Portsmouth Bypass

August 2013

COST ESTIMATE REVIEW

Final Report

U.S. Department of Transportation

Federal Highway Administration

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EXECUTIVE SUMMARY

A review team (Team) of the Federal Highway Administration (FHWA), the Ohio Department of Transportation (ODOT) and their consultants conducted a Cost Estimate Review (CER) to evaluate the cost and schedule estimates for the proposed Portsmouth Bypass project. The CER was a follow-up to the CER that was conducted for this project in March 2011 based on the Design-Bid-Build (DBB) delivery method and was necessary because of ODOT's decision to adopt a public-private partnership (P3) procurement, in this instance Design-Build-Finance-Operate-Maintain (DBFOM), which significantly changed the project's schedule and combined the project from the previous 3-phase approach under DBB to the combined single project under DBFOM. The CER workshop was held in Columbus, Ohio from August 28 through August 30, 2013. The Team limited their review to the costs and risks (threats and opportunities) associated with project delivery through the completion of construction. Costs associated with the Finance-Operate-Maintain components of the P3 procurement were not included in the CER analysis or results.

The objective of the review was to:

- verify the accuracy and reasonableness of the current project estimate (including all engineering, ROW, construction and other costs) and schedule.
- develop a probability range for the cost estimate that represents the project's current stage of development.
- determine potential schedule impacts on the project cost.

Range of Project Cost

The CER cost probability curve in Figure 1 shows the potential range of project cost in Year of Expenditure (YOE) dollars. FHWA requires the 70% level of confidence value or greater to be used for major project Financial Plans and for published project documents. At a 70% confidence level the CER project cost is $595 million.

The CER results are based on the Team's input related to base estimate variability, market conditions, inflation and risk factors for the project. The resulting range of probable project costs from the 20% to 80% confidence levels is from $519.5 million to $609.3 million.

Based on this review, the 70% level of confidence amount of $595 million (YOE) is the minimum that should be utilized in the financial plan annual update for the project.

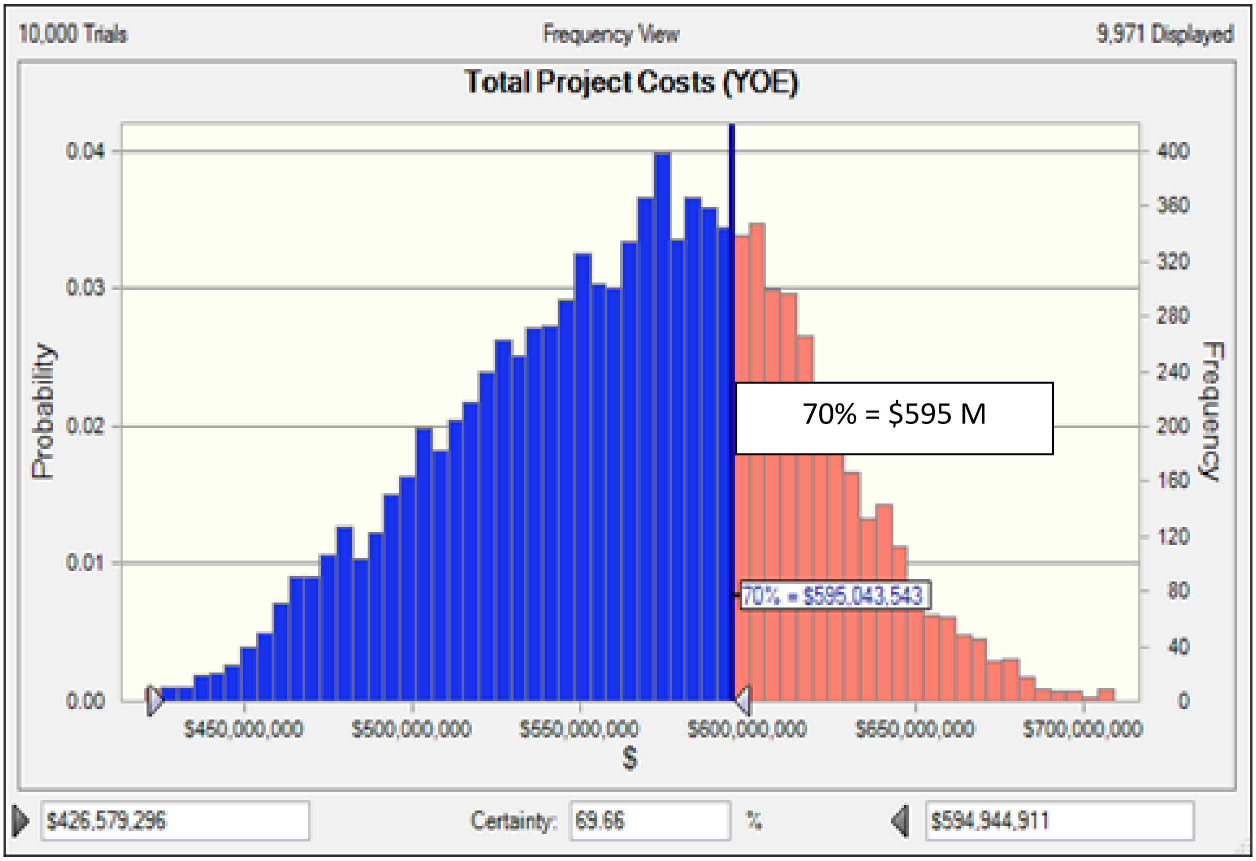


Figure 1: Year of Expenditure Cost Probability Curve

The Team's recommendations are to:

- Continue to manage threats and opportunities through the project's risk management plan, project management team, and communication platforms;
- Elevate awareness of the environmental project risks (wetlands and streams, endangered species) to ensure they receive adequate attention and support, both internally and externally with the regulatory agencies;
- Continue to advance both PAB and TIFIA financing scenarios to reduce potential procurement delays; continue to advance permitting, right-of-way acquisition, and utility relocation activities in parallel with other procurement activities; and
- Use the 70% YOE confidence value in the pending Finance Plan annual update for the Portsmouth Bypass project.

CHAPTER 1 – REVIEW PROCESS

A review team (Team) of the Federal Highway Administration (FHWA), the Ohio Department of Transportation (ODOT) and their consultants conducted a Cost Estimate Review (CER) to evaluate the cost and schedule estimates for the proposed Portsmouth Bypass project. The CER was a follow-up to the CER that was conducted for this project in March 2011 based on the Design-Bid-Build (DBB) delivery method and was necessary because of ODOT's decision to adopt a public-private partnership (P3) procurement, in this instance Design-Build-Finance-Operate-Maintain (DBFOM), which significantly changed the project's schedule and combined the project from the previous 3-phase approach under DBB to the combined single project under DBFOM. The CER workshop was held in Columbus, Ohio from August 28 through August 30, 2013. The Team limited their review to the costs and risks (threats and opportunities) associated with project delivery through the completion of construction. Costs associated with the Finance-Operate-Maintain components of the P3 procurement were not included in the CER analysis or results.

This document summarizes and reports the results of this review. Appendix D of this report includes the Team's close-out presentation provided on August 30 to FHWA, and ODOT management, and the Team.

The purpose of this chapter is to provide a general overview of the cost estimate review process, including 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
- develop a probability range for the cost estimate that represents the current stage of project design.
- determine potential schedule impacts on the project cost.

This review is a snapshot in time and it is recognized that the estimate will change as additional information becomes available.

BASIS OF REVIEW

The Moving Ahead for Progress in the 21st Century (MAP-21) Act (P.L. 112-141) requires the financial plan for all Federal-aid projects with an estimated total cost of $500M or more to be approved by the Secretary (i.e. FHWA) based on reasonable assumptions. The $500M threshold includes all project costs (Engineering, Construction, Right-of-Way, Utilities, Construction Engineering, Inflation, etc.). The FHWA has interpreted reasonable assumptions to be a risk based analysis. Financial plans for projects that are $100-$500 million are subject to review at the discretion of the FHWA Division Office. A CER is required to provide the risk based assessment of the estimate for project over $500M and is used in the approval of the financial plan.

REVIEW TEAM

The Team brought together individuals with a strong knowledge of the project, including expertise in specific disciplines represented in the project design. Throughout the CER individuals with specific project expertise briefed the Team on technical issues and the estimate development process, including the development of quantities, unit prices, assumptions, opportunities and threats.

The Review Team was comprised of members of the following organizations:

- FHWA
    - Division Office – OH and MO
    - Headquarters – Office of Innovative Program Delivery - TIFIA
    - Resource Center
- Ohio DOT
- Consultants

The list of all CER attendees / participants is included in the Appendix on the CER sign-in sheets.

DOCUMENTS REVIEWED

Documents provided to the Review Team prior to and during the workshop included:

- Project Cost Estimate
- Project Schedule
- Project Risk Register
- Project Web Site Link

REVIEW METHODOLOGY

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

- Verify Accuracy of Estimate
  - Review major cost elements
  - Review allowances and contingencies
  - Adjust estimate as necessary
- Discuss / Model
  - Base Variability
  - Market Conditions & Inflation
  - Key Schedule & Cost Risks
- Perform Monte Carlo simulation to generate a project estimate as forecast range
- Communicate Results to FHWA and ODOT leadership and the CER Team

VERIFY ACCURACY OF COST ESTIMATE

The Team was provided a project overview, including the scope of the project, stage of design and the ODOT consultant cost estimating process utilized. The Team interviewed the subject matter experts (SMEs) and developed an understanding of the estimate for both quantity and unit cost for the major cost categories.

MODEL UNCERTAINTIES

In general, uncertainties in the project estimate can be described as those relating to base variability, market risks, inflation and cost and schedule risk events. Each of these were discussed and modeled to reflect the total uncertainty associated with the estimate.

Inflation usually has a significant impact on Year of Expenditure (YOE) Total Project Costs, and its affects were modeled in this review. Costs were inflated using the current project schedule and inflating to the midpoint of the planned expenditure, including any delays where appropriate. The inflation base estimate utilized annual inflation rates per year. (See Table 3, Project Inflation Rates).

Base variability is a measure of uncertainty applied to the base estimate that represents the inherent randomness associated with the estimating process. For example, if a different estimator was to develop the estimate using the same data source and following the same general guidance his/her estimate would be different from the first estimator. Base variability is also a function of the project's current level of design and the process used to develop the estimate. Additionally, the lack of details about the project and assumptions that should be used to develop the estimate would cause more 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 has been applied to the base estimate exclusive of risks. Contingencies that include risks are removed from the estimate to avoid double counting risks identified in the risk register. Allowances, such as items included as percentages of other items in early estimates, and change orders typically remain in the base estimate.

Base variability - is defined using a symmetrical distribution and often stated as a percentage variation from the underlying base estimate. The team considered the variability to be from +/- 7.5%. This assumes the project is relatively well defined, has advanced engineering and identification of issues such that reasonable estimators would be in the range within 7.5% of the current estimate if estimated today.

Market Conditions - The Team discussed the uncertainties associated with Market Conditions at the time of the contractors or suppliers are pricing the project. There is typically a strong relationship between the number of bidders and the cost of a project at the time of pricing. Market conditions are a measure of uncertainty that reflects the overall competitive environment at the time of pricing. The market conditions are applied to the base estimate using a probability for better than planned, as-planned, or worse than planned bidding environments. The market condition probabilities for the Portsmouth Bypass project are shown in Table 1.

Project Element	Market Condition Probability of experiencing cost increase/decrease		
	Better Than Planned	As-Planned	Worse Than Planned
Design-Build	30%	65%	5%

Table 1. Market Condition - Probability of experiencing cost increase/decrease

Table 1 reflects that the Team expects there is a 5% chance that market conditions will increase prices higher than the current estimate (Worse Than Planned) and a 30% chance for a decrease (Better Than Planned) in prices from the current estimate. The Team expected cost variances from the current estimate (As-Planned) as shown in Table 2.

Project Element	Market Condition Cost Impact (Variance from As-Planned)	
	Better Than Planned	Worse Than Planned
Design-Build	15%	10%

Table 2. Market Conditions Variance from "As-Planned"

Table 2 also illustrates that the CER Team generally considered cost decreases would be greater than or equal to increases from the as-planned for market conditions at the time of bid. This demonstrates the Team's consideration that it is likely there will be strong competition during the P3 procurement of this project. Related to the P3 Procurement, there has been industry outreach and the industry has demonstrated interest from multiple entities. This interest has the project team considering the likelihood of robust competition that will drive the pricing to "better-than-planned".

Following the market conditions review, the CER Team discussed the Project cost estimate (See Appendix A), and the risk register for both the cost and the schedule risks was established. The project team provided a risk register prior to the study that was utilized to initially populate the CER risk register. Each of these risks was then analyzed based on current project conditions, and additional risks were added and developed during the CER. Many of the risks from the project team review had been avoided or mitigated, and this information was captured in the

CER risk register. The risk register includes the event risk name, a description of the event, a probability measure of the likelihood the event will occur, and 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.

After models were developed for market conditions, base variability, and risk events the Team utilized the Monte Carlo simulation to generate a probability based estimate of Year of Expenditure Total Project Costs. A simulation is essentially a rigorous extension of a "what-if" or sensitivity analysis that 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 result. It is important that each iteration represent a scenario, or outcome, that is 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 as shown in Figures 1 in the Executive Summary. The key benefit of this process is that probability is associated with costs (See Appendix C).

The Monte Carlo simulation is run using the present day cost estimate. The results are then escalated to the midpoint of the planned expenditures to account for inflation and provide YOE estimates. The inflation rates are shown in Table 3. These inflation rates were provided by ODOT's Bid Analysis & Review Team.

Year	Inflation Rate
2013	1.1%
2014	5.3%
2015	5.5%
2016	5.6%
2017	5.7%
2018	4.0%

Table 3. Project Inflation Rates

COMMUNICATE RESULTS

The last part of the review is to communicate the results. This is accomplished by providing the closeout presentation and final report to both ODOT and FHWA Division leaders. At the end of the review the CER Team provided a closeout presentation that summarized the review findings. The presentation identified the review objectives and agenda, discussed the methodology, available resources, and highlighted the results of the review including the pre/post workshop estimate results and identified any estimate adjustments made during the review. The closeout presentation also identified any significant cost and schedule risks, and provided a brief overview of recommendations by the Review Team. The closeout presentation for this project is included as Appendix D to this report.

It is important to understand that the estimate review is a snapshot in time of the estimate. As additional information becomes available it is expected that the estimate will change and be updated.

This report communicates all findings of the review to the State and Division and serves as the official document for the CER. As noted earlier, the review results are used in published reports and eventually in the approval of the financial plan. CER reports are maintained by the FHWA Office of Innovative Program Delivery's Project Delivery Team in Washington D.C.

CHAPTER 2 – REVIEW SUMMARY

PROJECT BACKGROUND, PURPOSE AND NEED

In 1999, the ODOT initiated the Portsmouth Transportation Study. The study investigated the transportation and economic needs of the Portsmouth area, examined alternate means of addressing the needs, and recommended detailed analysis of the Airport Bypass, a one-mile wide corridor within which a new 16-mile freeway from U.S. route 52 east of New Boston to U.S. route 23 north of Lucasville could be aligned.

The Airport Bypass was chosen to improve regional mobility and to increase potential regional economic development. The Airport Bypass alternative would improve access and opportunities for economic development, and would reduce travel time for existing traffic between Wheelersburg and Lucasville (ODOT reports that at about 14,000 vehicles per day, the travel time reduction saves all drivers a cumulative 1.5 million hours each year).

In the fall of 2001, ODOT began project development, examining the beneficial and adverse impacts of multiple alignment possibilities within the Airport Bypass corridor. The tradeoffs were best balanced by the "Hill Alignment," which was determined to be the preferred alternative in 2004. In June of 2006, the FHWA signed a Record of Decision pursuant to the National Environmental Policy Act (NEPA).

The project described in the 2006 Record of Decision is a new four-lane, limited access freeway, approximately 16 miles in length, bypassing approximately 26 miles of U.S. route 52 and U.S. route 23 through Portsmouth, Ohio. The new roadway includes interchanges with U.S. route 52, State Route 140, a relocated Shumway Hollow road accessing the Scioto County Airport, Lucasville-Minford Road, and U.S, route 23. This will be the largest earthworks project in ODOT's institutional memory. It will set new records for ODOT projects, such as one valley that is likely to require 160 feet of fill between road surface and culverts. It crosses five railroad lines. And, it will require relocation of at least one large electric transmission tower.

The previous design-bid-build delivery method split the project into three independently procured, sequentially constructed segments or phases, with overall completion estimated to be in 2022. In 2013, ODOT decided to use a P3 procurement process and to consolidate the three segments into a single Design-Build-Finance-Operate-Maintain contract. This decision changes some of the important project schedule and cost uncertainties. These changes were addressed by the Team, as were some new uncertainties such as the proposed listing of long-eared bat that are compounded by the new schedule. The new P3 project delivery approach anticipates construction to commence in 2015 and be completed in 2019.

BASE ESTIMATE

The project team provided a cost estimate for the project prior to the workshop. This pre-review estimate of project cost was $507.4 million in present day (2013) costs. This amount included $34.6 million in prior project costs, $70.6 million in Additional ODOT project costs, and $402.2 million in Design Build costs from the expected P3 DBFOM contract. See table 4. The summary of the Design Build costs are shown in Appendix A of this report.

Item Description	Cost Estimate Value (millions)
Prior Project Costs	$34.6
Additional ODOT Project Costs	$70.6
Design-Build Costs (from DBFOM estimate)	$402.2
Base Estimate Beginning the CER	$507.4

Table 4: Base Estimate Beginning the CER

The $70.6 million in Additional ODOT Costs include engineering services, plan development, procurement (legal, financial, technical), ROW, utilities, stipends and environmental mitigation.

BASE ESTIMATE ADJUSTMENTS

During the review of the project and estimate details, the review team adjusted the prior project costs from $34.6 million to $35.5 million. The prior costs include expenses related to environmental documentation and preliminary engineering. The team also made the following adjustments to the Additional ODOT Costs (Table 5) and Design-Build Costs (Table 6) components of the base estimate.

Item	Change to Base Estimate ($ in millions)
Pre-CER Total: $70,600,000 (including $18 M in ROW and $2 M in Utilities)	**$70.6**
Reduce ROW costs from $18 M to $9 M (and include $3 M ROW cost threat in risk register)	($9.0)
Increase Utility costs to $5 M (and include a potential $3 M - $8 M utility cost in the risk register) from $2 M	$3.0
Reduce stream and wetland mitigation from $30 M to $20 M (and include cost opportunity in the risk register that these mitigation costs may be as low as $10 M)	($10.0)
Adjusted Additional ODOT Costs	**$54.6**

Table 5: Adjusted Additional ODOT Costs

Item	Change to Base Estimate ($ in millions)
Pre-CER Total: (2012 $) including design, construction and DBFOM soft costs	**$397.8**
Delete mitigation allowance	($2.4)
Delete stream restoration amount	($5.0)
Increase bridge costs to account for more expensive tall and/or curved bridges	$10.0
Increase MSE wall costs to account for all components of MSE wall construction including backfill	$7.6
Add contingency for construction Change Orders at 3% of base hard construction cost	$11.9
Add $0.5 M for culverts under very deep fills	$0.5
Traffic management costs reduced from 3% to 1% of base hard construction cost	($6.0)
Subtotal Adjusted Costs in 2012 $	$414.4
Inflate Subtotal at 1.1% for 12 months to calculate the adjusted DBFOM construction costs in current 2013 $	**$419.0**

Table 6: Adjusted Design-Build Costs

Table 7 summarizes the adjusted base estimate amount that was used for the CER modeling.

Item Description	Cost Estimate Value (millions)
Prior Project Costs	$35.5
Additional ODOT Project Costs	$54.6
Design-Build Costs (from DBFOM estimate)	$419.0
Base Estimate Used for the CER Modeling	$509.1

Table 7: Adjusted Base Estimate for CER Modeling

SCHEDULE

Table 8 shows the project milestone schedule dates that were used as CER model inputs.

Project Phase / Scope	Schedule Start Date	Scheduled Completion Date
P3 Proposals Due (Market Conditions Considerations)	7/15/2014	
Design-Build	10/1/2014*	12/31/2019

Table 8: Project Summary Schedule Dates

(* - Likely to move back to early 2015)

REVIEW RECOMMENDATIONS

The Team's recommendations are to:

- Continue to manage threats and opportunities through the project's risk management plan, project management team, and communications platforms;
- Elevate awareness of the environmental project risks (wetlands and streams, endangered species) to ensure they receive adequate attention and support, both internally and externally with the regulatory agencies;
- Continue to advance both PAB and TIFIA financing scenarios to reduce potential procurement delays; continue to advance permitting, right-of-way acquisition, and utility relocation activities in parallel with other procurement activities; and
- Use the 70% YOE confidence value in the pending Finance Plan annual update for the Portsmouth Bypass project.

CHAPTER 3 – RISK ANALYSIS

Cost estimates, especially those for Major Projects, usually contain a degree of uncertainty due to unknowns and risks associated with the level of detailed design completion. 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 cost estimate review uncertainties in the Project estimate were modeled by the Team to reflect the opinions of the Subject Matter Experts (SMEs) interviewed. The Team used the Monte-Carlo simulation to incorporate the uncertainties into a forecast curve that represents a range of costs for the Project Probability is an essential component of the decision making process. Probability accounts for the uncertainty and reflects the collective "best guess" of SMEs. A probability distribution can be used to represent the estimate's Total

YOE Project Costs. Since the dollars represent YOE the curve is often referred to as a forecast curve. The forecast curve of YOE Total Project Cost for this Project is discussed below.

COST FORECAST

The forecast distribution curve for the project shown below (and also as Figure 1 in the Executive Summary) reflects all the underlying variation and risks associated with the project. This includes base variability, market conditions at time of letting (i.e. competition; supply and demand), inflation and project risks:

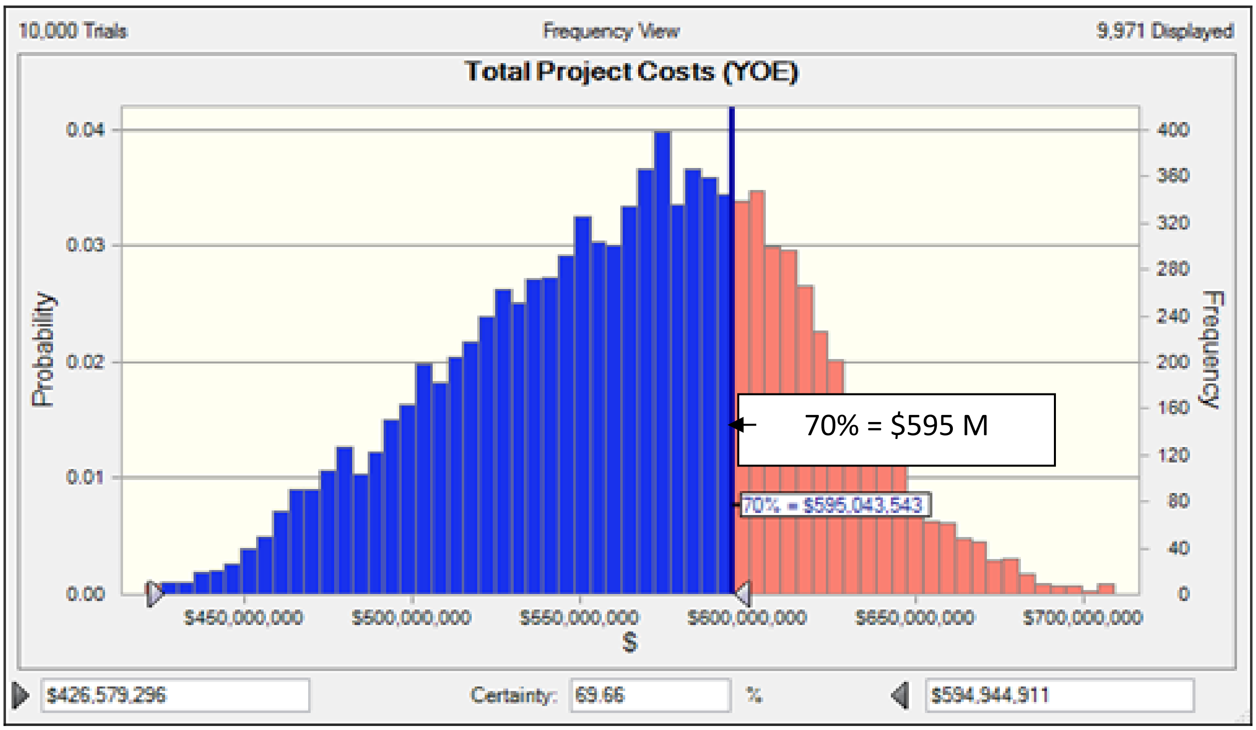


Figure 2. Distribution of Total Project Costs in YOE Dollars

The cost forecast depicted in Figure 2 includes construction, design/engineering, administration / overhead, right-of-way, inflation and contingencies (expressed in YOE dollars), and depict the following:

- The certainty in the Figure 2, shown by the blue shaded (darker shade on left) area, represents a 70% probability that the total project cost will be $595 million dollars or less.

- The red shaded area (lighter shade on right) of the graph represents a 30% probability that total project costs will exceed $595 million based on the underlying variation within the estimate.
- The 70% result of $595 million is higher than the 2011 CER 70% result of $569 million.

The following Table 9 displays the range of the total YOE probability result in Figure 2:

Percentile	Forecast values
0%	$399,376,753
10%	$494,542,860
20%	$519,517,235
30%	$537,818,464
40%	$553,975,894
50%	$568,820,227
60%	$581,703,350
70%	$595,043,543
80%	$609,285,746
90%	$628,105,776
100%	$742,226,996

Table 9. Percentile Rankings of Total Project Costs in YOE Dollars

Table 9 demonstrates that the 20% to 80% range for the cost estimate is from approximately $519.5 to $609.3 million.

PROJECT RISKS (THREATS AND OPPORTUNITIES)

The purpose of the Risk Register is to identify significant cost and schedule risks in the cost estimate. In the traditional cost estimate, risks are often accounted for using estimates of contingency. The Review Team worked together with the SMEs to develop the threats and opportunities shown in the Risk Register in Appendix B to this report. The most significant of these risks that could impact the project included the following:

THREATS TO INCREASE PROJECT COSTS AND/OR SCHEDULE

- **Topography, difficult access and potential long haul distances (10,000 feet +)**
- **404 permitting relative to wetlands and streams mitigation**

- **Endangered species – long eared bat**
- **Availability for disposal of waste material**
- **Higher than estimated ROW costs**
- **Inflation in general is trending up**

OPPORTUNITIES TO REDUCE PROJECT COSTS AND/OR SCHEDULE

- **P3 Procurement**
  - Let the entire project
  - Accelerate Project Completion
    - Reduced construction from 13 years to 5 years
  - Maximize Competition
    - Large national firms
    - Potential to reduce construction from 5 years to 4 years
  - Transfer Risk
    - Funding
    - Construction
  - Innovative Financing Tools
  - Reduce Life Cycle Cost/Risk Uncertainty
- **Procurement strategies encourage innovation and efficiencies:**
  - **Performance based outcomes**
  - **Design flexibility**
- **Economies of scale due to very large volumes, earthwork costs could be lower than currently estimated**
- **Anticipated good market conditions and strong bidding competition**

SCHEDULE FORECAST

Figure 3 displays the schedule forecast based on the CER model inputs, with a 70% confidence level that the project construction will be completed 12/17/2019. The "double-hump" schedule forecast distribution in Figure 3 can be explained by the significant schedule opportunity that was modeled, with the Team determining that there is a 50% likelihood that the successful P3 proposer will complete the construction a full 12 months in advance of the current target completion date of 12/31/2019.

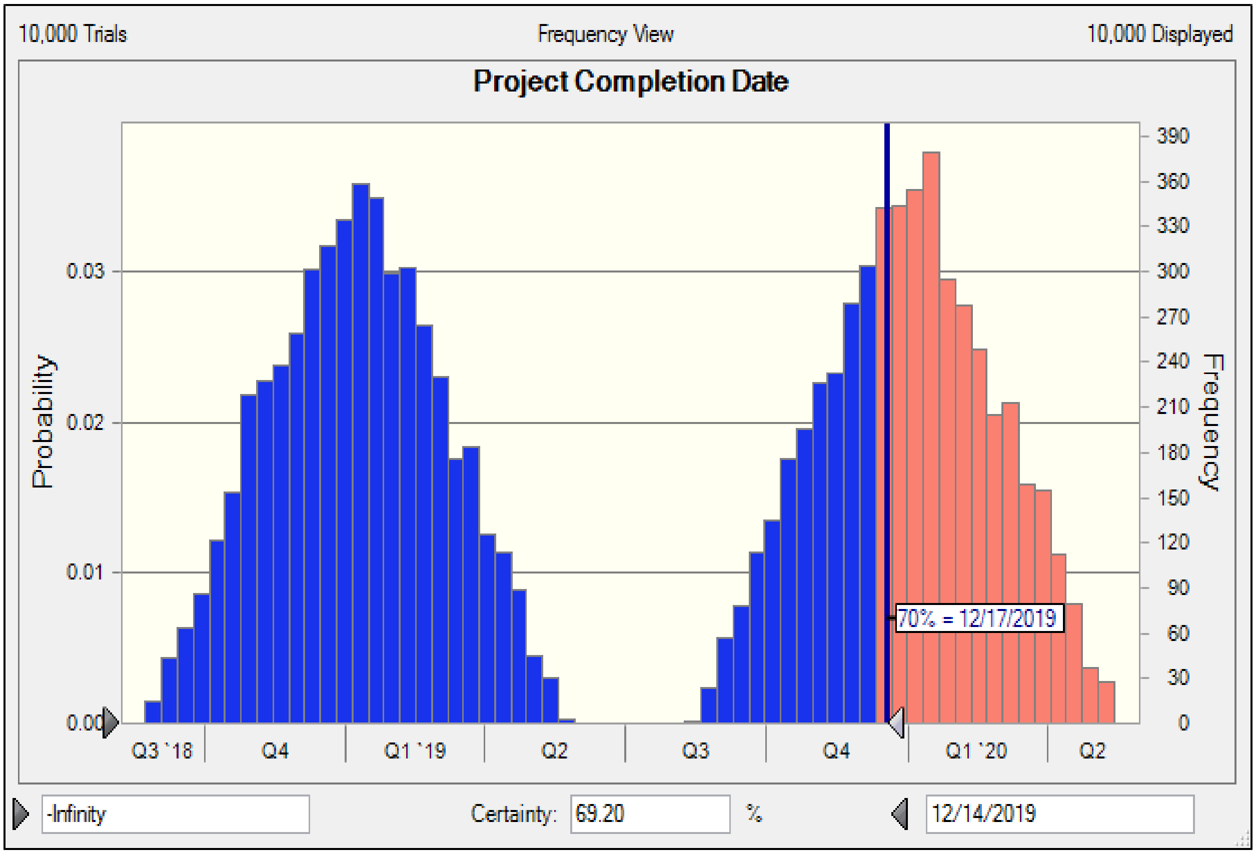


Figure 3: Project potential Schedule Variance

REVIEW CONCLUSION

Based on this review, the 70% level of confidence amount of $595 million (YOE) is the minimum that should be utilized in the financial plan annual update for the project.

APPENDICES

APPENDIX A – Pre-CER Project Cost Estimate

APPENDIX B – CER Risk Register

APPENDIX C – Crystal Ball Probability Analysis Results

APPENDIX D – Closeout Presentation

APPENDIX E – Workshop Agendas and Sign-in Sheets

APPENDIX A – Pre-CER Project Cost Estimate

Preliminary Construction Estimate

ITEM NO.	DESCRIPTION	BASIS		UNITS	ODOT RATE	PHASE 1 3.47 SR823	51%	PHASE 2 6.85 SR823	100% US 23	PHASE 3 5.64 SR823	82% SR140	TOTALS	ESTIMATED COST
442E10000	ASPHALT CONCRETE SURFACE COURSE, 12.5MM, TYPE A (446)	1.5	IN	CU YD	$ 136.72	10,939		15,812		11,590		38,341	$ 5,241,962
407E10000	TACK COAT	0.04	GAL/SY	GALLON	$ 1.91	10,501		15,180		11,127		36,808	$ 70,425
442E10100	ASPHALT CONCRETE INTERMEDIATE COURSE, 19MM, TYPE A (446)	1.75	IN	CU YD	$ 119.71	12,762		18,448		13,522		44,731	$ 5,354,906
407E14000	TACK COAT FOR INTERMEDIATE COURSE	0.075	GAL/SY	GALLON	$ 1.90	19,690		28,462		20,862		69,014	$ 130,982
302E46000	ASPHALT CONCRETE BASE, PG64-22 (5 IN)	5	IN	CU YD	$ 85.00	857		1,679		2,308		4,845	$ 411,796
302E46000	ASPHALT CONCRETE BASE, PG64-22 (6 IN)	6	IN	CU YD	$ 85.00	10,396		14,018		8,763		33,176	$ 2,819,958
302E46000	ASPHALT CONCRETE BASE, PG64-22 (8 IN)	8	IN	CU YD	$ 85.00	43,750		67,079		49,168		159,996	$ 13,599,702
408E10000	PRIME COAT	0.4	GAL/SY	GALLON	$ 3.16	107,303		163,603		132,627		403,533	$ 1,274,509
304E20000	6" AGGREGATE BASE	6	IN	CU YD	$ 37.47	44,710		67,239		54,980		166,928	$ 6,254,329
304E20000	8" AGGREGATE BASE	8	IN	CU YD	$ 37.47	0		1,239		375		1,614	$ 60,456
204E10000	SUBGRADE COMPACTION			SQ YD	$ 1.19	264,468		403,247		327,325		995,040	$ 1,180,458
526E30000	REINFORCED CONCRETE APPROACH SLABS (T=17")	17	IN	SQ YD	$ 227.56	1,941		2,623		2,307		6,870	$ 1,563,388
605E11110	6" SHALLOW PIPE UNDERDRAINS WITH FABRIC WRAP			FT	$ 7.06	54,319		102,829	4,386	90,388		251,922	$ 1,778,388
605E13410	6" DEEP PIPE UNDERDRAINS WITH FABRIC WRAP			FT	$ 11.00	48,807		92,961	3,375	79,384		224,527	$ 2,469,370
	WICK DRAIN ALLOWANCE	$250k	/ mile	MILE	$ 250,000	3.47		6.85		5.64		15.96	$ 3,989,287
606E13000	GUARDRAIL, TYPE 5			FT	$ 11.90	35,810		62,692	5,550	58,400		162,452	$ 1,933,183
609E24510	CURB, TYPE 4-C			FT	$ 16.46	335		536	126	545		1,543	$ 25,391
622E10100	CONCRETE BARRIER, SINGLE SLOPE, TYPE B1			FT	$ 80.15	8,000		23,661	109	15,518		47,288	$ 3,790,173
622E10140	CONCRETE BARRIER, SINGLE SLOPE, TYPE C1			FT	$ 65.19	5,000		12,569	2,052	15,009		34,631	$ 2,257,620
622E10160	CONCRETE BARRIER, SINGLE SLOPE, TYPE D			FT	$ 65.50	4,548		8,849	2,070	1,291		16,758	$ 1,097,684
659E10000	SEEDING AND MULCHING			SQ YD	$ 0.54	1,003,746		1,212,521		1,363,974		3,580,241	$ 1,937,060
659E00300	TOPSOIL			CU YD	$ 5.00	111,527		134,725		151,553		397,805	$ 1,989,023
659E20000	COMMERCIAL FERTILIZER			TON	$ 275.00	141		170		191		501	$ 137,839
659E35000	WATER			M GAL	$ 5.00	5,521		6,669		7,502		19,691	$ 98,457
606E10300	SPECIAL - NOISE BARRIER			SQ FT	$ 31.13					40,012		40,012	$ 1,245,460
840E20000	MECHANICALLY STABILIZED EARTH WALL			SQ FT	$ 21.22	4,222		56,952		80,237		141,411	$ 3,001,104
204E50000	GEOTEXTILE FABRIC			SQ YD	$ 1.19	14,835		11,925		0		26,760	$ 31,833
203E35120	GRANULAR MATERIAL, TYPE C			CU YD	$ 45.68	9,890		0		0		9,890	$ 451,762
203E10000	EXCAVATION, BLASTING & HAUL ($4 to $3/CY per Kokosing, so $3.5/CY)			CU YD	$ 4.00	3,781,887		10,290,109		10,256,697		24,328,693	$ 97,314,772
	~~$4.00 & $1.50 per CY agreed to for Ex & Emb by ODOT on 10/4/12, respectively~~												
XXXX	BLASTING (now included w/ Excavation & increased to 50%)			CU YD	$ -	1,890,944		5,145,055		5,128,349		12,164,347	$ -
XXXX	EXCAVATION, AS PER PLAN			CU YD	$ 1.00							0	$ -
203E20000	EMBANKMENT, WATER, **Borrow** & COMPACTION ($1.5 to $1.13/CY per Kokosing, so $1.25)			CU YD	$ 1.25	3,798,167		9,959,924		14,741,872		28,499,963	$ 35,624,954
XXXX	WASTE			CU YD	$ 1.10	341,124		1,488,351				1,829,475	$ 2,012,423
1.1	BRIDGE CONSTRUCTION			SQ FT	$ 153.03	90,745		145,497		192,409		428,651	$ 65,596,449
1.2	BRIDGE CONSTRUCTION			EACH		7		12		12		31	$ -
201E11000.1	CLEARING AND GRUBBING	$200k	/ mile	MILE	$ 200,000	3.47		6.85		5.64		15.96	$ 3,191,430
	MITIGATION ALLOWANCE	$150k	/ mile	MILE	$ 150,000	3.47		6.85		5.64		15.96	$ 2,393,572
202E56000	BUILDING DEMOLISHED	$100k	/ each	EACH	$ 100,000	3		5		4		12	$ 1,200,000
601E11000	RIPRAP USING 6" REINFORCED CONCRETE SLAB			SQ YD	$ 114.34	191		333	44	311		880	$ 100,677
603E05900	15" CONDUIT, TYPE B			FT	$ 55.38			7,068	815			7,883	$ 436,598
603E07400	18" CONDUIT, TYPE B			FT	$ 56.79			342	185			527	$ 29,926
603E10400	24" CONDUIT, TYPE B			FT	$ 79.05			845	390			1,235	$ 97,625
603E11700	27" CONDUIT, TYPE A			FT	$ 84.54	99						99	$ 8,369
603E13400	30" CONDUIT, TYPE B			FT	$ 94.64	114		115		410		639	$ 60,473
603E16200	36" CONDUIT, TYPE A			FT	$ 101.49	267				52		319	$ 32,375
603E19200	42" CONDUIT, TYPE A			FT	$ 165.17	690		240		248		1,178	$ 194,570
603E20700	48" CONDUIT, TYPE A			FT	$ 233.29	811				280		1,091	$ 254,522
603E22200	54" CONDUIT, TYPE A			FT	$ 311.62	1,451						1,451	$ 452,164
603E23600	60" CONDUIT, TYPE A			FT	$ 200.00	616		4,600		5,325		10,541	$ 2,108,200
603E25000	66" CONDUIT, TYPE A			FT	$ 240.00	1,451		1,350	270	1,666		4,737	$ 1,136,880
603E26000	72" CONDUIT, TYPE A			FT	$ 376.81	947		670	220	888		2,725	$ 1,026,811
603E27000	78" CONDUIT, TYPE A			FT	$ 390.00	612		520		534		1,666	$ 649,740
	90" CONDUIT, TYPE A			FT	$ 750.00	159						159	$ 119,250
603E32000	108" CONDUIT, TYPE A			FT	$ 1,200.00			430		448		878	$ 1,053,600

Preliminary Construction Estimate

ITEM NO.	DESCRIPTION	BASIS		UNITS	ODOT RATE	SR823 (3.47)	51%	SR823 (6.85)	US 23 (100%)	SR823 (5.64)	SR140 (82%)	TOTALS	COST
603E95000	10' X 5' CONDUIT, TYPE A, 706.05			FT	$ 641.13				160	168		328	$ 210,290
604E20514	INLET, NO. 3 FOR SINGLE SLOPE BARRIER, TYPE B1			EACH	$ 5,777.30	30		47		39		116	$ 668,604
604E20524	INLET, NO. 3 FOR SINGLE SLOPE BARRIER, TYPE C1			EACH	$ 7,186.01	0		19		16		35	$ 249,043
604E20530	INLET, NO. 3 FOR SINGLE SLOPE BARRIER, TYPE D			EACH	$ 6,345.32	7		12		10		29	$ 183,306
606E22010	ANCHOR ASSEMBLY, TYPE E-98			EACH	$ 1,709.69	11			1	1		13	$ 21,925
606E26500	ANCHOR ASSEMBLY, TYPE T			EACH	$ 597.92	13			1	1		15	$ 8,864
606E35000	BRIDGE TERMINAL ASSEMBLY, TYPE 1			EACH	$ 1,065.48	13		24	1	21		58	$ 62,082
606E35100	BRIDGE TERMINAL ASSEMBLY, TYPE 2			EACH	$ 333.67	12		23		19		54	$ 17,886
614E12336	WORK ZONE IMPACT ATTENUATOR (UNIDIRECTIONAL)			EACH	$ 1,988.59	1			1	1		2	$ 4,635
614E12338	WORK ZONE IMPACT ATTENUATOR (BIDIRECTIONAL)			EACH	$ 1,807.08	1			2	2		5	$ 8,423
	SMALL SIGNS AND STRIPING (100 SMALLS / MILE)	$ 20	$/LF	FT	$ 20.00	18,315		36,150		29,789		84,254	$ 1,685,075
	LARGE SIGNS (3 LARGES / MILE)	$ 250,000	$/Lmile	MILE	$ 250,000	3.5		7.0		5.5		16	$ 4,000,000
832	EROSION CONTROL	$ 35	$/LF	FT	$ 35.00	18,315		36,150		29,789		84,254	$ 2,948,881
	STREAM RESTORATION			LF	$ 250.00	6,000.0		9,200.0		4,965.0		20,165	$ 5,041,250

TOTAL CONSTRUCTION COST = $ 294,402,146

Preliminary Indirect Costs

ITEM NO.	DESCRIPTION	BASIS		COMMENTS	ESTIMATED COST
	Developer Advisors			See supporting document	$ 7,925,000
	Developer Overheads			See supporting document	$ 12,500,000
	Developer CE&I (4%)	4%			$ 11,776,086
	Design (5%)	5%			$ 14,720,107
	Mobilization (5%)	5%			$ 15,897,716
	Traffic Management (3%)	3%			$ 8,832,064
	Contingency (10%)	10%			$ 31,795,432

TOTAL INDIRECT COST = $ 103,446,405

TOTAL PROJECT COST = $ 397,848,551

APPENDIX B – CER Risk Register

Appendix B

Help Me (Click Me)
(Video: Show Me)

Risk #	Risk Status	Risk Dependency	Guidance for Discrete Probability	Functional Assignment	Phase	YOE Lookup	Event Risk Name	Risk Type	Detailed Description of Risk Event (Specific, Measurable, Attributable, Relevant, Timebound) [SMART]	Proposed Mitigation Action	Probability	Probability (Calcs.)	Probability (HardCode)
													************
1	Active	Independent	Prob<1	CN+CE+CO	Projectwide	CN+CE+CO-Proje	Earthwork	Cost	excavation unit cost	model range	50%	50%	50%
2	Active	Independent	Prob<1	CN+CE+CO	Projectwide	CN+CE+CO-Proje	Earthwork	Cost	embankment unit cost	model range	50%	50%	50%
3	Active	Independent	Prob<1	CN+CE+CO	Projectwide	CN+CE+CO-Proje	Environment	Cost	404 Permit	model and	40%	40%	40%
4	Active	Independent	Prob<1	CN+CE+CO	Projectwide	CN+CE+CO-Proje	Environment	Cost	ESA- long-eared bat	model and	60%	60%	60%
5	Active	Independent	Prob<1	CN+CE+CO	Projectwide	CN+CE+CO-Proje	Right of Way	Cost	settlements and more	model and stay out-of-court	50%	50%	50%
6	Active	Independent	Prob<1	CN+CE+CO	Projectwide	CN+CE+CO-Proje	Utilities	Cost	relocation	model range	50%	50%	50%
7	Active	Independent	Prob<1	CN+CE+CO	Projectwide	CN+CE+CO-Proje	Earthwork	Schedule	P3 capacity creates opportunity	model 4 & 5 years	50%	50%	50%
8	Active	Independent	Prob<1	CN+CE+CO	Projectwide	CN+CE+CO-Proje	Mobilization	Cost	50% chance; 2.5% opportunity	model	50%	50%	50%
9	Active	Independent	Prob<1	CN+CE+CO	Projectwide	CN+CE+CO-Proje	Procurement Method	Cost	DBFOM performance-based contract invites efficiencies and innovations	model range	60%	60%	60%
10	Active	Independent	Prob<1	CN+CE+CO	Global	CN+CE+CO-Globa	**Unidentified Risks**	Cost	Threats not identified (unknown-unknowns)	My Action	50%	50%	50%
11	Active	Independent	Prob<1	CN+CE+CO	Global	CN+CE+CO-Globa	**Unidentified Risks**	Cost	Opportunities not identified (unknown-unknowns)	My Action	50%	50%	50%

Risk #	Assumption Name	10% Cost	Most Likely Cost	90% Cost	Cost Impact	Correlation Prior Cost Risk	Cost Risk (Threat/ Opportunity)	Probable Cost Impact ($$$)	Assumption Name	10% Schedule (Mo)	Most Likely Schedule (Mo)	90% Schedule (Mo)	Schedule Impact	Schedule Risk (Threat/ Opportunity)	Correlation (Cost/ Duration)	Probable Schedule Impact (Mo)
	Min	10	ML	90	Max											
					************			$ (11,299,999)					*********			-6.001
1	ci 1Earthwork	$ -	$ 12,500,000	$ 25,000,000	$ 12,500,000	Nil	Opportunity	$ (6,250,000)	si 1Earthwork	0	0.01	0.02	0.01	Threat		0.005
2	ci 2Earthwork	$ (7,100,000)	$ -	$ 3,400,000	$ -	Nil	Opportunity	$ -	si 2Earthwork	0	0.01	0.02	0.01	Opportunity		-0.005
3	ci 3Environment	$ -	$ 5,000,000	$ 10,000,000	$ 5,000,000	Nil	Opportunity	$ (2,000,000)	si 3Environment	0	0.01	0.02	0.01	Threat		0.004
4	ci 4Environment	$ -	$ 5,000,000	$ 12,000,000	$ 5,000,000	Nil	Threat	$ 3,000,000	si 4Environment	0	0.01	0.02	0.01	Opportunity		-0.006
5	ci 5Right of Way	$ -	$ 1,500,000	$ 3,000,000	$ 1,500,000	Nil	Threat	$ 750,000	si 5Right of Way	0	0.01	0.02	0.01	Threat		0.005
6	ci 6Utilities	$ (2,000,000)	$ 1	$ 3,000,000	$ 1	Nil	Threat	$ 1	si 6Utilities	0	0.01	0.02	0.01	Opportunity		-0.005
7	ci 7Earthwork	$ 0	$ 0	$ 0	$ 1	Nil	Threat	$ 1	si 7Earthwork	12	12	12	12	Opportunity		-6
8	ci 8Mobilization	$ -	$ 4,000,000	$ 8,000,000	$ 4,000,000	Nil	Opportunity	$ (2,000,000)	si 8Mobilization	0	0.01	0.02	0.01	Opportunity		-0.005
9	ci 9Procurement Met	$ -	$ 8,000,000	$ 16,000,000	$ 8,000,000	Nil	Opportunity	$ (4,800,000)	si 9Procurement Me	0	0.01	0.02	0.01	Threat		0.006
10	ci 10Unidentified Risk	$ 2,430,000	$ 2,700,000	$ 2,970,000	$ 2,700,000	Nil	Threat	$ 1,350,000	si 10Unidentified Ris	0	0.01	0.02	0.01	Threat		0.005
11	ci 11Unidentified Risk	$ 2,430,000	$ 2,700,000	$ 2,970,000	$ 2,700,000	Nil	Opportunity	$ (1,350,000)	si 11Unidentified Ris	0	0.01	0.02	0.01	Opportunity		-0.005

APPENDIX C – Crystal Ball Probability Analysis

Crystal Ball Report - Full
Simulation started on 8/30/2013 at 9:04 AM
Simulation stopped on 8/30/2013 at 9:04 AM

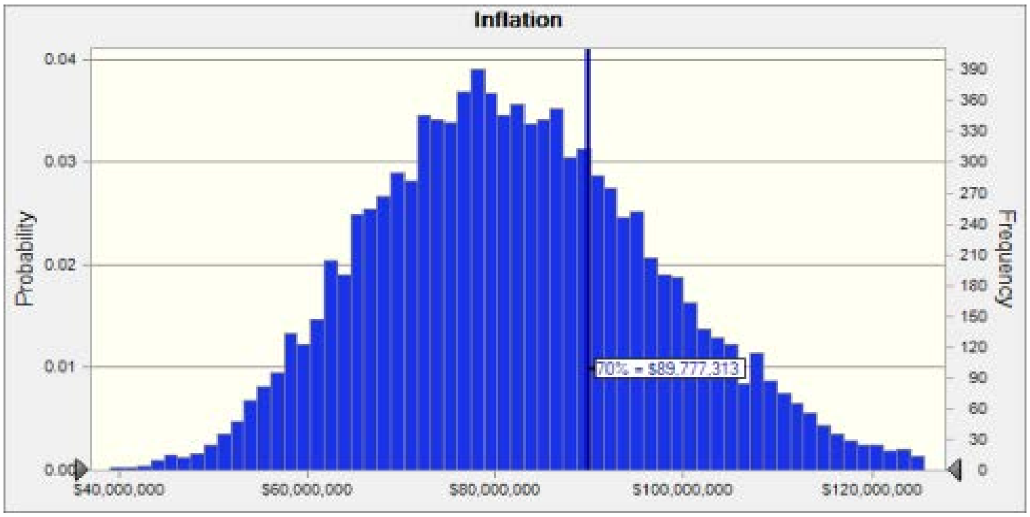
Run preferences:	
Number of trials run	10,000
Monte Carlo	
Random seed	
Precision control on	
Confidence level	95.00%
Run statistics:	
Total running time (sec)	28.75
Trials/second (average)	348
Random numbers per sec	19,829
Crystal Ball data:	
Assumptions	57
Correlations	0
Correlated groups	0
Decision variables	0
Forecasts	5

Forecasts

Worksheet: [Portsmouth Bypass CER August 2013 v3.0 with refined inflation low and high range

Forecast: Inflation **Cell: C20**

Summary:
Entire range is from $37,902,679 to $156,494,249
Base case is $80,345,353
After 10,000 trials, the std. error of the mean is $154,045



Statistics:	Forecast values	Precision
Trials	10,000	
Base Case	$80,345,353	
Mean	$82,309,405	0.37%
Median	$81,411,506	0.50%
Mode	---	
Standard Deviation	$15,404,514	1.39%
Variance	#################	
Skewness	0.3215	
Kurtosis	3.01	
Coeff. of Variability	0.1872	
Minimum	$37,902,679	
Maximum	$156,494,249	
Range Width	$118,591,570	
Mean Std. Error	$154,045	

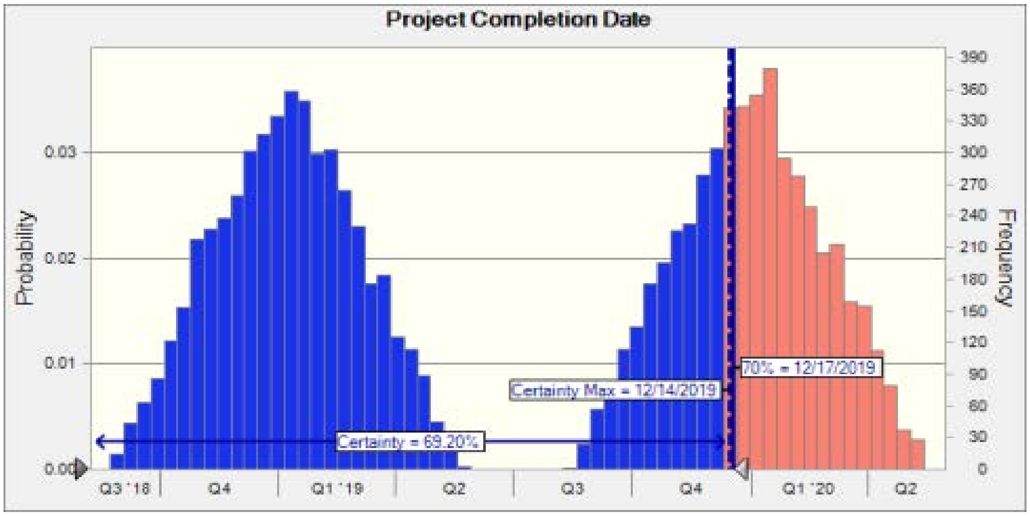
Forecast: Inflation (cont'd) **Cell: C20**

Percentiles:	Forecast values	Precision
0%	$37,902,679	
10%	$63,046,997	0.68%
20%	$68,979,618	0.50%
30%	$73,510,858	0.46%
40%	$77,518,473	0.41%
50%	$81,410,081	0.50%
60%	$85,530,864	0.43%
70%	$89,777,313	0.48%
80%	$95,118,099	0.43%
90%	$102,789,678	0.56%
100%	$156,494,249	

Attachment C

Forecast: Project Completion Date **Cell: C21**

Summary:
Certainty level is 69.20%
Certainty range is from -Infinity to 12/14/2019
Entire range is from 8/22/2018 to 5/12/2020
Base case is 7/3/2019
After 10,000 trials, the std. error of the mean is 1.88



Statistics:	Forecast values	Precision
Trials	10,000	
Base Case	7/3/2019	
Mean	7/6/2019	1/3/1900
Median	9/2/2019	3/21/1900
Mode	---	
Standard Deviation	187.74	1.06
Variance	35,248.12	
Skewness	-0.0147	
Kurtosis	1.33	
Coeff. of Variability	0.0043	
Minimum	8/22/2018	
Maximum	5/12/2020	
Range Width	628.85	
Mean Std. Error	1.88	

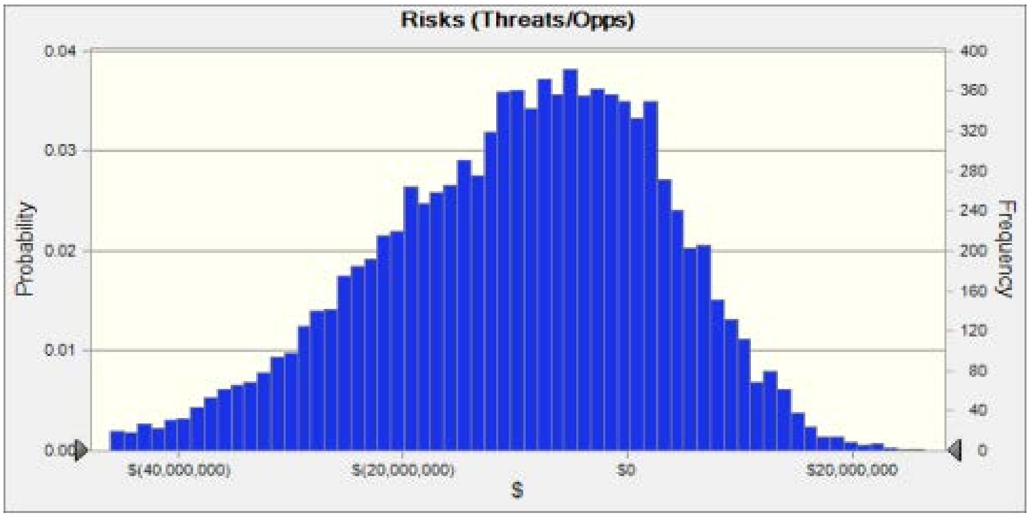
Forecast: Project Completion Date (cont'd) **Cell: C21**

Percentiles:	Forecast values	Precision
0%	8/22/2018	
10%	11/15/2018	1/2/1900
20%	12/23/2018	1/2/1900
30%	1/21/2019	1/2/1900
40%	2/26/2019	1/4/1900
50%	9/2/2019	3/21/1900
60%	11/11/2019	1/4/1900
70%	12/17/2019	1/2/1900
80%	1/14/2020	1/1/1900
90%	2/19/2020	1/2/1900
100%	5/12/2020	

Attachment C

Forecast: Risks (Threats/Opps) **Cell: C17**

Summary:
Entire range is from $(62,466,816) to $30,850,879
Base case is $(11,299,999)
After 10,000 trials, the std. error of the mean is $129,220



Statistics:	Forecast values	Precision
Trials	10,000	
Base Case	$(11,299,999)	
Mean	$(9,828,279)	$253,267
Median	$(8,536,320)	$315,325
Mode	$0	
Standard Deviation	$12,922,049	$179,934
Variance	################	
Skewness	-0.4440	
Kurtosis	3.02	
Coeff. of Variability	-1.31	
Minimum	$(62,466,816)	
Maximum	$30,850,879	
Range Width	$93,317,695	
Mean Std. Error	$129,220	

Forecast: Risks (Threats/Opps) (cont'd) **Cell: C17**

Percentiles:	Forecast values	Precision
0%	$(62,466,816)	
10%	$(27,339,428)	$442,233
20%	$(20,730,439)	$424,163
30%	$(16,050,083)	$402,595
40%	$(11,891,433)	$329,617
50%	$(8,537,602)	$315,325
60%	$(5,258,506)	$279,048
70%	$(2,030,617)	$274,607
80%	$1,400,891	$264,974
90%	$5,739,475	$333,374
100%	$30,850,879	

Attachment C

Forecast: Total Project Costs (CY) **Cell: C18**

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

Summary:
Certainty level is 69.71%
Certainty range is from -Infinity to $506,645,226
Entire range is from $354,344,359 to $608,275,291
Base case is $497,800,001
After 10,000 trials, the std. error of the mean is $413,969

Statistics:	Forecast values	Precision
Trials	10,000	
Base Case	$497,800,001	
Mean	$482,566,434	$811,364
Median	$486,056,031	$1,074,754
Mode	---	
Standard Deviation	$41,396,881	$521,490
Variance	#################	
Skewness	-0.2232	
Kurtosis	2.65	
Coeff. of Variability	0.0858	
Minimum	$354,344,359	
Maximum	$608,275,291	
Range Width	$253,930,932	
Mean Std. Error	$413,969	

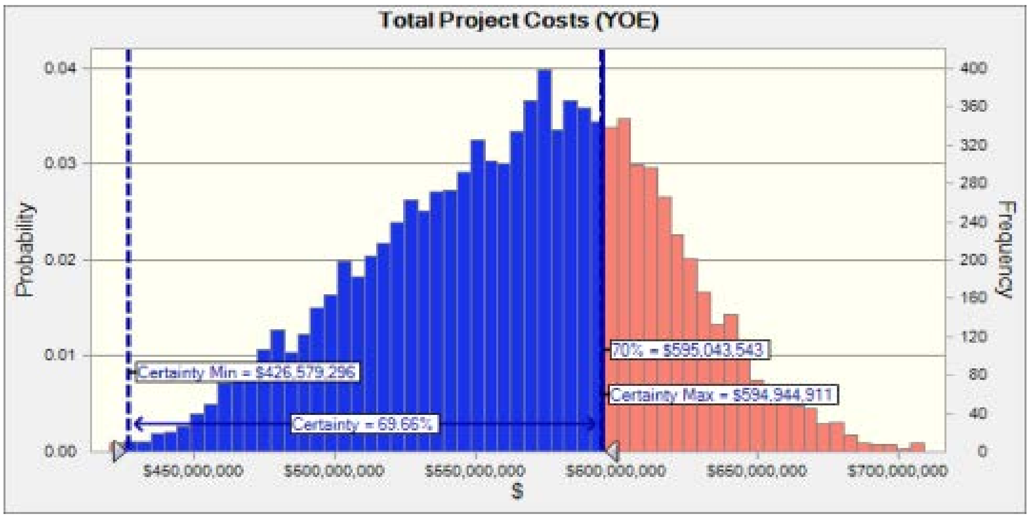
Forecast: Total Project Costs (CY) (cont'd) **Cell: C18**

Percentiles:	Forecast values	Precision
0%	$354,344,359	
10%	$424,549,912	$1,363,322
20%	$445,912,157	$1,312,612
30%	$461,429,669	$1,308,138
40%	$474,344,120	$1,179,699
50%	$486,055,958	$1,074,754
60%	$496,989,917	$878,592
70%	$507,074,097	$1,041,307
80%	$518,067,892	$1,018,503
90%	$533,285,325	$1,261,818
100%	$608,275,291	

Forecast: Total Project Costs (YOE) **Cell: C19**

Includes base costs, prior costs, fixed costs, risks, and inflation

Summary:
Certainty level is 69.66%
Certainty range is from $426,579,296 to $594,944,911
Entire range is from $399,376,753 to $742,226,996
Base case is $578,145,354
After 10,000 trials, the std. error of the mean is $515,334



Statistics:	Forecast values	Precision
Trials	10,000	
Base Case	$578,145,354	
Mean	$564,875,838	$1,010,036
Median	$568,822,697	$1,201,338
Mode	---	
Standard Deviation	$51,533,405	$659,628
Variance	#################	
Skewness	-0.1648	
Kurtosis	2.71	
Coeff. of Variability	0.0912	
Minimum	$399,376,753	
Maximum	$742,226,996	
Range Width	$342,850,242	
Mean Std. Error	$515,334	

Forecast: Total Project Costs (YOE) (cont'd) **Cell: C19**

Percentiles:	Forecast values	Precision
0%	$399,376,753	
10%	$494,542,860	$1,669,380
20%	$519,517,235	$1,664,463
30%	$537,818,464	$1,551,640
40%	$553,975,894	$1,440,749
50%	$568,820,227	$1,201,338
60%	$581,703,350	$1,262,177
70%	$595,043,543	$1,095,877
80%	$609,285,746	$1,205,321
90%	$628,105,776	$1,371,387
100%	$742,226,996	

End of Forecasts

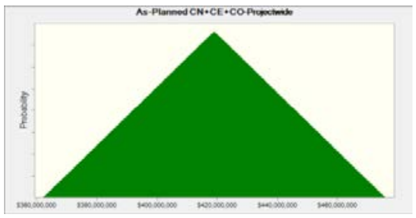
Assumptions

Worksheet: [Portsmouth Bypass CER August 2013 v3.0 with refined inflation low and high range:

Assumption: As-Planned CN+CE+CO-Projectwide **Cell: L44**

Triangular distribution with parameters:

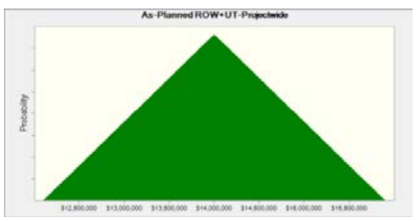
10%	$387,575,000	(=I36)
Likeliest	$419,000,000	(=J36)
90%	$450,425,000	(=K36)



Assumption: As-Planned ROW+UT-Projectwide **Cell: L43**

Triangular distribution with parameters:

10%	$12,950,000	(=I35)
Likeliest	$14,000,000	(=J35)
90%	$15,050,000	(=K35)

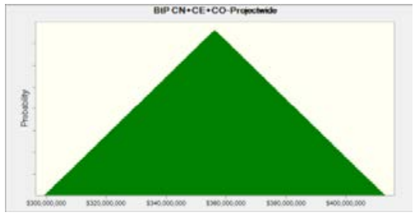


Assumption: BtP CN+CE+CO-Projectwide **Cell: K44**

Triangular distribution with parameters:

10%	$324,725,000	(=F36)
Likeliest	$356,150,000	(=G36)
90%	$387,575,000	(=H36)

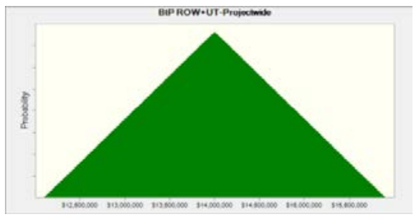
Assumption: BtP CN+CE+CO-Projectwide (cont'd) **Cell: K44**



Assumption: BtP ROW+UT-Projectwide **Cell: K43**

Triangular distribution with parameters:

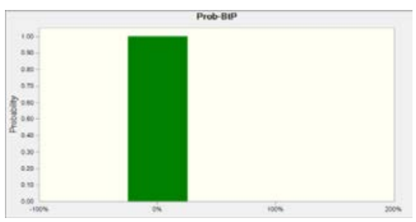
10%	$12,950,000	(=F35)
Likeliest	$14,000,000	(=G35)
90%	$15,050,000	(=H35)



Assumption: Prob-BtP **Cell: I43**

Yes-No distribution with parameters:

Probability of Yes(1)	0.0	(=D43)

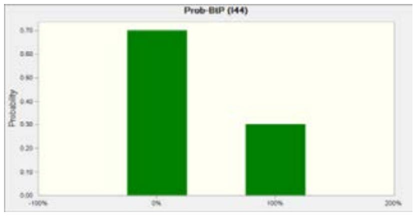


Assumption: Prob-BtP (I44) **Cell: I44**

Yes-No distribution with parameters:

Probability of Yes(1)	0.3	(=D44)

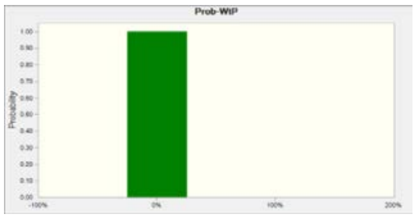
Assumption: Prob-BtP (I44) (cont'd) **Cell: I44**



Assumption: Prob-WtP **Cell: J43**

Yes-No distribution with parameters:

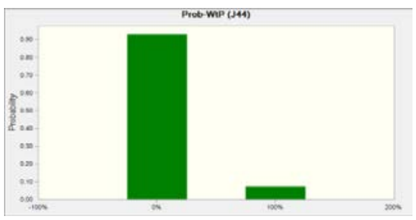
Probability of Yes(1)	0.0	(=E43)



Assumption: Prob-WtP (J44) **Cell: J44**

Yes-No distribution with parameters:

Probability of Yes(1)	0.0714285714286	(=E44)

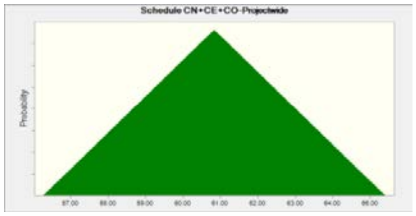


Assumption: Schedule CN+CE+CO-Projectwide **Cell: L17**

Triangular distribution with parameters:

Minimum	56.27	(=J17*(1-K17))
Likeliest	60.83	(=J17)
Maximum	65.40	(=J17*(1+K17))

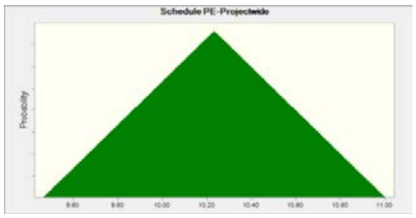
Assumption: Schedule CN+CE+CO-Projectwide (cont'd) **Cell: L17**



Assumption: Schedule PE-Projectwide **Cell: L15**

Triangular distribution with parameters:

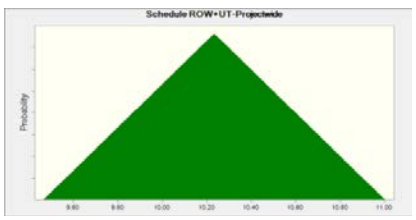
Minimum	9.47	(=J15*(1-K15))
Likeliest	10.23	(=J15)
Maximum	11.00	(=J15*(1+K15))



Assumption: Schedule ROW+UT-Projectwide **Cell: L16**

Triangular distribution with parameters:

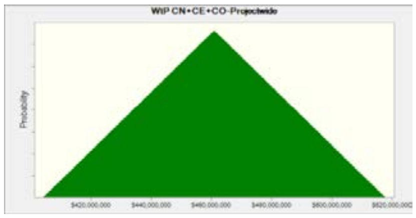
Minimum	9.47	(=J16*(1-K16))
Likeliest	10.23	(=J16)
Maximum	11.00	(=J16*(1+K16))



Assumption: WtP CN+CE+CO-Projectwide **Cell: M44**

Triangular distribution with parameters:

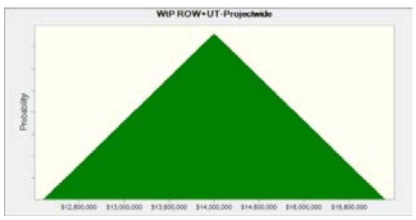
10%	$429,475,000	(=L36)
Likeliest	$460,900,000	(=M36)
90%	$492,325,000	(=N36)



Assumption: WtP ROW+UT-Projectwide **Cell: M43**

Triangular distribution with parameters:

10%	$12,950,000	(=L35)
Likeliest	$14,000,000	(=M35)
90%	$15,050,000	(=N35)



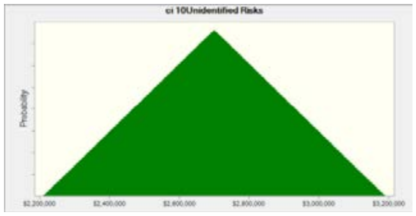
Worksheet: [Portsmouth Bypass CER August 2013 v3.0 with refined inflation low and high range

Assumption: ci 10Unidentified Risks **Cell: S19**

Triangular distribution with parameters:

10%	$2,430,000	(=P19)
Likeliest	$2,700,000	(=Q19)
90%	$2,970,000	(=R19)

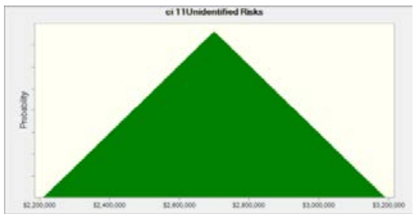
Assumption: ci 10Unidentified Risks (cont'd) **Cell: S19**



Assumption: ci 11Unidentified Risks **Cell: S20**

Triangular distribution with parameters:

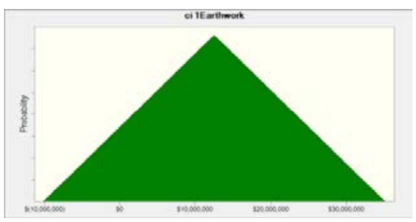
10%	$2,430,000	(=P20)
Likeliest	$2,700,000	(=Q20)
90%	$2,970,000	(=R20)



Assumption: ci 1Earthwork **Cell: S10**

Triangular distribution with parameters:

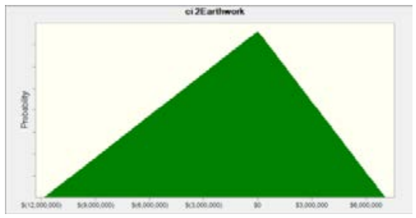
10%	$0	(=P10)
Likeliest	$12,500,000	(=Q10)
90%	$25,000,000	(=R10)



Assumption: ci 2Earthwork **Cell: S11**

Triangular distribution with parameters:

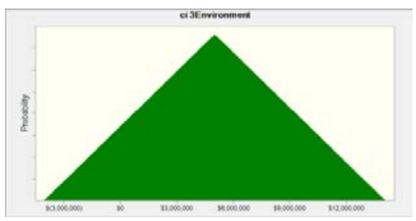
10%	$(7,100,000)	(=P11)
Likeliest	$0	(=Q11)
90%	$3,400,000	(=R11)



Assumption: ci 3Environment **Cell: S12**

Triangular distribution with parameters:

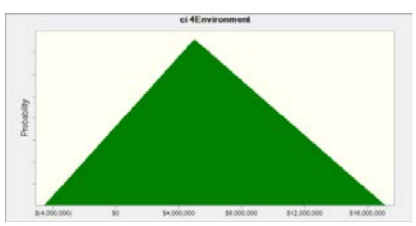
10%	$0	(=P12)
Likeliest	$5,000,000	(=Q12)
90%	$10,000,000	(=R12)



Assumption: ci 4Environment **Cell: S13**

Triangular distribution with parameters:

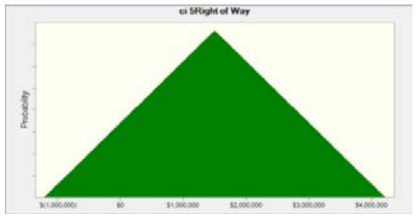
10%	$0	(=P13)
Likeliest	$5,000,000	(=Q13)
90%	$12,000,000	(=R13)



Assumption: ci 5Right of Way **Cell: S14**

Triangular distribution with parameters:

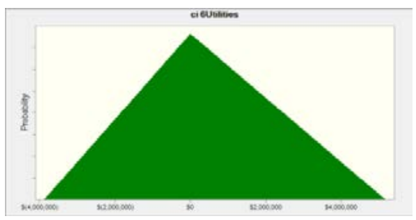
10%	$0	(=P14)
Likeliest	$1,500,000	(=Q14)
90%	$3,000,000	(=R14)



Assumption: ci 6Utilities **Cell: S15**

Triangular distribution with parameters:

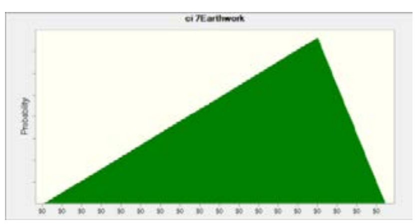
10%	$(2,000,000)	(=P15)
Likeliest	$1	(=Q15)
90%	$3,000,000	(=R15)



Assumption: ci 7Earthwork **Cell: S16**

Triangular distribution with parameters:

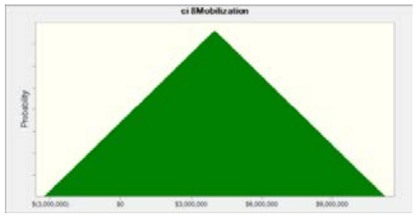
10%	$0	(=P16)
Likeliest	$0	(=Q16)
90%	$0	(=R16)



Assumption: ci 8Mobilization **Cell: S17**

Triangular distribution with parameters:

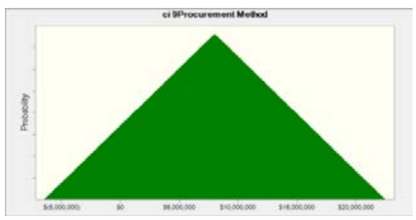
10%	$0	(=P17)
Likeliest	$4,000,000	(=Q17)
90%	$8,000,000	(=R17)



Assumption: ci 9Procurement Method **Cell: S18**

Triangular distribution with parameters:

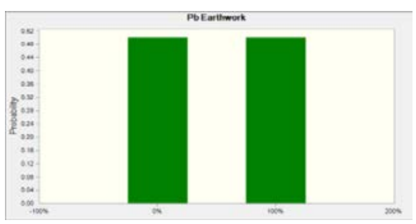
10%	$0	(=P18)
Likeliest	$8,000,000	(=Q18)
90%	$16,000,000	(=R18)



Assumption: Pb Earthwork **Cell: N16**

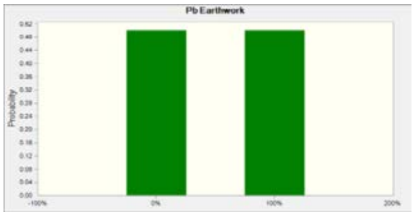
Yes-No distribution with parameters:

Probability of Yes(1)	0.5	(=N16)



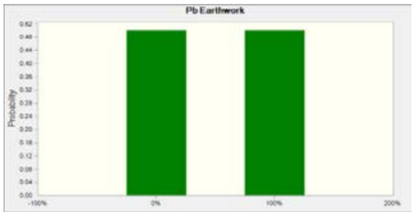
Assumption: Pb Earthwork **Cell: N11**

Yes-No distribution with parameters:
Probability of Yes(1) 0.5 (=N11)



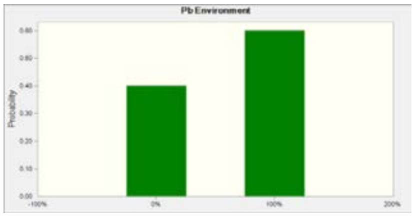
Assumption: Pb Earthwork **Cell: N10**

Yes-No distribution with parameters:
Probability of Yes(1) 0.5 (=N10)



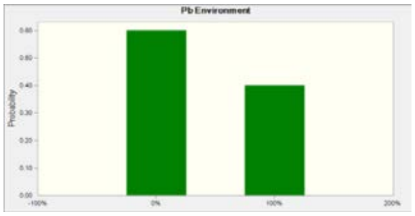
Assumption: Pb Environment **Cell: N13**

Yes-No distribution with parameters:
Probability of Yes(1) 0.6 (=N13)



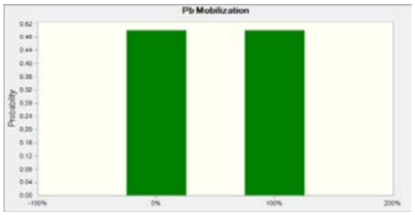
Assumption: Pb Environment **Cell: N12**

Yes-No distribution with parameters:
Probability of Yes(1) 0.4 (=N12)



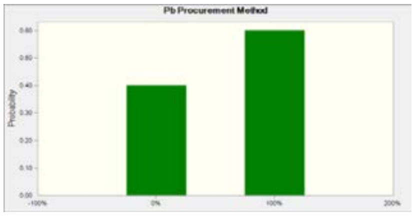
Assumption: Pb Mobilization **Cell: N17**

Yes-No distribution with parameters:
Probability of Yes(1) 0.5 (=N17)



Assumption: Pb Procurement Method **Cell: N18**

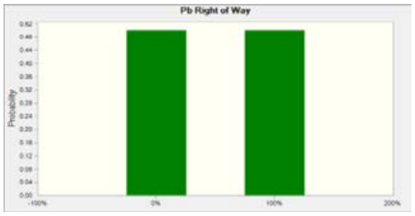
Yes-No distribution with parameters:
Probability of Yes(1) 0.6 (=N18)



Assumption: Pb Right of Way **Cell: N14**

Yes-No distribution with parameters:

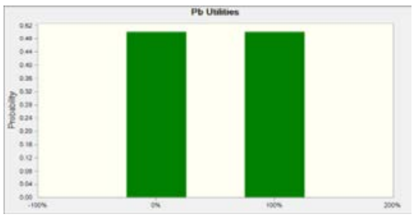
Probability of Yes(1)	0.5	(=N14)



Assumption: Pb Utilities **Cell: N15**

Yes-No distribution with parameters:

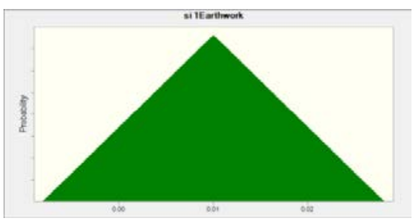
Probability of Yes(1)	0.5	(=N15)



Assumption: si 1Earthwork **Cell: AA10**

Triangular distribution with parameters:

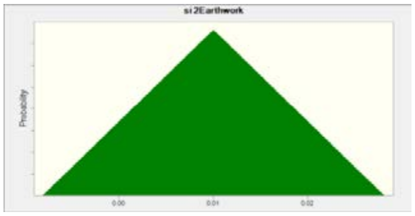
10%	0.00	(=X10)
Likeliest	0.01	(=Y10)
90%	0.02	(=Z10)



Assumption: si 2Earthwork **Cell: AA11**

Triangular distribution with parameters:

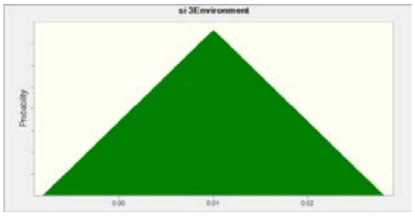
10%	0.00	(=X11)
Likeliest	0.01	(=Y11)
90%	0.02	(=Z11)



Assumption: si 3Environment **Cell: AA12**

Triangular distribution with parameters:

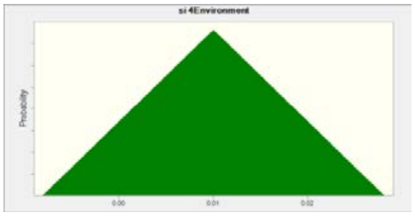
10%	0.00	(=X12)
Likeliest	0.01	(=Y12)
90%	0.02	(=Z12)



Assumption: si 4Environment **Cell: AA13**

Triangular distribution with parameters:

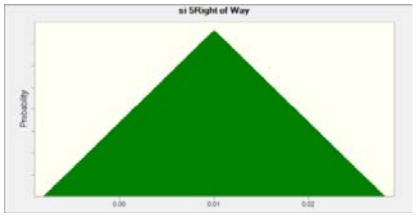
10%	0.00	(=X13)
Likeliest	0.01	(=Y13)
90%	0.02	(=Z13)



Assumption: si 5Right of Way **Cell: AA14**

Triangular distribution with parameters:

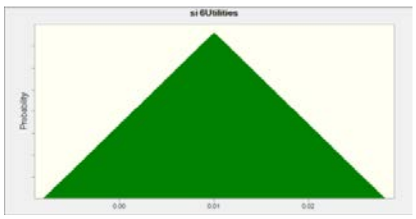
10%	0.00	(=X14)
Likeliest	0.01	(=Y14)
90%	0.02	(=Z14)



Assumption: si 6Utilities **Cell: AA15**

Triangular distribution with parameters:

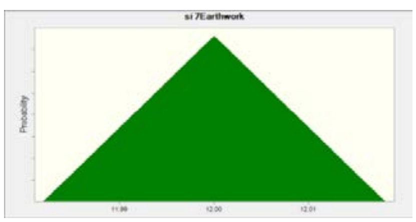
10%	0.00	(=X15)
Likeliest	0.01	(=Y15)
90%	0.02	(=Z15)



Assumption: si 7Earthwork **Cell: AA16**

Triangular distribution with parameters:

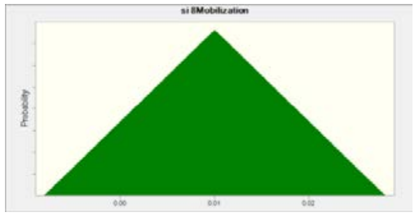
10%	11.99	
Likeliest	12.00	(=Y16)
90%	12.01	



Assumption: si 8Mobilization **Cell: AA17**

Triangular distribution with parameters:

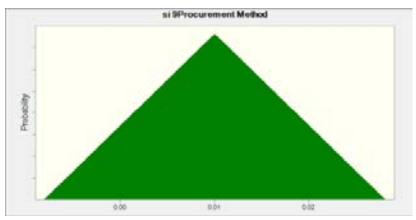
10%	0.00	(=X17)
Likeliest	0.01	(=Y17)
90%	0.02	(=Z17)



Assumption: si 9Procurement Method **Cell: AA18**

Triangular distribution with parameters:

10%	0.00	(=X18)
Likeliest	0.01	(=Y18)
90%	0.02	(=Z18)



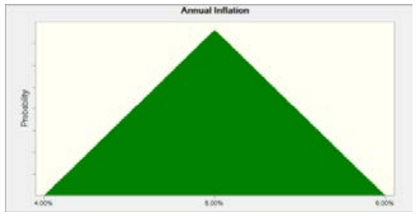
Worksheet: [Portsmouth Bypass CER August 2013 v3.0 with refined inflation low and high range

Assumption: Annual Inflation **Cell: V4**

Triangular distribution with parameters:

Minimum	4.00%	(=V4-1%)
Likeliest	5.00%	(=V4)
Maximum	6.00%	(=V4+1%)

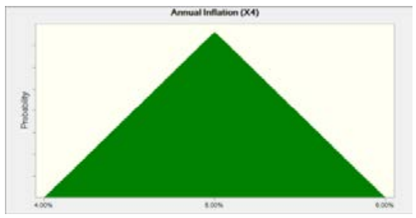
Assumption: Annual Inflation (cont'd) **Cell: V4**



Assumption: Annual Inflation (X4) **Cell: X4**

Triangular distribution with parameters:

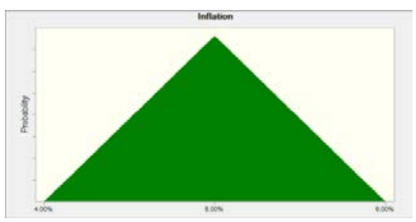
Minimum	4.00%	(=X4-1%)
Likeliest	5.00%	(=X4)
Maximum	6.00%	(=X4+1%)



Assumption: Inflation **Cell: V5**

Triangular distribution with parameters:

Minimum	4.00%	(=V5-1%)
Likeliest	5.00%	(=V5)
Maximum	6.00%	(=V5+1%)

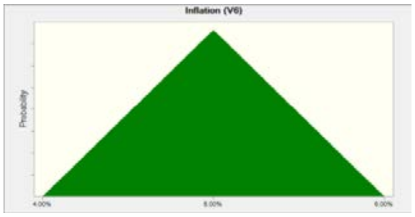


Attachment C

Assumption: Inflation (V6) **Cell: V6**

Triangular distribution with parameters:

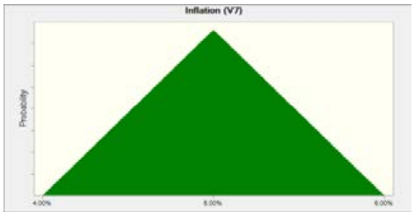
Minimum	4.00%	(=V6-1%)
Likeliest	5.00%	(=V6)
Maximum	6.00%	(=V6+1%)



Assumption: Inflation (V7) **Cell: V7**

Triangular distribution with parameters:

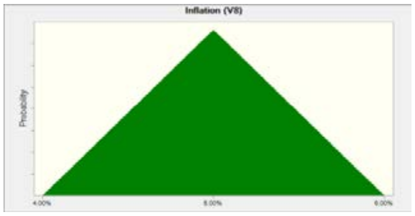
Minimum	4.00%	(=V7-1%)
Likeliest	5.00%	(=V7)
Maximum	6.00%	(=V7+1%)



Assumption: Inflation (V8) **Cell: V8**

Triangular distribution with parameters:

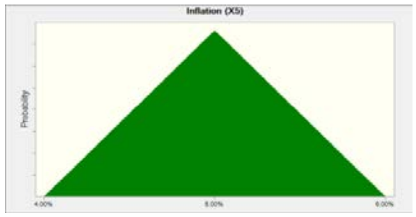
Minimum	4.00%	(=V8-1%)
Likeliest	5.00%	(=V8)
Maximum	6.00%	(=V8+1%)



Assumption: Inflation (X5) **Cell: X5**

Triangular distribution with parameters:

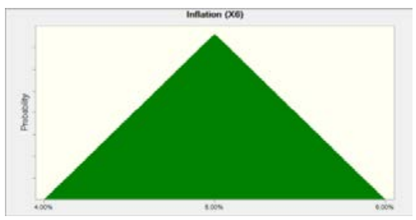
Minimum	4.00%	(=X5-1%)
Likeliest	5.00%	(=X5)
Maximum	6.00%	(=X5+1%)



Assumption: Inflation (X6) **Cell: X6**

Triangular distribution with parameters:

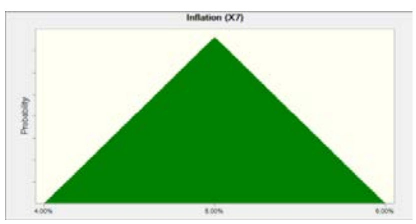
Minimum	4.00%	(=X6-1%)
Likeliest	5.00%	(=X6)
Maximum	6.00%	(=X6+1%)



Assumption: Inflation (X7) **Cell: X7**

Triangular distribution with parameters:

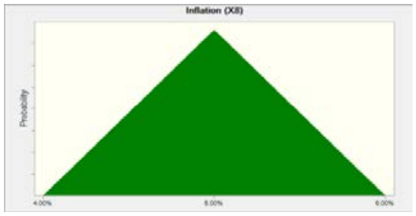
Minimum	4.00%	(=X7-1%)
Likeliest	5.00%	(=X7)
Maximum	6.00%	(=X7+1%)



Assumption: Inflation (X8) **Cell: X8**

Triangular distribution with parameters:

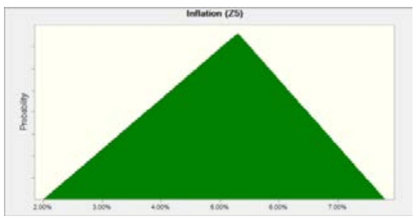
Minimum	4.00%	(=X8-1%)
Likeliest	5.00%	(=X8)
Maximum	6.00%	(=X8+1%)



Assumption: Inflation (Z5) **Cell: Z5**

Triangular distribution with parameters:

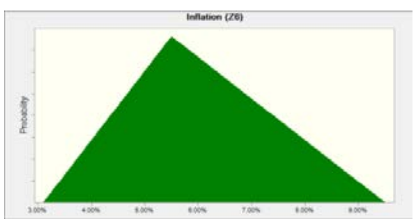
Minimum	2.00%	
Likeliest	5.30%	(=Z5)
Maximum	7.80%	



Assumption: Inflation (Z6) **Cell: Z6**

Triangular distribution with parameters:

Minimum	3.10%	
Likeliest	5.50%	(=Z6)
Maximum	9.50%	



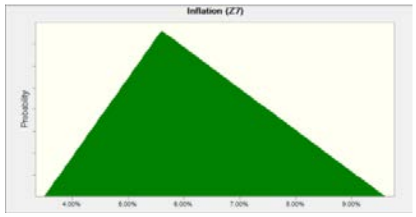
Attachment C

REPORT5.xlsx

Assumption: Inflation (Z7) **Cell: Z7**

Triangular distribution with parameters:

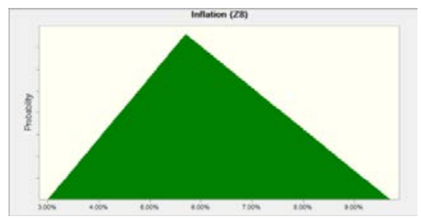
Minimum	3.50%	
Likeliest	5.60%	(=Z7)
Maximum	9.60%	



Assumption: Inflation (Z8) **Cell: Z8**

Triangular distribution with parameters:

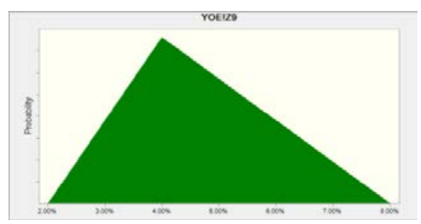
Minimum	3.00%
Likeliest	5.70%
Maximum	9.70%



Assumption: Z9 **Cell: Z9**

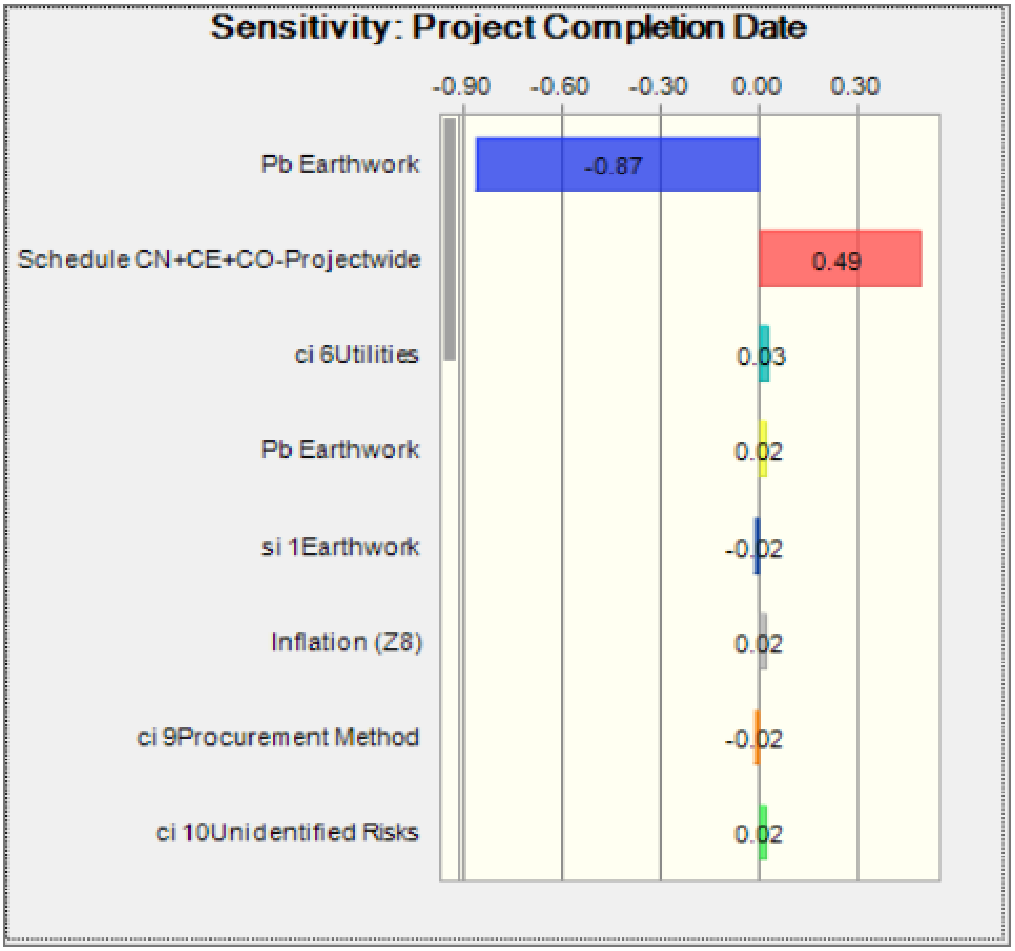
Triangular distribution with parameters:

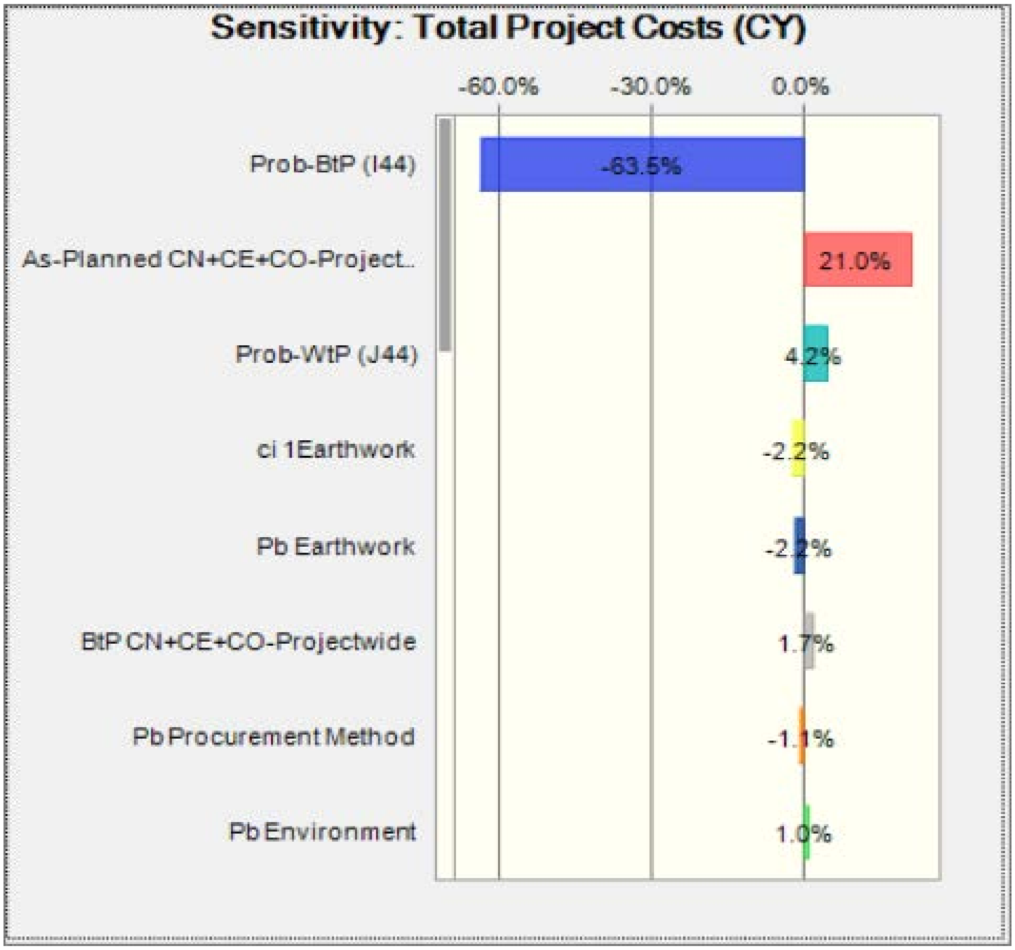
Minimum	2.00%
Likeliest	4.00%
Maximum	8.00%

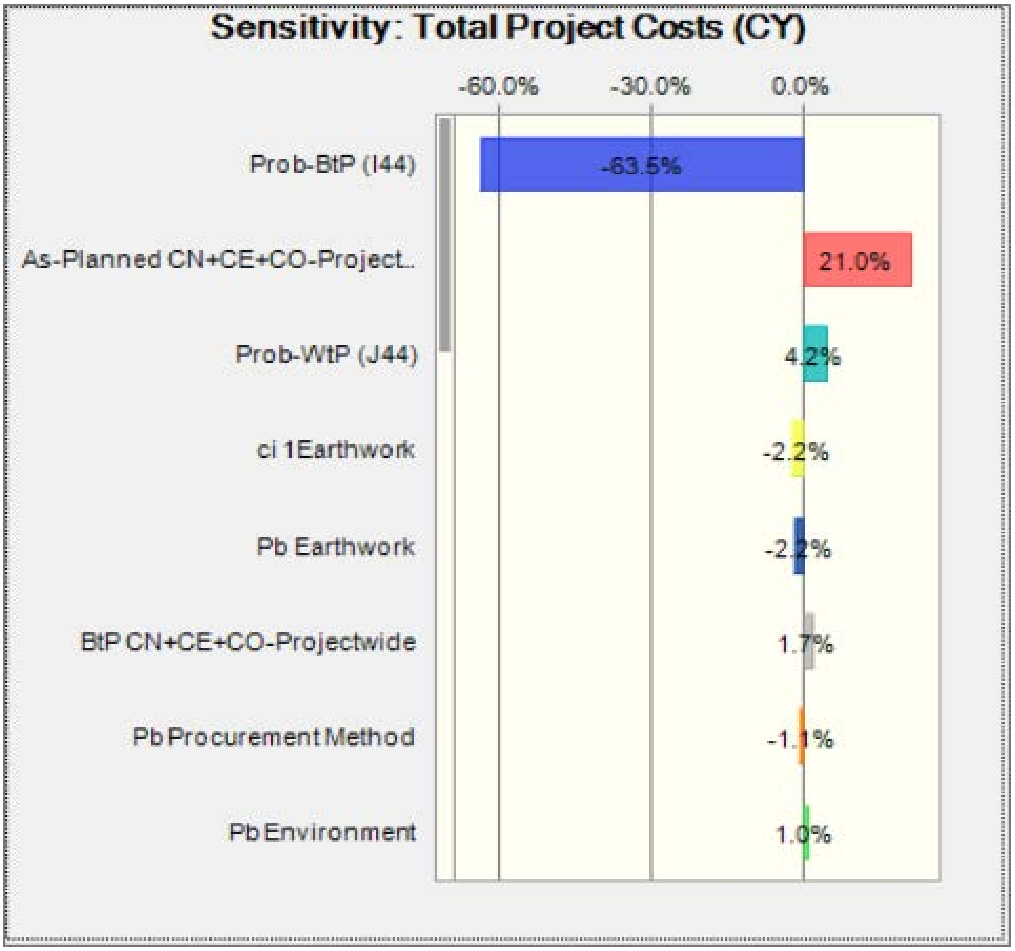


End of Assumptions

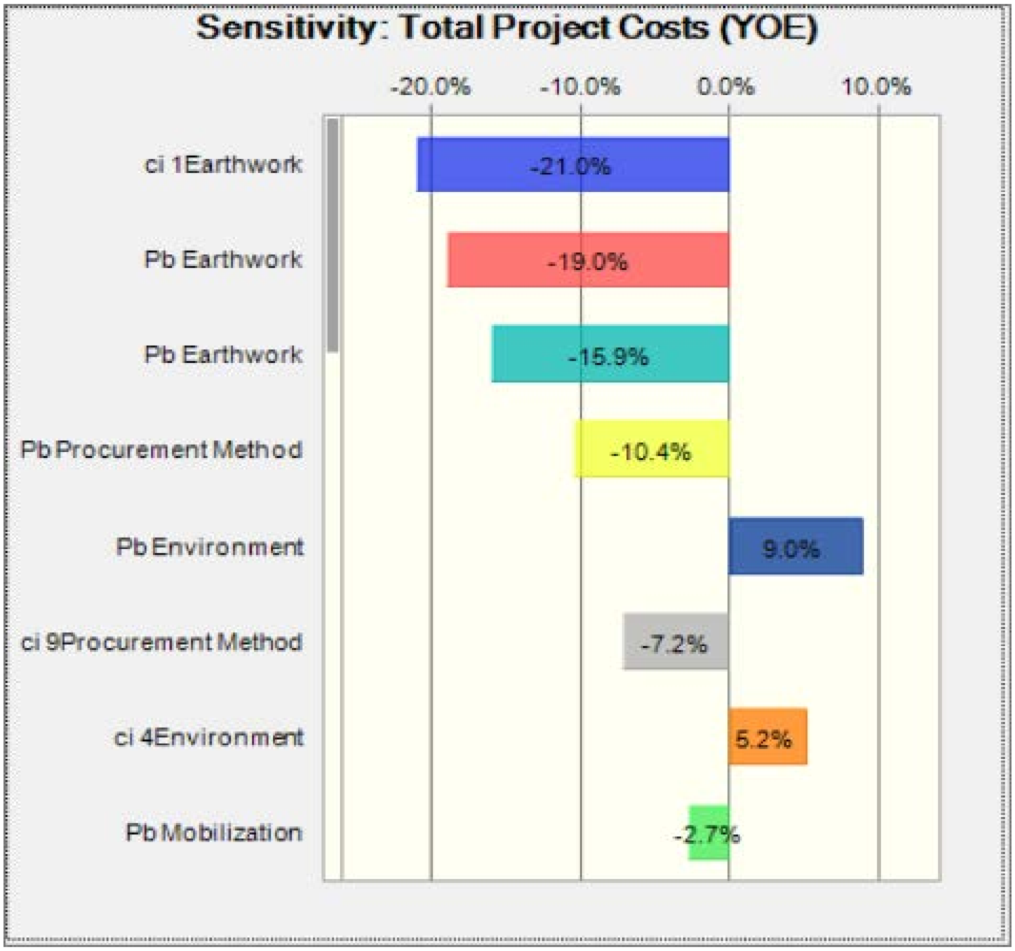
Sensitivity Charts



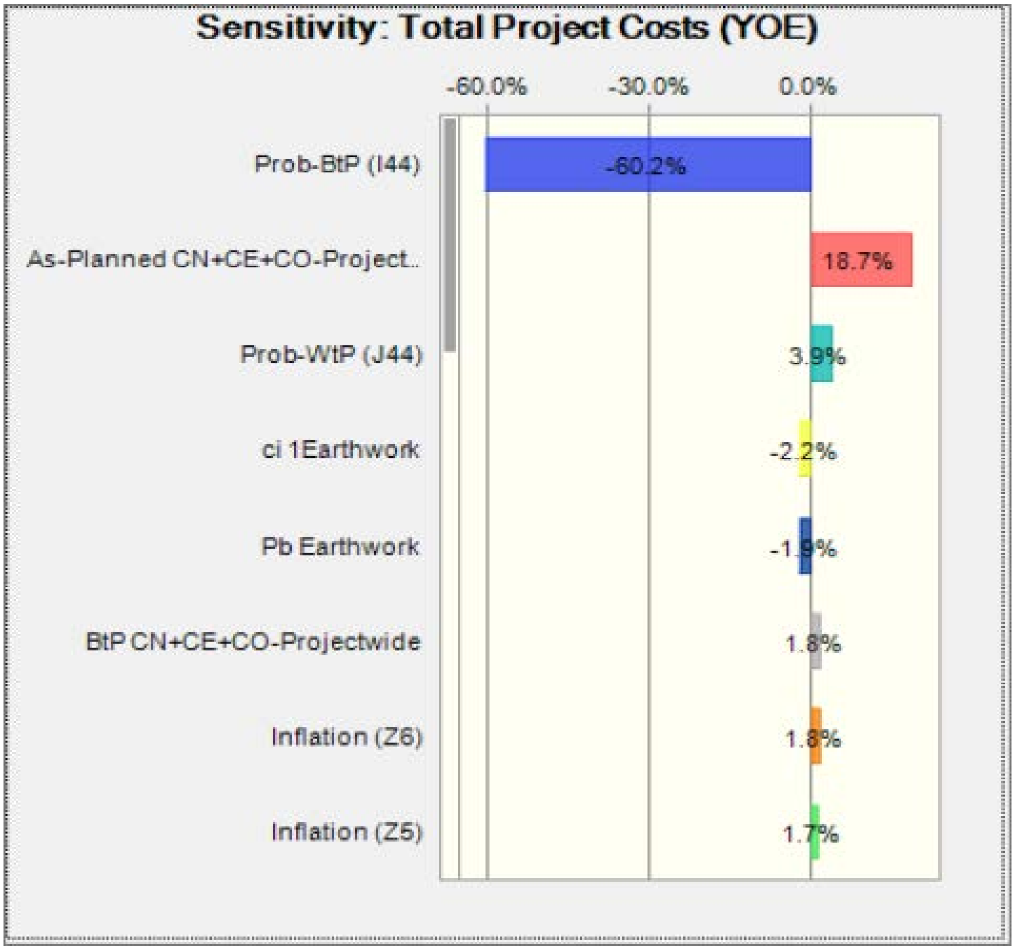

Sensitivity: Total Project Costs (CY)
-60.0%
-30.0%
0.0%
Prob-BtP (I44)
-63.5%
As-Planned CN+CE+CO-Project..
21.0%
Prob-WtP (J44)
4.2%
ci 1Earthwork
-2.2%
Pb Earthwork
-2.2%
BtP CN+CE+CO-Projectwide
1.7%
Pb Procurement Method
-1.1%
Pb Environment
1.0%


Sensitivity: Total Project Costs (CY)
-60.0%
-30.0%
0.0%
Prob-BtP (I44)
-63.5%
As-Planned CN+CE+CO-Project...
21.0%
Prob-WtP (J44)
4.2%
ci 1Earthwork
-2.2%
Pb Earthwork
-2.2%
BtP CN+CE+CO-Projectwide
1.7%
Pb Procurement Method
-1.1%
Pb Environment
1.0%

Attachment C



Attachment C



End of Sensitivity Charts

APPENDIX D – Closeout Presentation

Attachment D

823 Portsmouth Bypass

An Appalachian Development Highway

Cost Estimate Review
Close Out

August 28 - 30, 2013

Columbus, Ohio

Cost Estimate Review Objective

Conduct an unbiased risk-based review to verify the accuracy and reasonableness of the current total cost estimate to complete ***The Portsmouth Bypass Project*** and to develop a probability range for the cost estimate that represents the project's current stage of design.

823 Portsmouth Bypass

An Appalachian Development Highway

Basis of Review

Review based on estimates provided by the Team in advance

Review to determine the reasonableness of assumptions used in the estimate

Not an independent FHWA estimate:

- We did not verify quantities and unit prices
- Goal is to verify accuracy and reasonableness of estimate

Risk-based Probabilistic Approach Cost Estimate Review

823 Portsmouth Bypass

An Appalachian Development Highway

Attachment D

Cost Estimate Review & Financial Plans (23 U.S.C §106(h)(2))

Financial Plans are required for the following thresholds:

Over $100 Million Total Project Cost

Required, review is at FHWA Ohio Division's discretion

Over $500 Million Total Project Cost

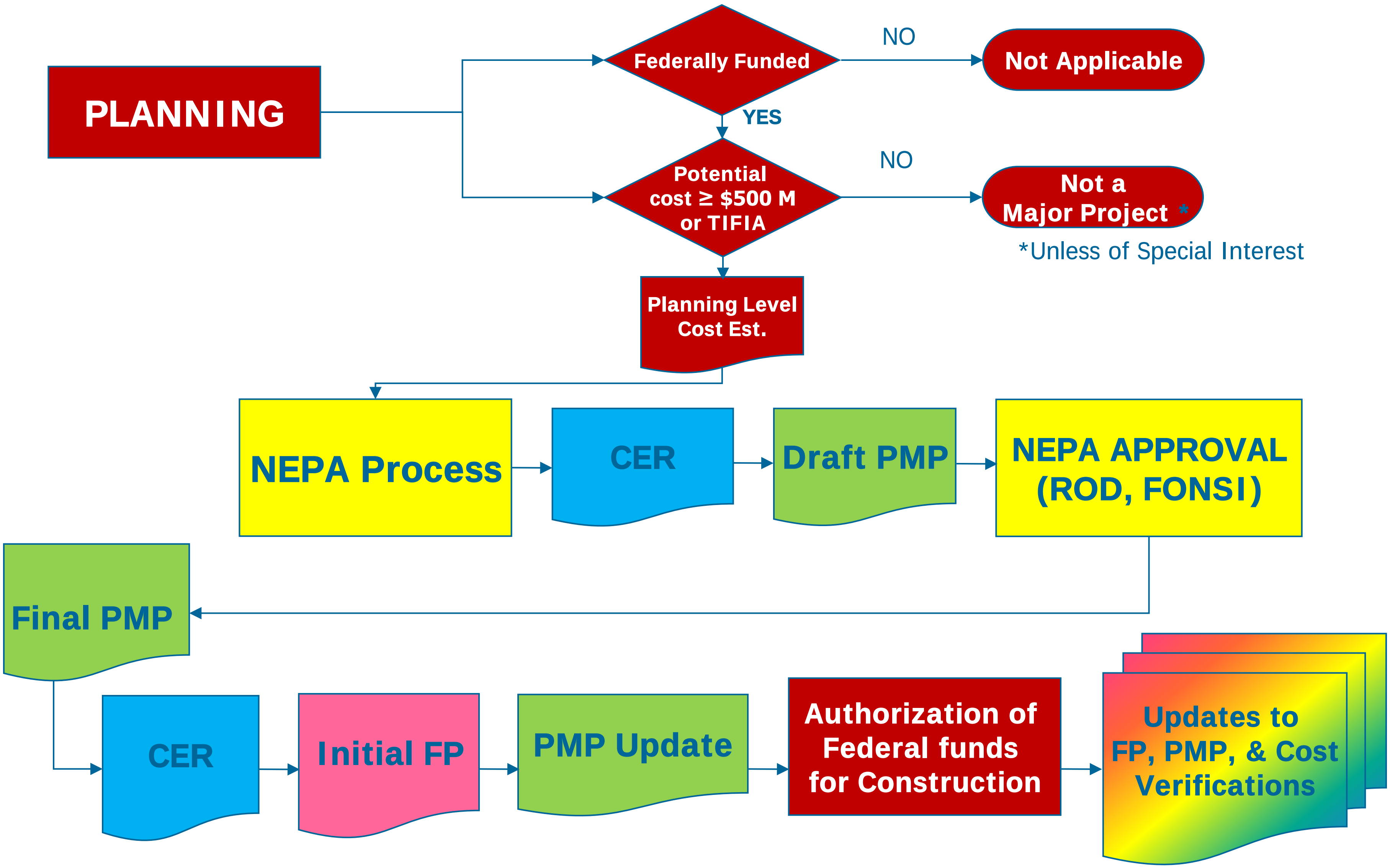
Major Project – Requires concurrence from FHWA's Headquarters

Total Project Cost = **ALL COSTS** - Engineering, Construction, ROW, Utilities… in Year of Expenditure (YOE) Dollars

"Cost to complete estimates based on reasonable assumptions as determined by the Secretary (FHWA)"

Reasonable assumptions = Risk based analysis

Basic Major Project Process



Review Participants

- FHWA
  - Division Offices – Ohio and Missouri
  - HQ- TIFIA Office
  - Resource Center
- Ohio Department of Transportation (ODOT)
  - District 9
  - Planning, Geotechnical & Estimating
- ODOT Consultant (DLZ, CH2M)

823 Portsmouth Bypass

An Appalachian Development Highway

Agenda

Attachment D

Portsmouth Bypass

An Appalachian Development Highway

Portsmouth Bypass Project Cost Estimate Review
August 28 - 30, 2013
ODOT Central Office, Columbus, Ohio

WEDNESDAY: August 28, 2013	
9:00 AM	CER Introduction by FHWA
9:45 AM	Project Overview by Project Personnel ***
10:30 AM	Overview of ODOT Estimation Process
11:00 AM	Contingency/Risk Register Items
12:00 PM	Lunch
1:00 PM	Roadway, Erosion Control, Drainage and Pavement
2:00 PM	Earthworks
3:00 PM	Structures, Retaining Walls and Sound Barriers
4:00 PM	Environmental
4:45 PM	Soft Costs (Administrative, inflation, allowances)
5:00 PM	Adjourn

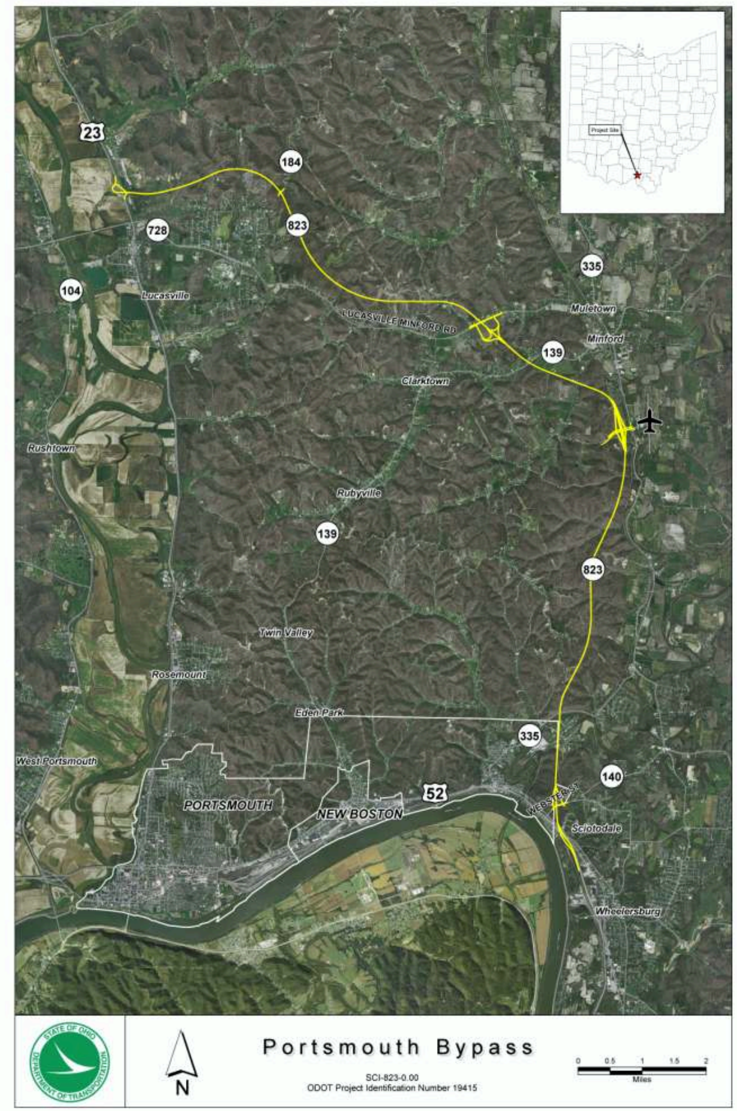
Agenda (cont.)

Attachment D

THURSDAY: August 29, 2013	
8:00 AM	Continuation of Soft Costs (if needed)
8:15 AM	Traffic Control and Miscellaneous Traffic
8:45 AM	Right of Way and Utilities
9:30 AM	Revisit estimate items – as necessary
10:00 AM	Finalize risk register, including descriptions and aggregate minor risks
12:00 PM	Lunch
1:00 PM	Findings and Report Preparation
5:00 PM	Adjourn
FRIDAY: August 30, 2013	
8:00 AM	Presentation Dry Run
10:00 AM	Closeout Presentation
12:00 PM	Adjourn

Portsmouth Bypass - Overview

- 16-mile, 4-lane, limited access highway in Scioto County
- Bypasses 26 miles of US 23 and US 52
- Interchanges: US 52, SR 140, SR 335 (Airport), CR 28, and US 23
- 16 minute time saving
- Crossing of CSX and NS Railroads



Attachment D

Portsmouth Bypass – Original Phasing

Originally anticipated to be built in three phases - Design-Bid-Build

Phase 1

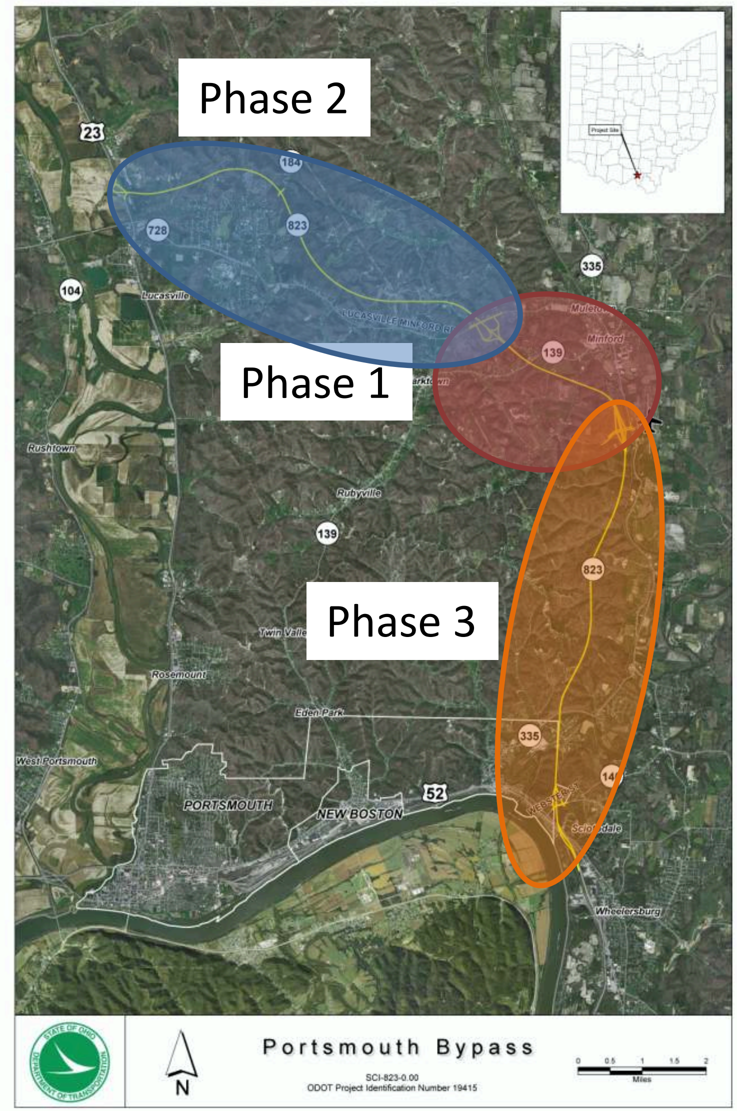
Shumway-Hollow Road to Lucasville-Minford Road (approx 3 miles)

Phase 2

Lucasville-Minford Road to US 23 (approx 7.4 miles)

Phase 3

US 52 to Shumway-Hollow Road (approx 5.6 miles)



Portsmouth Bypass – P3 Approach

Project Objectives

- Accelerate construction of the Bypass
- Maximize competition and obtain lowest price
- Recognize economies of scale
- Drive economic development

dID DIVISION OF INNOVATIVE DELIVERY

Ohio Department of Transportation

Portsmouth Bypass - P3 Approach

P3 Project Scope

- Design, Build, Finance, Operate and Maintain approach for new Portsmouth Bypass
- Construction expected – 2015 to 2019
- Operations and Maintenance – 2019 to 2053 (35 years)
- Availability payment mechanism

dID DIVISION OF INNOVATIVE DELIVERY

OHIO DEPARTMENT OF TRANSPORTATION

Attachment D

Schedule

Activity	Target Date
Issue RFQ	June 7, 2013
SOQs Submitted	August 9, 2013
Shortlist Proposers	September 6, 2013
Issue RFP	Q4 2013
Proposals Due	Q2/Q3 2014
Award	Q3 2014
Commercial / Financial Close	Q4 2014

Attachment D

Base Cost Estimate – Current $

Pre-CER

Prior Costs:	$34.6 M
Additional ODOT Costs:	$70. 6 M
DBFOM Construction Related Costs:	$402.2 M
Total	$507.4 M

Post-CER

Prior Costs:	$35.5 M
Additional ODOT Costs:	$54.6 M
DBFOM Construction Related Costs:	$419.0 M
Total	$509.1 M

823 Portsmouth Bypass

An Appalachian Development Highway

Review Methodology

1. **Estimate Review**
   - Overview Estimate development process
   - Ensure estimate accounts for complete project scope
   - Major cost drivers for estimate were included
     - Line item large costs, design allowance, inflation rates
     - ROW, Utilities, Design, Construction Management
   - Threats and Opportunities for various items
2. **Threats and Opportunities Analysis**
   - Reviewed/discussed major risk elements
   - Develop probability assumption distributions
3. **Performed Monte Carlo simulation to generate a <u>probability based</u> project estimate forecast**

Threats

- Topography, difficult access and potential long haul distances (10,000 feet +)
- 404 permitting relative to wetlands and streams mitigation
- Endangered species – long eared bat
- Availability for disposal of waste material
- Higher than estimated ROW costs
- Inflation in general is trending up

Attachment D

Opportunities

- P3 Procurement
  - Let the entire project
  - Accelerate Project Completion
    - Reduced construction from 13 years to 5 years
  - Maximize Competition
    - Large national firms
    - Potential to reduce construction from 5 years to 4 years
  - Transfer Risk
    - Funding
    - Construction
  - Innovative Financing Tools
  - Reduce Life Cycle Cost/Risk Uncertainty

823 Portsmouth Bypass

An Appalachian Development Highway

Attachment D

Opportunities

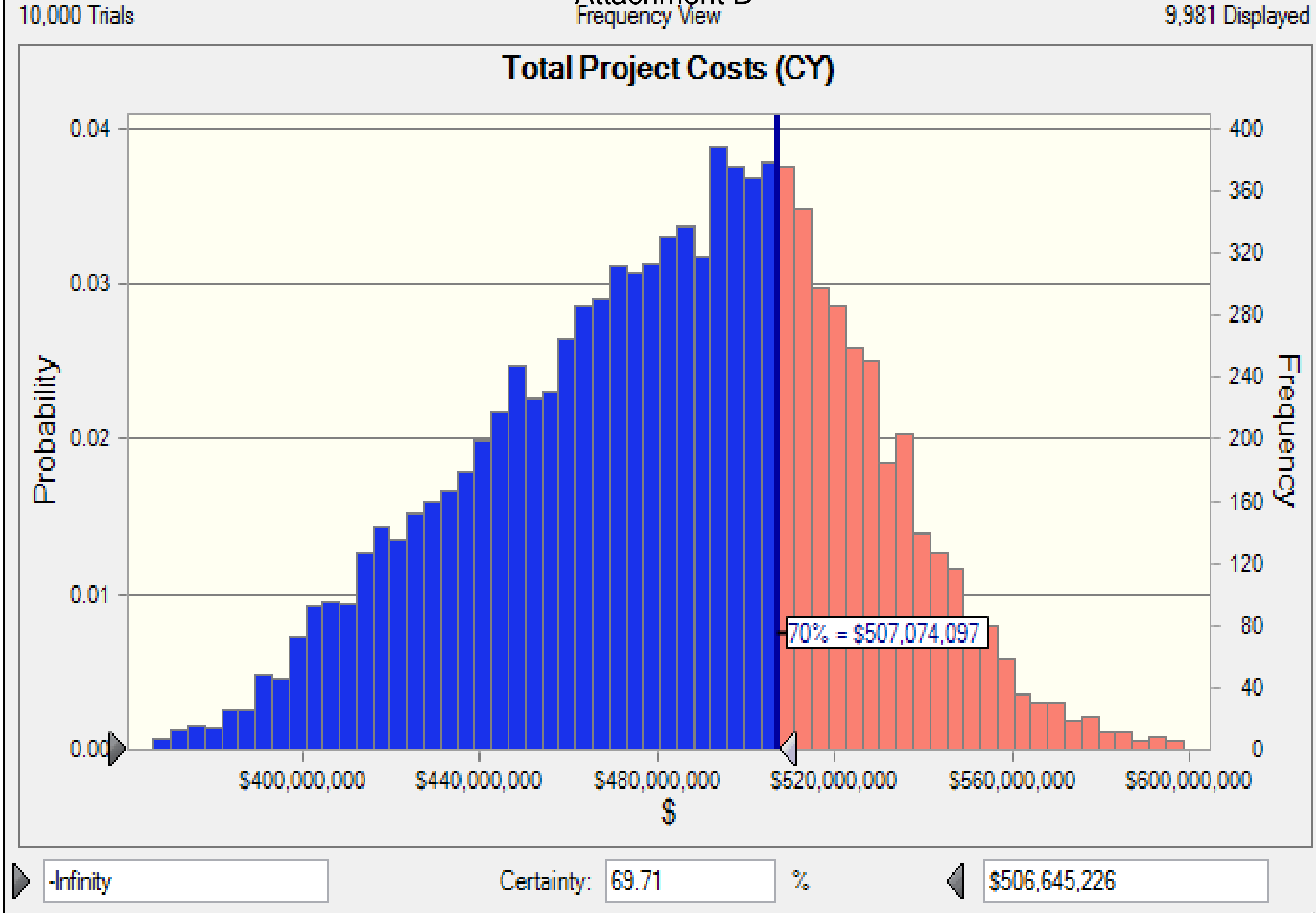
- Procurement strategies encourage innovation and efficiencies:
  - Performance based outcomes
  - Design flexibility
- Economies of scale due to very large volumes, earthwork costs could be lower than currently estimated
- Anticipated good market conditions and strong bidding competition

823 Portsmouth Bypass

An Appalachian Development Highway

Monte Carlo Output

Attachment D



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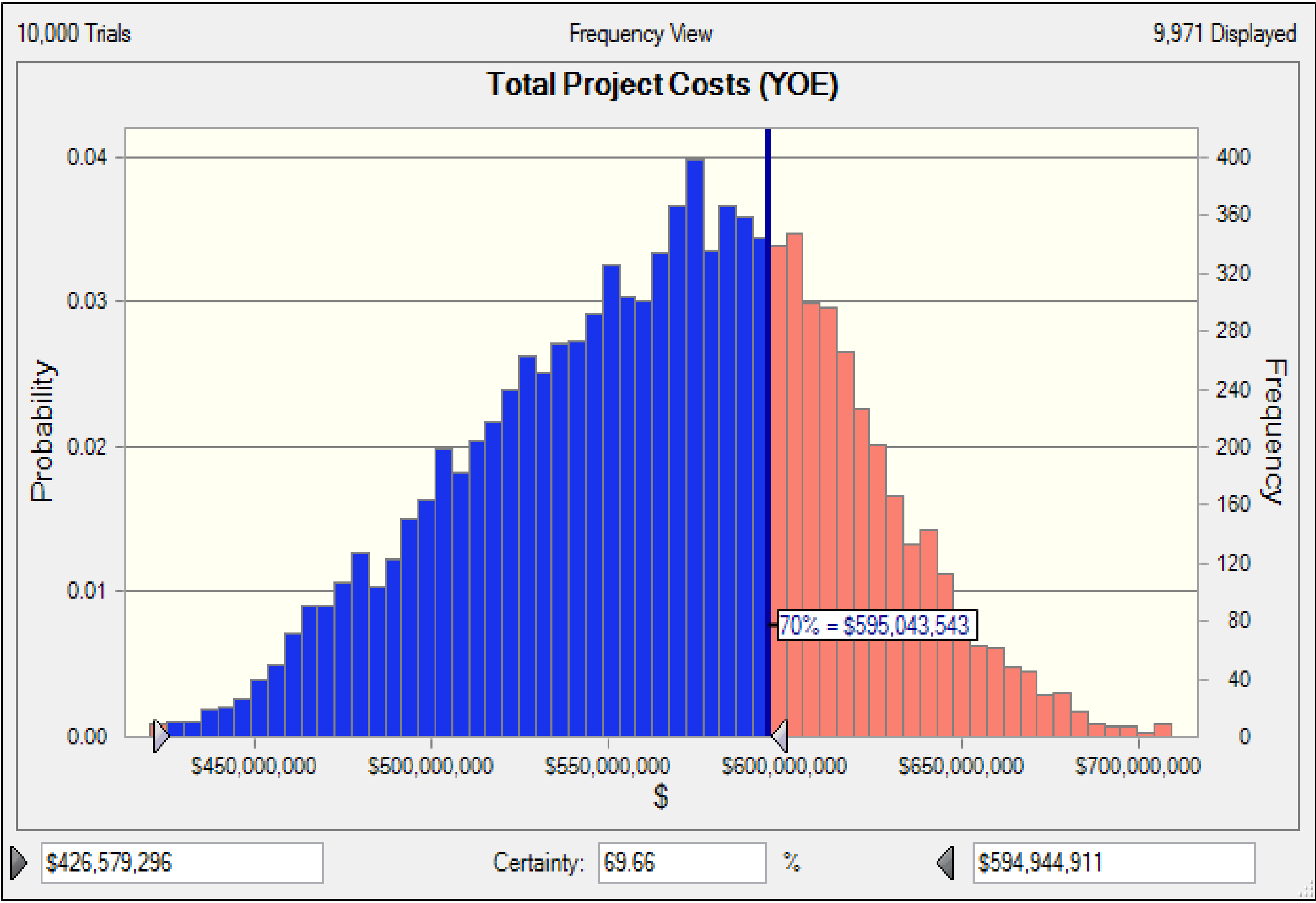


Attachment D

YOE Percentiles

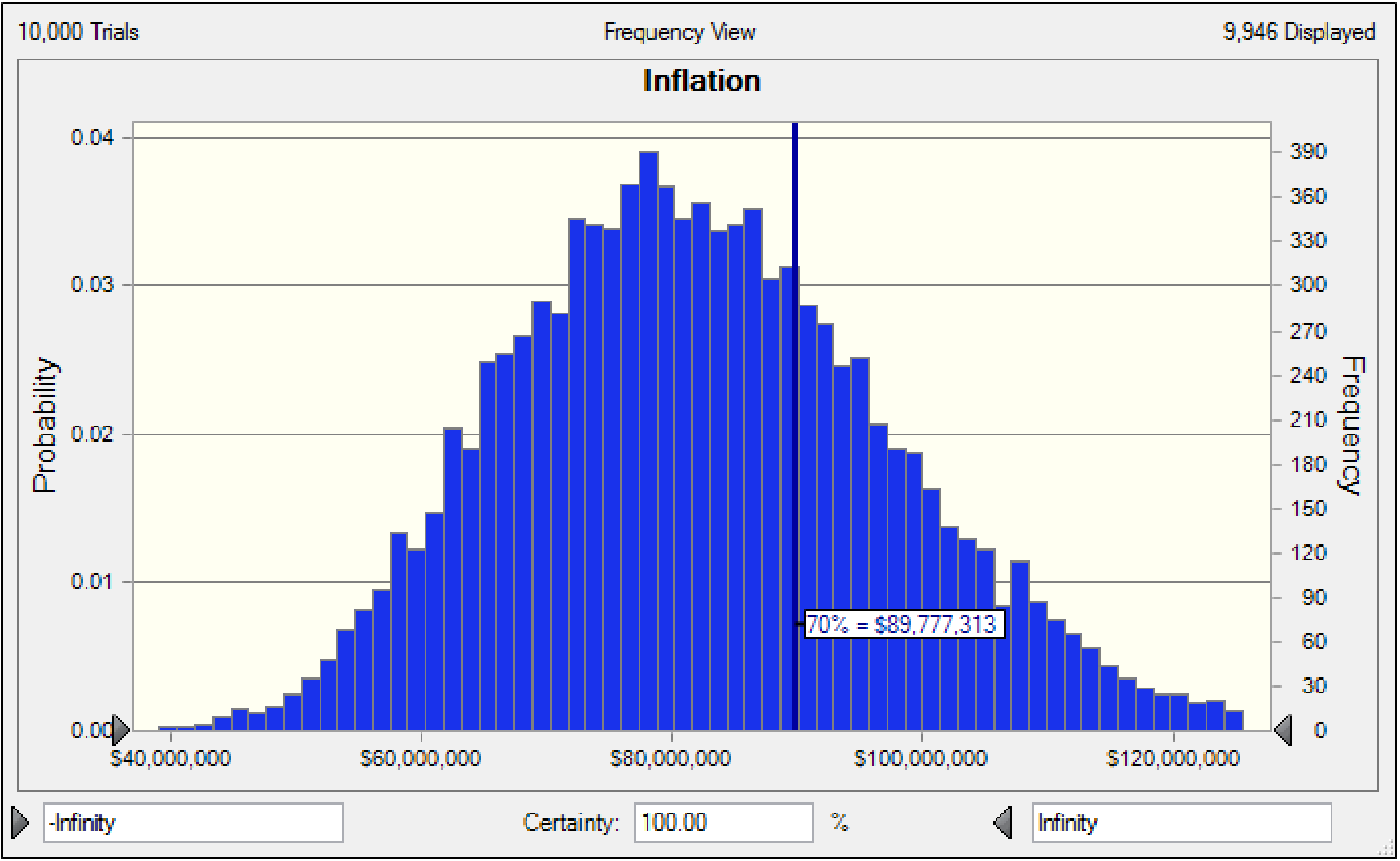
Percentile	Forecast values
0%	$399,376,753
10%	$494,542,860
20%	$519,517,235
30%	$537,818,464
40%	$553,975,894
50%	$568,820,227
60%	$581,703,350
70%	$595,043,543
80%	$609,285,746
90%	$628,105,776
100%	$742,226,996

Attachment D

Inflation Model Inputs

2013	1.1%
2014	5.3%
2015	5.5%
2016	5.6%
2017	5.7%
2018	4.0%
2019	4.0%
2020	4.0%

Attachment D



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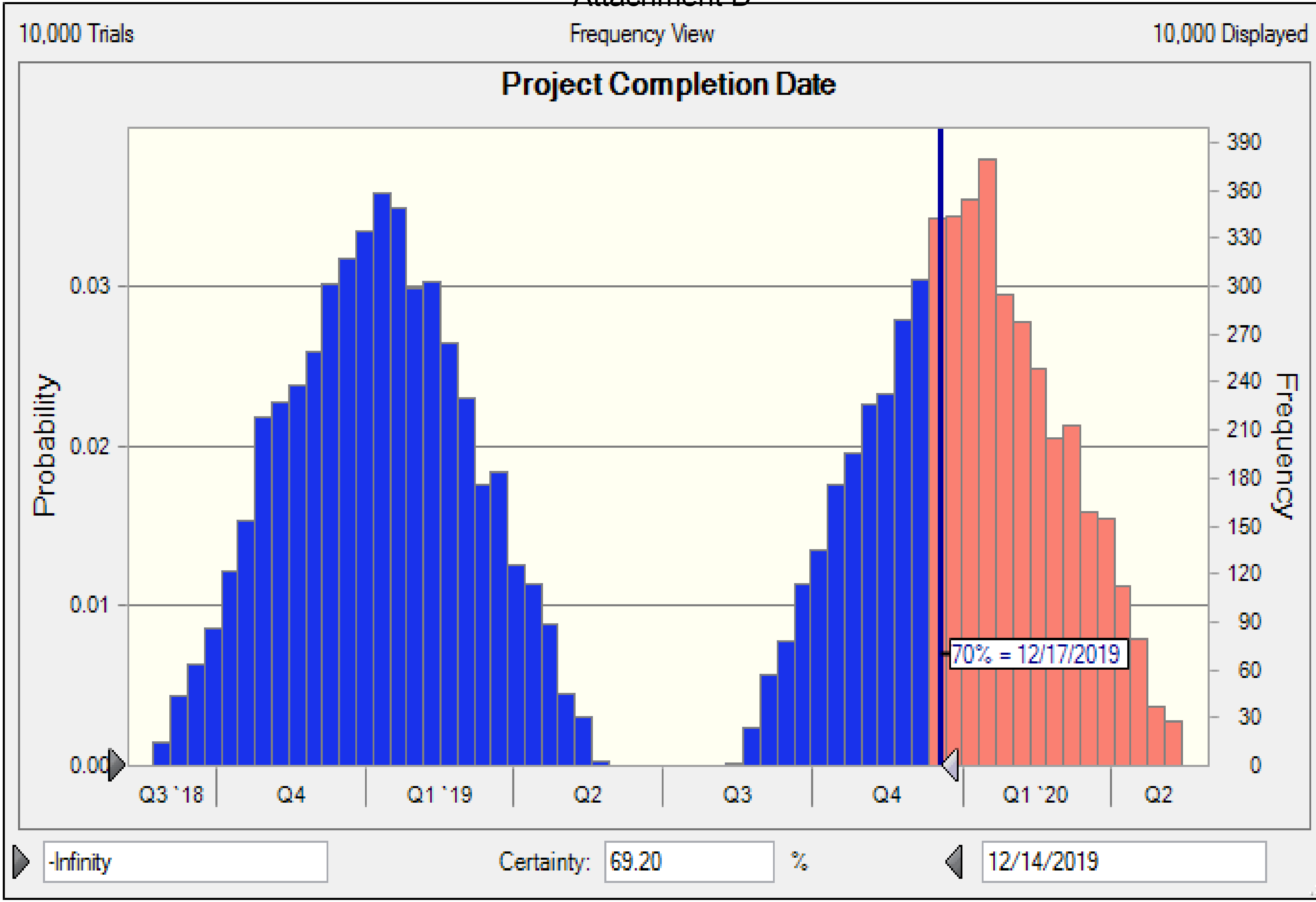
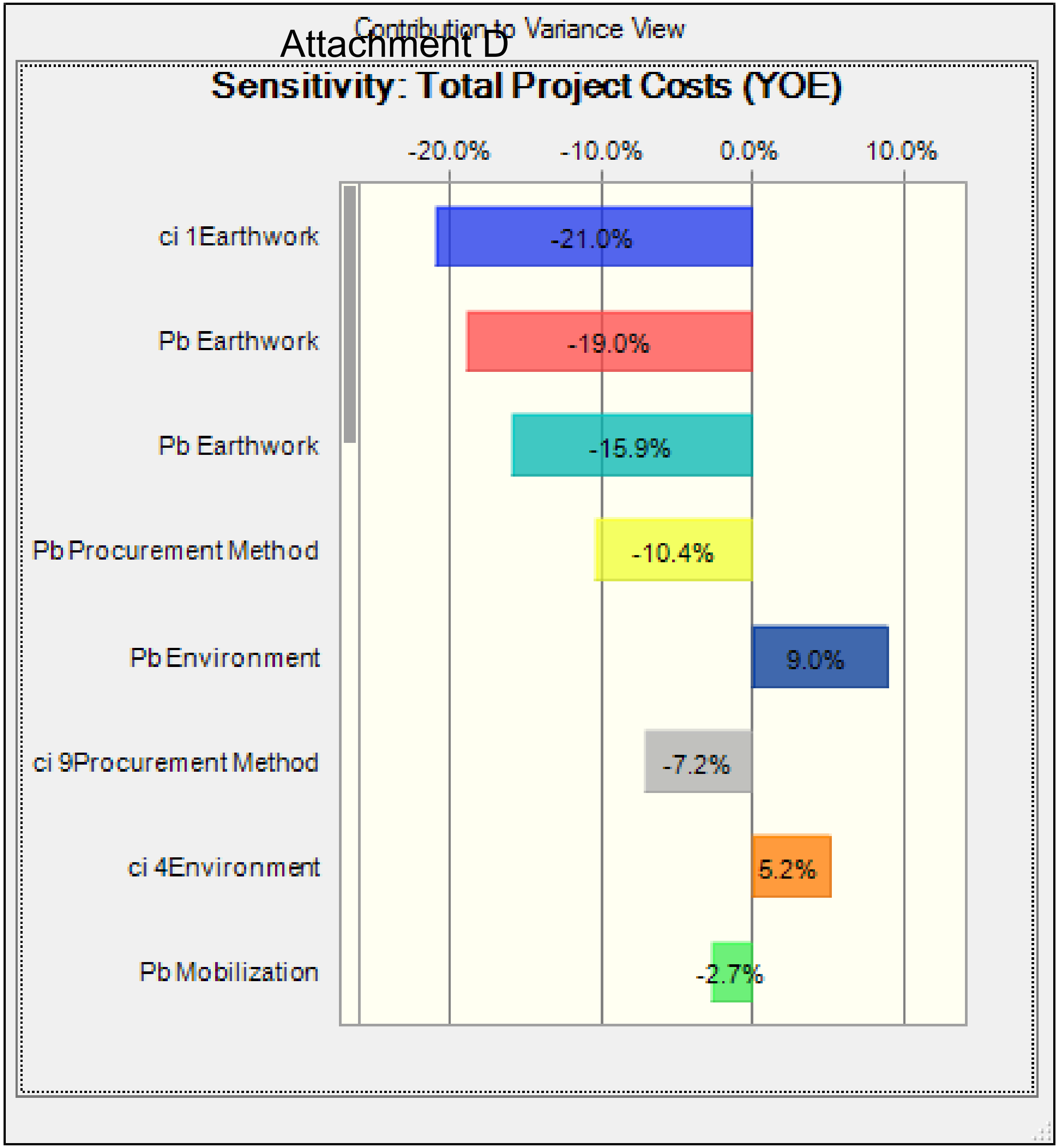


Sensitivity: Items with impact

Attachment D



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Cost Estimate Review Draft Recommendations

- Continue to manage threats / opportunities through the project's risk management plan
- Elevate the awareness of the environmental project risks (wetlands, streams, endangered species) to ensure that they receive adequate attention and support internally and from resource agencies
- Continue to advance both PAB and TIFIA financing scenarios to reduce potential procurement delays related to financing
- Continue to advance permitting, ROW acquisition and utility relocation activities in parallel with procurement
- Use the 70% certainty YOE number from this week's CER Update in the pending Finance Plan Annual Update for the Portsmouth Bypass

Attachment D

Cost Estimate Review

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 Office
  - ❖ Division Office will review the draft and forward it to the Team
  - ❖ Final report within 30 days after receipt of comments will be forwarded to the Division Office for distribution to the Team
- FHWA uses the report for the review of the Financial Plan Annual Update
- Estimate review is a snapshot of the current estimate

823 Portsmouth Bypass

An Appalachian Development Highway

APPENDIX E – Workshop Agendas and Sign-In Sheets

Attachment E

MEETING AGENDA

ROJECT:	SCI-823 Portsmouth Bypass PID: 19415
SUBJECT:	**FHWA Cost Estimate Review (CER)**
MEETING DATE:	August 28th to 30th, 2013
MEETING ROOM:	ODOT Central Office - Room 1C
DIAL-IN INFORMATION:	866-203-7023 (code 891-704-8233)

TIME	DESCRIPTION
WEDNESDAY: August 28, 2013	
9:00 AM	CER Introduction by FHWA
9:45 AM	Project Overview by Project Personnel ***
10:30 AM	Overview of ODOT Estimation Process
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*** Google 3D will be used as an alternative to a site visit.

Attachment E

PORTSMOUTH BY PASS CER - AUGUST 28-30

NAME	REPRESENTING	DAY 1 AM	DAY 1 PM	DAY 2 AM	DAY 3 AM
PETE CLOGSTON	FHWA	✓	✓	✓	✓
KEVIN MOVIUS	FHWA	✓	✓	✓	✓
KEVIN MOODY	FHWA	✓	✓	✓	✓
Dan Brodhag	FHWA	✓	✓	✓	✓
Tim Pritchard	ODOT Estimating	✓	✓	✓	
George Raysavy	ODOT Estimating	✓	✓	✓	
Joe Anthony	ODOT Estimating	✓	✓	✓	✓
Justin Hickey	ODOT Estimating	✓	✓	✓	✓
TOM RAGLAND	CH2M HILL	✓	✓	✓	✓
SHAWN THOMPSON	CH2M HILL	✓	✓	✓	✓
Jeff Crace	ODOT OSE	✓	✓	✓	✓
Manoj Sethi	DLZ	✓	✓		
Eddie Church	CH2M Hill	✓	✓	✓	
MICHAEL KERRIGAN	CH2M HILL	✓	✓	✓	✓
Tom Barnitz	ODOT-D9	✓	✓	✓	✓
MIKE WAWSZKIEWICZ	ODOT-D10	✓	✓	✓	✓
Jerry Workman	ODOT-Planning	✓	✓	✓	✓
Matt Perlik	ODOT-OES	✓/2	✓/2		
Adeel Mallick	CH2M-Hill	✓			
Jeff Hisem	ODOT-C.O.-Estimating	X			
RON BAUER	ODOT-ESTIMATING	✓	✓		
Travis McKibben	ODOT Estimating	✓	✓		
Chad Rundle	DLZ		✓		
Steve Taliaferro	ODOT Geotech		✓		
Tim Hampshire	DLZ		✓		
Paul Painter	ODOT Geotech		✓		
Dave Snyder	FHWA		✓		

(OVER)

Attachment E

NAME	REPRESENTING	DAY 1 AM	DAY 1 PM	DAY 2 AM	DAY 3 AM
BRAD JONES	ODOT			✓	
DOUGLAS PACK	ODOT			✓	