Appendix B
Cost Risk Analysis Report

1. **Cost Risk Analysis Report**

PAUL S. SARBANES ECOSYSTEM RESTORATION
POPLAR ISLAND, BALTIMORE, MD
Project Cost and Schedule
Risk Analysis Report - 2012

Prepared for:

U.S. Army Corps of Engineers,
Baltimore District

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December 17, 2012

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EXECUTIVE SUMMARY

Under the auspices of the U.S. Army Corps of Engineers (USACE), Baltimore District, this report presents the results of a cost and schedule risk analysis for the Paul S. Sarbanes Ecosystem Restoration Project - Poplar Island LRR, Talbot County Maryland. In compliance with Engineer Regulation (ER) 1110-2-1302, Civil Works Cost Engineering, dated September 15, 2008, a formal *Monte Carlo* style risk analysis study was conducted by the Project Delivery Team (PDT) for the development of contingency on the total project cost. The purpose of this risk analysis study was to establish project contingencies by identifying and measuring the cost and schedule impact of project uncertainties with respect to the estimated total project cost.

In late 2010, a risk analysis study was performed, resulting in the most likely project cost estimated at approximately $601 million for the existing island construction and $435 million for the expansion project. Based on the risk analysis, the Cost Engineering Mandatory Center of Expertise (MCX), located in Walla Walla District, recommended a contingency value of $70 million, or 21.3 percent, and $92 million, or 21.2 percent, respectively. Contingency total was estimated at $162 million.

In late 2012, the PDT updated the base cost estimate and readdressed the risks to determine whether a rerun of the risk analysis was required. When addressing the risks presented within the risk register, it was determined that there was not sufficient risk change that would significantly alter the previous contingency outcome; i.e., 21 percent on remaining work. The risk register included some revisions, but the 21 percent was added to the newly estimated figures in support of the current total project cost: $62.6 million on the existing and $98.0 million on the expansion. Contingency total is near the 2012 estimate and is now $161 million.

This does not include a major risk item (PM-08) where the project is dependent on delivery of required dredged material as funded by local agencies. Lack of quantities will increase cost and lengthen schedule; increased quantities could accelerate some construction placement but potential for acceleration is limited while potential for delays results in a much greater impact. This risk was kept separate due to the sheer magnitude of the risk, which could result in a major lengthening of the project and higher cost. If this event were to occur, a separate funding request and schedule lengthening would be required to complete the project.

The following table ES-1 portrays the 21% contingencies for the project based on the latest October 2012 estimate. The contingency is based on an 80 percent confidence level, as per accepted USACE Civil Works guidance.

Table ES-1. Contingency Summary FY 2013

Poplar Island Existing, PH 1&2

WBS	FEATURE	Spent $K	Remaining $K	Cont 21% $K	TOTAL FY13 $K
12	Nav Ports & Harbors	289,344	287,713	60,420	637,477
01	Lands & Damages	39	0	0	39
30	PED	11,650	8,898	1,869	22,417
31	Construction Mgmt	7,319	1,583	333	9,235
TOTAL					**669,168**

Poplar Island Expansion, PH 3

WBS	FEATURE	Spent $K	Remaining $K	Cont 21% $K	TOTAL FY13 $K
12	Nav Ports & Harbors	0	434,798	91,308	526,106
01	Lands & Damages	0	0	0	0
30	PED	0	22,015	4,623	26,638
31	Construction Mgmt	0	9,789	2,056	11,845
TOTAL					**564,589**

KEY FINDINGS/OBSERVATIONS RECOMMENDATIONS

Though not specifically defined, the greatest risks relate to large project costs over an extended duration to year 2043. Project costs place greater risk in the ability for parties to fund, the potential for scope changes, changing environmental restrictions, unexpected project escalations, and estimate confidence in the out-years.

Existing Island Cost Risks in Order of Risk Sensitivity:

- ES-13 Estimate and Schedule confidence for the upland development, currently untested.
- ES-19 Historic Unit Prices based on a collaborative effort for the remaining work and cost forecast into year 2043.
- ES-04 Fuel Price Fluctuations that effect dredging costs greatly.
- RE-06 Environmental and Water Quality standards can change and the construction activities may not meet those standards related to dredging, sediment transport, and placement.

Island Expansion Cost Risks in Order of Risk Sensitivity:

- ES-04 Fuel Price Fluctuations which effect dredging costs greatly.

- EX-14 Project Funding, both Federal and non-Federal, is critical in maintaining the current schedule. Delays in sufficient funding result in risks related to unexpected local inflations, changes in environmental criteria, changes in scope, and Federal and sponsor long-term support.

- ES-13 Estimate and Schedule confidence for the upland development, currently untested.

- EX-03 Unexpected Escalation over time may exceed the Office of Management and Budget escalation forecasts at the local level, exceeding the authorization amount.

- RE-06 Environmental and Water Quality standards can change and the construction activities may not meet those standards related to dredging, sediment transport, and placement.

- ES-19 Historic Unit Prices based on a collaborative effort for the remaining work and cost forecast into year 2043.

Schedule Risks:

- RE-06 Environmental and Water Quality standards can change over time and the construction activities may not meet those standards related to dredging, sediment transport, and placement. This may result in unanticipated scope risks and delays.

- PM-15 Communications between the many parties on such a large and extended project must be maintained to ensure long-term success.

- PM-08 Availability of U.S. Army Corps of Engineers, Philadelphia District (CENAP), Sites (PM-08): This project is directly dependent upon dredged material delivered from a separate project and related dredging sites. Should those project sites fail to deliver, schedule growth could be immeasurable and the associated cost and schedule risk growth unrealistic. This major risk item is treated separately within the risk analysis due to level of impact (another 142 months as a single risk or a total of 168 months including other risks). In the event this risk does occur, separate funding request will be submitted for execution of project.

Recommendations: Project success is heavily dependent upon party communications, planning, and cost and schedule monitoring/management. This project is scheduled annually far into the future, leaving many uncertainties that are difficult to forecast and manage. Cost and schedule management include annual cost and schedule reconciliation to actual occurrences and to the baseline cost estimate (project authorization). Annual reconciliation must include updated evaluation of the risks.

1. PURPOSE

This risk analysis is based on Poplar Island Hurricane and Storm Damage Reduction General Investigations Study. The purpose for a cost and schedule risk analysis (CSRA) is to present information from studied elements related to cost and schedule with an outcome contingency calculation at the recommended confidence level for both cost and schedule that are measured in terms of dollars. The most common and recommended contingency has been established at 80 percent confidence.

2. BACKGROUND

Poplar Island is an environmental restoration project located in the Chesapeake Bay, Talbot County, Maryland; 39 miles (34 nautical miles) south-southeast of the Port of Baltimore, and 2 miles northwest of Tilghman Island. Dredged material from the Upper Chesapeake Bay Approach Channels to the Port of Baltimore is being beneficially used to restore 1,140 acres of wetland and upland habitat. The Poplar Island Environmental Restoration Project (PIERP) is planned to create approximately 570 acres of wetland and 570 acres of upland habitat, and it is estimated that by 2014, PIERP will provide up to 40 million cubic yards (mcy) of dredged material placement capacity. The island restoration will resemble the approximate 1847 footprint, which, as of 1996, had eroded to three separate islands with an area of less than three acres. To date, approximately 12 mcy of dredged material has been placed at the site.

The goals of the PIERP are to:

- Restore remote island habitat in the mid-Chesapeake Bay using clean dredged material from the Chesapeake Bay Approach Channels to the Port of Baltimore.

- Optimize site capacity for clean dredged material while meeting the environmental restoration purpose of the project.

- Protect the environment around the restoration site.

The PIERP was developed through the cooperative efforts of Federal and state agencies along with private, commercial, and environmental organizations. Prior to the start of construction, an Integrated Feasibility Report and Environmental Impact Statement for the PIERP was completed in 1996 (U.S. Army Corps of Engineers [USACE]/MPA, 1996). Phase I (the northern 640 acres) of the exterior dike construction at PIERP started in 1998 and was completed in 2000, and dredged material inflow at PIERP commenced in April 2001. Phase II (the southern 500 acres) construction of the PIERP was completed in 2002.

3. REPORT SCOPE

The scope of the risk analysis report is to calculate and present the cost and schedule contingencies at the 80 percent confidence level using the risk analysis processes, as mandated by USACE Engineer Regulation (ER) 1110-2-1150, Engineering and Design for Civil Works Projects, ER 1110-2-1302, Civil Works Cost Engineering, and Engineer Technical Letter 1110-2-573, Construction Cost Estimating Guide for Civil Works. The report presents the contingency results for cost risks for all project features. The study and presentation does not include consideration for operation and maintenance or life cycle costs.

3.1 Project Scope

The scope of this study addresses the identification of problems, needs, opportunities, and potential solutions that are viable from an economic, environmental, and engineering viewpoint. It is important to note that the project is comprised of two major construction elements: existing island building and island expansion. There is existing useful cost data that supports the risk analysis study.

3.2 USACE Risk Analysis Process

The risk analysis process follows the USACE Headquarters requirements as well as the guidance provided by the Cost Engineering Mandatory Center of Expertise (MCX), located in Walla Walla District. The risk analysis process reflected within the risk analysis report uses probabilistic cost and schedule risk analysis methods within the framework of the Crystal Ball software. The risk analysis results are intended to serve several functions – one being the establishment of reasonable contingencies reflective of an 80 percent confidence level to successfully accomplish the project work within that established contingency amount. Furthermore, the scope of the report includes the identification and communication of important steps, logic, key assumptions, limitations, and decisions to help ensure that risk analysis results can be appropriately interpreted.

Risk analysis results are also intended to provide project leadership with contingency information for scheduling, budgeting, and project control purposes, as well as provide tools to support decision making and risk management as the project progresses through planning and implementation. To fully recognize its benefits, cost and schedule risk analyses should be considered as an ongoing process conducted concurrent to, and iteratively with, other important project processes such as scope and execution plan development, resource planning, procurement planning, cost estimating, budgeting, and scheduling.

In addition to broadly defined risk analysis standards and recommended practices, the risk analysis is performed to meet the requirements and recommendations of the following documents and sources:

- Cost and Schedule Risk Analysis Process guidance prepared by the USACE Cost Engineering MCX.

- Memorandum from Major General Don T. Riley (US Army Director of Civil Works), dated July 3, 2007.
- Engineering and Construction Bulletin issued by James C. Dalton, P.E. (Chief, Engineering and Construction, Directorate of Civil Works), dated September 10, 2007.
- Engineering Regulation ER 1110-2-1150 dated August 31, 1999.
- Engineering Regulation ER 1110-2-1302 dated September 15, 2008.
- Engineering Technical Letter 1110-2-573 dated September 30, 2008.

4. METHODOLOGY/PROCESS

The risk analysis process for this study is intended to determine the probability of various cost outcomes and quantify the required contingency needed in the cost estimate to achieve any desired level of cost confidence.

In simple terms, contingency is an amount added to an estimate to allow for items, conditions or events for which the occurrence or impact is uncertain and that experience suggests will likely result in additional costs being incurred or additional time being required. The amount of contingency included in project control plans depends, at least in part, on the project leadership's willingness to accept risk of project overruns. The less risk that project leadership is willing to accept the more contingency should be applied in the project control plans. The risk of overrun is expressed, in a probabilistic context, using confidence levels.

The Cost Engineering MCX guidance for cost and schedule risk analysis generally focuses on the 80-percent level of confidence (P80) for cost contingency calculation. It should be noted that use of P80 as a decision criteria is a risk averse approach (whereas the use of P50 would be a risk neutral approach, and use of levels less than 50 percent would be risk seeking). Thus, a P80 confidence level results in greater contingency as compared to a P50 confidence level. The selection of contingency at a particular confidence level is ultimately the decision and responsibility of the project's District and/or Division management.

The risk analysis process uses *Monte Carlo* techniques to determine probabilities and contingency. The *Monte Carlo* techniques are facilitated computationally by a commercially available risk analysis software package (Crystal Ball) that is an add-in to Microsoft Excel. Cost estimates are packaged into an Excel format and used directly for cost risk analysis purposes. The level of detail recreated in the Excel-format schedule is sufficient for risk analysis purposes that reflect the established risk register, but generally less than that of the native format.

The primary steps, in functional terms, of the risk analysis process are described in the following subsections. Risk analysis results are provided in section 6.

4.1 Identify and Assess Risk Factors

Identifying the risk factors via the project development team (PDT) is considered a qualitative process that results in establishing a risk register that serves as the document for the quantitative study using the Crystal Ball risk software. Risk factors are events and conditions that may influence or drive uncertainty in project performance. They may be inherent characteristics or conditions of the project or external influences, events, or conditions such as weather or economic conditions. Risk factors may have either favorable or unfavorable impacts on project cost and schedule.

Checklists or historical databases of common risk factors are sometimes used to facilitate risk factor identification. However, key risk factors are often unique to a project and not readily derivable from historical information. Therefore, input from the entire PDT is obtained using creative processes such as brainstorming or other facilitated risk assessment meetings. In practice, a combination of professional judgment from the PDT and empirical data from similar projects is desirable and is considered.

Formal PDT meetings were held for the purposes of identifying and assessing risk factors. Critical meetings were held November 17 and December 15 of 2010. Another critical meeting was held October 24, 2012 to assess potential risk changes. The meetings included capable and qualified representatives from multiple project team disciplines and functions, for example:

- Project/Program managers
- Planning Division - Environmental
- Civil and Coastal Design
- Cost and schedule engineers
- Operations – Navigation Branch
- Key Sponsors
- Cost Engineering MCX – Advisor/Risk facilitator

Off-line meetings included the Contracting office. Since this has been an ongoing effort, contracting methods and historical costs have been fairly well established. The real Estate and Relocations office was not included because neither is involved in this project.

Those meetings were conducted to establish the potential risks anticipated or envisioned by the team. At this stage, the risks could be deemed low, moderate or high, but based on professional judgment, intuition, conjecture or actual experience. While the team presented all identified key risks within the risk register, the next study phase (quantitative assignment of impact values), focused on the moderate and high risks.

4.2 Quantify Risk Factor Impacts

The quantitative impacts of risk factors on project plans are analyzed using a combination of professional judgment, empirical data, and analytical techniques. Risk factor impacts are quantified using probability distributions (density functions), because risk factors are entered into the Crystal Ball software in the form of probability density functions.

Similar to the identification and assessment process, risk factor quantification involves multiple project team disciplines and functions. However, the quantification process relies more extensively on collaboration between cost engineering, designers, and risk analysis team members with lesser inputs from other functions and disciplines.

The following is an example of the PDT quantifying risk factor impacts by using an iterative, consensus-building approach to estimate the elements of each risk factor:

- Maximum possible value for the risk factor.
- Minimum possible value for the risk factor.
- Most likely value (the statistical mode), if applicable.
- Nature of the probability density function used to approximate risk factor uncertainty.
- Mathematical correlations between risk factors.
- Affected cost estimate and schedule elements.

The resulting product from the PDT discussions is captured within a risk register, 2012 update, as presented in Appendix A for both cost and schedule risk concerns. Note that the risk register records the PDT's risk concerns, discussions related to those concerns, and potential impacts to the current cost and schedule estimates. The concerns and discussions are meant to support the team's decisions related to event likelihood, impact, and the resulting risk levels for each risk event.

4.3 Analyze Cost Estimate and Schedule Contingency

Contingency is analyzed using the Crystal Ball software, an add-in to the Microsoft Excel format of the cost estimate and schedule. *Monte Carlo* simulations are performed by applying the risk factors (quantified as probability density functions) to the appropriate estimated cost and schedule elements identified by the PDT. Contingencies are calculated by applying only the moderate and high level risks identified for each option (i.e., low-level risks are typically not considered, but remain within the risk register to serve historical purposes as well as support follow-on risk studies as the project and risks evolve).

For the cost estimate, the contingency is calculated as the difference between the P80 cost forecast and the baseline cost estimate. Each option-specific contingency is then allocated on a civil works feature level based on the dollar-weighted relative risk of each feature as quantified by *Monte Carlo* simulation. Standard deviation is used as the feature-specific measure of risk for contingency allocation purposes. This approach results in a relatively larger portion of all the project feature cost contingency being allocated to features with relatively higher estimated cost uncertainty.

5. PROJECT ASSUMPTIONS

The following data sources and assumptions were used in quantifying the costs associated with the with- and without-project conditions at Poplar Island:

- The cost comparisons and risk analyses performed and reflected within this report are based on design scope and estimates that are at the feasibility level.
- The Cost Engineering MCX guidance generally focuses on the 80 percent level of confidence (P80) for cost contingency calculation. For this risk analysis, the 80 percent level of confidence (P80) was used. It should be noted that the use of P80 as a decision criteria is a moderately risk averse approach, generally resulting in higher cost contingencies. However, the P80 level of confidence also assumes a small degree of risk that the recommended contingencies may be inadequate to capture actual project costs.
- Only high and some moderate risk level impacts, as identified in the risk register, were considered for the purposes of calculating cost contingency. Low level risk impacts should be maintained in project management documentation, and reviewed at each project milestone to determine if they should be placed on the risk “watch list” for further monitoring and evaluation.

6. RISK CONTINGENCY RESULTS

The following table summarizes the results of the risk analysis currently identified as a 15.5 percent and 25 percent contingency amount based on 80 percent confidence level. The complete list of tables and figures are included within appendix A.

Table 1. Contingency Summary FY 2013

Poplar Island Existing, PH 1&2

WBS	FEATURE	Spent $K	Remaining $K	Cont 21% $K	TOTAL FY13 $K
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WBS	FEATURE	Spent $K	Remaining $K	Cont 21% $K	TOTAL FY13 $K
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30	PED	0	22,015	4,623	26,638
31	Construction Mgmt	0	9,789	2,056	11,845
TOTAL					**564,589**

6.1 Risk Register

A risk register is a tool commonly used in project planning and risk analysis. The actual risk register is provided in appendix A. The complete risk register includes low level risks, as well as additional information regarding the nature and impacts of each risk.

It is important to note that a risk register can be an effective tool for managing identified risks throughout the project life cycle. As such, it is generally recommended that risk registers be updated as the designs, cost estimates, and schedule are further refined, especially on large projects with extended schedules. Recommended uses of the risk register going forward include:

- Documenting risk mitigation strategies being pursued in response to the identified risks and their assessment in terms of probability and impact.
- Providing project sponsors, stakeholders, and leadership/management with a documented framework from which risk status can be reported in the context of project controls.
- Communicating risk management issues.
- Providing a mechanism for eliciting feedback and project control input.
- Identifying risk transfer, elimination, or mitigation actions required for implementation of risk management plans.

6.2 Cost Risk Analysis

Tables 2 and 3 present the contingency outcome for both the existing and the expansion risk calculations established from December 2010.

Table 2. Existing Island Development Contingency

Confidence Level	Simulated Cost	Contingency %	
0%	**$(24,066,117)**	-7.39%	
10%	**$7,456,388**	2.29%	
20%	**$17,189,627**	5.28%	
30%	**$25,373,483**	7.79%	
40%	**$33,042,534**	10.15%	
50%	**$40,871,892**	12.55%	
60%	**$49,120,371**	15.08%	
70%	**$58,466,997**	17.95%	
80%	**$69,868,104**	**21.45%**	
90%	**$86,324,441**	26.50%	
100%	**$196,837,472**	60.44%	

* - Does not include PM-08

** - Represents PM-08

Table 3. Island Expansion

Confidence Level	Simulated Cost	Contingency %	
0%	**$(7,466,321)**	-1.72%	
10%	**$30,466,154**	7.01%	
20%	**$40,812,367**	9.39%	
30%	**$49,022,615**	11.28%	
40%	**$56,373,222**	12.97%	
50%	**$64,017,778**	14.73%	
60%	**$71,989,155**	16.56%	
70%	**$80,951,151**	18.62%	
80%	**$91,991,553**	**21.16%**	*
90%	**$107,612,261**	24.76%	
100%	**$216,277,788**	49.76%	

* - Does not include PM-08

** - Represents PM-08

6.3 Schedule Risk Analysis – Total Project Duration Contingency Results

Table 4 provides the schedule duration contingencies calculated for the P80 confidence level. The schedule duration contingencies for the P50 and P100 confidence levels are also provided for illustrative purposes.

Table 4. Schedule Duration Contingencies for P80

Confidence Level	Simulated Additional Months
0%	**0 Months**
10%	**1 Months**
20%	**4 Months**
30%	**7 Months**
40%	**10 Months**
50%	**13 Months**
60%	**16 Months**
70%	**20 Months**
80%	**26 Months**
90%	**33 Months**
100%	**61 Months**

Schedule duration contingency was quantified as 26 months based on the P80 level of confidence, when excluding the Risk PM-08. These contingencies were used to calculate the projected “overhead” cost impacts (Federal, non-Federal and contractor) of project delays that are included in the cost presentation of total cost contingency. The schedule contingencies were calculated by applying the high level schedule risks identified in the risk register for each option to the durations of critical path and near critical path tasks.

The schedule was not resource loaded and contained open-ended tasks and non-zero lags (gaps in the logic between tasks) that limit the overall utility of the schedule risk analysis. These issues should be considered as limitations in the utility of the schedule contingency data presented. Schedule contingency impacts presented in this analysis are based solely on projected “Hotel” costs. Resource impacts related to potential schedule delays could not be evaluated.

7. FINDINGS AND MITIGATION RECOMMENDATIONS

Risk management is an all-encompassing, iterative, and life-cycle process of project management. The Project Management Institute’s (PMI) *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)*, *4th edition*, states that “project risk management includes the processes concerned with conducting risk management planning, identification, analysis, responses, and monitoring and control on a project.” Risk identification and analysis are processes within the knowledge area of risk management. Its outputs pertinent to this effort include the risk register, risk quantification (risk analysis model), contingency report, and the sensitivity analysis.

The intended use of these outputs is implementation by the project leadership with respect to risk responses (such as mitigation) and risk monitoring and control. In short, the effectiveness of the project risk management effort requires that the proactive management of risks not conclude with the study completed in this report.

The CSRA produced by the PDT identifies issues that require the development of subsequent risk response and mitigation plans. This section provides a discussion of the identified major risks and a list of recommendations for continued management of those risks. Note that this list is not all inclusive and should not substitute a formal risk management and response plan.

1. Key Cost Risk Drivers: The key cost risk drivers identified through sensitivity analysis.

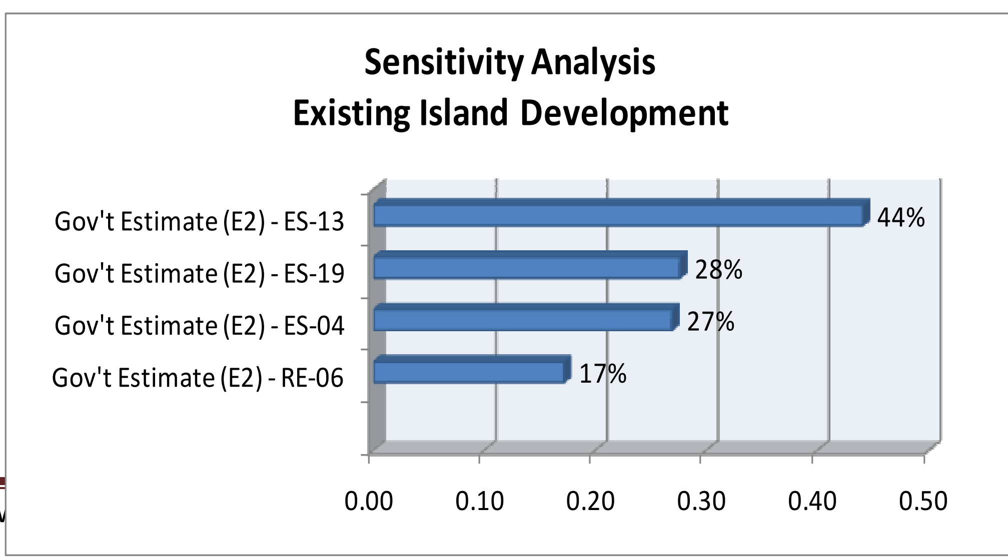

Figure 1. Sensitivity Analysis - Existing Island Development

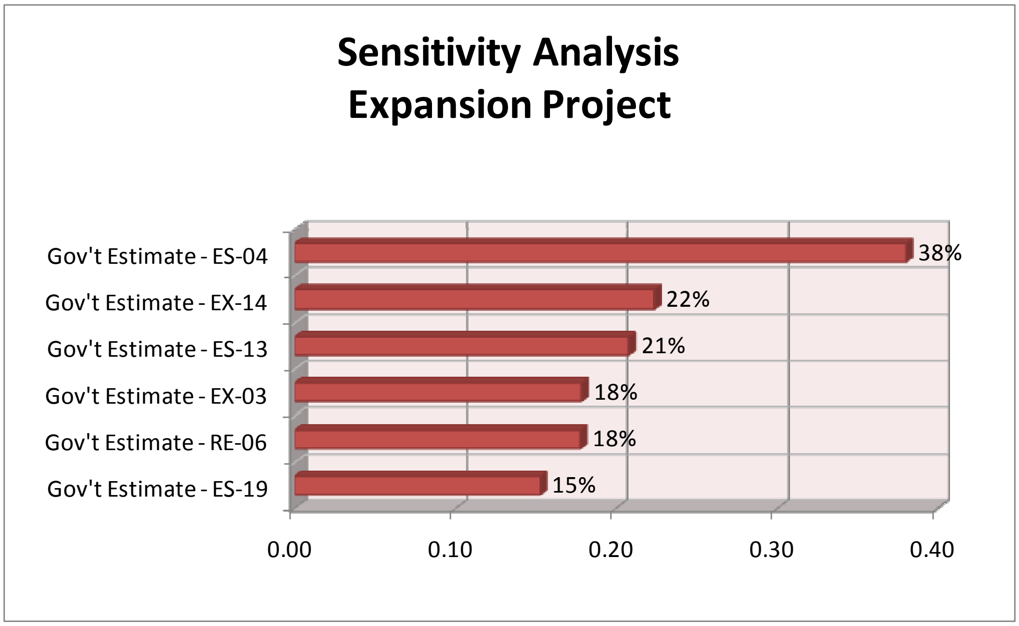

Figure 2. Sensitivity Analysis - Expansion Project

- Overall Confidence in Estimate and Schedule (ES-13): Difficulties concerning construction_cost and schedule of upland cells concerning final scope and requirements. Development of upland land for this project is untested. There are risks in the development of required cost and schedule. The cost could be higher or lower than the current assumptions within the baseline cost +25 and -15 percent low, schedule in minimal.
- Use of Historical Unit Prices (ES-19): For site work, adjustments to historical information was used. Concern if the adjustment factor will be accurate over life of project.
- Fuel Pricing (ES-04): The price of diesel fuel could change from the time the quote was obtained and the work performed. Work involves heavy equipment dependant on fuel (crane, clamshell, and marine).
- Environmental and Water Quality Issues (RE-06): Water quality parameters are a concern; historically projects have not met the water quality standards. As a result, a change of construction methods on projects may be required. Continued alternatives are a concern.
- Adequacy of Project Funding (incremental or full funding) (EX-14): Current estimated project length (2041), cost, and schedule is dependent on full funding on a yearly basis. Both by USACE and by local government, which provides dredged material for site. Current design efforts are based on 100 percent funded.
- Market conditions and bidding competition (EX-04): Concern over low amount of potential bidders. Dependant on contract acquisition, and availability of contractors.

- Unexpected Escalation on Key Materials (EX-3): Stone material cost is significant to project. There is an extremely limited amount of potential cost effective sources for project. Currently, local provider has provided rock at cost effective pricing. Concern of higher escalation cost of stones due to limited supply.

2. Key Schedule Risk Drivers: The key schedule risk drivers identified through sensitivity analysis.

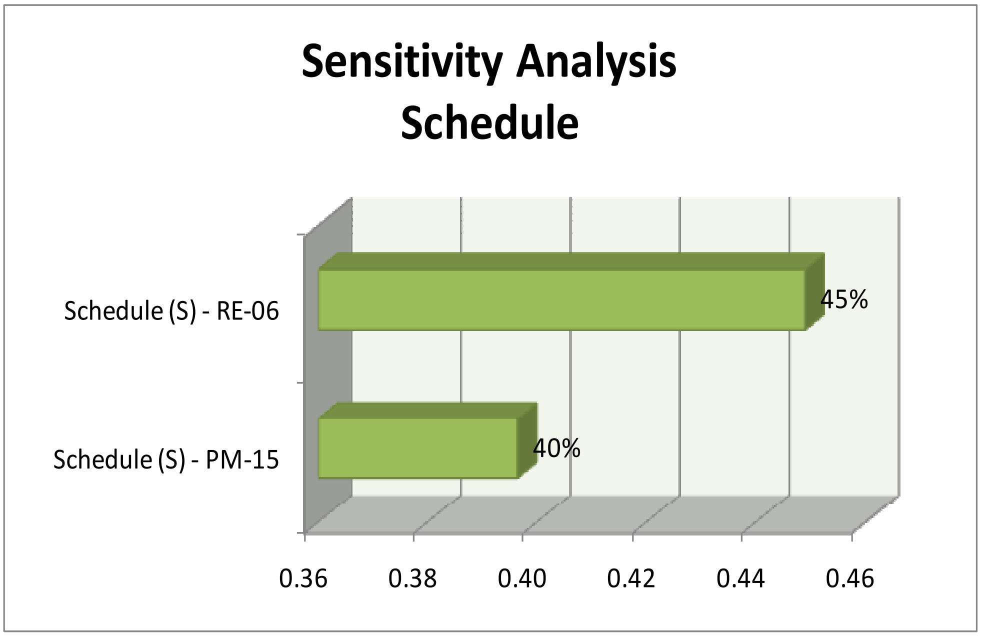

Figure 3. Schedule Sensitivity Analysis - Existing Island and Expansion

- Environmental and Water Quality Standards (RE-06) can change over time, and the construction activities may not meet those standards related to dredging, sediment transport, and placement. This may result in unanticipated scope risks and delays.
- Communications (PM-15) between the many parties on such a large and extended project must be maintained to ensure long-term success.
- Availability of CENAP Sites (PM-08): This project is directly dependent upon dredged material delivered from a separate project and related dredging sites. Should those project sites fail to deliver, schedule growth could be immeasurable and the associated cost and schedule risk growth unrealistic. This major risk item is treated separately within the risk analysis due to level of impact (another 142 months as a single risk or a total of 168 months including other risks). In the event this risk does occur, separate funding

request will be submitted for execution of project.

3. Risk Management: Project leadership should use the outputs created during the risk analysis effort as tools in future risk management processes. The risk register should be updated at each major project milestone. The results of the sensitivity analysis may also be used for response planning strategy and development. These tools should be used in conjunction with regular risk review meetings.

4. Risk Analysis Updates: Project leadership should review risk items identified in the original risk register and add others, as required, throughout the project life-cycle. Risks should be reviewed for status and reevaluation (using qualitative measure, at a minimum) and placed on risk management watch lists if any risk's likelihood or impact significantly increases. Project leadership should also be mindful of the potential for secondary (new risks created specifically by the response to an original risk) and residual risks (risks that remain and have unintended impact following response).

APPENDIX A – RISK REGISTER
2012 UPDATE

APPENDIX A

Legend
***Likelihood, Impact, and Risk Level to be verified through market research and analysis (conducted by cost engineer).**
1. **Risk/Opportunity** identified with reference to the Risk Identification Checklist and through deliberation and study of the PDT.
2. **Discussions and Concerns** elaborates on Risk/Opportunity Events and includes any assumptions or findings (should contain information pertinent to eventual study and analysis of event's impact to project).
3. **Likelihood** is a measure of the probability of the event occurring -- **Very Unlikely**, **Unlikely**, **Moderately Likely**, **Likely**, **Very Likely.** The likelihood of the event will be the same for both Cost and Schedule, regardless of impact.
4. **Impact** is a measure of the event's effect on project objectives with relation to scope, cost, and/or schedule -- **Negligible**, **Marginal**, **Significant**, **Critical**, or **Crisis.** Impacts on Project Cost may vary in severity from impacts on Project Schedule.
5. **Risk Level** is the resultant of Likelihood and Impact **Low**, **Moderate**, or **High**. Refer to the matrix located at top of page.
6. **Variance** Distribution refers to the behavior of the individual risk item with respect to its potential effects on Project Cost and Schedule. For example, an item with clearly defined parameters and a solid most likely scenario would probably follow a triangular or normal distribution. A risk item for which the PDT has little data or probability of modeling with respect to effects on cost or schedule (i.e. "anyone's guess") would probably follow a uniform or discrete uniform distribution.
7. **Responsibility or POC** is the entity responsible as the Subject Matter Expert (SME) for action, monitoring, or information on the PDT for the identified risk or opportunity.
8. **Correlation** recognizes those risk events that may be related to one another. Care should be given to ensure the risks are handled correctly without a "double counting."
9. **Affected Project Component** identifies the specific item of the project to which the risk directly or strongly correlates.
10. **Project Implications** identifies whether or not the risk item affects project cost, project schedule, or both. The PDT is responsible for conducting studies for both Project Cost and for Project Schedule.
11. **Results** of the risk identification process are studied and further developed by the Cost Engineer, then analyzed through the Monte Carlo Analysis Method for Cost (Contingency) and Schedule (Escalation) Growth.

POPLAR ISLAND CSRA - 2012 UPDATE, BALTIMORE DISTRICT

Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions	Project Cost: Likelihood ©	Project Cost: Impact ©	Project Cost: Risk Level ©	Project Schedule: Likelihood (S)	Project Schedule: Impact (S)	Project Schedule: Risk Level (S)	Cost Variance Distribution	Schedule Variance Distribution
Risk Report:											
Project & Program Management (PM)											
PM-19	Accelerated schedule	Design of Expansion Project is required to be completed by FY15. The design effort will begin in FY13.	Risk Mitigation due to not building of expansion project is raising existing upland dikes on a accelerated schedule. The team discussed the ramifications of accerateed design cost. It was concluded this overall this would be a low marginal amount. The team agreed this should not be included within the risk	Unlikely	Marginal	Low	Unlikely	Marginal	Low	N/A -Not Modeled	N/A -Not Modeled
PM-21	Hi-Level Oversight	High level of scrutiny on project has resulted in additional efforts.	New requirements due to external review (EC 209) regarding IEPR and other requirements have caused additional time to project execution	Certain	Negligible	Low	Certain	Marginal	Moderate	N/A -Not Modeled	N/A -Not Modeled
Technical Design (TD)											
TD-08	Incomplete engineering studies	Revised H&H design could effect quantities on project.	Design is ongoing, however, H&H has not been finalized. Design will change from feasibility, little potential change to qty's and very little schedule, due to work can be completed by other resources. Overall the net cost effect would be a negligable to marginal impact. The team agreed not	Very Likely	Marginal	Moderate	Unlikely	Negligible	Low	N/A -Not Modeled	N/A -Not Modeled
External (EX)											
EX-04	Market conditions and bidding competition	Concern over low amount of potential bidders	Recent contract bidding history indicates that there are enough contractors in this field that the PDT is reasonably assured of competition.	Unlikely	Significant	Moderate	Likely	Negligible	Low	Triangular	N/A -Not Modeled
EX-14	Sufficient project funding	Current estimated project length (2041), Project cost and schedule is dependant on full funding on a yearly basis	Optimum funding as forecast in the project estimate is critical to maintaining the overall schedule. During the dike construction of the expansion there are 3 years of construction funding to the order of $60M/per yr that will be required to maintain this schedule.	Very Likely	Significant	High	Likely	Significant	High	Uniform	N/A -Not Modeled

Project & ogram Management (PM)											
PM-08	Availablity of Dredge Matrl	Project is dependant on qty's of dredged material delivered to site. Lack of qty's of dredged material will lengthen schedule, increased qty's could accelerate some construction placement but potential for acceleration is limited	Based on 2M cyds thru FY14 and 3.2 M cyds thereafter. This includes 1.2M cyds of placement from NAP project. Potential risk that NAP yardage to this site could be diverted to closed CDF's and chnage the overall project placement schedule.	Very Likely	Significant	High	Very Likely	Significant	High	Triangular	Discrete Uniform
PM-11	Sufficient Project Personnel	Project is considered to be one of the high priority civil works in District , district resources anticipated to be allocated accordingly.	If sponsor cannot meet requirements for allocated work responsibilities for site work is passed to corps contracts. Overall the net cost effect would be a neglible to marginal impact. The team agreed not to be included wihtin the risk model.	Likely	Marginal	Moderate	Likely	Marginal	Moderate	N/A -Not Modeled	N/A -Not Modeled
PM-13	Priorities change on existing program	Competition between ports for federal funding.	The team discussed the possibilities the project would loose required qty's to complete the site. If so, this would in a major change to the project development. All parties are working together and all parties support the development of the project. This risk was identified as a unlikley event. However, if this were to happen, the impacts would be risk the project being constructed. Therefore the team agreed this should not be a risk model event since this would require a full restructure and appropriations event.	Unlikely	Crisis	High	Unlikely	Crisis	High	N/A -Not Modeled	N/A -Not Modeled
PM-15	Communication breakdown with project team	Lack of dialogue issues between local sponsor and corps.	There has been prior examples of communication issues which have caused increase to cost and / or schedule. However, the team feels that the relationship with the customer is as strong as it has ever been in the past.	Very Likely	Marginal	Moderate	Very Likely	Marginal	Moderate	Triangular	N/A -Not Modeled
PM-18	A/E/C Consultant or contractor delays	Concern over A/E design delays due to number of small contracts which could cause delays to project	Risk has been managed by performing critical path items such as design using in-house services	Unlikely	Marginal	Low	Unlikely	Marginal	Low	N/A - Not Modele	N/A - Not Modele
PM-22	Unplanned Work	Unforeseen events which required internal resources	Example: Coastal storm, levee safety. However this is not anticipated to have cost impacts as the PDT has been able to remain flexible with the workload and meet the project requirements.	Unlikely	Negligible	Low	Unlikely	Negligible	Low	N/A -Not Modeled	N/A -Not Modeled
PM-23	Local agency/regulator issues	Potential for change to design/construction. As an example Potential for change of standards by Maryland Department of Environment.	All parties are working together to assure scope does not change on project. This is a unlikely event which the team agreed to not include within the risk analysis. The team agreed to not model this event.	Unlikely	Marginal	Low	Unlikely	Marginal	Low	N/A -Not Modeled	N/A -Not Modeled

Construction (CO)											
CO-14	Site access / restrictions	Early habitat of construction zone with wildlife such as Nesting Shorebirds, and eagle area during construction of (5a & 5b)	Potential future Impact or delays on construction windows, Limited instances of accordance and alternative are in place to handle this type situation. Overall the net cost effect would be a neglible to marginal impact. The team agreed not to be included wihtin the risk model.	Likely	Marginal	Moderate	Likely	Marginal	Moderate	N/A -Not Modeled	N/A -Not Modeled
CO-22	Inefficient contractor	Concern over contractors ability to perform work in a timely cost effective manner	Current acquisition strategy is to use a pre-qualification (2 step) contract to perform work. Past history have included various contract types with various results.	Unlikely	Marginal	Low	Unlikely	Marginal	Low	N/A -Not Modeled	N/A -Not Modeled
CO-25	In-water work	Inherent risk of in-water placement due to wind, waves and storms	Placing of sand/stone in an open water setting can be challenging work and an experienced contractor is critical. . However, because the currently implemented 2-step acquisition strategy minimizes selection of inexperienced stone contractors, it is unlikely that in-water work will be affected. Consideration of qualified contractors for future in-water work will therefore result in negligible impact in costs and schedule.	Very Unlikely	Negligible	Low	Very Unlikely	Negligible	Low	N/A -Not Modeled	N/A -Not Modeled
CO-37	Survey information/ Grading of wetlands	Concerns over shaping of material to the precision required for the site.	Construction efforts in final grading of wetland cells seem to be more challenging than previously expected. However, the onsite contractor has historically proven to overcome the site grading challenge. Therefore, it is unlikely that grading will become a real problem. And even if it did, grading cost has been validated to be low annual cost, resulting marginal cost impact overall. Project schedule may have a significant impact if grading was a recurring problem because it will require the PDT additional time to find alternative solutions.	Unlikely	Marginal	Low	Unlikely	Significant	Moderate	N/A -Not Modeled	N/A -Not Modeled

Cost and Schedule (ES)											
ES-04	Fuel Prices	The price of diesel fuel could change between when the quote was obtained and the work performed.	Because the project involves heavy equipment dependant on fuel (Crane, Clamshell, Marine Equipment, etc), if fuel cost is irrationally increased, the total project will have significant impact. Historically it has shown that fuel has had significant cost impacts to the project. High fuel cost however, does not result in delays schedule if funding is sufficient.	Likely	Significant	High	Likely	Negligible	Low	Triangular	N/A -Not Modeled
ES-13	Estimate Confidence	Construction cost and schedule of Upland Cells	Development of Upland land for this project is untested. There are risk in the development of required cost and schedule.	Likely	Marginal	Moderate	Unlikely	Negligible	Low	Triangular	N/A -Not Modeled
ES-19	Historic estimates	For site work, adjustments to historical information was used. Concern if the adjustment factor will be accurate over life of project.	PDT used a collaborate approach to adjust on a yearly basis, + or - could occur. Cost 20% increase	Unlikely	Significant	Moderate	Likely	Negligible	Low	Triangular	N/A -Not Modeled
External (EX)											
EX-03	Unexpected escalation on key materials	Stone material cost is significant to project. There is a extremely limited amount of potential cost effective sources for project. Currently local provider has provided rock at cost	Recent inquiries to the quarry indicate that there is still ample inventory to provide the required amount of rock for the project.	Unlikely	Significant	Moderate	Likely	Negligible	Low	Triangular	N/A -Not Modeled
EX-06	Political opposition / threat of lawsuits	Potential for lawsuits or measures to stop work	The team discussed the probability of this occuring and all agreed this event has a Unlikely chance of happening, and therefore would not be modeled within the risk model.	Unlikely	Negligible	Low	Unlikely	Critical	Moderate	N/A -Not Modeled	N/A -Not Modeled
EX-09	Stakeholders request late changes	History for changes of scope by stakeholders could result in additional design or construction requirements.	Such as alignment of expansion	Unlikely	Marginal	Low	Unlikely	Marginal	Low	N/A - Not Modele	N/A - Not Modele
EX-11	Loss of public trust / goodwill	Required placement of harbor material. Concerns over material quality with potential contaminants would jeopardize local trust	This is hypothetic since it is unknown this scenario would ever take place.	Very Unlikely	Significant	Low	Very Unlikely	Significant	Low	N/A -Not Modeled	N/A -Not Modeled
EX-12	Local communities pose objections	Concern over local objections	Communication with local authorities has been positive	Very Unlikely	Negligible	Low	Very Unlikely	Negligible	Low	N/A - Not Modele	N/A - Not Modele

Regulatory & Environmental (RE)											
RE-06	Environmental and Water quality issues	Water quality parameters are a concern, past history projects have not met the water quality standards.	The effects of the EPA established TMDLs for the Chesapeake Bay on the project are not yet known. As a result, a change in the operations of the project could result in schedule delay, which in turn, result in multiple years of site operations and maintenance.	Likely	Marginal	Moderate	Likely	Significant	High	Triangular	Triangular
RE-19	Potential for critical regulation changes	Potential change in state standards	Could result in design/construction changes. This risk is always a possibility. At this time there is no know potential for regulation change. The team agreed this would not be a modeled event.	Unlikely	Significant	Moderate	Unlikely	Significant	Moderate	N/A -Not Modeled	N/A -Not Modeled
RE-21	Project in the Coastal Zone	Potential for coastal storms, hurricanes and sea level rise	Storm damage to project during construction would require additional construction efforts during the construction of project. Also high probability during life of project, resulting in design. Sea Level Rise 5-10%, Hurricane 2 - 10% and North Eastern 5 -10%	Likely	Marginal	Moderate	Likely	Marginal	Moderate	Uniform	N/A -Not Modeled
Technical Design (TD)											
TD-19	Adaptive Management features.	Current adaptive management is working (not including upland which has not started). Project is using lessons learned from previous completion unit on project to incorporate for future (<3% of construction cost, excluding monitoring).	The team discussed the probability of this occuring and all agreed this event has a Unlikely chance of happening, and therefore would not be modeled within the risk model.	Unlikely	Negligible	Low	Unlikely	Negligible	Low	N/A -Not Modeled	N/A -Not Modeled

Cost Risk Levels

Risk Level ©	Risk No.	Risk/Opportunity Event
High	ES-04	Fuel Prices
	ES-13	Overall confidence in estimate and schedule
	ES-19	Historic estimates for unit prices adequate for critical items
	EX-03	Unexpected escalation on key materials
	EX-04	Market conditions and bidding competition
	EX-14	Adequacy of project funding (incremental or full funding)
	PM-08	Risk to Project schedule
	PM-13	Priorities change on existing program
	PM-15	Communication breakdown with project team
	RE-21	Project in the Coastal Zone
Moderate	CO-14	Site access / restrictions
	PM-11	Functional and Technical labor units not available or overloaded
	PM-19	Pressure to deliver project on an accelerated schedule
	PM-23	Local agency/regulator issues
	RE-06	Environmental and Water quality issues
	RE-19	Potential for critical regulation changes
	TD-08	Incomplete studies (geotech, hydrology and hydraulic, structural, HTRW, etc)
Low	CO-22	Inefficient Contractors
	CO-25	In-water work
	CO-37	Survey information/ shaping requirement
	EX-06	Political opposition / threat of lawsuits
	EX-09	Stakeholders request late changes
	EX-11	Loss of public trust / goodwill
	EX-12	Local communities pose objections
	PM-18	A/E/C Consultant or contractor delays
	PM-21	Program oversight at HQ level (reviews)
	PM-22	Unplanned work that must be accommodated
	TD-19	Adaptive Management features (<3% of construction cost, excluding monitoring)

Schedule Risk Levels

Risk Level (S)	Risk No.	Risk/Opportunity Event
High	PM-08	Risk to Project schedule
	PM-13	Priorities change on existing program
	RE-06	Environmental and Water quality issues
Moderate	CO-14	Site access / restrictions
	CO-37	Survey information/ shaping requirement
	EX-06	Political opposition / threat of lawsuits
	PM-11	Functional and Technical labor units not available or overloaded
	PM-15	Communication breakdown with project team
	PM-19	Pressure to deliver project on an accelerated schedule
	PM-21	Program oversight at HQ level (reviews)
	PM-22	Unplanned work that must be accommodated
	PM-23	Local agency/regulator issues
	RE-19	Potential for critical regulation changes
	RE-21	Project in the Coastal Zone
Low	CO-22	Inefficient contractor
	CO-25	In-water work
	ES-04	Fuel Prices
	ES-13	Overall confidence in estimate and schedule
	ES-19	Historic estimates for unit prices adequate for critical items
	EX-03	Unexpected escalation on key materials
	EX-04	Market conditions and bidding competition
	EX-09	Stakeholders request late changes
	EX-11	Loss of public trust / goodwill
	EX-12	Local communities pose objections
	EX-14	Adequacy of project funding (incremental or full funding)
	PM-18	A/E/C Consultant or contractor delays
	TD-08	Incomplete studies (geotech, hydrology and hydraulic, structural, HTRW, etc)
	TD-19	Adaptive Management features (<3% of construction cost, excluding monitoring)

Modeled Risk

Row Labels	Risk/Opportunity Event	Risk Level ©	Likelihood ©	Cost Variance Distribution	Risk Level (S)	Likelihood (S)	Schedule Variance Distribution
Contract Cost							
ES-04	Fuel Prices	High	Likely	Triangular	Low	Likely	N/A -Not Modeled
ES-19	Historic estimates for unit prices adequate for critical items	High	Likely	Triangular	Low	Likely	N/A -Not Modeled
EX-03	Unexpected escalation on key materials	High	Likely	Triangular	Low	Likely	N/A -Not Modeled
EX-04	Market conditions and bidding competition	High	Likely	Triangular	Low	Likely	N/A -Not Modeled
Contract Cost & Schedule							
PM-15	Communication breakdown with project team	High	Very Likely	Triangular	Moderate	Very Likely	N/A -Not Modeled
Project Cost & Schedule							
PM-08	Risk to Project schedule	High	Very Likely	Triangular	High	Very Likely	Uniform
Project Cost							
ES-13	Overall confidence in estimate and schedule	High	Likely	Triangular	Low	Unlikely	N/A -Not Modeled
EX-14	Adequacy of project funding (incremental or full funding)	High	Very Likely	Uniform	Low	Likely	N/A -Not Modeled
RE-06	Environmental and Water quality issues	Moderate	Likely	Triangular	High	Likely	Triangular
RE-21	Project in the Coastal Zone	High	Likely	Uniform	Moderate	Likely	N/A -Not Modeled