies do not appear to adequately cover the risks for this portion of the project. With the project anticipated to be priced by proposers in 2025, the range of variation between the 10% ($905 million) and 90% ($1,037 million) confidence level results is nearly a 15% variance (versus a 10% variance for Section 1). This demonstrates the risk for potential unknowns as the project moves forward.

The schedule results for Section 2 are the same as the Total Project schedule results, with a 70% confidence level completion date of December 9, 2032 and a pre-CER completion date of June 1, 2032.

PROBABILITY ASSUMPTIONS

The assumptions discussed below describe how the review team modeled the risk events, base variability, inflation, and market conditions that served as inputs for the results shown in the previous section of the report. As discussed in Chapter 1, the Monte Carlo analysis selects random inputs from these distributions to determine discrete values for a given number of iterations. The model runs the simulation through 10,000 iterations and ranks the results to determine the likely range of cost and schedule for the project.

Risk - Threats and Opportunities

In a traditional cost estimate, risks are often accounted for by using a contingency percentage. For this CER, the pre-CER workshop estimate included about $110 million in contingencies that were removed from the base estimate before input to the Monte Carlo simulation model.

The purpose of the risk register is to identify and quantify significant cost and schedule risks in the estimate. The review team identified and discussed risks to the project in terms of threats and opportunities. The initial basis for the risk register was the pre-workshop risk register that the project team had developed. From this basis, each of the risks were analyzed based on the most current information, resulting in some being considered of low potential risk and not included in the model, some with medium or high risk that were modeled with probability of occurrence and potential impact should they occur, and some new risks were identified considering the current status of the project. For purposes of this review, a threat is a risk event that can add to the cost and/or schedule of the project and an opportunity is an event that can reduce the cost and/or shorten the schedule.

Risk events are quantified by likelihood of the occurrence and impact if it occurs. For example, Figure 8 shows a 50% risk likelihood that additional cost would be realized to address a sample risk of unforeseen ground conditions encountered, meaning that 50% of the 10,000 simulations will have this risk included. Figure 9 shows the cost threat impact triangular distribution, which defines how the cost impact was modeled for this sample risk. Essentially, these two figures state that for the 50% of the Monte Carlo simulations where this risk is triggered, it will randomly select a cost from this triangular distribution ($3M - $5M), with more frequent sampling near the most likely cost amount ($4M).

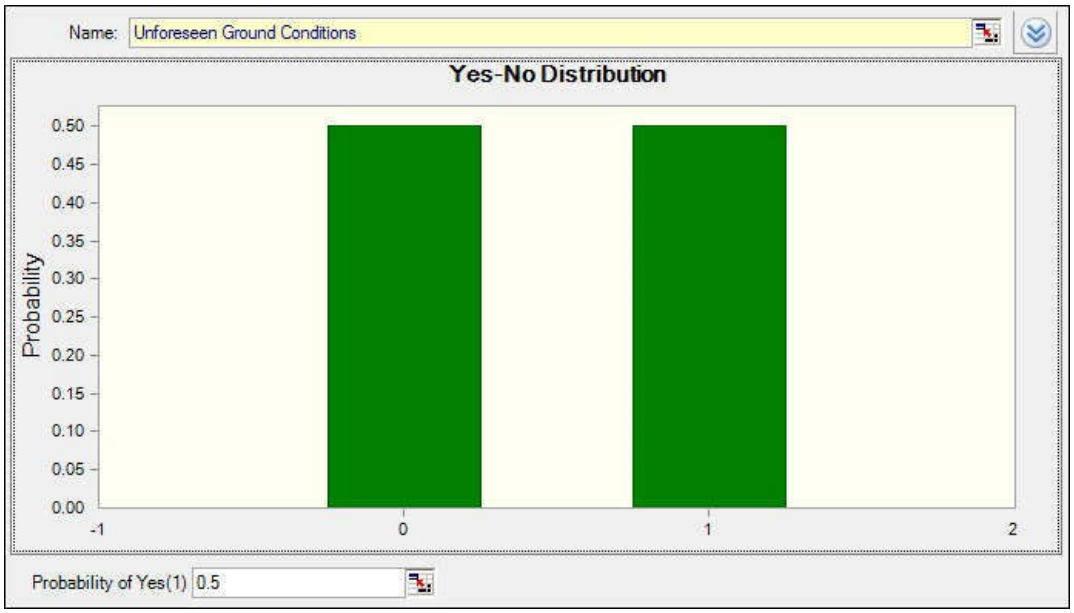

Figure 10: Example of Binomial Distribution for a Project Risk's Likelihood of Occurrence

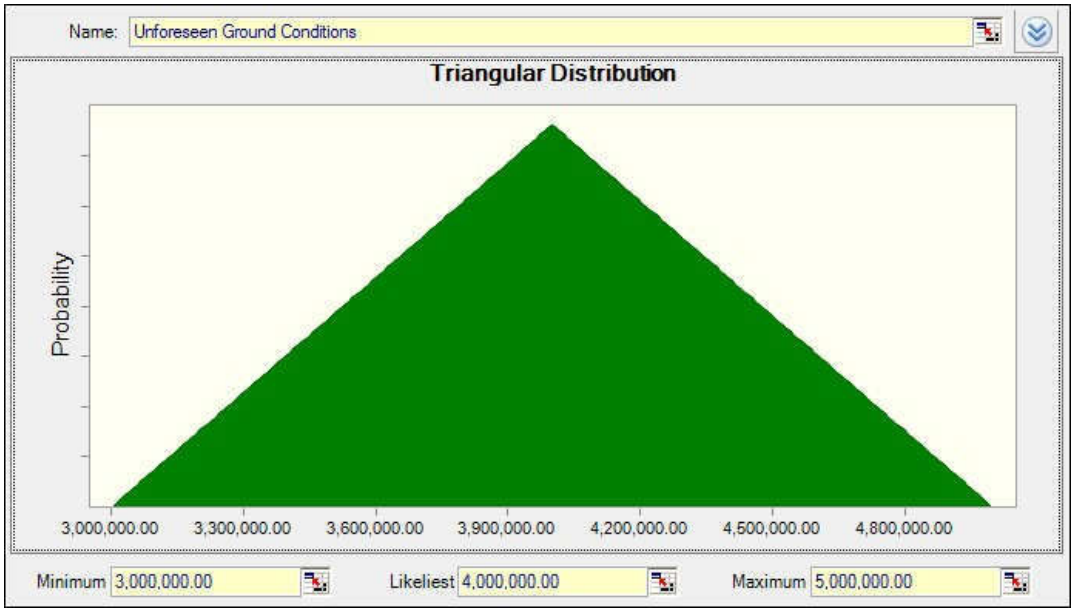

Figure 11: Example of Triangular Distribution for a Project Risk's Cost Impact

Table 5 shows the major cost threats that were identified, quantified, and modeled for this project. The range of potential cost impact that was modeled for each risk is also included.

Event Risk Name	Probability	Cost Threat / Opportunity	Low Cost ($)	Most Likely Cost ($)	High Cost ($)
Design Development Risks	100%	Threat	$ 10,000,000	$ 11,500,000	$ 13,000,000
Flooding - earthwork impacts	25%	Threat	$ 5,250,000	$ 7,875,000	$ 10,500,000
Geotechnical uncertainty	90%	Threat	$ 2,650,000	$ 5,300,000	$ 8,000,000
High groundwater impacting availability of on-site materials	50%	Threat	$ 665,000	$ 3,460,000	$ 5,320,000
Owner Directed Change in Scope	50%	Threat	$ 1,000,000	$ 3,000,000	$ 5,000,000
ATCs and DB Innovations	75%	Opportunity	$ 3,000,000	$ 5,000,000	$ 7,000,000

Table 5: Section 1 Significant Cost Threats

The most significant cost risks are further described as follows:

Design Development: This risk is related to design developing and additional items being identified and quantified that will add costs to the project. This was included as a 100% probability of occurrence, with an impact range from $10 million to $13 million.

Flooding – earthwork impacts: The team considered that a threat of flooding of Section 1 could impact earthwork. The probability of occurrence is at 25%, the impact would be delay damages that could range from $5.25 million to $10.5 million.

Geotechnical Uncertainty: The team considered a 90% probability that geotechnical issues could cause additional costs . The geotechnical data does not only have an impact on the foundation design in this project but will also affect the overall bridge design as the subsurface conditions are the main driver of the seismic design constraint. Section 1 is more critical as its soil site classification is worse than Section 2. The impact of this risk ranges from $2.65 million to $8 million.

High Groundwater impacting availability of On-Site Materials: Higher groundwater on-site than considered could impact getting materials to the site to proceed with construction. The team

considered a 50% probability that this may result in additional cost not captured in the current cost estimate, with an impact range of $.6 million to $5.3 million.

Owner Directed Scope Changes: the review team considered a 50% probability that additional costs in the range of $1 million to $5 million could occur to meet any owner directed changes in scope to meet project needs.

Opportunity for ATCs and DB Innovations: Design-Builders (DB) will be able to present Alternative Technical Concepts (ATC) for the owners to review, and if accepted would reduce the cost of the project. They also have the opportunity to innovate to reduce costs on their own. The DB and the team considered a 75% probability that opportunities could save the project in the range of $3 million to $7 million.

Schedule Risk Analysis – Section 1

Event Risk Name	Probability	Schedule Threat / Opportunity	Low Schedule (mo)	Most Likely Schedule (mo)	High Schedule (mo)
Big Rivers transmission Line	50%	Threat	6.0	9.0	12.0
Delays in obtaining ROW	25%	Threat	6.0	9.0	12.0
Flooding - earthwork impacts	25%	Threat	6.0	9.0	12.0
CLOMR/LOMR - acquisition of permit	25%	Threat	3.0	4.5	6.0
Delays in obtaining permits 401/404	25%	Threat	3.0	4.5	6.0

Table 6: Section 1 Significant Schedule Risks

The Section 1 schedule risks outlined in Table 6 are further described with the following:

Big Rivers Transmission Line: The team identified a 50% probability that the relocation of Big Rivers electrical transmission line could cause a delay of 6 months to 12 months to Section 1.

Delays in obtaining ROW: The team identified a 25% probability that delay in obtaining right-of-way could cause a delay of 6 months to 12 months.

Flooding – Earthwork Impacts: The team identified a 25% probability flooding could impact earthwork from 6 months to 12 months.

CLOMR/LOMR – Acquisition of Permit: The team identified a 25% probability that the acquisition of the CLOMR/LOMR permits could delay the project from 3 to 6 months. CLOMR is a Conditional Letter of Map Revision which is the Federal Emergency Management Administration (FEMA) comment on a proposed project that could result in the modification of existing flood hazards. A LOMR is a Letter of Map Revision that allows FEMA to revise flood hazard information via a letter without physically revising and reprinting the entire Flood Insurance Study (FIS) and map panel(s).

Delays in Obtaining 401/404 Permits: The team identified a 25% probability that a delay of obtaining the 401/404 U.S. Army Corps of Engineers permits that are related to regulating discharge of dredged or fill material into waters, including wetlands. This could delay the project from 3 to 6 months.

Cost Risk Analysis – Section 2

Event Risk Name	Probability	Cost Threat / Opportunity	Low Cost ($)	Most Likely Cost ($)	High Cost ($)
Efficiency in bridge construction - Site accessibility	75%	Threat	$ 20,000,000	$ 30,000,000	$ 60,000,000
Bridge Superstructure Design Allowance	100%	Threat	$ 29,000,000	$ 34,000,000	$ 44,000,000
Seismic design secondary bridges	75%	Threat	$ 19,500,000	$ 23,000,000	$ 30,000,000
Final Design Cost higher than estimated (up to 3%)	75%	Threat	$ 5,000,000	$ 12,500,000	$ 20,000,000
Non bridge design development	100%	Threat	$ 10,000,000	$ 11,500,000	$ 15,000,000
CM and CEI higher than estimated (up to 3%)	50%	Threat	$ 6,000,000	$ 12,000,000	$ 18,000,000
Geotechnical: Soil liquefaction potential	50%	Threat	$ 3,000,000	$ 6,000,000	$ 9,000,000
Seismic design (River Bridge)	50%	Threat	$ 5,500,000	$ 6,500,000	$ 8,500,000
ATCs and DB Innovations	75%	Opportunity	$ 20,000,000	$ 40,000,000	$ 50,000,000

Table 7: Section 2 Cost Risks

The Section 2 cost risks outlined in Table 7 are further described with the following:

Efficiency in Bridge Construction – Site Accessibility: This risk is related to the potential for the design-builder to have to build an access trestle to facilitate the river bridge approach work. The team identified a 75% chance of occurrence and a range of $20 million to $60 million impact.

Bridge Superstructure Design Allowance: This risk is related to the potential for additional costs as the design develops on the superstructure of the bridges. This was part of an allowance in the pre-CER estimate, so the team considers a 100% chance of occurrence and a range of $29 million to $44 million impact.

Seismic Design Secondary Bridges: This risk is related to the potential for additional costs as the design develops related to meeting seismic criteria for the secondary bridges (other than the river bridge). This was part of an allowance in the pre-CER estimate, and the team considers a 75% chance of occurrence and a range of $19.5 million to $30 million impact.

Final Design Cost higher than estimated (up to 3%): the final design portion of the design-builder cost is in the pre-CER estimate is approximately $27 million. The team considered a 75% probability that this design cost could increase an additional $5 million to $20 million, with a $12.5 million increase most likely.

Non-bridge Design Development: This risk is related to the potential for the design-builder to have to build an access trestle to facilitate the river bridge approach work. The team identified a 75% chance of occurrence and a range of $20 million to $60 million impact.

CM and CEI higher than estimated (up to 3%): This risk is related to the potential for additional costs as the design develops on the superstructure of the bridges. This was part of an allowance in the pre-CER estimate, so the team considers a 100% chance of occurrence and a range of $29 million to $44 million impact.

Geotechnical: Soil Liquefaction potential: This risk is related to the potential for additional costs as the design develops related to meeting seismic criteria for the secondary bridges (other than the river bridge). This was part of an allowance in the pre-CER estimate, and the team considers a 75% chance of occurrence and a range of $19.5 million to $30 million impact.

Seismic Design (River Bridge): the final design portion of the design-builder cost is in the pre-CER estimate is approximately $27 million. The team considered a 75% probability that this design cost could increase an additional $5 million to $20 million, with a $12.5 million increase most likely.

Opportunity for ATCs and DB Innovations: Design-Builders (DB) will be able to present Alternative Technical Concepts (ATC) for the owners to review, and if accepted would reduce the cost of the project. They also have the opportunity to innovate to reduce costs on their own. The team considered a 75% probability that opportunities could save the project in the range of $20 million to $50 million.

Schedule Risk Analysis – Section 2

Event Risk Name	Probability	Schedule Threat / Opportunity	Low Schedule (mo)	Most Likely Schedule (mo)	High Schedule (mo)
States disagree on procurement process	15%	Threat	12.0	18.0	24.0
Flooding Year 1	75%	Threat	0.0	1.5	3.0
Flooding Year 2	75%	Threat	0.0	1.5	3.0
Flooding Year 3	75%	Threat	0.0	1.5	3.0
Flooding Year 4	75%	Threat	0.0	1.5	3.0

Table 8: Section 2 Schedule Risks

The Section 2 schedule risks outlined in Table 8 are further described with the following:

States Disagree on Procurement Process: The team considered a low (15%) probability that the states of Kentucky and Indiana could have a disagreement on the procurement process. Should this occur, Section 2 of the project could be delayed from 12 months to 24 months.

Flooding in Contract Years: The team considered a 75% probability that an additional flooding event could occur each contract year beyond the one flooding event per contract year currently considered in the schedule. Each time this additional flooding occurs, it could cause a likely delay of 1.5 months with a high-end impact of 3 months.

Note that the schedule delays to Section 1 of the project did not impact the start of the Section 2 of the project in the CER model. The general assumption is that the delays to Section 1 would likely not impact the start of the Section 2 preliminary engineering and procurement process.

Project Variables

Base variability captures the variability and uncertainty inherently associated with the cost estimating process. Based on feedback from the project team and subject matter experts about the level of design completed to date for each Section of the project, the base variability for the estimate was determined to be the following for all remaining costs and schedule to complete the project.

Table 9 shows that the team considered a lower cost (+/-8%) and schedule (+/-6%) variability for

Section 1 due to the Section being further developed with design, being less complex and being procured in 2021. Section 2 variabilities were at +/-10% for both cost and schedule.

Variable	Section 1 (2021-2024)	Section 2 (2025-2032)
Base Cost Variability	8%	10%
Base Schedule Variability	6%	10%
Inflation Calculations		
Design / Construction / Utilities	2.5%	2.5%
Right-of-Way	1.5%	1.5%
Market Conditions		
Better Than Planned / Delta from As Planned	15% / 10%	25% / 10%
Worse Than Planned / Delta from As Planned	5% / 5%	33% / 10%
As Planned	80%	42%

Table 9: Base Variability / Inflation / Market Conditions

Inflation

Table 9 shows the inflation rates that were used in the CER model. The 2.5% is standard from the states and the 1.5% for Right-of-Way is due to the team considering a low inflation rate for the type of land to be purchased for the project.

Market Conditions

The primary reason for modeling market conditions is to reflect the uncertainty associated with the bidding environment. These discussions consider the potential number of bidders on project contracts and the large amount of resources that will be required to deliver the project. Other factors considered were labor and material availability and the influence of other large projects scheduled to be advertised in the same timeframe.

The CER team discussed market conditions and came up with the probabilities and impacts as shown in Table 9. The probabilities denote the likelihood of occurrence for “Better Than Planned” (lower than the current estimate), “Worse Than Planned” (higher than the current estimate) or “As Planned” (consistent with the current estimate) and the delta denotes the magnitude as a percent of planned value for better than planned and worse than planned.

As demonstrated by the Market Conditions modeled, the Review Team considered that Section 1 has an 80% probability of the pricing being near the current estimate, with a slightly higher probability (15%) that the market conditions are favorable for lower pricing than the 5% probability for higher pricing. The potential variance from the As Planned is also greater if better than planned market conditions being 10% versus the variance of 5% if worse than planned. These variances kept the Section 1 results relatively narrow and were based on the team considering that there is good current design-builder interest in the Section 1 contract.

Section 2 has a much broader range of market conditions as the procurement is several years in the future. The Review Team considered a 42% probability of the pricing being near the current estimate, with a lower probability (25%) that the market conditions are favorable for lower pricing than the 33% probability for higher pricing. The potential variance from the As Planned is 10% for both the Better Than Planned and Worse Than Planned conditions. This broad range of market conditions is a high contributor to the broad range of the Section 2 results, due to this uncertainty.

CONCLUSION

Table 10 summarizes the 70% confidence YOE results for the Monte Carlo simulation that was run for this CER, along with a comparison to the Pre-CER Estimate.

#	Description	$ in Millions (*) Pre-CER Estimate (YOE)	$ in Millions (*) CER 70% Result (YOE) **	% Cost Delta	Pre-CER Project Scheduled Completion Date	CER 70% Completion Date	Sch. Delta (mos.)
1	Section 1	$254.1	$259.5	+2%	Nov. 27, 2024	Sep. 14, 2025	10.5
2	Section 2	$920.4	$997.3	+8%	June 1, 2032	Dec. 9, 2032	6.5
	Total Project	**$1,174.5**	**$1,252.6**	**+7%**	**June 1, 2032**	**Dec. 9, 2032**	**6.5**

Notes (*) The result values include approximately $21 million in prior and fixed costs with Section 1
(**) 70% Results do not add due to the Monte Carlo simulation process

Table 10: Total Project Cost and Schedule Summary ($ in Millions)
(identical to Table 1 in Executive Summary)

Table 10 demonstrates that the YOE result at the 70% confidence level of $1,253 million is approximately 7% above the pre-CER workshop YOE estimate of $1,175 million. This resulting increase is primarily associated with Section 2 of the project, which includes the Ohio River Crossing and Approaches and currently has greater risks than Section 1, due to the uncertainty of future market conditions, flooding risks, and seismic design and construction accessibility risks for the bridges.

The team will gain information in 2021 as the design-builders propose on Section 1 and will be able to refine the Section 2 estimate over time as the risk mitigation occurs. Since this CER is based on an estimate and conditions that are a snapshot in time, it is expected that, through further project development, the risks and associated estimate will change.

APPENDICES

A – Cost Estimate Review Closing Presentation

B – Pre-CER Cost Estimate

C – Pre-CER Schedule

D – Cost Estimate Review Agenda

E – Cost Estimate Review Sign-In Sheets

F – CER Model Results

G – Risk Register

Appendix A

Cost Estimate Review Closing Presentation

Cost Estimate Review
FHWA Closeout Presentation
March 26, 2021

ORX 69 OHIO RIVER CROSSING

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I-69 Ohio River Crossing

Section 1

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I-69 Ohio River Crossing

Section 2

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Cost Estimate Review Objective

Conduct an unbiased risk-based review to verify the accuracy and reasonableness of the current total cost estimate and project schedule to complete the

I-69 Ohio River Crossing

project and to develop a probability range for the cost estimate and schedule that represents the project's current stage of design.

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Review Participants

- FHWA
  - Division Offices – IN and KY
  - CER Cadre Team- FHWA HQ
- INDOT / KYTC
- Consultants

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Documentation Provided
(prior to CER)

- Project Cost Estimate
- Project Schedule
- Project Risk Register
- Project website (including DEIS)

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Pre-Review Webinar

March 3, 2021

- Introductions
- Review of CER Process (Carter)
- Project Briefing (project sponsor)
- Review of current project cost estimate
- Review of current project schedule
- Review of draft Risk Register
- Finalize Workshop Agenda & Participation

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CER Outline Agenda

March 23 - 26, 2021

- Day 1: Introductions / Model Variables / Begin Risk Register Development
- Day 2: Continue Risk Register with Focus on Section 1 subjects
- Day 3: Continue Risk Register with Focus on Section 2 subjects / Soft Costs / ROW; Complete Risk Register and Run Model
- Day 4: Closeout Presentation

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CER Observations

- The Project Team and SMEs have an excellent grasp of the project's scope & schedule, and sufficiently developed estimates based on the current level of design including geological and hydrologic challenges of the project to conduct a good workshop.
- At the CER, there was good and open discussion by all parties while reviewing the risk register to determine risk attributes
- Project Personnel, INDOT and KYTC have a good understanding of potential mitigation activities that could reduce risk and are actively thinking of more.
- SME participation was critical to the success of the CER workshop.
- The Project Team brought forth additional risks during the course of the review that were instrumental in the review's outcome.

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Review Methodology

Verify
- Major cost elements
- Allowances/contingencies
- Adjust estimate as necessary

Model
- Base variability
- Market conditions and inflation
- Risk events (cost, schedule, probability, impact, relationships)
- Monte Carlo simulation

Communicate
- Closeout Presentation
- Final report
- Issuance of NEPA Decision Document
- Approval of finance plan

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Review Baseline

Total Cost Est. in millions

	2021	YOE
• Project Devt:	$ 21.1	$ 21.5
• Section 1:	$ 221.8	$ 232.6
• Section 2:	$ 758.6	$ 920.4
• Total Project:	$1,001.5	$1,174.5

Project Completion Dates:

- Section 1: November 27, 2024
- Section 2: June 1, 2032

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Total Project – Variables

Variable	Section 1 (2021-2024)	Section 2 (2025-2032)
Base Cost Variability	8%	10%
Base Schedule Variability	6%	10%
Inflation Calculations		
Design / Construction / Utilities	2.5%	2.5%
Right-of-Way	1.5%	1.5%
Market Conditions		
Better Than Planned / Delta from As Planned	15% / 10%	25% / 10%
Worse Than Planned / Delta from As Planned	5% / 5%	33% / 10%
As Planned	80%	42%

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Section 1 – Significant Cost Risks

Event Risk Name	Probability	Cost Threat / Opportunity	Low Cost ($)	Most Likely Cost ($)	High Cost ($)
Design Development Risks	100%	Threat	$ 10,000,000	$ 11,500,000	$ 13,000,000
Flooding - earthwork impacts	25%	Threat	$ 5,250,000	$ 7,875,000	$ 10,500,000
Geotechnical uncertainty	90%	Threat	$ 2,650,000	$ 5,300,000	$ 8,000,000
High groundwater impacting availability of on-site materials	50%	Threat	$ 665,000	$ 3,460,000	$ 5,320,000
Owner Directed Change in Scope	50%	Threat	$ 1,000,000	$ 3,000,000	$ 5,000,000
ATCs and DB Innovations	75%	Opportunity	$ 3,000,000	$ 5,000,000	$ 7,000,000

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Section 1 – Significant Schedule Risks

Event Risk Name	Probability	Schedule Threat / Opportunity	Low Schedule (mo)	Most Likely Schedule (mo)	High Schedule (mo)
Big Rivers transmission Line	50%	Threat	6.0	9.0	12.0
Delays in obtaining ROW	25%	Threat	6.0	9.0	12.0
Flooding - earthwork impacts	25%	Threat	6.0	9.0	12.0
CLOMR/LOMR - acquisition of permit	25%	Threat	3.0	4.5	6.0
Delays in obtaining permits 401/404	25%	Threat	3.0	4.5	6.0

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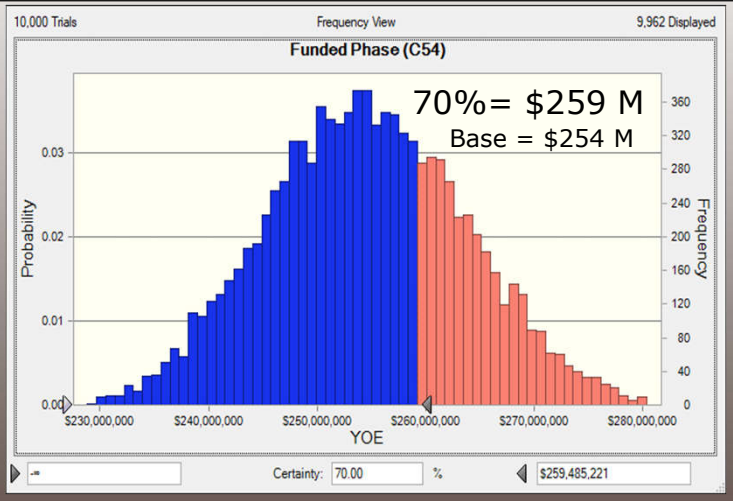
Section 1 (Funded Phase) YOE



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Section 1 YOE Percentile Ranking

Percentile	Total Project Costs Forecast values
0%	$224,829,613
10%	$242,660,438
20%	$246,722,718
30%	$249,550,852
40%	$252,058,660
50%	$254,430,013
60%	$256,845,973
70%	**$259,485,221**
80%	$262,426,813
90%	$266,568,651
100%	$288,318,996

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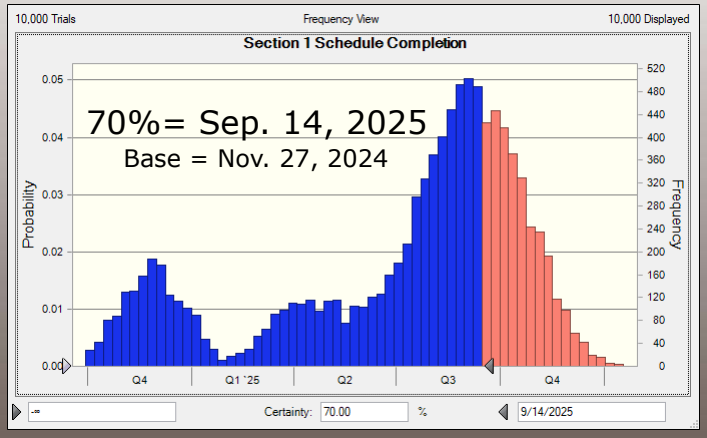
Section 1 (Funded Phase) Schedule



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Section 2 – Significant Cost Risks

Event Risk Name	Probability	Cost Threat / Opportunity	Low Cost ($)	Most Likely Cost ($)	High Cost ($)
Efficiency in bridge construction - Site accessibility	75%	Threat	$ 20,000,000	$ 30,000,000	$ 60,000,000
Bridge Superstructure Design Allowance	100%	Threat	$ 29,000,000	$ 34,000,000	$ 44,000,000
Seismic design secondary bridges	75%	Threat	$ 19,500,000	$ 23,000,000	$ 30,000,000
Final Design Cost higher than estimated (up to 3%)	75%	Threat	$ 5,000,000	$ 12,500,000	$ 20,000,000
Non bridge design development	100%	Threat	$ 10,000,000	$ 11,500,000	$ 15,000,000
CM and CEI higher than estimated (up to 3%)	50%	Threat	$ 6,000,000	$ 12,000,000	$ 18,000,000
Geotechnical: Soil liquefaction potential	50%	Threat	$ 3,000,000	$ 6,000,000	$ 9,000,000
Seismic design (River Bridge)	50%	Threat	$ 5,500,000	$ 6,500,000	$ 8,500,000
ATCs and DB Innovations	75%	Opportunity	$ 20,000,000	$ 40,000,000	$ 50,000,000

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Section 2 – Significant Schedule Risks

Event Risk Name	Probability	Schedule Threat / Opportunity	Low Schedule (mo)	Most Likely Schedule (mo)	High Schedule (mo)
States disagree on procurement process	15%	Threat	12.0	18.0	24.0
Flooding Year 1	75%	Threat	0.0	1.5	3.0
Flooding Year 2	75%	Threat	0.0	1.5	3.0
Flooding Year 3	75%	Threat	0.0	1.5	3.0
Flooding Year 4	75%	Threat	0.0	1.5	3.0

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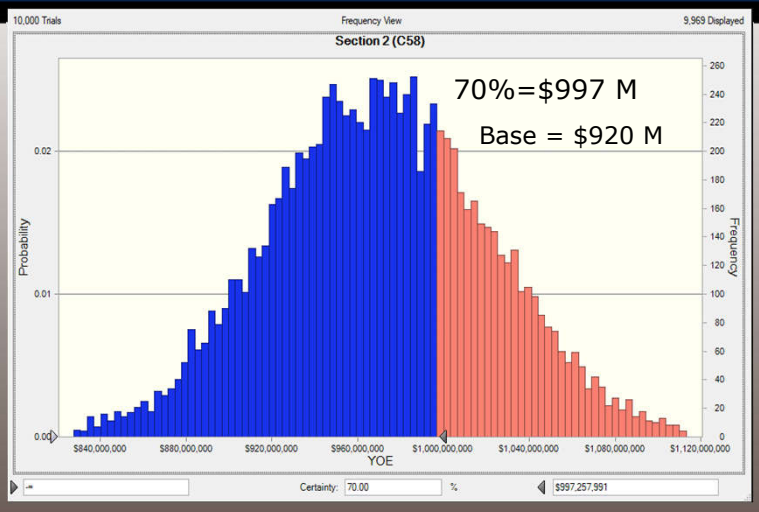
Section 2 - YOE



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Section 2 YOE Percentile Ranking

Percentile	Total Project Costs Forecast values
0%	$771,368,462
10%	$905,050,429
20%	$927,286,140
30%	$943,304,775
40%	$956,613,081
50%	$970,251,730
60%	$983,336,722
70%	**$997,257,991**
80%	$1,013,785,895
90%	$1,036,845,760
100%	$1,135,558,975

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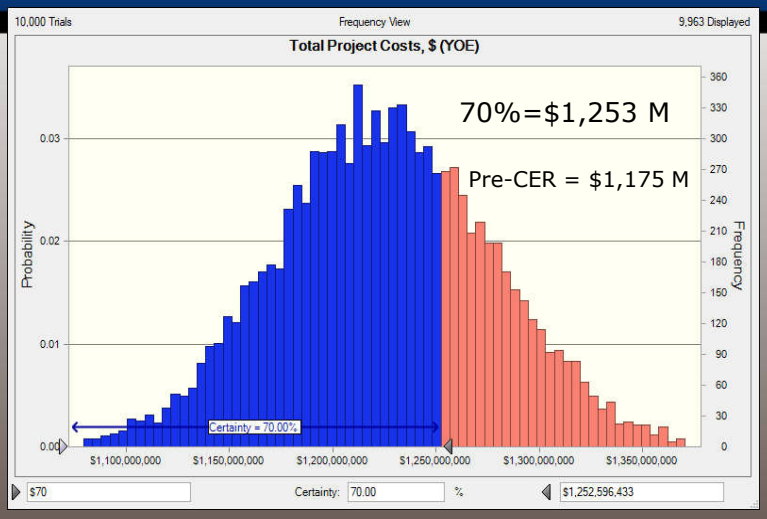
Total Project - YOE



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Total Project YOE Percentile Ranking

Percentile	Total Project Costs Forecast values
0%	$1,029,007,198
10%	$1,158,180,873
20%	$1,181,354,915
30%	$1,197,137,161
40%	$1,211,382,682
50%	$1,224,482,645
60%	$1,238,057,164
70%	**$1,252,596,433**
80%	$1,269,722,154
90%	$1,292,706,565
100%	$1,387,933,581

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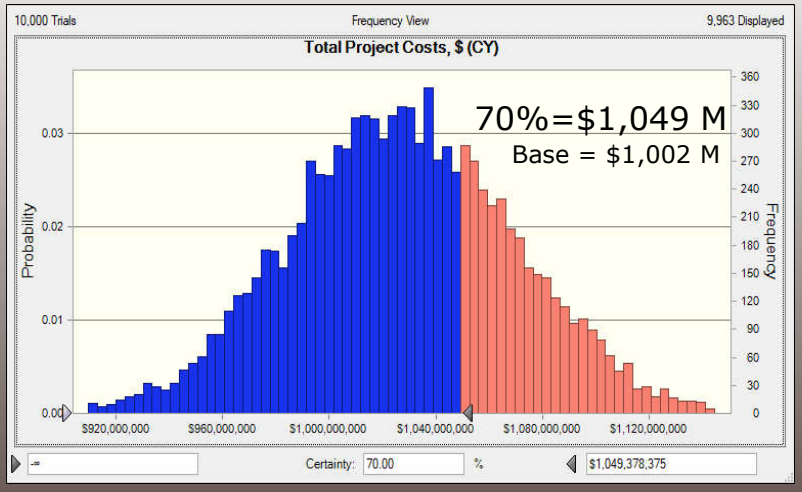
Total Project - CY



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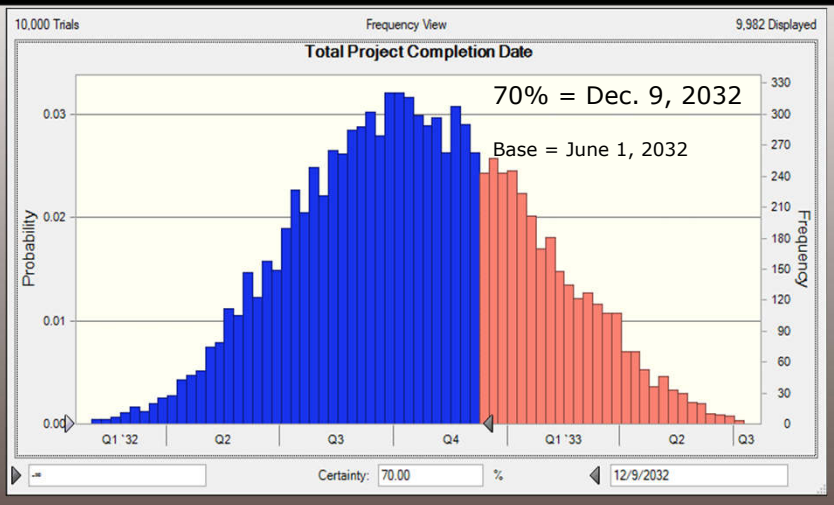
Total Project – Schedule



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CER Recommendations

- Update the project estimate, schedule and risk register to reflect adjustments made during the review.
- Continue to evaluate and maintain the risk register for opportunities to reduce or mitigate risk such as advancing ROW acquisition, and to allocate risk in the future design build contracts.
- A second CER may be advisable and/or necessary to inform future FPAs when funding becomes available for Section 2.
  - Reduction of risk uncertainty will affect forecast values
  - Capture changes in market conditions, pricing and industry capacity and accurately reflect those in future dollars.

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CER Recommendations

- The use a cost forecast range in the pending FEIS/ROD to inform the public of the cost uncertainty based on the complexity and design development.
- Use the CER 70% YOE amount in setting the project's baseline cost in the IFP. If significant cost changes occur prior to the IFP submittal, they can be accounted for as adjustments to the CER 70% YOE amount in establishing the baseline cost in the IFP.
  - Changes between the CER Final Report and the IFP must be documented in the IFP.
- The CER 70% schedule completion forecast date should be used when setting the project's baseline completion date in the IFP.
  - Additional information is also found in FHWA's guidance on Estimating Schedule for FHWA Major Projects: https://fhwatest.fhwa.dot.gov/majorprojects/schedule_estimating/

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CER Next Steps

- FHWA will prepare a final report documenting review findings.
  - Draft report for review within 30 days
  - Draft report will be e-mailed to Division Offices
  - Division Offices will review the draft and forward it to the Project Team
  - Final report issued within 30 days after receipt of comments
  - Final report forwarded to the Division Offices for distribution to the Project Team
- FHWA uses the results as the official cost estimate for the project (NEPA, IFP, reporting)
- Estimate review is a snapshot of the current estimate

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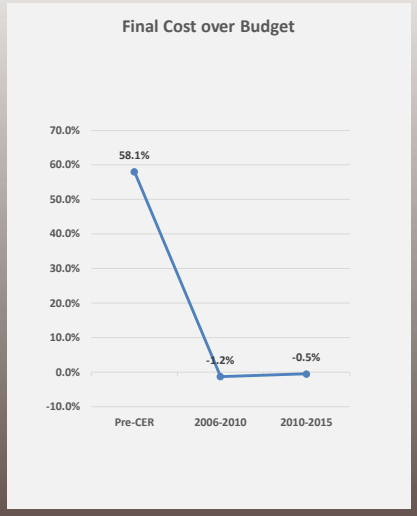
Long Term Measurement: Cost

- **Final Cost vs IFP Estimate**
  - 15 Projects prior to CER
    - Total Cost 58.1% over budget
  - 27 Projects 2006 – 2010
    - **Average 1.2% under budget**
  - 16 Projects 2011 – 2014
    - **Average 0.5% under budget**



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Long Term Measurement: Schedule

- **Final Project Duration vs Planned Project Duration**
  - **Pre-CER**
    - **30.1% over Schedule**
  - **2006 to 2010**
    - **27.0% over Schedule**
  - **2011 to 2015**
    - **2.8% over Schedule**

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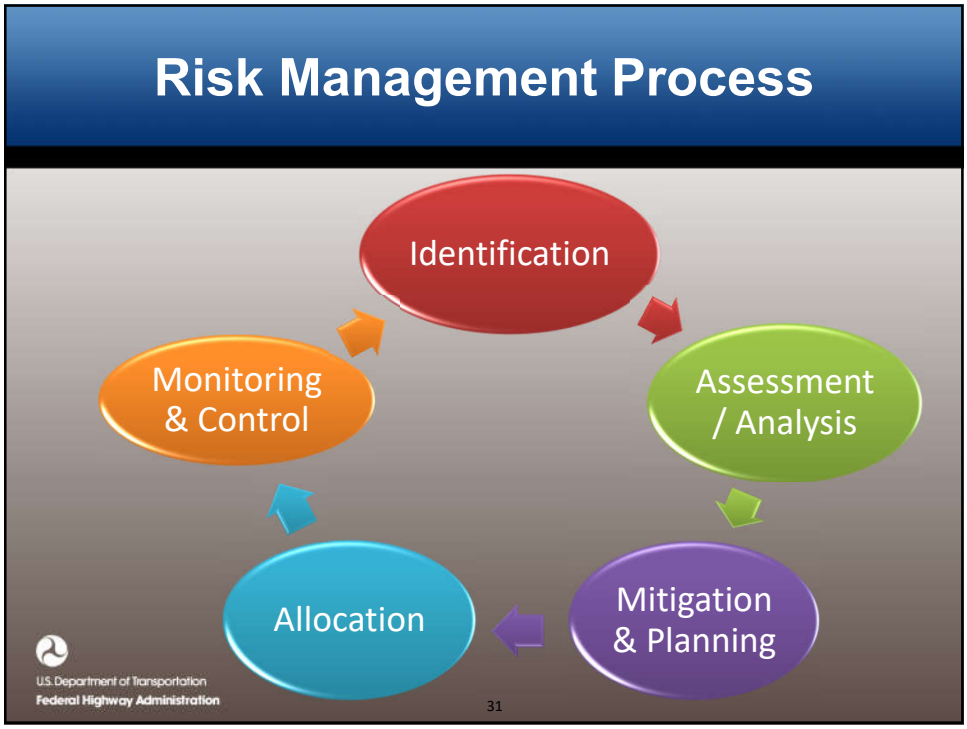
Risk Management Process
Identification
Assessment / Analysis
Mitigation & Planning
Allocation
Monitoring & Control
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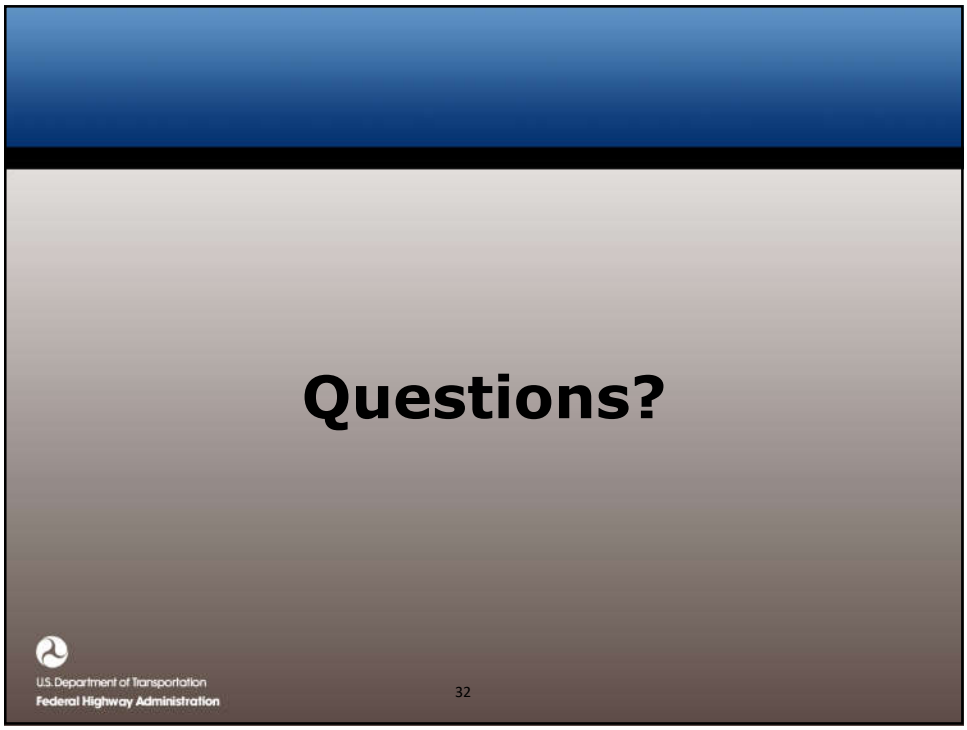
Questions?
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Appendix B

Pre-CER Cost Estimate

Estimate Summary
1-69 Ohio River Crossing
Section 1

Estimate Description	Units	Quantities	2018 Total	Quantities	2021 Total
Embankment	CY	2,154,767	$ 14,996,000	2,237,446	$ 26,123,000
Structures (Bridges)	S	74,320	$ 30,748,000	106,886	$ 26,849,000
Paving	SY	403,814	$ 41,541,000	283,929	$ 34,250,000
Retaining alls	S		$	26,861	$ 1,064,000
Noise Walls	S		$	25,000	$ 2,060,000
Lighting Signals	S	1	$ 1,384,000	1	$ 982,000
Drainage Structures		4,261	$ 6,391,000	3,620	$ 5,792,000
Other	S	1	$ 11,962,000	1	$ 13,332,000
Subtotal Direct Cost			$ 107,022,000		$ 110,452,000
Indirect Costs			$ 23,126,000		$ 31,419,000
Construction Contingencies			$ 7,895,000		$ 7,095,000
Design			$ 9,187,000		$ 7,449,000
Subtotal Design & Construction			$ 147,230,000		$ 156,415,000
Allowances					
Design Evolution					
River Bridge			$		$
Secondary Bridges			$ 5,933,000		$ 5,358,000
All other ork			$ 33,345,000		$ 17,784,000
Total Section 1			**$ 186,508,000**		**$ 179,557,000**

Section 2

Estimate Description	Units	Quantities	2018 Total	Quantities	2021 Total
Embankment	CY	1,385,446	$ 10,692,000	821,306	$ 12,939,000
Structures (Bridges)	S	1,418,859	$ 314,191,000	1,216,424	$ 329,975,000
Paving	SY	161,915	$ 25,410,000	209,357	$ 28,068,000
Retaining Walls	S		$		$
Noise Walls	S		$		$
Lighting Signals	S		$		$
Drainage Structures			$	2,100	$ 3,245,000
Other	S	1	$ 22,572,000	1	$ 21,893,000
Subtotal Direct Cost			$ 372,865,000		$ 396,120,000
I ndirect Costs			$ 67,156,000		$ 67,537,000
Construction Contingencies			$ 20,614,000		$ 23,184,000
Design			$ 24,439,000		$ 27,406,000
Subtotal Design & Construction			$ 485,074,000		$ 514,247,000
Allowances					
Design Evolution					
River Bridge			$ 35,378,000		$ 19,846,000
Secondary Bridges			$ 57,199,000		$ 43,843,000
All other ork			$ 17,402,000		$ 22,845,000
Toll System			$		$ 12,300,000
S 41 North Bound Bridge Rehabilation			$		$ 21,000,000
S 41 Approach Reconfiguration			$		$ 5,000,000
Total Section 2			**$ 595,053,000**		**$ 639,081,000**
Project otal - Setions 1 & 2					
Direct costs			$ 479,887,000		$ 506,572,000
Indirect costs			$ 90,282,000		$ 98,956,000
Total Construction			$ 570,169,000		$ 605,528,000
Contingencies			$ 28,509,000		$ 30,279,000
Design			$ 33,626,000		$ 34,855,000
Allowances			$ 149,257,000		$ 147,976,000
Total Construction Estimate			**$ 781,561,000**		**$ 818,638,000**

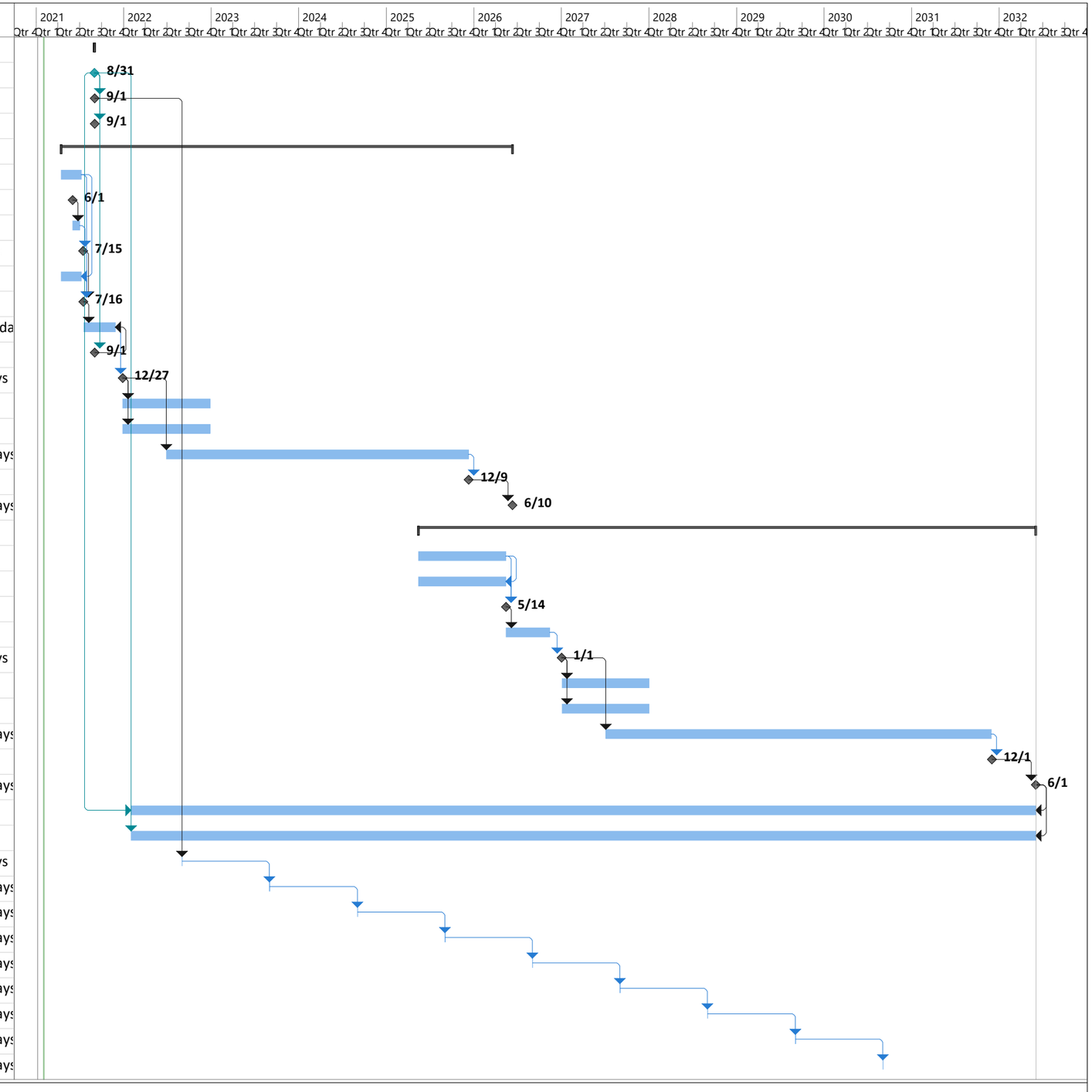
Estimate Notes

The estimat reflects cost for the last quarter of 2020, and include vender pricing for major structural elements such as the bridge joist. A cost of $1.50 CY is assumed for borrow material not furnished from the proposed borrow pit. This cost excludes hauling charges. t is assumed the additioal borrow material is available within 5 of the project.

Appendix C

Pre-CER Schedule

ID	Task Mode	Task Name	Duration	Start	Finish	Predecessors
1		**NEPA**	**2 days**	**8/31/21**	**9/1/21**	
2		FEIS/ROD	1 day	8/31/21	8/31/21	
3		Initial Financial Plan	1 day	9/1/21	9/1/21	2
4		Project Management Plan	1 day	9/1/21	9/1/21	2
5		**Section 1**	**1345 days?**	**4/15/21**	**6/10/26**	
6		S1-Preliminary Design	60 days	4/15/21	7/7/21	
7		S1-RFQ	1 day	6/1/21	6/1/21	
8		S1-SOQ Submittal	21 days	6/2/21	6/30/21	7
9		S1-Shortlist Announced	1 day	7/15/21	7/15/21	8FS+10 days
10		S1-Procurement Documents	60 days	4/15/21	7/7/21	6FF
11		S1-Draft RFP	1 day	7/16/21	7/16/21	6,10,9
12		S1-Design Build Proposal	95 days	7/19/21	11/26/21	11,13FF+21 da
13		S1-Final RFP	1 day?	9/1/21	9/1/21	2
14		S1-Design Build Award	1 day	12/27/21	12/27/21	12FS+20 days
15		S1-Final Design	260 days	12/28/21	12/26/22	14
16		S1-Permits	260 days	12/28/21	12/26/22	14
17		S1-Construction	900 days	6/28/22	12/8/25	14FS+130 days
18		S1-Substantial Completion	1 day	12/9/25	12/9/25	17
19		S1-Contract Completion	1 day	6/10/26	6/10/26	18FS+130 days
20		**Section 2**	**1839 days**	**5/15/25**	**6/1/32**	
21		S2-Preliminary Design	260 days	5/15/25	5/13/26	
22		S2-Procurement Documents	260 days	5/15/25	5/13/26	21FF
23		S2-RFP	1 day	5/14/26	5/14/26	21,22
24		S2-Design Build Proposal	130 days	5/15/26	11/12/26	23
25		S2-Design Build Award	1 day	1/1/27	1/1/27	24FS+20 days
26		S2-Final Design	260 days	1/4/27	12/31/27	25
27		S2-Permits	260 days	1/4/27	12/31/27	25
28		S2-Construction	1150 days	7/5/27	11/28/31	25FS+130 days
29		S2-Substantial Completion	1 day	12/1/31	12/1/31	28
30		S2-Contract Completion	1 day	6/1/32	6/1/32	29FS+130 days
31		Mitigation/Environmental Commitments	2696 days	2/1/22	6/1/32	2SS,30FF
32		Public Involvement	2696 days	2/1/22	6/1/32	2,30FF
33		Project Mgmt Plan/Financial Plan Update #1	1 day	9/1/22	9/1/22	3FS+260 days
34		Project Mgmt Plan/Financial Plan Update #2	1 day	9/1/23	9/1/23	33FS+260 days
35		Project Mgmt Plan/Financial Plan Update #3	1 day	9/2/24	9/2/24	34FS+260 days
36		Project Mgmt Plan/Financial Plan Update #4	1 day	9/2/25	9/2/25	35FS+260 days
37		Project Mgmt Plan/Financial Plan Update #5	1 day	9/2/26	9/2/26	36FS+260 days
38		Project Mgmt Plan/Financial Plan Update #6	1 day	9/2/27	9/2/27	37FS+260 days
39		Project Mgmt Plan/Financial Plan Update #7	1 day	9/1/28	9/1/28	38FS+260 days
40		Project Mgmt Plan/Financial Plan Update #8	1 day	9/3/29	9/3/29	39FS+260 days
41		Project Mgmt Plan/Financial Plan Update #9	1 day	9/3/30	9/3/30	40FS+260 days



Project: I-69 ORX Sections 1 and 2 Project Schedule
Date: 2/2/21

Task — Milestone — Project Summary — Progress
Split — Summary — Manual Summary Rollup

Appendix D

Cost Estimate Review Agenda

MEETING AGENDA

Date: **March 23-26, 2021**
Time: **(see agenda below**
Meeting: **I-69 ORX FHWA Cost Estimate Review (CER) Workshop**
Location: **Teams [link] w/ Teleconference: 951-465-7634; 721 609 148 #**

Date/Time (All times ET)	Description	Attendees
Tuesday 3/23		
9:00 am ~ 9:30 am	Introductions, Opening Presentation – Cost Estimate Review Overview (by FHWA)	PM, States
9:30 am ~ 10:30 am	Project Overview by Project Team – Scope, Procurement Approach, Status (Include Large Blowouts of Project Layout Maps/Google Earth views, etc.)	PM, States
10:30 am ~ 11:30 am	Base Variability, Market Condition, Inflation Rates	PM, States
11:30 am ~ noon	Public Private Partnerships (Discuss justification for use or nonuse of P3 and will document with FHWA's checklist)	PM, States
Noon – 1:00 pm	Lunch	
1:00 pm ~ 3:00 pm	FHWA CER Model Overview – Risk Register Discuss/Quantify Risks/Opportunities Probability/Impact on Project Schedule	Whole Team
3:00 pm	Adjourn	
Wednesday 3/24	Discuss/Quantify Risks/Opportunities Probability/Impact related to the following topics (see daily agenda items below)	
9:00 am – 11:00 am	Drainage, Excavation, Pavement, Barrier, Guardrail, MOT, Signing, Lighting, Striping, Signals, Demolition, Landscaping, Fencing, Tolling, ITS	PM, States, Roadway
11:00 am ~ 12:00 am	Utilities and Environmental	PM, States, Roadway, Util, Env
Noon – 1:00 pm	Lunch	
1:00 pm ~ 3:00 pm	Structures, Geotech, Flooding (Bridges, Walls, etc.)	PM, States, Structures
3:00 pm	Adjourn	
Thurs 3/25		
9:00 am ~ 9:30 am	Soft Costs (Design, PM/CM, other oversight)	PM, States
9:30 am ~ 10:30 am	Right-of-Way Acquisition	PM, States, ROW
10:30 am ~ noon	Review Risk Register and any outstanding items	Whole team

MEETING AGENDA – March 23-26, 2021 FHWA CER Workshop

Date/Time (All times ET)	Description	Attendees
Noon – 1:00 pm	Lunch	
1:00 pm ~ 3:00 pm	Contingency time to complete Risk Register Review FHWA Preparation for Final Presentation	Whole team
3:00 pm	Adjourn	
Friday 3/26		
9:00 am ~ 10:00 am	Walk through of Closing Presentation and comments	PM, States
10:00 am ~ 11:00 am	Closeout Presentation and Q&A	Whole Team
11:00 am - noon	Presentation by Special Designated Project Oversight Manager (SdPOM) – Finance Plan/PMP	PM, States, PMP, FP
Noon	Adjourn	

Attendees/Teams

NAME	ORGANIZATION	EMAIL	PHONE	TEAM
Adam Johnson	FHWA	Adam.Johnson@dot.gov		FHWA
Michelle Allen	FHWA – Indiana	Michelle.Allen@dot.gov		FHWA
Joiner Lagpacan	FHWA - Indiana	Joiner.Lagpacan@dot.gov		FHWA
Eric Rothermel	FHWA – Kentucky	Eric.Rothermel@dot.gov		FHWA
Michael Loyselle	FHWA - Kentucky	Michael.Loyselle@dot.gov		FHWA
Dan Corbin	INDOT	dcorbin@indot.in.gov	317-914-4977	States
Jim Poturalski	INDOT	jpoturalski@indot.in.gov	317-234-0410	States
Kyanna Wheeler	INDOT	KWheeler@indot.in.gov	812-203-2009	States
Brad Rood	INDOT	brood@indot.in.gov		States
Paul Boone	INDOT	pboone@indot.in.gov		States
Laura Hilden	INDOT	lhilden@indot.IN.gov	317-232-5018	Env
Gary Valentine	KYTC	gvalentine@ky.gov	502-782-4965	States
Deneatra Henderson	KYTC	Deneatra.Henderson@ky.gov		States
Jason Ward	KYTC	Jason.Ward@ky.gov		States
Larry Krueger	KYTC	Larry.Krueger@ky.gov		States
Tim Foreman	KYTC	Tim.Foreman@ky.gov		Env
Kelly Divine	KYTC	Kelly.Divine@ky.gov		ROW
Steve Nicaise	Parsons	Steven.Nicaise@parsons.com	502-653-6622	PM
Dan Prevost	Parsons	Daniel.Prevost@parsons.com	513-552-7013	PM
Dave Ayala	Parsons	Dave.Ayala@parsons.com		PM
Junell ODonnell	Parsons	Junell.ODonnell@parsons.com		PM

NAME	ORGANIZATION	EMAIL	PHONE	TEAM
Michael Jackson	Parsons	Michael.Jackson@parsons.com		PM
Roger Stickels	Parsons	Roger.Stickels@parsons.com		PM
Toby Randolph	Parsons	Tobias.Randolph@parsons.com	317-616-1016	Roadway
Chuck Allen	Parsons	Chuck.Allen@parsons.com		Roadway
Kyle Chism	Parsons	Kyle.Chism@parsons.com		Roadway/ Structures
Corinna Goodwin	Parsons	Corinna.Goodwin@parsons.com		Roadway/ Structures
Murat Aydemir	Parsons	Murat.Aydemir@parsons.com		Structures
Martin Furrer	Parsons	Martin.Furrer@parsons.com		Structures
Kenny Franklin	Parsons	Kenny.Franklin@parsons.com		Utilities
Ben Quinn	AEI	benq@aei.cc		PM
Jerry Leslie	AEI	jleslie@aei.cc		Roadway/ Structures
Kevin McClearn	AEI	kmcclearn@aei.cc		Roadway/ Utilities
Dennis Mitchell	AEI	dmitchell@aei.cc		Structures
Ray Robison	Burgess & Niple	ray.robison@burgessniple.com		Roadway/ Structures
Mindy Peterson	C2	mindy@c2strategic.com		Whole Team
Paul Looney	EAP	plooney@eapartners.com		PM
Tamar Henkin	Henkin	tamar@tamarhenkin.com		IFP
Tim Miller	HNTB	TNMiller@HNTB.com		Whole Team, PMP/IFP
Adin McCann	HNTB	amccann@HNTB.com		Whole Team, PMP/IFP
Mark Willis	HNTB	mwillis@hntb.com		Whole Team, PMP/IFP
Catherine Reddick	Mercator	creddick@mercatoradvisors.com		IFP
Brian Aldridge	Stantec	Brian.Aldridge@stantec.com	502-212-5000	PM
Adam Crace	Stantec	adam.crace@stantec.com		Structures
Tony Hunley	Stantec	tony.hunley@stantec.com		Structures
Mark Litkenhus	Stantec	mark.litkenhus@stantec.com		Structures
Mark Askin	Strand	Mark.Askin@strand.com		ROW

Notes:
Whole Team = all CER Invitees
FHWA – Invited to all sessions
Team members to attend sessions for your team and "Whole Team" sessions

Appendix E

Cost Estimate Review Sign-In Sheets

Name	Firm	3/23 - AM	3/23 - PM	3/24 - AM	3/24 - PM	3/25 - Soft Costs	3/25 - RW	3/25 - Risks	3/26 - Overview	3/26 - Closeout	3/26 - IFP/PMP
Adam Johnson	FHWA	X	X	X	X	X	X	X	X	X	X
Bernadette Dupont	FHWA			X							
Boday Borres	FHWA									X	
Chris Youngs	FHWA	X	X	X	X	X	X	X	X	X	
David Whitworth	FHWA	X								X	
Dimas Prasetya	FHWA			X							
Eileen Vaughan	FHWA	X									
Eric Rothermel	FHWA	X	X	X		X			X	X	X
Jay DuMontel	FHWA	X	X	X		X	X	X	X	X	X
Jermaine Hannon	FHWA	X									
Jill Asher	FHWA	X	X		X			X		X	
John Ballantyne	FHWA	X	X								
Joiner Lagpacan	FHWA	X	X	X		X		X			
Jose Ortiz	FHWA	X			X						
Keenan Clarke	FHWA					X					
Keith Hoernschemeyer	FHWA	X								X	X
Michael Loyselle	FHWA	X	X	X	X	X	X	X	X	X	
Michelle Allen	FHWA	X	X	X	X	X	X	X	X	X	X
Todd Jeter	FHWA									X	
Michael Green	Volpe	X	X	X	X	X	X	X	X	X	X
Michael Kay	Volpe	X	X	X	X	X	X		X	X	X
David Carter	Atkins	X	X	X	X	X	X	X	X	X	
Brad Rood	INDOT							X		X	X
Dan Corbin	INDOT	X	X	X	X				X	X	X
Jim Poturalski	INDOT	X	X	X	X	X	X	X		X	X
Laura Hilden	INDOT		X	X							
Deneatra Henderson	KYTC	X	X					X			
Gary Valentine	KYTC	X	X	X	X	X	X	X	X	X	X
Jason Ward	KYTC	X		X	X	X	X	X	X	X	X
John Moore	KYTC									X	
Ron Rigney	KYTC									X	X
Tim Foreman	KYTC			X							
Chuck Allen	Parsons		X	X				X			
Corinna Goodwin	Parsons		X	X	X			X			
Dan Prevost	Parsons			X							
Dave Ayala	Parsons	X	X			X		X	X	X	
Junell O'Donnell	Parsons	X	X	X	X	X	X	X	X	X	X
Kyle Chism	Parsons		X	X	X			X		X	
Martin Furrer	Parsons				X			X		X	
Michael Jackson	Parsons		X	X		X		X	X	X	X
Murat Aydemir	Parsons		X		X			X		X	
Roger Stickels	Parsons				X						
Steve Nicaise	Parsons	X	X	X	X	X	X		X	X	X
Tobias Randolph	Parsons		X	X				X		X	
Todd Bergstrom	Parsons							X			
Ben Quinn	AEI	X	X	X	X	X	X	X			
Dennis Mitchell	AEI		X		X			X		X	
Jerry Leslie	AEI		X	X	X			X		X	
Kevin McClearn	AEI		X	X				X		X	
Mindy Peterson	C2		X					X		X	
Paul Looney	EAP	X	X	X	X	X	X	X	X	X	X
Tamar Henkin	Henkin		X							X	X
Mark Willis	HNTB		X					X		X	
Catherine Reddick	Mercator	X						X			
Mark Litkenhus	Stantec		X		X			X		X	
Mark Askin	Strand						X				

Appendix F

CER Model Results

Crystal Ball Report - Full
Simulation started on 3/25/2021 at 4:23 PM
Simulation stopped on 3/25/2021 at 4:31 PM

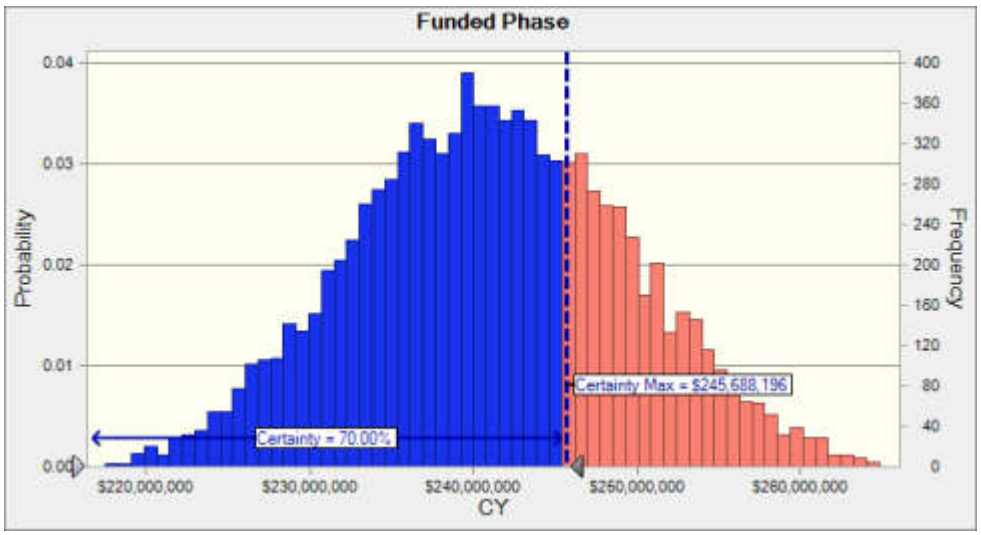
Run preferences:	
Number of trials run	10,000
Monte Carlo	
Random seed	
Precision control on	
Confidence level	95.00%
Run statistics:	
Total running time (sec)	247.55
Trials/second (average)	40
Random numbers per sec	0
Crystal Ball data:	
Assumptions	0
Correlations	0
Correlation matrices	0
Decision variables	0
Forecasts	11

Forecasts

Worksheet: [CER Template v69.5_IR 69 ORC MAR252021 1600 hrs.xlsb]YOE

Forecast: Funded Phase **Cell: C53**

Summary:
Certainty level is 70.00%
Certainty range is from -∞ to $245,688,196
Entire range is from $214,462,688 to $272,504,641
Base case is $233,191,900
After 10,000 trials, the std. error of the mean is $84,317



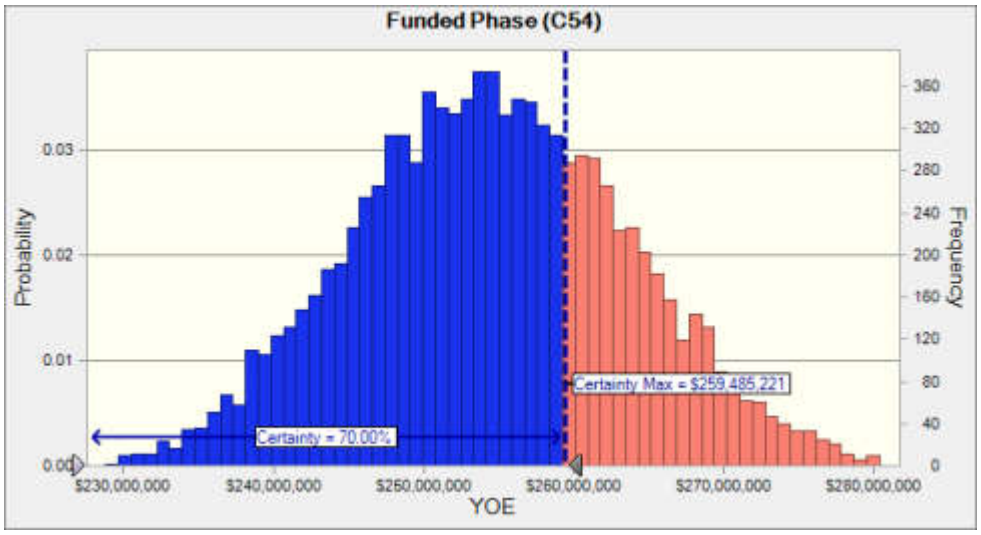
Statistics:	Forecast values
Trials	10,000
Base Case	$233,191,900
Mean	$241,169,514
Median	$241,022,336
Mode	$228,631,164
Standard Deviation	$8,431,727
Variance	$71,094,013,012,288
Skewness	0.0931
Kurtosis	2.82
Coeff. of Variation	0.0350
Minimum	$214,462,688
Maximum	$272,504,641
Range Width	$58,041,953
Mean Std. Error	$84,317

Forecast: Funded Phase (cont'd) **Cell: C53**

Percentiles:	Forecast values
0%	$214,462,688
10%	$230,290,478
20%	$233,921,986
30%	$236,501,340
40%	$238,913,012
50%	$241,021,774
60%	$243,209,248
70%	$245,688,196
80%	$248,343,249
90%	$252,203,859
100%	$272,504,641

Forecast: Funded Phase (C54) **Cell: C54**

Summary:
Certainty level is 70.00%
Certainty range is from -∞ to $259,485,221
Entire range is from $224,829,613 to $288,318,996
Base case is $244,662,040
After 10,000 trials, the std. error of the mean is $91,960



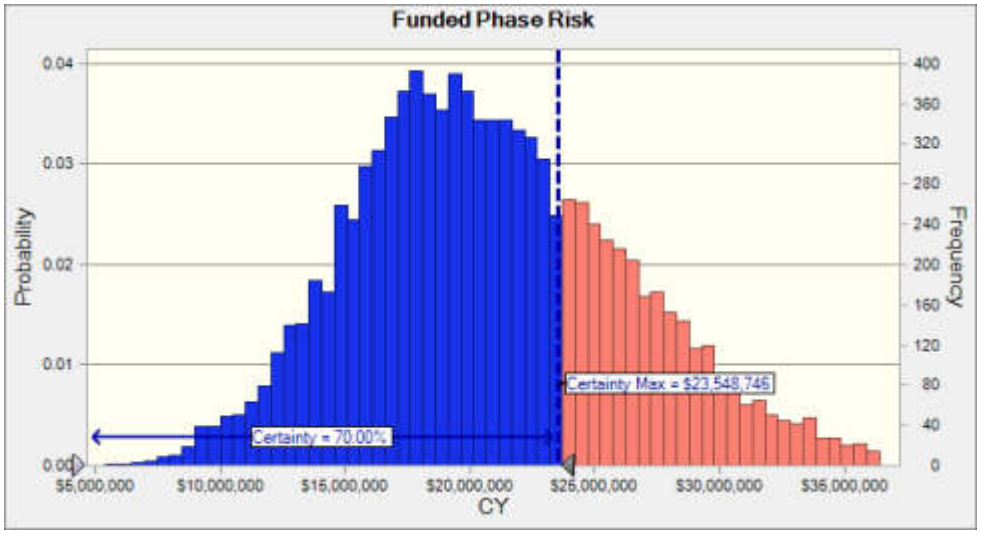
Statistics:	Forecast values	Precision
Trials	10,000	
Base Case	$244,662,040	
Mean	$254,595,019	$180,238
Median	$254,431,009	$179,822
Mode	$240,646,925	
Standard Deviation	$9,195,965	$121,400
Variance	$84,565,765,339,994	
Skewness	0.1020	
Kurtosis	2.81	
Coeff. of Variation	0.0361	
Minimum	$224,829,613	
Maximum	$288,318,996	
Range Width	$63,489,383	
Mean Std. Error	$91,960	

Forecast: Funded Phase (C54) (cont'd) **Cell: C54**

Percentiles:	Forecast values	Precision
0%	$224,829,613	
10%	$242,660,438	$341,504
20%	$246,722,718	$261,707
30%	$249,550,852	$264,904
40%	$252,058,660	$231,361
50%	$254,430,013	$179,822
60%	$256,845,973	$204,340
70%	$259,485,221	$241,954
80%	$262,426,813	$249,491
90%	$266,568,651	$309,380
100%	$288,318,996	

Forecast: Funded Phase Risk **Cell: C55**

Summary:
Certainty level is 70.00%
Certainty range is from -∞ to $23,548,746
Entire range is from $4,534,127 to $43,140,019
Base case is $12,836,667
After 10,000 trials, the std. error of the mean is $55,319



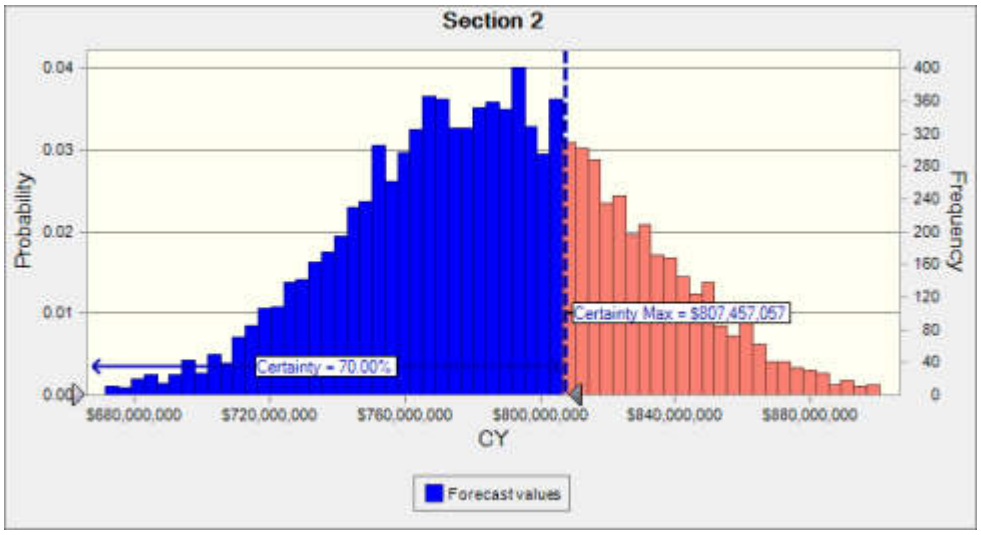
Statistics:	Forecast values
Trials	10,000
Base Case	$12,836,667
Mean	$20,901,592
Median	$20,386,778
Mode	$10,867,533
Standard Deviation	$5,531,898
Variance	$30,601,894,997,782
Skewness	0.3984
Kurtosis	3.05
Coeff. of Variation	0.2647
Minimum	$4,534,127
Maximum	$43,140,019
Range Width	$38,605,892
Mean Std. Error	$55,319

Forecast: Funded Phase Risk (cont'd) **Cell: C55**

Percentiles:	Forecast values
0%	$4,534,127
10%	$14,191,073
20%	$16,216,072
30%	$17,670,780
40%	$19,024,613
50%	$20,386,487
60%	$21,877,036
70%	$23,548,746
80%	$25,552,324
90%	$28,341,162
100%	$43,140,019

Forecast: Section 2 **Cell: C57**

Summary:
Certainty level is 70.00%
Certainty range is from -∞ to $807,457,057
Entire range is from $623,891,090 to $920,021,619
Base case is $779,394,667
After 10,000 trials, the std. error of the mean is $408,004



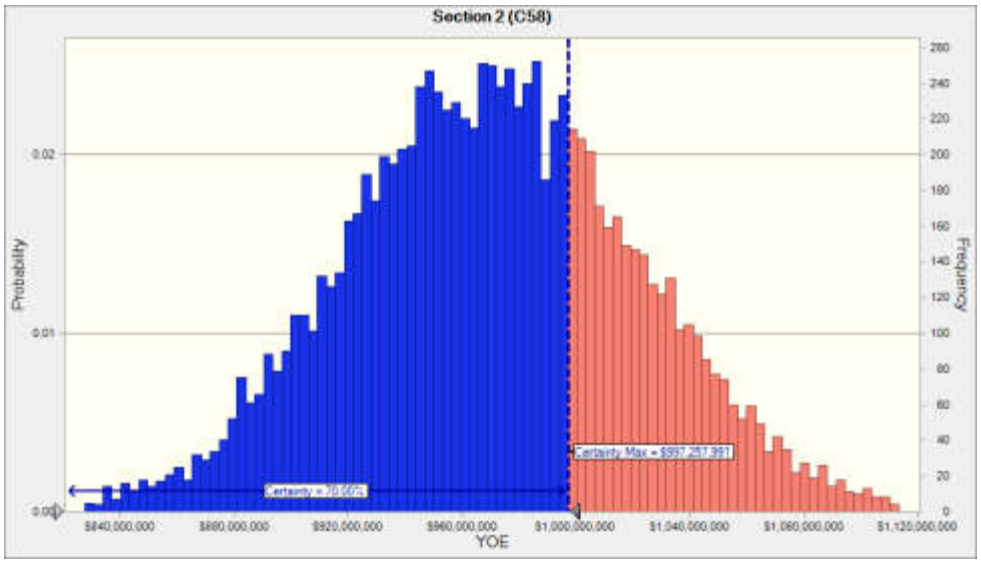
Statistics:	Forecast values
Trials	10,000
Base Case	$779,394,667
Mean	$785,899,699
Median	$785,777,592
Mode	$766,403,315
Standard Deviation	$40,800,375
Variance	##################
Skewness	0.0214
Kurtosis	2.87
Coeff. of Variation	0.0519
Minimum	$623,891,090
Maximum	$920,021,619
Range Width	$296,130,530
Mean Std. Error	$408,004

Forecast: Section 2 (cont'd) **Cell: C57**

Percentiles:	Forecast values
0%	$623,891,090
10%	$733,531,955
20%	$751,325,493
30%	$764,147,138
40%	$774,658,962
50%	$785,777,252
60%	$795,901,370
70%	$807,457,057
80%	$820,503,394
90%	$839,180,417
100%	$920,021,619

Forecast: Section 2 (C58) **Cell: C58**

Summary:
Certainty level is 70.00%
Certainty range is from -∞ to $997,257,991
Entire range is from $771,368,462 to $1,135,558,975
Base case is $963,688,057
After 10,000 trials, the std. error of the mean is $509,531



Statistics:	Forecast values
Trials	10,000
Base Case	$963,688,057
Mean	$970,493,013
Median	$970,260,492
Mode	$949,461,373
Standard Deviation	$50,953,088
Variance	##################
Skewness	0.0249
Kurtosis	2.86
Coeff. of Variation	0.0525
Minimum	$771,368,462
Maximum	$1,135,558,975
Range Width	$364,190,513
Mean Std. Error	$509,531

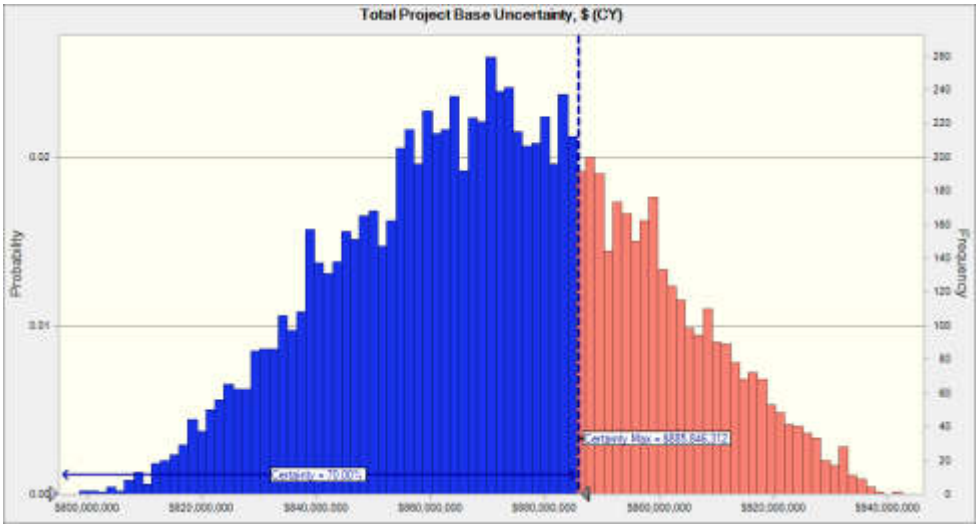
Forecast: Section 2 (C58) (cont'd) **Cell: C58**

Percentiles:	Forecast values
0%	$771,368,462
10%	$905,050,429
20%	$927,286,140
30%	$943,304,775
40%	$956,613,081
50%	$970,251,730
60%	$983,336,722
70%	$997,257,991
80%	$1,013,785,895
90%	$1,036,845,760
100%	$1,135,558,975

Forecast: Total Project Base Uncertainty, $ (CY) **Cell: C38**

Base Uncertainty = Base Variability + Market Conditions
Note base variability and market conditions are included only on the phase table.

Summary:
Certainty level is 70.00%
Certainty range is from -∞ to $885,846,312
Entire range is from $798,363,276 to $942,491,050
Base case is $871,486,233
After 10,000 trials, the std. error of the mean is $260,307



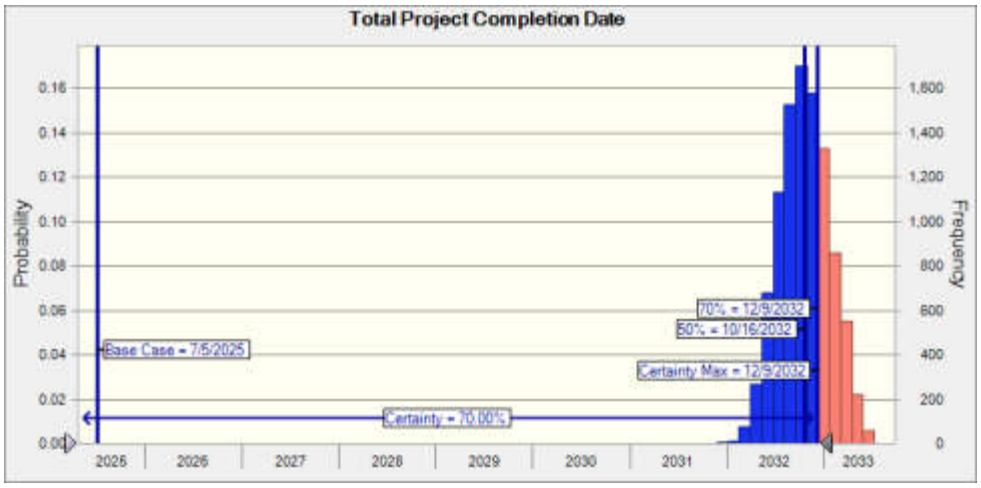
Statistics:	Forecast values	Precision
Trials	10,000	
Base Case	$871,486,233	
Mean	$871,531,487	0.06%
Median	$871,411,685	0.08%
Mode	$855,265,806	
Standard Deviation	$26,030,701	1.19%
Variance	$677,597,410,330,824	
Skewness	0.0088	
Kurtosis	2.49	
Coeff. of Variation	0.0299	
Minimum	$798,363,276	
Maximum	$942,491,050	
Range Width	$144,127,774	
Mean Std. Error	$260,307	

Forecast: Total Project Base Uncertainty, $ (CY) (cont'd) **Cell: C38**

Percentiles:	Forecast values	Precision
0%	$798,363,276	
10%	$836,970,015	0.10%
20%	$848,316,073	0.09%
30%	$857,078,704	0.08%
40%	$864,290,213	0.07%
50%	$871,409,656	0.08%
60%	$878,525,828	0.08%
70%	$885,846,312	0.07%
80%	$894,811,255	0.08%
90%	$906,360,006	0.09%
100%	$942,491,050	

Forecast: Total Project Completion Date **Cell: C48**

Summary:
Certainty level is 70.00%
Certainty range is from -∞ to 12/9/2032
Entire range is from 12/6/2031 to 8/27/2033
Base case is 11/30/2032
After 10,000 trials, the std. error of the mean is 0.9358



Statistics:	Forecast values
Trials	10,000
Base Case	11/30/2032
Mean	10/19/2032
Median	10/17/2032
Mode	7/3/2032
Standard Deviation	93.58
Variance	8,756.82
Skewness	0.0711
Kurtosis	2.64
Coeff. of Variation	0.0019
Minimum	12/6/2031
Maximum	8/27/2033
Range Width	630.17
Mean Std. Error	0.9358

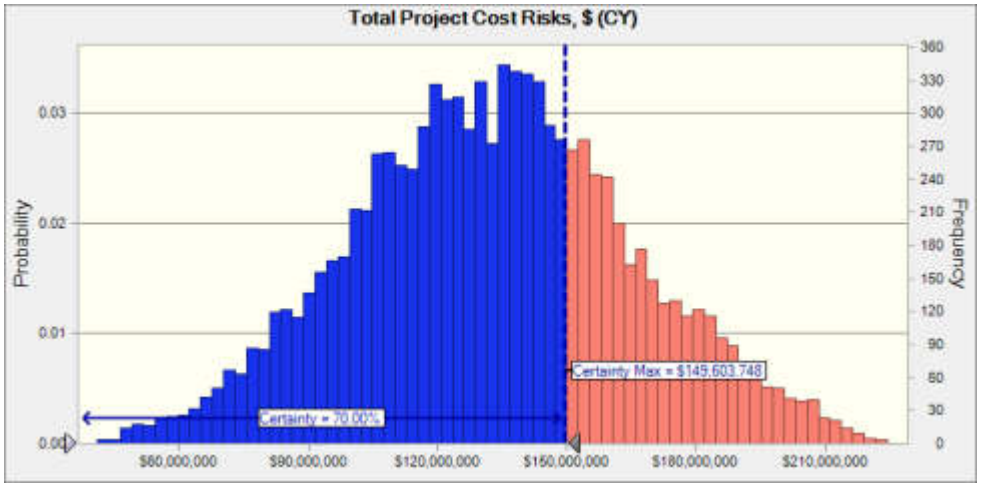
Forecast: Total Project Completion Date (cont'd) **Cell: C48**

Percentiles:	Forecast values
0%	12/6/2031
10%	6/20/2032
20%	7/29/2032
30%	8/28/2032
40%	9/23/2032
50%	10/16/2032
60%	11/12/2032
70%	12/9/2032
80%	1/9/2033
90%	2/21/2033
100%	8/27/2033

Forecast: Total Project Cost Risks, $ (CY) **Cell: C39**

Current Year: Cost Risks

Summary:
Certainty level is 70.00%
Certainty range is from -∞ to $149,603,748
Entire range is from $24,938,098 to $231,855,789
Base case is $118,303,333
After 10,000 trials, the std. error of the mean is $327,190



Statistics:	Forecast values
Trials	10,000
Base Case	$118,303,333
Mean	$132,740,725
Median	$132,775,302
Mode	$104,432,187
Standard Deviation	$32,719,042
Variance	##################
Skewness	0.0237
Kurtosis	2.80
Coeff. of Variation	0.2465
Minimum	$24,938,098
Maximum	$231,855,789
Range Width	$206,917,692
Mean Std. Error	$327,190

Forecast: Total Project Cost Risks, $ (CY) (cont'd) **Cell: C39**

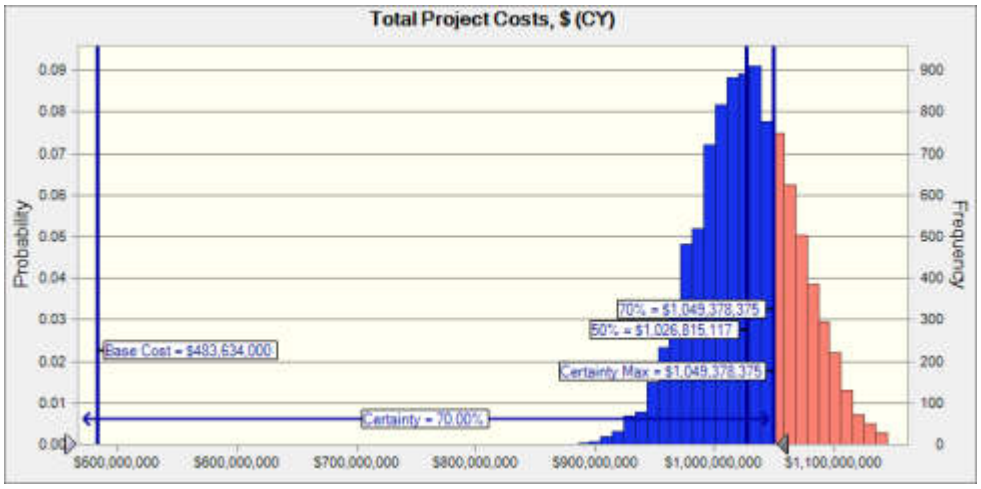
Percentiles:	Forecast values
0%	$24,938,098
10%	$90,378,624
20%	$105,153,336
30%	$115,441,639
40%	$124,117,293
50%	$132,774,929
60%	$140,819,260
70%	$149,603,748
80%	$159,788,534
90%	$176,266,641
100%	$231,855,789

Forecast: Total Project Costs, $ (CY) **Cell: C40**

Current Year: Base Variability + Market Conditions+Risks+Prior+Fixed

Note: Includes base costs, prior costs, fixed costs, and risks

Summary:
Certainty level is 70.00%
Certainty range is from -∞ to $1,049,378,375
Entire range is from $867,659,323 to $1,159,691,778
Base case is $1,012,586,567
After 10,000 trials, the std. error of the mean is $418,433



Statistics:	Forecast values
Trials	10,000
Base Case	$1,012,586,567
Mean	$1,027,069,212
Median	$1,026,815,394
Mode	$995,034,479
Standard Deviation	$41,843,337
Variance	###################
Skewness	0.0139
Kurtosis	2.87
Coeff. of Variation	0.0407
Minimum	$867,659,323
Maximum	$1,159,691,778
Range Width	$292,032,455
Mean Std. Error	$418,433

Forecast: Total Project Costs, $ (CY) (cont'd) **Cell: C40**

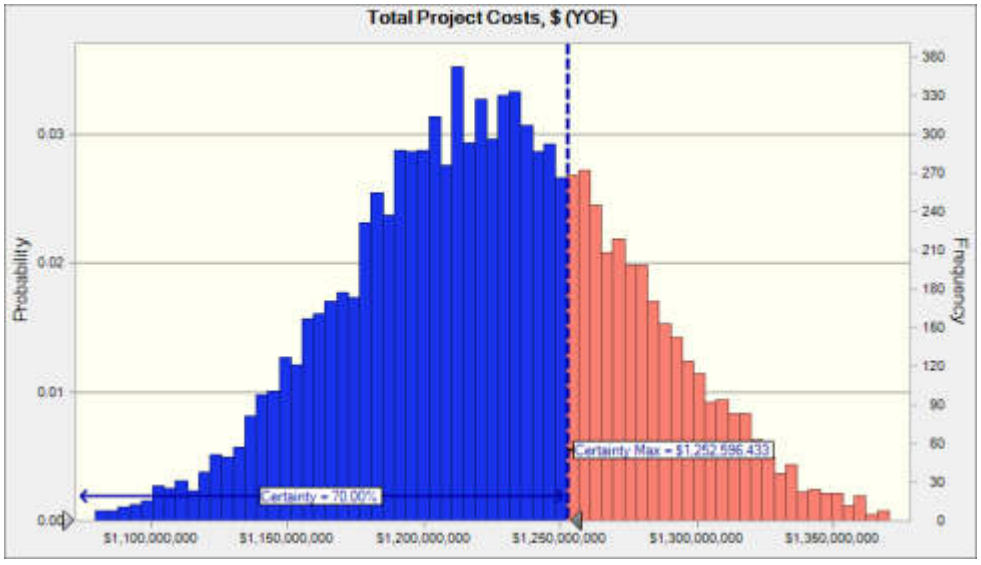
Percentiles:	Forecast values
0%	$867,659,323
10%	$973,350,530
20%	$992,044,451
30%	$1,004,636,164
40%	$1,015,808,460
50%	$1,026,815,117
60%	$1,037,398,085
70%	$1,049,378,375
80%	$1,062,797,093
90%	$1,081,482,073
100%	$1,159,691,778

Forecast: Total Project Costs, $ (YOE) **Cell: C49**

YOE: Base Variability + Market Conditions+Risks+Prior+Fixed

Note: Includes base costs, prior costs, fixed costs, and YOE Costs (base costs adjusted for market conditions and risks) inflated to YOE.

Summary:
Certainty level is 70.00%
Certainty range is from $70 to $1,252,596,433
Entire range is from $1,029,007,198 to $1,387,933,581
Base case is $1,208,350,097
After 10,000 trials, the std. error of the mean is $519,662



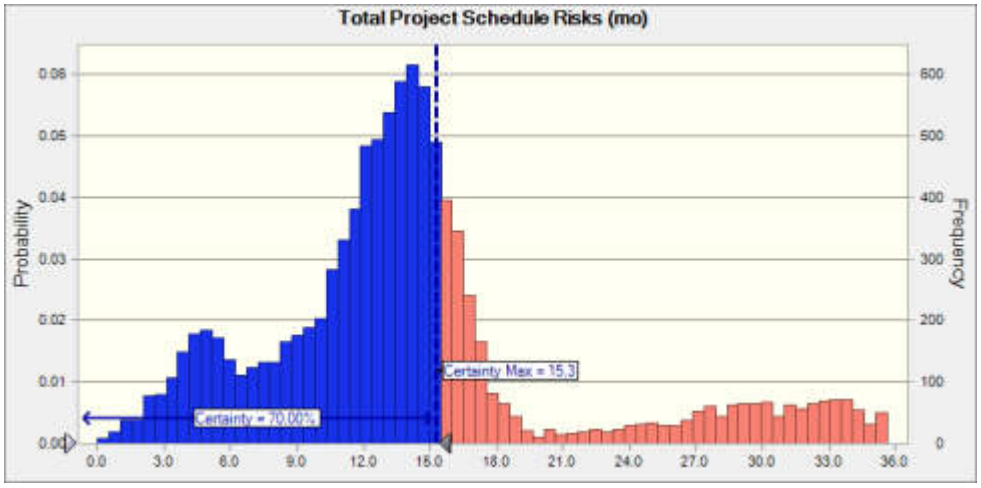
Statistics:	Forecast values
Trials	10,000
Base Case	$1,208,350,097
Mean	$1,225,088,032
Median	$1,224,483,046
Mode	$1,190,108,298
Standard Deviation	$51,966,180
Variance	##################
Skewness	0.0185
Kurtosis	2.87
Coeff. of Variation	0.0424
Minimum	$1,029,007,198
Maximum	$1,387,933,581
Range Width	$358,926,383
Mean Std. Error	$519,662

Forecast: Total Project Costs, $ (YOE) (cont'd) **Cell: C49**

Percentiles:	Forecast values
0%	$1,029,007,198
10%	$1,158,180,873
20%	$1,181,354,915
30%	$1,197,137,161
40%	$1,211,382,682
50%	$1,224,482,645
60%	$1,238,057,164
70%	$1,252,596,433
80%	$1,269,722,154
90%	$1,292,706,565
100%	$1,387,933,581

Forecast: Total Project Schedule Risks (mo) **Cell: C36**

Summary:
Certainty level is 70.00%
Certainty range is from -∞ to 15.3
Entire range is from 0.0 to 41.8
Base case is 6.0
After 10,000 trials, the std. error of the mean is 0.1



Statistics:	Forecast values
Trials	10,000
Base Case	6.0
Mean	14.4
Median	13.5
Mode	0.0
Standard Deviation	7.6
Variance	57.3
Skewness	1.15
Kurtosis	4.27
Coeff. of Variation	0.5243
Minimum	0.0
Maximum	41.8
Range Width	41.8
Mean Std. Error	0.1

Forecast: Total Project Schedule Risks (mo) (cont'd) **Cell: C36**

Percentiles:	Forecast values
0%	0.0
10%	5.5
20%	9.2
30%	11.3
40%	12.5
50%	13.5
60%	14.3
70%	15.3
80%	16.6
90%	27.8
100%	41.8

End of Forecasts

Appendix G

Risk Register

Phase Impacted	Event Risk Name	Probability including Dependency	Low Cost ($)	Most Likely Cost ($)	High Cost ($)	Cost Impact	Cost (Threat/ Opportunity)	Low Schedule (mo)	Likely Schedule (mo)	High Schedule (mo)
CN-Section 1	Capture Design Development Risks (Contractor Design Evolution)	100%	$10,000,000	$11,500,000	$13,000,000	$ 11,500,000	Threat			
CN-Section 1	Flooding - earthwork impacts	25%	$5,250,000	$7,875,000	$10,500,000	$ 7,875,000	Threat	6.0	9.0	12.0
CN-Section 1	Geotechnical uncertainty: The geotechnical data does not only have an impac	90%	$2,650,000	$5,300,000	$8,000,000	$ 5,316,667	Threat			
CN-Section 1	ATCs and DB Innovations	75%	$3,000,000	$5,000,000	$7,000,000	$ 5,000,000	Opportunity			
CN-Section 1	High groundwater impacting availability of on-site materials	50%	$665,000	$3,460,000	$5,320,000	$ 3,148,333	Threat			
CN-Section 1	Owner Directed Change in Scope	50%	$1,000,000	$3,000,000	$5,000,000	$ 3,000,000	Threat			
CN-Section 1	Availability of qualified DBEs / workforce	25%	$1,300,000	$2,650,000	$4,000,000	$ 2,650,000	Threat			
CN-Section 1	Geotechnical uncertainty: Quality of bedrock for foundation -highly weathered	50%	$1,725,000	$2,650,000	$3,500,000	$ 2,625,000	Threat			
CN-Section 1	Big Rivers transmission Line	50%	$675,000	$1,300,000	$2,000,000	$ 1,325,000	Threat	6.0	9.0	12.0
CN-Section 1	Geotechnical uncertainty: Liquefaction and lateral spreading hazards	75%	$665,000	$1,065,000	$1,330,000	$ 1,020,000	Threat			
CN-Section 1	CLOMR/LOMR - acquisition of permit	25%				$ -		3.0	4.5	6.0
CN-Section 1	Delays in obtaining permits 401/404	25%				$ -		3.0	4.5	6.0
CN-Section 1	Delays in obtaining ROW	25%				$ -	Threat	6.0	9.0	12.0
CN-Section 2	ATCs and DB Innovations	75%	$24,000,000	$48,000,000	$60,000,000	$ 44,000,000	Opportunity			
CN-Section 2	Bridge Super Design Allowance	100%	$34,800,000	$40,800,000	$52,800,000	$ 42,800,000	Threat			
CN-Section 2	Efficiency in bridge construction - Site accessability, local road maintance and	75%	$20,000,000	$30,000,000	$60,000,000	$ 36,666,667	Threat			
CN-Section 2	siesmic design secondary structures (secondary bridges)	75%	$23,400,000	$27,600,000	$36,000,000	$ 29,000,000	Threat			
CN-Section 2	Final Design Cost higher than estimated (up to 3%)	75%	$6,000,000	$15,000,000	$24,000,000	$ 15,000,000	Threat			
CN-Section 2	CM and CEI higher than estimated (up to 3%)	50%	$7,200,000	$14,400,000	$21,600,000	$ 14,400,000	Threat			
CN-Section 2	non bridge design development	100%	$12,000,000	$13,800,000	$18,000,000	$ 14,600,000	Threat			
CN-Section 2	Owner Directed Change in Scope	10%	$6,000,000	$9,000,000	$12,000,000	$ 9,000,000	Threat			
CN-Section 2	siesmic design (River Bridge)	50%	$6,600,000	$7,800,000	$10,200,000	$ 8,200,000	Threat			
CN-Section 2	Geotechnical: Soil liquefaction potential	50%	$3,600,000	$7,200,000	$10,800,000	$ 7,200,000	Threat			
CN-Section 2	Geotechnical uncertainty: Quality of bedrock for foundation -highly weathered	35%	$4,800,000	$6,600,000	$8,400,000	$ 6,600,000	Threat			
CN-Section 2	Wildlife crossing issues	95%	$1,200,000	$2,400,000	$3,600,000	$ 2,400,000	Threat			
CN-Section 2	Flooding Year 1	75%	$0	$2,250,000	$4,500,000	$ 2,250,000	Threat	0.0	1.5	3.0
CN-Section 2	Flooding Year 2	75%	$0	$2,250,000	$4,500,000	$ 2,250,000	Threat	0.0	1.5	3.0
CN-Section 2	Flooding Year 3	75%	$0	$2,250,000	$4,500,000	$ 2,250,000	Threat	0.0	1.5	3.0
CN-Section 2	Flooding Year 4	75%	$0	$2,250,000	$4,500,000	$ 2,250,000	Threat	0.0	1.5	3.0
CN-Section 2	CLOMR/LOMR - acquisition of permit	10%				$ -		3.0	4.5	6.0
PE-Section 2	States disagree on procurement process	15%				$ -	Threat	12.0	18.0	24.0