US Army Corps
of Engineers ®
San Francisco District

PAJARO RIVER FLOOD RISK MANAGEMENT PROJECT
SANTA CRUZ AND MONTEREY COUNTIES
CALIFORNIA

COST ENGINEERING
APPENDIX G APRIL 2018

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INTRODUCTION

The cost estimate for the Pajaro River Flood Risk Management Project's Feasibility Report was developed using the Micro-Computer Aided Cost Estimating System (MCACES), Second Generation (MII) software and the USACE established Civil Works Work Breakdown Structure (CWWBS). The estimate used quantities provided by the Civil Design Section, and was based on USACE cost estimating standards, and the cost estimating knowledge and judgment of USACE cost engineers as they apply to civil works projects.

REFERENCES

Reference materials used to prepare the cost estimate, along with the basis for the estimate and any applicable facts and/or assumptions impacting the estimate, are documented below.

- Report Synopsis, Pajaro River Project, Watsonville, California, draft General Reevaluation Report (GRR) Tentatively Selected Plan Milestone (12 May 2015)
- USACE Engineer Regulation, ER 1110-2-1150, Engineering and Design for Civil Works Projects
- USACE Engineering Regulation, ER 1110-1-1300, Cost Engineering Policy And General Requirements
- USACE Engineering Regulation, ER 1110-2-1302, Civil Works Cost Engineering
- USACE Engineering Technical Letter, ETL 1110-2-573, Construction Cost Estimating Guide for Civil Works
- USACE Engineering Manual, EM 1110-2-1304, Civil Works Construction Cost Index System (CWCCIS)
- USACE Engineering Pamphlet, EP 1110-1-8, Vol. 07, Construction Equipment Ownership and Operating Expense Schedule
- Cost and Schedule Risk Analysis Process, March 2008

BASIS/FACTS/ASSUMPTIONS

The basis for the estimate was the scoping documents provided by the Project Delivery Team (PDT). The unit costs for the construction features were computed by estimating the equipment, labor, material, and production rates suitable for the project.

EFFECTIVE PRICE LEVEL

The cost estimate effective price level is April 2018.

CONSTRUCTION WINDOW

Due to endangered species/environmental concerns, the window for in-stream work is from June 15 to October 15. For all other work, the construction window is April to November.

OVERTIME

The estimate assumed that the work will be done during 8-hour shifts, 5 days a week and that no overtime will be required.

ACQUISITION PLAN

The acquisition plan is unknown at this time, however, the cost estimate was developed assuming Invitation for Bid (IFB) competitive bidding, under multiple contracts with a prime

contractor and subcontractors. It is assumed that construction will take four to five years to complete, and there will be a five separate contracts, one for each reach.

SITE ACCESS
There are no site access issues for the Contractor for this project, therefore no additional cost impacts have been applied to the IGE for this element.

CONSTRUCTION METHOD
No special construction technologies are required for the job.

UNUSUAL CONDITIONS
No unusual conditions are anticipated.

EQUIPMENT /LABOR AVAILABILITY AND DISTANCE TRAVELED
The project is located within Santa Cruz and Monterey Counties, California. All labor and equipment are assumed available within a 100-miles radius in order to allow for fair competition.

ENVIRONMENTAL CONCERNS
No special environmental concerns beyond those stated in the construction window.

LABOR RATES
The labor rates used are from the 2018 Davis-Bacon wage rates tables for the San Francisco Bay Area, California.

EQUIPMENT RATES
Equipment rates are based upon the latest approved U.S. Army Corps of Engineers, Engineer Pamphlet (EP) 1110-1-8, Vol. 07, Construction Equipment Ownership and Operation Expense Schedule.

MATERIAL COSTS
Material prices were obtained from vendor and supplier quotes, discussions with USACE personnel and local government agencies, historical cost data from previous projects, and the MCACES Unit Price Book.

The Pajaro River Flood Risk Management Project area is within the Pajaro River watershed on the central coast of California. The watershed is about 75 miles south of San Francisco and includes portions of Santa Cruz, Monterey, Santa Clara, and San Benito Counties.

The flood risk management project is divided into two sections: the mainstem section of the Pajaro River (Reaches 2, 3, and 4) which acts as the dividing line between the City of Watsonville (Santa Cruz County) and the Town of Pajaro (Monterey County), and the tributaries section (Reaches 5 and 6) which encompasses Salsipuedes Creek and Corralitos Creek, within Santa Cruz County. Reaches 7 and 8 are no longer a part of the project.

There were originally four alternatives for each section, resulting in a total of eight alternatives. The purpose of the initial project estimates was to calculate the construction costs of each of the 8 alternatives. The results were then transferred to the Corps' Sacramento District Economics Section to formulate, evaluate, and select the National Economic Development (NED) alternative for each section based on its costs and estimated net economic benefits.

This estimate is the tentatively selected plan (TSP) and it is composed of the NED alternatives for the mainstem and the tributaries sections modified to compensate for hydraulic induced flooding in Reaches 5 and 6.

The quantities used in this estimate were supplied by the USACE San Francisco District Civil Design Section.

Estimated by
Designed by
Prepared by Rita Foti
Preparation Date 3/28/2018
Effective Date of Pricing 3/28/2018
Estimated Construction Time Days

Description	UOM	ProjectCost
Summary of Costs		**181,385,498.64**
1 Contract 1	**EA**	*44,374,455.48* **44,374,455.48**
2 Contract 2	**EA**	*9,912,018.53* **9,912,018.53**
3 Contract 3	**EA**	*49,328,957.71* **49,328,957.71**
4 Contract 4	**EA**	*44,184,143.33* **44,184,143.33**
5 Contract 5	**EA**	*33,585,923.58* **33,585,923.58**

Currency in US dollars

US Army Corps
of Engineers®

Pajaro River Flood Risk Management Project
General Reevaluation Report & Integrated Environmental Assessment

Project Cost and Schedule Risk Analysis Report

Prepared for:

U.S. Army Corps of Engineers,
San Francisco District

Prepared by:

Phillip C. Ohnstad, CPC, CCC

April 2018

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EXECUTIVE SUMMARY

The US Army Corps of Engineers (USACE), San Francisco District, presents this cost and schedule risk analysis (CSRA) report regarding the risk findings and recommended contingencies for the Pajaro River Flood Risk Management Project General Reevaluation Report & Integrated Environmental Assessment. In compliance with Engineer Regulation (ER) 1110-2-1302 CIVIL WORKS COST ENGINEERING, dated September 15, 2008, a *Monte-Carlo* based risk analysis was conducted by the Project Development Team (PDT) on remaining costs. The purpose of this risk analysis study is to present the cost and schedule risks considered, those determined and respective project contingencies at a recommended 80% confidence level of successful execution to project completion.

The purpose of the project is to reduce flood risk to the City of Watsonville, the Town of Pajaro, and surrounding agricultural lands. The purpose of the study was to determine the Federal interest in investing in additional flood risk management solutions in the study area. The Pajaro River Watershed has a long history of flooding that has resulted in substantial damages in the urban areas of the Town of Pajaro and City of Watsonville and surrounding agricultural areas. The study involved the formulation of alternative plans to reduce flood risk in the study area, evaluation of economic and environmental impacts of the alternatives including the no action alternative, and identifying the plan that maximizes the net National Economic Development (NED) benefits and complies with applicable federal and state environmental regulations.

Specific to the Pajaro River Flood Risk Management Project General Reevaluation Report, the current project base cost estimate, pre-contingency, approximates $244M. The Real Estate office provided a separate 31% average contingency for its real estate requirements, the Cost MCX performed study on the estimated remaining construction costs of $180M. Based on the results of the analysis, the Cost Engineering Mandatory Center of Expertise for Civil Works (MCX located in Walla Walla District) recommends a contingency value of $72M or approximately 40% of base project cost at an 80% confidence level of successful execution. The contingencies include a separate $20M for Real Estate, another $7.2M for construction management, and $9.4M for planning, engineering and design.

Cost estimates fluctuate over time. During this period of study, minor cost fluctuations can and have occurred. For this reason, contingency reporting is based in cost and percent values. Should costs vary to a slight degree with similar scope and risks, contingency percent values will be reported, and cost values rounded.

Table ES-1. Construction Contingency Results

Base Case Construction Cost Estimate	**$180,000,000**	
Confidence Level	**Construction Value ($$) w/ Contingencies**	**Contingency (%)**
50%	$241,000,000	35%
80%	**$251,000,000**	**40%**
90%	$255,000,000	42%

KEY FINDINGS/OBSERVATIONS RECOMMENDATIONS

The PDT worked through the risk register on March 6, 2018. The key risk drivers identified through sensitivity analysis suggest a cost contingency of $72M and schedule risks adding 20 months, both at an 80% confidence level.

Cost Risks: From the CSRA, the key or greater Cost Risk items include:

- EX2: Market Condition and Bidding Competition – If competition is good, contractor bids could approach 5% lower. Lack of competition could lead to costs as much as 10% higher than the government estimate.
- ES7: Bridge Raise Estimate – Bridge raise, roads, ramps and culvert relocation costs are provided by the sponsors. Bridge costs are predominately a single cost item for each bridge that have been escalated from 2006 to current price levels. Bridge scope of work is unclear. Detailed bridge costs are not available at this time and there is lack of confidence in the critical cost item.
- TR10: Reuse of Levee Material – Estimate assumes 75% reuse of existing levee material. Moderate probability existing material is unsuitable and may need to import borrow material and haul unsuitable material to a disposal site.
- TR4: Levee Design and Quantities - Using existing mapping, utility, property boundary, road, bridge, as-built, and structures data. During PED, the survey data could change the design and quantities. Design is for 3:1 side slopes with a 20 foot wide crown. Existing levees are 12 feet -14 feet wide at the crown. Future design changes could change quantities as much as much as -5% to +11%.
- ES11: Fuel Costs – The price of fuel has the potential of rising. Since this a relatively equipment minimal project, fuel is anticipated to be a marginal risk.
- CO10: Modifications and Claims – Due to the inherent unknowns, there is a possibility of a modification and claim. Unknown and changing conditions are a moderate cost and schedule risk. Testing and sampling during PED will minimize the possibility of claims during construction. This risk is modeled on modifications and claims risk excluding scope growth.

- TR9: Fill Material Haul Costs - The fill material source is unknown and could add to the haul costs. Estimate assumes a 12 mile haul one-way and is optimistic.
- CA2: Small Business Goals - A Full and Open Acquisition Risk would present minimal costs risks. Best Value or 8(a) Small Business would present additional cost risk. No additional subcontracts anticipated due to small business requirements but is possible with moderate costs impacts.
- TR2: Pump Station Costs - Utility relocation unit costs are provided by the sponsors. Costs estimate data has no basis, not verifiable, and could vary based on actual scope of work and conditions. It is unclear if the input unit cost is fully burdened and we have included an additional burden causing the pricing to be overstated.

Schedule Risks: The high value of schedule risk indicates a significant uncertainty of key risk items, time duration growth that can translate into added costs. Over time, risks increase on those out-year contracts where there is greater potential for change in new scope requirements, uncertain market conditions, and unexpected high inflation. The greatest risk is:

- ES12: Construction Schedule - Schedule does not depict logical construction sequencing, resourcing phasing, and parallel activities. The PDT believes a 4 to 5 year construction period is adequate for construction but without a properly develop construction schedule, there is a risk of schedule delays.
- PM1: Funding - Inadequate funding will protract the project schedule. It will delay awarding the project but will not delay a contract once it is awarded. No WRDS required and will go directly to a Directors Report. Moderate risk to schedule. If there is a delay, it could delay the project for 1 year.
- CA2: Small Business Goals – Small business goals could lead to lower productivity and schedule delays.
- ES2: Levee Productivity Rates – Levee construction productivity rates are assumed and are likely to change due to impacts from environmental restrictions, working around communities, haul route restrictions, etc.
- CO6: HTRW - Risk of encountering HTRW is unknown –may range from nothing, to materials that require special handling/disposal to large scale clean up prior to construction.

Recommendations:

Recommend updating the levee quantities with the latest hydraulic modeling data. Provide detailed scopes of work for the relocations and update the design and cost data.

The PDT must include the recommended cost and schedule contingencies and incorporate risk monitoring and mitigation on those identified risks. Further iterative study and update of the risk analysis throughout the project life-cycle is important in support of the remaining project work within an approved budget and appropriation.

MAIN REPORT

1.0 PURPOSE

Within the authority of the US Army Corps of Engineers (USACE), San Francisco District, this report presents the efforts and results of the cost and schedule risk analysis for the Pajaro River Flood Risk Management Project General Reevaluation Report & Integrated Environmental Assessment. The report includes risk methodology, discussions, findings, and recommendations regarding the identified risks and the necessary contingencies to confidently administer the project, presenting a cost and schedule contingency value with an 80% confidence level of successful execution.

2.0 BACKGROUND

The purpose of the project is to reduce flood risk to the City of Watsonville, the Town of Pajaro, and surrounding agricultural lands. The purpose of the study was to determine the Federal interest in investing in additional flood risk management solutions in the study area. The Pajaro River Watershed has a long history of flooding that has resulted in substantial damages in the urban areas of the Town of Pajaro and City of Watsonville and surrounding agricultural areas. The study involved the formulation of alternative plans to reduce flood risk in the study area, evaluation of economic and environmental impacts of the alternatives, including the no action alternative, and identifying the plan that maximizes the net National Economic Development (NED) benefits and complies with applicable federal and state environmental regulations.

3.0 REPORT SCOPE

The scope of the risk analysis report is to identify cost and schedule risks with a resulting recommendation for contingencies at the 80 percent confidence level using the risk analysis processes, as mandated by U.S. Army Corps of Engineers (USACE) Engineer Regulation (ER) 1110-2-1150, Engineering and Design for Civil Works, 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 construction features. The CSRA excludes Real Estate costs and does not include consideration for life cycle costs.

3.1 Project Scope

The formal process included extensive involvement of the PDT for risk identification and the development of the risk register. The analysis process evaluated the Micro Computer Aided Cost Estimating System (MCACES) cost estimate, project schedule, and funding profiles using Crystal Ball software to conduct a *Monte Carlo* simulation and statistical sensitivity analysis, per the guidance in Engineer Technical Letter (ETL) CONSTRUCTION COST ESTIMATING GUIDE FOR CIVIL WORKS, dated September 30, 2008.

The project technical scope, estimates, and schedules were developed and presented by the San Francisco District. Consequently, these documents serve as the basis for the risk analysis.

The scope of this study addresses the identification of concerns, needs, opportunities and potential solutions that are viable from an economic, environmental, and engineering viewpoint.

3.2 USACE Risk Analysis Process

The risk analysis process for this study follows the USACE Headquarters requirements as well as the guidance provided by the Cost Engineering MCX. The risk analysis process reflected within this report uses probabilistic cost and schedule risk analysis methods within the framework of the Crystal Ball software. 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 to 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 analysis 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, this risk analysis was 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.

- Engineer Regulation (ER) 1110-2-1302 CIVIL WORKS COST ENGINEERING, dated September 15, 2008.

- Engineer Technical Letter (ETL) CONSTRUCTION COST ESTIMATING GUIDE FOR CIVIL WORKS, dated September 30, 2008.

4.0 METHODOLOGY / PROCESS

The Cost Engineering MCX performed the Cost and Schedule Risk Analysis, relying on local San Francisco District staff to provide expertise and information gathering. The San Francisco PDT conducted initial risk identification via webinar/teleconference with the Walla Walla Cost Engineering MCX facilitator on March 6, 2018. The initial risk

identification meeting also included qualitative analysis to produce a risk register that served as the draft framework for the risk analysis.

Participants in the risk identification meeting included:

Risk Facilitator	Phillip Ohnstad	

Risk Register Meeting

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Date: 3/6/2018

Attendance	Name	Office	Representing
Full	Jamie O'Halloran	USACE-SPN	Project Management
Morning Only	Ricardo Galdamez	USACE-SPN	Technical Lead
Full	Christopher Eng	USACE-SPN	Environmental
Full	Rita Foti	USACE-SPN	Cost Engineering
Full	Terry Bautista	USACE-SPN	Eng & Tech Services Deputy Chief
Full	Mark Strudley	County of Santa Cruz	Flood Control Program Manager
Full	Ted Turney	USACE - SPN	Contracting
Full	Brian Hubel	USACE - SPN	Geotechnical Chief
Full	Bonievee Delapaz	USACE - SPN	Real Estate
Full	Andrew Muha	USACE - SPN	Water Resource Planner
Full	Jim Howells	USACE-SPN	Plan/Economics
Full	Tanis Toland	USACE-SPN	Planning
Full	Lidia Gutierrez	Gutierrez Consultants	Local Public Agencies

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 the desired level of cost confidence. Per regulation and guidance, the P80 confidence level (80% confidence level) is the normal and accepted cost confidence level. District Management has the prerogative to select different confidence levels, pending approval from Headquarters, USACE.

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 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 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.

A formal PDT meeting was held with the San Francisco District office for the purposes of identifying and assessing risk factors. The meeting included capable and qualified representatives from multiple project team disciplines and functions, including project management, cost engineering, design, environmental compliance, and real estate.

The initial formal meetings focused primarily on risk factor identification using brainstorming techniques, but also included some facilitated discussions based on risk factors common to projects of similar scope and geographic location. Additionally, numerous conference calls and informal meetings were conducted throughout the risk analysis process on an as-needed basis to further facilitate risk factor identification, market analysis, and risk assessment in order to finalize the risk register, resulting CSRA model, findings, and results.

4.2 Quantify Risk Factor Impacts

The quantitative impacts (putting it to numbers of cost and time) of risk factors on project plans were analyzed using a combination of professional judgment, empirical data and analytical techniques. Risk factor impacts were 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 involved multiple project team disciplines and functions. However, the quantification process relied more extensively on collaboration between cost engineering and risk analysis team members with lesser inputs from other functions and disciplines. This process used an iterative approach to estimate the following 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 as presented in Section 6 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 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.

5.0 PROJECT ASSUMPTIONS

The following data sources and assumptions were used in quantifying the costs associated with the project.

a. A key risk, Sponsor Funding, was not included within the cost risk analysis because its occurrence would stop the project and there is no reasonable measure that could be modeled; it's either a go or a no-go. The sponsor funding is critical to project objectives. Without successful agreements, critical elements of the objectives cannot be met. Currently, the risk of occurrence is considered unlikely.

b. The San Francisco District provided MII MCACES (Micro-Computer Aided Cost Estimating Software) files electronically. The MII and CWE files transmitted and downloaded on April 8, 2018 was the basis for the initial cost and schedule risk analyses. The MII and CWE files dated April 20, 2018 (post ATR) served as the basis for the CSRA.

c. The cost comparisons and risk analyses performed and reflected within this report are based on design scope and estimates that are at the preconstruction engineering and design (PED) level, most approximating a 10% design.

d. Schedules are analyzed for impact to the project cost in terms of delayed funding, uncaptured escalation (variance from OMB factors and the local market) and unavoidable fixed contract costs and/or languishing federal administration costs incurred throughout delay.

e. The Cost Engineering MCX guidance generally focuses on the eighty-percent level of confidence (P80) for cost contingency calculation. For this risk analysis, the eighty-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.

f. Only high and 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".

6.0 RESULTS

The cost and schedule risk analysis results are provided in the following sections. In addition to contingency calculation results, sensitivity analyses are presented to provide decision makers with an understanding of variability and the key contributors to the cause of this variability.

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 Contingency and Sensitivity Analysis

The result of risk or uncertainty analysis is quantification of the cumulative impact of all analyzed risks or uncertainties as compared to probability of occurrence. These results, as applied to the analysis herein, depict the overall project cost at intervals of confidence (probability).

Table 1 provides the construction cost contingencies calculated for the P80 confidence level and rounded to the nearest thousand. The construction cost contingencies for the P5, P50 and P90 confidence levels are also provided for illustrative purposes only.

Cost contingency for the construction risks (including schedule impacts converted to dollars) was quantified as approximately $72 Million at the P80 confidence level (40% of the baseline construction cost estimate).

Table 1. Construction Cost Contingency Summary

Base Case Construction Cost Estimate	**$180,000,000**	
Confidence Level	**Construction Value ($$)**	**Contingency (%)**
50%	$241,000,000	34%
80%	**$251,000,000**	**40%**
90%	$255,000,000	42%

6.2.1 Sensitivity Analysis

Sensitivity analysis generally ranks the relative impact of each risk/opportunity as a percentage of total cost uncertainty. The Crystal Ball software uses a statistical measure (contribution to variance) that approximates the impact of each risk/opportunity contributing to variability of cost outcomes during *Monte Carlo* simulation.

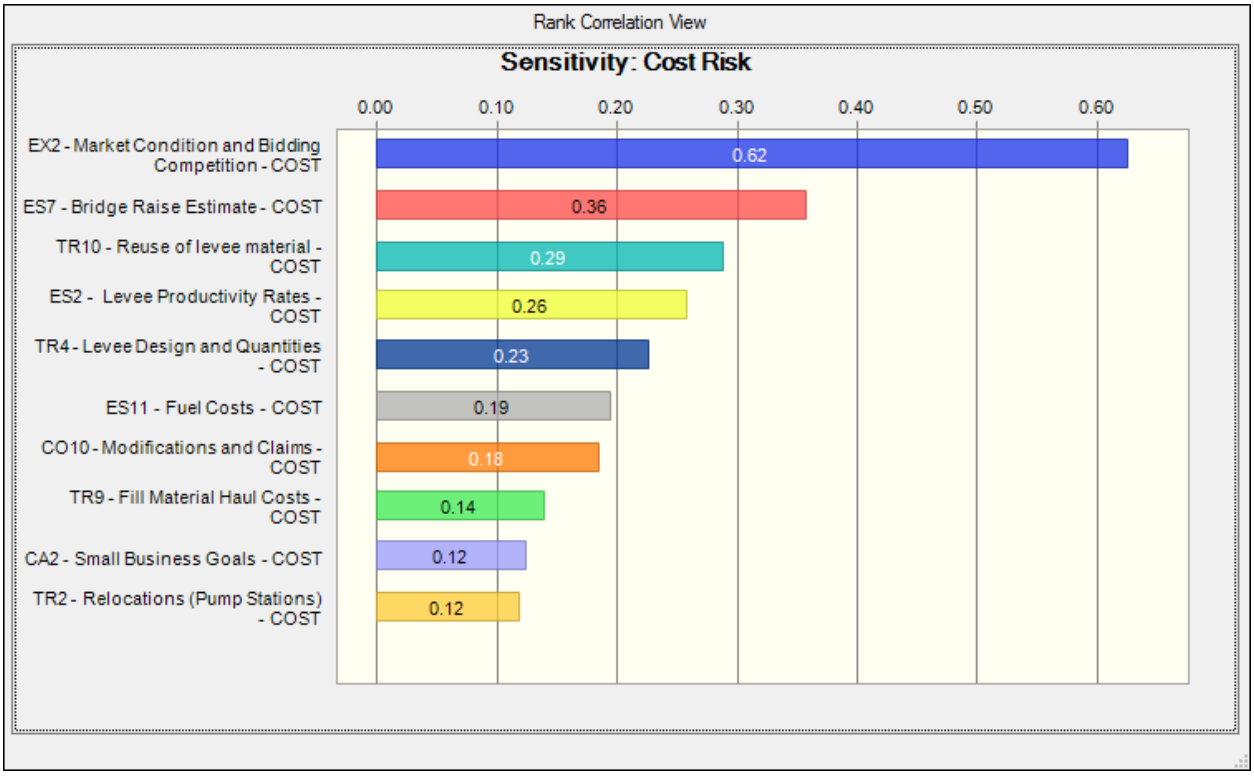
Key cost drivers identified in the sensitivity analysis can be used to support development of a risk management plan that will facilitate control of risk factors and their potential impacts throughout the project lifecycle. Together with the risk register, sensitivity analysis results can also be used to support development of strategies to eliminate, mitigate, accept, or transfer key risks.

6.2.2 Sensitivity Analysis Results

The risks/opportunities considered as key or primary cost drivers and the respective value variance are ranked in order of importance in contribution to variance bar charts. Opportunities that have a potential to reduce project cost and are shown with a negative sign; risks are shown with a positive sign to reflect the potential to increase project cost. A longer bar in the sensitivity analysis chart represents a greater potential impact to project cost.

Figure 1 presents a sensitivity analysis for cost growth risk from the high level cost risks identified in the risk register. Likewise, Figure 2 presents a sensitivity analysis for schedule growth risk from the high level schedule risks identified in the risk register.

Figure 1. Cost Sensitivity Analysis



6.3 Schedule and Contingency Risk Analysis

The result of risk or uncertainty analysis is quantification of the cumulative impact of all analyzed risks or uncertainties as compared to probability of occurrence. These results, as applied to the analysis herein, depict the overall project duration at intervals of confidence (probability).

Table 2 provides the schedule duration contingencies calculated for the P80 confidence level. The schedule duration contingencies for the P50 and P90 confidence levels are also provided for illustrative purposes.

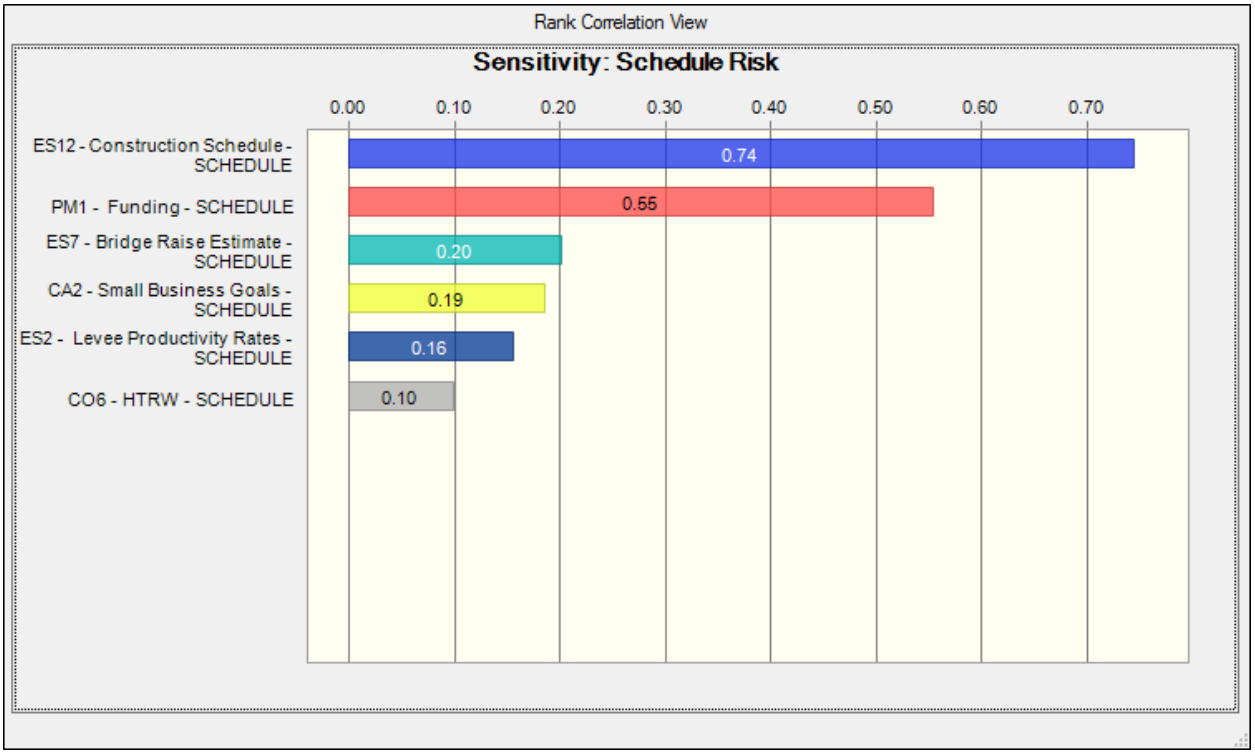
Schedule duration contingency was quantified as 20 months based on the P80 level of confidence. These contingencies were used to calculate the projected residual fixed cost impact of project delays that are included in the Table 1 presentation of total cost contingency. The schedule contingencies were 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 residual fixed costs.

Table 2. Schedule Duration Contingency Summary

Risk Analysis Forecast (base schedule of 57 months)	Duration w/ Contingencies (months)	Contingency[1] (months)
50% Confidence	83	14
80% Confidence	88	20
90% Confidence	90	22

Figure 2. Schedule Sensitivity Analysis



7.0 MAJOR FINDINGS/OBSERVATIONS/RECOMMENDATIONS

This section provides a summary of significant risk analysis results that are identified in the preceding sections of the report. Risk analysis results are intended to provide project leadership with contingency information for scheduling, budgeting, and project control purposes, as well as to provide tools to support decision making and risk management as projects progress through planning and implementation. Because of the potential for use of risk analysis results for such diverse purposes, this section also reiterates and highlights important steps, logic, key assumptions, limitations, and decisions to help ensure that the risk analysis results are appropriately interpreted.

7.1 Major Findings/Observations

Project cost and schedule comparison summaries are provided in Table 3 and Table 4 respectively. Additional major findings and observations of the risk analysis are listed below.

The PDT worked through the risk register on March 6, 2018. The key risk drivers identified through sensitivity analysis suggest a cost contingency of $72M and schedule risks adding 20 months, both at an 80% confidence level.

Cost Risks: From the CSRA, the key or greater Cost Risk items of include:

- EX2: Market Condition and Bidding Competition – If competition is good, contractor bids could approach 5% lower. Lack of competition could lead to costs as much as 10% higher than the government estimate.
- ES7: Bridge Raise Estimate – Bridge raise, roads, ramps and culvert relocation costs are provided by the sponsors. Cost are predominately a single cost item that have been escalated from 2006 to current price levels. Bridge scope of work is unclear. Detailed bridge costs not available at this time and there is lack of confidence in the critical cost item.
- TR10: Reuse of Levee Material – Estimate assumes 25% reuse of existing levee material. Moderate probability existing material in unsuitable and may need to import borrow and haul unsuitable material to a disposal site.
- TR4: Levee Design and Quantities - Using existing mapping, utility, property boundary, road, bridge, as-built, and structures data. During PED, the survey data could change the design and quantities. Design is for 3:1 side slopes with 20 foot wide crown. Existing levees are 12 feet to14 feet wide at the crown. Future design changes could change quantities as much as much as -5% to +11%.
- ES11: Fuel Costs – The price of fuel have the potential of rising. Since this a relatively equipment minimal project, fuel is anticipated to be a marginal risk.
- CO10: Modifications and Claims – Due to the inherent unknowns there is a possibility of a modification and claim. Unknown and changing conditions are a moderate cost and schedule risk. Testing and sampling during PED will

minimize the possibility of claims during construction. This risk is modeled on modifications and claims risk excluding scope growth.

- TR9: Fill Material Haul Costs - The fill material source is unknown and could add to the haul costs. Estimate assumes a 12 mile haul and is optimistic.
- CA2: Small Business Goals - A Full and Open Acquisition Risk would present minimal Costs risks. Best Value or 8(a) Small Business would present additional cost risk. No additional subcontracts anticipated due to small business requirements but is possible with moderate costs impacts.
- TR2: Pump Station Costs - Utility relocation unit costs are provided by the sponsors. Costs estimate data has no basis, not verifiable and could vary based on actual scope of work and conditions. It is unclear if the input unit cost is fully burdened and we have included an additional burden causing the pricing to be overstated.

Schedule Risks: The high value of schedule risk indicates a significant uncertainty of key risk items, time duration growth that can translate into added costs. Over time, risks increase on those out-year contracts where there is greater potential for change in new scope requirements, uncertain market conditions, and unexpected high inflation. The greatest risk is:

- ES12: Construction Schedule - Schedule does not depict logical construction sequencing, resourcing phasing and parallel activities. The PDT believes a 4 year construction period is adequate for construction but without a properly develop construction schedule there is a risk of schedule delays.
- PM1: Funding - Inadequate funding will protract the project schedule. These will delay awarding the project but will not delay a contract once it is awarded. No WRDS required and will go directly to a Directors Report. Moderate risk to schedule if there is a delay it could delay the project for 1 year.
- CA2: Small Business Goals – Small business goals could lead to lower productivity and schedule delays.
- ES2: Levee Productivity Rates – Levee construction productivity rates are assumed and are likely to change due to impacts from environmental restrictions, working around communities, haul route restrictions, etc.
- CO6: HTRW - Risk of encountering HTRW is unknown –may range from nothing, to materials that require special handling/disposal to large scale clean up prior to construction.

Table 3. Construction Cost Comparison Summary (Uncertainty Analysis)

INITIAL CONSTRUCTION
Contingency Analysis

Base Case Estimate (Excluding 01)	$179,630,727	
Confidence Level	**ntingency Val**	**Contingency**
0%	28,740,916	16%
10%	46,703,989	26%
20%	50,296,604	28%
30%	53,889,218	30%
40%	57,481,833	32%
50%	61,074,447	34%
60%	64,667,062	36%
70%	66,463,369	37%
80%	**71,852,291**	**40%**
90%	75,444,906	42%
100%	102,389,515	57%

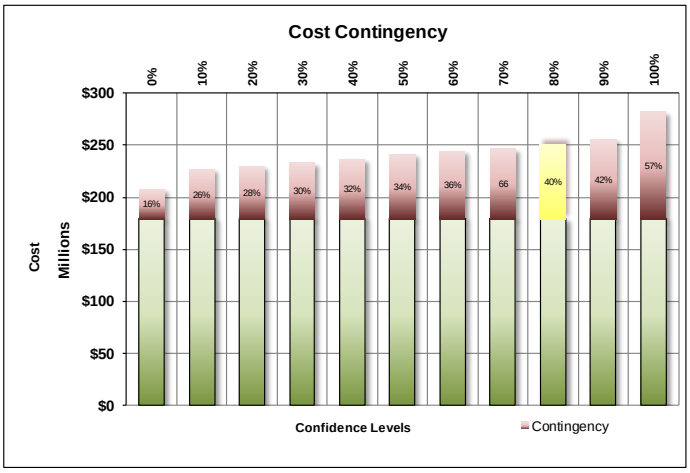
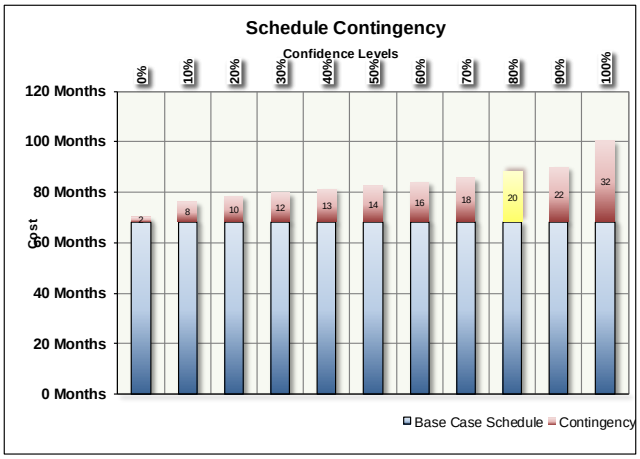


Table 4. Construction Schedule Comparison Summary (Uncertainty Analysis)

Contingency Analysis

Base Case Schedule	68.2 Months	
Confidence Level	**ntingency Val**	**Contingency**
0%	2 Months	3%
10%	8 Months	12%
20%	10 Months	15%
30%	12 Months	17%
40%	13 Months	19%
50%	14 Months	21%
60%	16 Months	23%
70%	18 Months	26%
80%	**20 Months**	**29%**
90%	22 Months	32%
100%	32 Months	47%



7.2 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 Cost and Schedule Risk Analysis (CSRA) produced by the PDT identifies issues that require the development of subsequent risk response and mitigation plans. This section provides a list of recommendations for continued management of the risks identified and analyzed in this study. Note that this list is not all inclusive and should not substitute a formal risk management and response plan.

- Update the levee and floodwall design and estimate with the latest hydrological data.
- Refine the design, estimate, and plan for the Highway 152 and Highway 129 bridge modifications.
- Update the design, estimate and plan for the utility relocations.
- Identify a borrow site for levee import material.

The CSRA study serves as a "road map" towards project improvements and reduced risks over time. Timely coordination and risk resolution between the Sponsor and USACE is needed in areas of ROW, home relocations, site access and staging, and funding needs and updates as applicable. The PDT must include the recommended cost and schedule contingencies and incorporate risk monitoring and mitigation on those identified risks. Further iterative study and update of the risk analysis throughout the project life-cycle is important in support of remaining within an approved budget and appropriation.

Risk Management: Project leadership should use of 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.

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

				Project Cost			Project Schedule			Other Information			
CREF	Risk/Opportunity Event	Risk Event Description	PDT Discussions on Impact and Likelihood	Likelihood ©	Impact ©	Risk Level ©	Likelihood (S)	Impact (S)	Risk Level (S)	Cost Variance Distribution	Schedule Variance Distribution	Responsibility/ POC	Affected Project Component
Organizational and Project Management Risks (PM)													
PM1	Funding	Project funding delays increase PED costs. There is a risk that the project may not obtain funding in a timely manner due to other large projects competing for funds.	Inadequate funding will protract the project schedule. These will delay awarding the project but will not delay a contract once it is awarded. No WRDS required and will go directly to a Directors Report. Moderate risk to schedule if there is a delay it could delay the project for 1 year.	Possible	Marginal	**Low**	Possible	Moderate	**Medium**	Triangular	Triangular	Programs	N/A -Not Modeled
PM2	Losing Key Staff	As more staff retire or are shifted to other projects over the life of the project, there is risk of losing key staff members within the implementation schedule of the project and the associated learning curves.	Losing critical staff could delay the implementation process due to the learning curve experienced due to turnover.	Possible	Marginal	**Low**	Possible	Marginal	**Low**	Triangular	Triangular	Programs	N/A -Not Modeled
PM3	Functional and Technical Labor Over Allocated	There have been over allocation of staff resources, especially function and technical.	This risk is having impact to staff and implementation. It could delay some of the project milestones.	Possible	Marginal	**Low**	Unlikely	Marginal	**Low**	Triangular	Triangular	Programs	N/A -Not Modeled
PM4	Timely Response to Critical Decisions	There are inherent communication and coordination issues. However, this is ultimately all captured by the risk of not making a decision at a critical time on the project.	Senior Management is incorporated into the decision making process and critical decisions are a high priority.	Unlikely	Marginal	**Low**	Unlikely	Marginal	**Low**	Triangular	Triangular	Programs	N/A -Not Modeled
PM5	Accelerated Schedule	Schedule accelerations may lead to increased costs.	Schedule accelerations may remain but at this point are considered unlikely and can be accommodated.	Possible	Marginal	**Low**	Unlikely	Marginal	**Low**	Triangular	Triangular	Programs	N/A -Not Modeled
PM6	Staffing	Limited direct control of project progress competing with outside districts other priorities.	Construction is slated for FY20 thru FY24. Anticipate no critical path schedule delays.	Unlikely	Marginal	**Low**	Unlikely	Marginal	**Low**	Triangular	Triangular	Programs	N/A -Not Modeled
PM7	Scope Definition	Project scope definition is unclear or incomplete	Adding scope would add project costs. The sponsor and team do anticipate additional scope. The team is committed to working within our existing scope.	Unlikely	Marginal	**Low**	Unlikely	Marginal	**Low**	Triangular	Triangular	Programs	N/A -Not Modeled

Contract Acquisition Risks (CA)													
CA1	Contract Acquisition Type	The type of contract of contract is assumed and different types of contracts could add to the overall costs of the project.	Estimate assumes 5 IFB construction contracts. The work has been coordinated with contracting and is not expected to change.	Possible	Marginal	**Low**	Possible	Marginal	**Low**	Triangular	Triangular	Contracting	Project Cost & Schedule
CA2	Small Business Goals	Utilizing small business could lead to increased costs and schedule delays.	A Full and Open Acquisition Risk would present minimal Costs risks. Best Value or 8(a) Small Business would present additional cost risk. No additional subcontracts anticipated due to small business requirements but is possible with moderate costs impacts.	Possible	Moderate	**Medium**	Possible	Moderate	**Medium**	Triangular	Triangular	Contracting	Project Cost & Schedule
CA3	Joint Venture	Joint venture can lead to increased costs.	Added oversight but typically lower pricing due to competition.	Unlikely	Marginal	**Low**	Unlikely	Marginal	**Low**	Triangular	Triangular	Contracting	N/A -Not Modeled
CA4	Timing of Contracts	Delays in contract acquisition could lead to contractor costs.	Risk is not getting contractor in time to construct for the season and could lead to increased construction and mob/demob costs. Mitigate risk through contract acquisition and planning. Delays are unlikely but if they do happen they could add to the costs.	Unlikely	Moderate	**Low**	Possible	Marginal	**Low**	Triangular	Triangular	Contracting	Project Cost
General Technical Risks (TR)													
TR1	Relocations (Utilities) Scope	Utility relocations are known but the locations are unknown.	Drainage and pipe crossing are known and list provided. Actual scope of work associated with the relocations is unknown. The relocations could happen during the levee construction and not likely a schedule concern.	Likely	Moderate	**Medium**	Possible	Marginal	**Low**	Triangular	N/A -Not Modeled	Local Sponsor	Project Cost
TR2	Relocations (Pump Stations)	Relocations pump stations	Pump stations are old facilities that are adjacent to the existing levees. There is no room for moving the existing pump stations due to real estate restrictions. The current scope of work and estimate does not include the pump stations. It is unlikely the pump stations will need to be moved but if it happened it the costs would be significant.	Unlikely	Significant	**Medium**	Unlikely	Significant	**Medium**	Triangular	N/A -Not Modeled	Local Sponsor	Project Cost
TR3	Bridge Scope of work	Bridge scope of work unknown.	There is no anticipated real estate risks with constructing the bridges. The bridge design is unknown at this stage and represents a high risk. The estimate is based on conceptual cost from 2006 and escalated current price levels. Bridge cost risk is captured in ES7.	Likely	Significant	**High**	Possible	Marginal	**Low**	Triangular	Triangular	Local Sponsor	Project Cost

TR4	Levee Design and Quantities	Site-specific Geo-tech/HH/ER unknowns result in cost/quantity variability.	Using existing mapping, utility, property boundary, road, bridge, as-built, and structures data. During PED the survey data could change the design and quantities. Design is for 3:1 side slopes with 20' wide crown. Existing levee is 12'-14' wide at the crown. Future design changes could change quantities as much as -5% to +11%.	Very Likely	Moderate	**High**	Likely	Marginal	**Medium**	Triangular	Triangular	Geotechnical/Civil Design	Contract Cost & Schedule
TR5	Quality/Skills/Size of design team	In house design in lieu of A/E Design.	More review and scrutiny for in house design. Low risk of adding additional cost and schedule delays. Could be PED schedule delays.	Possible	Marginal	**Low**	Possible	Marginal	**Low**	Triangular	Triangular	Project Management	Contract Cost & Schedule
TR6	Import Fill Material Costs	Levee design is preliminary and if specialized material is required it could add costs.	Design for material is preliminary and if specialized import material is required it could add to material costs.	Likely	Significant	**High**	Possible	Marginal	**Low**	Triangular	N/A -Not Modeled	Geotechnical/Civil Design	Project Cost
TR7	Levee Footprint Changes Design	The levee footprint is restricted by real estate. Changing the footprint could require a new design, adding to the costs.	Footprint of levee is restricted by real estate and may require specialized material. This is captured in the geometry risk. Toe of levee could encroach on the property owners. Need updated survey.	Possible	Negligible	**Low**	Possible	Negligible	**Low**	N/A -Not Modeled	N/A -Not Modeled	Geotechnical/Civil Design	N/A -Not Modeled
TR8	Railroad Requirements	Railroad requirements can be stringent and add costs.	Railroad requirements can be stringent and add to costs for design review and approval. Closure gate may need to be bigger than what is included in estimate. Schedule is a high risk but not assumed to impact the critical path and therefore not modeled.	Possible	Marginal	**Low**	Likely	Marginal	**Medium**	N/A -Not Modeled	Triangular	Geotechnical/Civil Design	Project Schedule
TR9	Fill Material Haul Costs	Fill material source is unknown.	The fill material source is unknown and could add to the haul costs. Estimate assumes a 12 mile haul and is optimistic.	Possible	Moderate	**Medium**	Possible	Negligible	**Low**	Triangular	N/A -Not Modeled	Geotechnical/Civil Design	Project Cost
TR10	Reuse of levee material	Reuse of existing material % may change.	Estimate assumes 25% reuse of existing levee material. Moderate probability existing material in unsuitable and may need to import borrow and haul unsuitable material to a disposal site.	Likely	Moderate	**Medium**	Likely	Negligible	**Low**	Triangular	N/A -Not Modeled	Geotechnical/Civil Design	Project Cost
TR11	Specialty Levee Design	Modifying the design to add a cutoff wall could increase costs.	If a seepage or cutoff wall is required it would be a significant cost impact. Currently the geotechnical appendix notes there is no cutoff wall planned or anticipated and therefore not modeled.	Unlikely	Moderate	**Low**	Possible	Marginal	**Low**	Triangular	Triangular	Geotechnical/Civil Design	Project Cost & Schedule
TR12	Floodwall Design	Floodwall design is conceptual and could change.	Concept design is concrete. Design could change to sheet pile. Cost impacts would be marginal. The revised H&H model will modify the quantities of the floodwall. The mainstem floodwall and Reach 5 right bank will decrease while the reach 5 left bank will increase. The volumes are assume to offset each other and the cost risk is low.	Possible	Marginal	**Low**	Possible	Marginal	**Low**	Triangular	N/A -Not Modeled	Geotechnical/Civil Design	Project Cost & Schedule

TR13	Scour Protection Design	Limited analysis of scour protection. Changes could impact costs.	Levee material could change the amount of scour protection required. H&H modeled this and made assumptions but Riprap quantity could increase.	Unlikely	Moderate	**Low**	Unlikely	Moderate	**Low**	N/A -Not Modeled	N/A -Not Modeled	Geotechnical/Civil Design	N/A -Not Modeled
TR14	Recreational Features	Recreational Features not in scope and if required will add to costs.	Estimate assumes gravel road on top of levees. Google earth shows bike paths. Additional features will add to costs not captured in the estimate. PDT confirms no features are included or anticipated for the project.	Unlikely	Marginal	**Low**	Unlikely	Negligible	**Low**	N/A -Not Modeled	N/A -Not Modeled	Geotechnical/Civil Design	N/A -Not Modeled
TR15	Hydrology Model Update	Hydrology Model Outdated	Design is at a concept level based on 1997 hydrology. Design refinements could result in significant quantity and cost variations.	Very Likely	Marginal	**Medium**	Very Likely	Marginal	**Medium**	N/A -Not Modeled	N/A -Not Modeled	Geotechnical/Civil Design	N/A -Not Modeled
TR16	Levee Stormwater Utility relocations	Stormwater lines may need to be relocated over the top of the levees.	Stormwater lines are intended to be relocated through the new levees. If pumped lines are required to go over levee, it would add to costs.	Possible	Marginal	**Low**	Unlikely	Negligible	**Low**	Yes-No	N/A -Not Modeled	Geotechnical/Civil Design	N/A -Not Modeled
Lands and Damages (LD)													
LD1	Levee Alignment/footprint	If Levee alignment or the footprint changes, it will require the acquisition of property.	Real Estate Footprints are assumed. If resource agencies demand alignment, or the footprint changes due to design changes, it could lead to changes in real estate acquisition costs. Updated acquisition costs based on a worst case scenario and do not anticipate real estate changes. Real estate risk covered in Lands and damages contingency and no other real estate risks are anticipated or modeled.	Possible	Marginal	**Low**	Unlikely	Moderate	**Low**	N/A -Not Modeled	N/A -Not Modeled	Project Management	N/A -Not Modeled
LD2	Confidence in estimated cost and schedule to acquire/resolve real estate	The estimate is not clear on what the real estate costs cover.	The real estate estimate includes relocations for business and residential accounts. Estimate is to be updated and included in TPCS. No cost risks considered.	Possible	Marginal	**Low**	Possible	Marginal	**Low**	N/A -Not Modeled	N/A -Not Modeled	Project Management	N/A -Not Modeled
LD3	R&R railroad tracks	Construction of the railroad floodgate may require the relocation of the rail line (02 account).	If the railroad lines need to be moved it is considered a relocation and would add to the real estate costs. The PDT felt this was possible but a marginal cost risk.	Unlikely	Moderate	**Low**	Possible	Marginal	**Low**	N/A -Not Modeled	N/A -Not Modeled	Project Management	N/A -Not Modeled
LD4	UPRR Coordination	UPRR coordination can add schedule delays.	UPRR coordination needs to be done and can add schedule delays. This scope of work is not on the critical path and therefore not modeled.	Possible	Marginal	**Low**	Possible	Marginal	**Low**	N/A -Not Modeled	N/A -Not Modeled	Project Management	N/A -Not Modeled
LD5	Relocations of business	Relocations of business can cause schedule delays.	Business coordination can lead to schedule delays. Continued coordination will mitigate the impacts to the construction.	Possible	Marginal	**Low**	Possible	Moderate	**Medium**	N/A -Not Modeled	Triangular	Project Management	Project Schedule
LD6	Relocations of Residential	Relocations of residential can cause schedule delays.	Residential coordination can lead to schedule delays. Continued coordination will mitigate the impacts to the construction.	Possible	Marginal	**Low**	Possible	Moderate	**Medium**	N/A -Not Modeled	Triangular	Project Management	Project Schedule

LD7	Housing availability	Housing may not be available for residential relocations.	If housing is not available in Monterey county, then the available housing boundary may be extended and add costs. It is anticipated to have availability in Santa Cruz county and minimal costs are anticipated.	Unlikely	Moderate	**Low**	Possible	Marginal	**Low**	N/A -Not Modeled	N/A -Not Modeled	Project Management	N/A -Not Modeled
LD8	Crop Losses	Construction could induce crop losses from adjacent land owners.	Construction could lead to crop losses and require compensation for lost production. This has been accounted for in the real estate estimate and therefore is not modeled.	Unlikely	Moderate	**Low**	Possible	Marginal	**Low**	N/A -Not Modeled	N/A -Not Modeled	Project Management	N/A -Not Modeled
Regulatory Environmental Risks (RG)													
RG1	Mitigation	There is no compensatory mitigation required for the project. If this changes it could add costs.	The project has been designed to be self-mitigating and additional compensatory habitat mitigation is possible. Planting in offset areas is possible.	Possible	Marginal	**Low**	Unlikely	Negligible	**Low**	N/A -Not Modeled	N/A -Not Modeled	Environmental Compliance	N/A -Not Modeled
RG2	Ecosystem restoration modeling	USACE ecosystem restoration modeling could change the design.	No ecosystem model planned and only input from H&H/HY. Results of the model have been incorporated. Local sponsor has history of vegetation projects and will continue similar design concepts.	Unlikely	Moderate	**Low**	Unlikely	Negligible	**Low**	N/A -Not Modeled	N/A -Not Modeled	Environmental Compliance	N/A -Not Modeled
RG3	Water Quality	Requirements could exceed what is included in the cost estimate.	Additional sediment control measures and BMP's could lead to additional requirements and costs. 401 water certificate could include additional conditions. MII estimate includes SWPP measures for BMP's and water quality reduction measures. Do not anticipate additional costs. Costs could be reduced. Risk of regulating bodies may require additional modeling of the final design and the effects of water quality. This is not a risk to the construction cost or schedule. Coordination will mitigate any schedule or cost risk.	Unlikely	Marginal	**Low**	Unlikely	Negligible	**Low**	Triangular	N/A -Not Modeled	Environmental Compliance	Project Cost
RG4	State National Historic Preservation Act.	Some of the project related measures, such as the construction of floodwalls and new levees have the potential to result in the alteration or destruction of recorded prehistoric and archaeological resources. These activities could also reveal buried or otherwise obscured archaeological deposits.	Mitigation to ensure that effects are less than significant is accomplished through consultation with the State Historic Preservation Officer (SHPO) andNative American Tribes, and execution and implementation of a Section 106 ProgrammaticAgreement (PA). The risk is low for cost and schedule.	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**	N/A -Not Modeled	N/A -Not Modeled	Environmental Compliance	N/A -Not Modeled

RG5	Emissions	Emission standards could exceed the standards.	If the emissions exceed the standards, it could lead to breaking the construction contracts into multiple seasons. The work is in an attainment zone so there should be no additional emissions restrictions.	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**	N/A -Not Modeled	N/A -Not Modeled	Environmental Compliance	N/A -Not Modeled
RG6	Endangered species	Additional endangered species measures would lead to additional construction or monitoring costs.	Concurrence from USFWS and NMFS has been requested and it not likely to adversely affect federally listed species. Work windows have already been established for spawning salmon. Formal consultation is a possibility in PED but is a low cost and schedule risk. Migratory bird and channel bird nesting is not anticipated as a risk.	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**	N/A -Not Modeled	N/A -Not Modeled	Environmental Compliance	N/A -Not Modeled
RG7	NEPA documents	Legal challenge to NEPA could impact the construction cost and schedule.	Sponsor CEQA process reduces the risk. The stakeholders have concerns addressed through the CEQA process. No additional construction requirements are anticipated.	Unlikely	Marginal	**Low**	Unlikely	Marginal	**Low**	N/A -Not Modeled	N/A -Not Modeled	Environmental Compliance	N/A -Not Modeled
Construction Risks (CO)													
CO1	Work Windows	Work window could cause delays.	Estimated construction period is 22 months and 7 months/year work window. Work window is pretty standard, will be established in the solicitation, and not anticipated to add to costs or schedule.	Possible	Marginal	**Low**	Possible	Marginal	**Low**	N/A -Not Modeled	N/A -Not Modeled	Construction	N/A -Not Modeled
CO2	Specialty Equipment	If specialized equipment is required it could add to the costs.	Screening of existing material required the use of specialty equipment but is assumed to be available in the area at the time of construction. Reuse of material is not anticipated and thus no special construction is anticipated.	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**	N/A -Not Modeled	N/A -Not Modeled	Construction	N/A -Not Modeled
CO3	Specialty Contractors	Specialty contractors can lead to increased costs.	There are no specialty contractors anticipated other than the railroad flood gate and that is included in the estimate.	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**	N/A -Not Modeled	N/A -Not Modeled	Construction	N/A -Not Modeled
CO4	Incompetent Contractor	Incompetent Contractor could lead to inefficiencies and schedule delays.	Incompetent contractor could lead to productivity problems and schedule delays. Contract termination would add mob/demob cost and schedule delays for a new solicitation. This is considered a manageable risk and not modeled. Prequalifying contractors will minimize this risk.	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**	N/A -Not Modeled	N/A -Not Modeled	Construction	N/A -Not Modeled
CO5	Workforce/Equipment	Workforce/Equipment may not be available.	Highly populated area and it is highly unlikely that labor will not be available at the time of construction. This is related to market conditions and not modeled.	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**	N/A -Not Modeled	N/A -Not Modeled	Construction	N/A -Not Modeled
CO6	HTRW	There is a possibility of uncovering undiscovered hazardous waste during excavation.	Risk of encountering HTRW is unknown –may range from nothing, to materials that require special handling/disposal to large scale clean up prior to construction.	Possible	Moderate	**Medium**	Possible	Moderate	**Medium**	Triangular	Triangular	Construction	N/A -Not Modeled

CO7	Security	Urban area security issues.	Project requires security including fencing and guards. There is no more anticipated security.	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**	N/A -Not Modeled	N/A -Not Modeled	Construction	N/A -Not Modeled
CO8	Haul Restrictions	Haul restrictions in Watsonville and Pajaro could increase costs.	Watsonville/Pajaro restrict haul times from 9-3. This will require additional haul trucks but is not anticipated to increase cost or delay schedule.	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**	N/A -Not Modeled	N/A -Not Modeled	Construction	N/A -Not Modeled
CO9	Dust Control	Dust Control around crops.	Dust control could be more than average due to sensitive crops. Water truck included in the estimate for levee work but not for dust control. It is likely there will be additional dust control cost but the cost risk is marginal.	Possible	Marginal	**Low**	Unlikely	Negligible	**Low**	Triangular	Triangular	Construction	Project Cost
CO10	Modifications and Claims	Changes and or Claims are always a possibility	Due to the inherent unknowns there is a possibility of a modification and claim. Unknown and changing conditions are a moderate cost and schedule risk. Testing and sampling during PED will minimize the possibility of claims during construction. This risk is modeled on modifications and claims risk excluding scope growth.	Likely	Marginal	**Medium**	Unlikely	Marginal	**Low**	Triangular	N/A -Not Modeled	Construction	Contract Cost
Estimate and Schedule Risks (ES)													
ES1	Levee Material Pricing	Levee Material Pricing could change.	Cost estimates rely on cost book costs and actual costs of levee material I is likely to change based on actual pricing. Cost book material cost of $16.75/BCY is used but the price is likely to change. This cost is modeled in TR6.	Possible	Moderate	**Medium**	Unlikely	Negligible	**Low**	Triangular	N/A -Not Modeled	Cost Engineering	Project Cost
ES2	Levee Productivity Rates	Levee Productivity rates could be higher or lower and affect cost and schedule.	Levee construction productivity rates are assumed and are likely to change due to impacts from environmental restrictions, working around communities, haul route restrictions, etc.	Likely	Marginal	**Medium**	Likely	Negligible	**Low**	Triangular	Triangular	Cost Engineering	N/A -Not Modeled
ES3	Levee Haul Cost around Watsonville	Watsonville construction could be restricted and lead to increased costs.	Local opposition to noise and haul traffic through Watsonville could lead to use of overtime and reduce working time.	Possible	Marginal	**Low**	Unlikely	Negligible	**Low**	N/A -Not Modeled	N/A -Not Modeled	Cost Engineering	N/A -Not Modeled
ES4	Labor Rates	Actual labor rates could change.	Bay area labor wage rates were assumed and the local wage rates are possible to decrease.	Possible	Negligible	**Low**	Unlikely	Negligible	**Low**	N/A -Not Modeled	N/A -Not Modeled	Cost Engineering	N/A -Not Modeled
ES5	Utility Relocation Costs	Utility relocation rates could change.	Utility relocation unit costs are provided by the sponsors. Costs estimate data has no basis, not verifiable and could vary based on actual scope of work and conditions. It is unclear if the input unit cost is fully burdened and we have included an additional burden causing the pricing to be overstated.	Likely	Significant	**High**	Unlikely	Negligible	**Low**	Triangular	N/A -Not Modeled	Cost Engineering	Project Cost
ES6	Flood Gate pricing	Flood gate pricing could change.	Flood gate construction pricing and scope is assumed and could change due to impacts from environmental restrictions, working with sponsors, haul route restrictions, final design, etc. The estimated cost and scope is conservative, the cost risk is low, and therefore not modeled.	Possible	Negligible	**Low**	Unlikely	Negligible	**Low**	N/A -Not Modeled	N/A -Not Modeled	Cost Engineering	N/A -Not Modeled

ES7	Bridge Raise Estimate	Lack of confidence in bridge scope and pricing.	Bridge raise, roads, ramps and culvert relocation costs are provided by the sponsors. Cost are predominately a single cost item that have been escalated from 2006 to current price levels. Bridge scope of work is unclear. Detailed bridge costs not available at this time and there is lack of confidence in the critical cost item.	Likely	Significant	**High**	Unlikely	Negligible	**Low**	Triangular	Triangular	Cost Engineering	Project Cost
ES8	Bridge Ramps	Bridge ramps size may change.	Bridge ramps are sized for the 250 year flood year. It is likely that they will be designed to the 100 year. The volumes in the estimate are likely to increase due to the updated hydraulic model. This is modeled in ES7.	Likely	Marginal	**Medium**	Unlikely	Marginal	**Low**	Uniform	Uniform	Cost Engineering	Contract Cost & Schedule
ES9	Culvert Costs	Culvert cost could change.	Culvert work is outside the project cost and to be completed by the sponsor. It is possible this scope could be added to the project.	Possible	Marginal	**Low**	Unlikely	Negligible	**Low**	N/A -Not Modeled	N/A -Not Modeled	Cost Engineering	N/A -Not Modeled
ES10	Rip Rap Productivity	Rip rap productivity may decrease.	Riprap installation productivity rates are assumed and are likely to change due to impacts from environmental restrictions, working with sponsors, haul route restrictions, etc. Local opposition to noise and haul traffic through Watsonville could lead to use of overtime.	Likely	Negligible	**Low**	Unlikely	Negligible	**Low**	N/A -Not Modeled	N/A -Not Modeled	Cost Engineering	N/A -Not Modeled
ES11	Fuel Costs	Fuel costs have the potential for rising.	The price of fuel have the potential of rising. Since this a relatively equipment minimal project, fuel is anticipated to be a marginal risk.	Likely	Marginal	**Medium**	Unlikely	Negligible	**Low**	Triangular	N/A -Not Modeled	Cost Engineering	Project Cost
ES12	Construction Schedule	Construction Schedule has not been fully developed.	Schedule does not depict logical construction sequencing, resourcing phasing and parallel activities. The PDT believes a 4 year construction period is adequate for construction but without a properly develop construction schedule there is a risk of schedule delays.	Likely	Negligible	**Low**	Likely	Significant	**High**	Triangular	Triangular	Cost Engineering	Project Cost
ES13	Estimate confidence in large and critical quantities	There is no takeoff to verify takeoff quantities.	With no takeoff quantities there is a lack of confidence in the levee, earthwork, and floodwall quantities. Quantities updated by civil design. Risk for levee quantities reduced to minimal.	Possible	Marginal	**Low**	Possible	Marginal	**Low**	N/A -Not Modeled	N/A -Not Modeled	Cost Engineering	N/A -Not Modeled
ES15	Asphalt Access Road Removal and Replacement	The levee asphalt road in reach 3 and 5 have not been accounted for in the estimate.	The Asphalt road will have to removed and hauled away. It is unknown if a new asphalt road will be required. It is likely this scope will happen with a marginal cost.	Likely	Marginal	**Medium**	Unlikely	Marginal	**Low**	Uniform	Uniform	Cost Engineering	Contract Cost & Schedule
ES16	Pump Stations	The estimate currently has 3 pump stations. This scope of work has been deleted.	Pump stations have been removed from the scope of work and estimate. Risk to cost and schedule reduced to negligible.	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**	Uniform	Uniform	Cost Engineering	Contract Cost & Schedule
ES17	Water Diversion Costs	Water diversion could be required if levee construction is completed during the winter season. (Nov-Mar).	If water diversion is required in reach 5 and 6 it could add costs.	Likely	Significant	**High**	Unlikely	Marginal	**Low**	Triangular	N/A -Not Modeled	Cost Engineering	Contract Cost & Schedule

External Risks (EX)													
EX1	LERRDS	LERRDS are a sponsor completed item and if not completed could lead to remobilization or project delays.	If LERRDS are not completed it may require additional mob/demob costs. LERRDS need to be accomplished by sponsors prior to construction. If the work does not get done it could delay the construction contracts. Unwilling landowners may not allow access or acquisitions, and negotiations could lead to additional time and acquisition costs.	Possible	Negligible	**Low**	Unlikely	Negligible	**Low**	N/A -Not Modeled	N/A -Not Modeled	Local Sponsor	N/A -Not Modeled
EX2	Market Condition and Bidding Competition	Current market conditions could vary the construction costs.	If competition is good, contractor bids could approach 5% lower. Lack of competition could lead to costs as much as 10% higher than the government estimate.	Likely	Marginal	**Medium**	Unlikely	Negligible	**Low**	Triangular	N/A -Not Modeled	Contracting	Project Cost
EX3	Sponsor Funding	Sponsor funding could delay the project.	Bond measures will be required. The risk is assumed prior to construction and will be through an assessment process. If the total project cost exceeds the estimate amount or the assessment process does not happen, it could kill the project. If there is a significant construction cost that exceeds the anticipated cost share, there is a minimal cost risk of not having the sponsor funding. Another rate setting process would need to be initiated leading to schedule delays.	Possible	Negligible	**Low**	Unlikely	Negligible	**Low**	N/A -Not Modeled	N/A -Not Modeled	Local Sponsor	N/A -Not Modeled
EX4	Weather	Unexpected weather could cause schedule delays and added costs.	Weather window is a constraint but adverse weather is not anticipated to impact the project.	Possible	Negligible	**Low**	Unlikely	Negligible	**Low**	N/A -Not Modeled	N/A -Not Modeled	Contracting	N/A -Not Modeled
EX5	Adjacent Landowners	Adjacent landowners may impose additional restrictions.	Additional dust control or work hour restrictions may be imposed. Low risk.	Unlikely	Marginal	**Low**	Unlikely	Negligible	**Low**	N/A -Not Modeled	N/A -Not Modeled	Contracting	N/A -Not Modeled
EX6	Political changes	Political changes could eliminate funding for project.	Political changes could reduce momentum and funding for project. If momentum was lost the project would not be carried forward.	Unlikely	Marginal	**Low**	Unlikely	Negligible	**Low**	N/A -Not Modeled	N/A -Not Modeled	Contracting	N/A -Not Modeled

WALLA WALLA COST ENGINEERING MANDATORY CENTER OF EXPERTISE

COST AGENCY TECHNICAL REVIEW

CERTIFICATION STATEMENT

For Project No. 104552

SPN – Pajaro River Flood Risk Management General Reevaluation Report

The Pajaro River Flood Risk Management GRR, as presented by San Francisco District, has undergone a successful Cost Agency Technical Review (Cost ATR), performed by the Walla Walla District Cost Engineering Mandatory Center of Expertise (Cost MCX) team. The Cost ATR included study of the project scope, report, cost estimates, schedules, escalation, and risk-based contingencies. This certification signifies the products meet the quality standards as prescribed in ER 1110-2-1150 Engineering and Design for Civil Works Projects and ER 1110-2-1302 Civil Works Cost Engineering.

As of April 20, 2018, the Cost MCX certifies the estimated total project cost:

FY18 Project First Cost: $397,002,000
Fully Funded Amount: $447,525,000

It remains the responsibility of the District to correctly reflect these cost values within the Final Report and to implement effective project management controls and implementation procedures including risk management through the period of Federal Participation.

JACOBS.MICHAEL.PIERRE.1160569537

Digitally signed by JACOBS.MICHAEL.PIERRE.1160569537
DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=JACOBS.MICHAEL.PIERRE.1160569537
Date: 2018.04.20 14:02:48 -07'00'

Michael P. Jacobs, PE, CCE
Chief, Cost Engineering MCX
Walla Walla District

**** TOTAL PROJECT COST SUMMARY ****

PROJECT: **PAJARO RIVER FLOOD RISK MANAGEMENT PROJECT**
PROJECT NO: P2 104552
LOCATION: SANTA CRUZ AND MONTEREY COUNTIES, CA

DISTRICT: **SAN FRANCISCO DISTRICT** **PREPARED:** **4/11/2018**
POC: **CHIEF, COST ENGINEERING, SON T. HA**

This Estimate reflects the scope and schedule in report; PAJARO RIVER GRR

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)						TOTAL PROJECT COST (FULLY FUNDED)			
						Program Year (Budget EC): 2018									
						Effective Price Level Date: 1 OCT 17									
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	**TOTAL ($K)**	Spent Thru: **1-Oct-17** ($K)	**TOTAL FIRST COST** ($K)	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*K*	*L*	*M*	*N*	*O*
02	RELOCATIONS	$37,616	$15,046	40.0%	$52,662	0.0%	$37,616	$15,046	$52,662	$0	$52,662	12.2%	$42,194	$16,878	$59,072
11	LEVEES & FLOODWALLS	$135,586	$54,234	40.0%	$189,821	0.0%	$135,586	$54,234	$189,821	$0	$189,821	11.1%	$150,632	$60,253	$210,885
16	BANK STABILIZATION	$8,183	$3,273	40.0%	$11,457	0.0%	$8,183	$3,273	$11,457	$0	$11,457	12.8%	$9,229	$3,692	$12,920
	CONSTRUCTION ESTIMATE TOTALS:	$181,385	$72,554		$253,940	0.0%	$181,385	$72,554	$253,940	$0	$253,940	11.4%	$202,055	$80,822	$282,877
01	LANDS AND DAMAGES	$64,534	$20,123	31.2%	$84,657	0.0%	$64,534	$20,123	$84,657	$0	$84,657	10.2%	$71,081	$22,203	$93,284
30	PLANNING, ENGINEERING & DESIGN	$23,580	$9,432	40.0%	$33,012	0.0%	$23,580	$9,432	$33,012	$0	$33,012	19.7%	$28,232	$11,293	$39,524
31	CONSTRUCTION MANAGEMENT	$18,139	$7,255	40.0%	$25,394	0.0%	$18,139	$7,255	$25,394	$0	$25,394	25.4%	$22,743	$9,097	$31,840
	PROJECT COST TOTALS:	$287,638	$109,364	38.0%	$397,002		$287,638	$109,364	**$397,002**	$0	**$397,002**	12.7%	$324,110	$123,415	$447,525

ESTIMATED TOTAL PROJECT COST: **$447,525**

_____ **CHIEF, COST ENGINEERING, SON T. HA**

_____ **PROJECT MANAGER, JAIME L. O'HALLORAN**

_____ **CHIEF, REAL ESTATE, xxx**

_____ **CHIEF, PLANNING, xxx**

_____ **CHIEF, ENGINEERING, SON T. HA**

_____ **CHIEF, OPERATIONS, xxx**

_____ **CHIEF, CONSTRUCTION, xxx**

_____ **CHIEF, CONTRACTING,xxx**

_____ **CHIEF, PM-PB, xxxx**

_____ **CHIEF, DPM, xxx**

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: PAJARO RIVER FLOOD RISK MANAGEMENT PROJECT
LOCATION: SANTA CRUZ AND MONTEREY COUNTIES, CA
This Estimate reflects the scope and schedule in report; PAJARO RIVER GRR

DISTRICT: SAN FRANCISCO DISTRICT
POC: CHIEF, COST ENGINEERING, SON T. HA

PREPARED: 4/11/2018

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: 4-Apr-18 Effective Price Level: 1-Oct-17				Program Year (Budget EC): 2018 Effective Price Level Date: 1 OCT 17								
				RISK BASED										
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	CONTRACT 1 (REACH 2)													
02	RELOCATIONS	$1,151	$460	40.0%	$1,611	0.0%	$1,151	$460	$1,611	2021Q3	7.2%	$1,234	$494	$1,728
11	LEVEES & FLOODWALLS	$42,659	$17,064	40.0%	$59,723	0.0%	$42,659	$17,064	$59,723	2021Q3	7.2%	$45,750	$18,300	$64,050
16	BANK STABILIZATION	$564	$226	40.0%	$790	0.0%	$564	$226	$790	2021Q4	7.8%	$608	$243	$852
	CONSTRUCTION ESTIMATE TOTALS:	$44,374	$17,750	40.0%	**$62,124**		$44,374	$17,750	$62,124			$47,592	$19,037	$66,629
01	LANDS AND DAMAGES	$6,724	$1,800	26.8%	$8,524	0.0%	$6,724	$1,800	$8,524	2020Q2	4.6%	$7,034	$1,883	$8,918
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	$444	$177	40.0%	$621	0.0%	$444	$177	$621	2020Q2	9.3%	$485	$194	$679
1.0%	Planning & Environmental Compliance	$444	$177	40.0%	$621	0.0%	$444	$177	$621	2020Q2	9.3%	$485	$194	$679
7.0%	Engineering & Design	$3,106	$1,242	40.0%	$4,349	0.0%	$3,106	$1,242	$4,349	2020Q2	9.3%	$3,395	$1,358	$4,753
0.5%	Reviews, ATRs, IEPRs, VE	$222	$89	40.0%	$311	0.0%	$222	$89	$311	2020Q2	9.3%	$242	$97	$339
0.5%	Life Cycle Updates (cost, schedule, risks)	$222	$89	40.0%	$311	0.0%	$222	$89	$311	2020Q2	9.3%	$242	$97	$339
0.5%	Contracting & Reprographics	$222	$89	40.0%	$311	0.0%	$222	$89	$311	2020Q2	9.3%	$242	$97	$339
1.0%	Engineering During Construction	$444	$177	40.0%	$621	0.0%	$444	$177	$621	2021Q3	14.9%	$510	$204	$714
0.5%	Planning During Construction	$222	$89	40.0%	$311	0.0%	$222	$89	$311	2021Q3	14.9%	$255	$102	$357
0.5%	Adaptive Management & Monitoring	$222	$89	40.0%	$311	0.0%	$222	$89	$311	2020Q2	9.3%	$242	$97	$339
0.5%	Project Operations	$222	$89	40.0%	$311	0.0%	$222	$89	$311	2020Q2	9.3%	$242	$97	$339
31	CONSTRUCTION MANAGEMENT													
6.0%	Construction Management	$2,662	$1,065	40.0%	$3,727	0.0%	$2,662	$1,065	$3,727	2021Q3	14.9%	$3,060	$1,224	$4,284
2.0%	Project Operation:	$887	$355	40.0%	$1,242	0.0%	$887	$355	$1,242	2021Q3	14.9%	$1,020	$408	$1,428
2.0%	Project Management	$887	$355	40.0%	$1,242	0.0%	$887	$355	$1,242	2021Q3	14.9%	$1,020	$408	$1,428
	CONTRACT COST TOTALS:	$61,305	$23,633		$84,937		$61,305	$23,633	**$84,937**			$66,069	$25,497	**$91,567**

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: PAJARO RIVER FLOOD RISK MANAGEMENT PROJECT
LOCATION: SANTA CRUZ AND MONTEREY COUNTIES, CA
This Estimate reflects the scope and schedule in report; PAJARO RIVER GRR

DISTRICT: SAN FRANCISCO DISTRICT
POC: CHIEF, COST ENGINEERING, SON T. HA

PREPARED: 4/11/2018

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: 4-Apr-18 Effective Price Level: 1-Oct-17				Program Year (Budget EC): 2018 Effective Price Level Date: 1 OCT 17								
WBS NUMBER *A*	Civil Works Feature & Sub-Feature Description *B*	COST ($K) *C*	CNTG ($K) *D*	CNTG (%) *E*	TOTAL ($K) *F*	ESC (%) *G*	COST ($K) *H*	CNTG ($K) *I*	TOTAL ($K) *J*	Mid-Point Date *P*	INFLATED (%) *L*	COST ($K) *M*	CNTG ($K) *N*	FULL ($K) *O*
	CONTRACT 2 (REACH 3)													
02	RELOCATIONS	$1,277	$511	40.0%	$1,788	0.0%	$1,277	$511	$1,788	2023Q1	10.5%	$1,411	$564	$1,975
11	LEVEES & FLOODWALLS	$7,275	$2,910	40.0%	$10,185	0.0%	$7,275	$2,910	$10,185	2023Q1	10.5%	$8,036	$3,215	$11,251
16	BANK STABILIZATION	$1,360	$544	40.0%	$1,904	0.0%	$1,360	$544	$1,904	2023Q3	11.6%	$1,517	$607	$2,124
	CONSTRUCTION ESTIMATE TOTALS:	$9,912	$3,965	40.0%	**$13,877**		$9,912	$3,965	$13,877			$10,964	$4,386	$15,350
01	LANDS AND DAMAGES	$6,612	$1,926	29.1%	$8,538	0.0%	$6,612	$1,926	$8,538	2021Q2	6.7%	$7,056	$2,056	$9,111
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	$99	$40	40.0%	$139	0.0%	$99	$40	$139	2021Q2	13.8%	$113	$45	$158
1.0%	Planning & Environmental Compliance	$99	$40	40.0%	$139	0.0%	$99	$40	$139	2021Q2	13.8%	$113	$45	$158
7.0%	Engineering & Design	$694	$278	40.0%	$971	0.0%	$694	$278	$971	2021Q2	13.8%	$789	$316	$1,105
0.5%	Reviews, ATRs, IEPRs, VE	$50	$20	40.0%	$69	0.0%	$50	$20	$69	2021Q2	13.8%	$56	$23	$79
0.5%	Life Cycle Updates (cost, schedule, risks)	$50	$20	40.0%	$69	0.0%	$50	$20	$69	2021Q2	13.8%	$56	$23	$79
0.5%	Contracting & Reprographics	$50	$20	40.0%	$69	0.0%	$50	$20	$69	2021Q2	13.8%	$56	$23	$79
1.0%	Engineering During Construction	$99	$40	40.0%	$139	0.0%	$99	$40	$139	2023Q1	22.1%	$121	$48	$169
0.5%	Planning During Construction	$50	$20	40.0%	$69	0.0%	$50	$20	$69	2023Q1	22.1%	$61	$24	$85
0.5%	Adaptive Management & Monitoring	$50	$20	40.0%	$69	0.0%	$50	$20	$69	2021Q2	13.8%	$56	$23	$79
0.5%	Project Operations	$50	$20	40.0%	$69	0.0%	$50	$20	$69	2021Q2	13.8%	$56	$23	$79
31	CONSTRUCTION MANAGEMENT													
6.0%	Construction Management	$595	$238	40.0%	$833	0.0%	$595	$238	$833	2023Q1	22.1%	$726	$290	$1,016
2.0%	Project Operation:	$198	$79	40.0%	$278	0.0%	$198	$79	$278	2023Q1	22.1%	$242	$97	$339
2.0%	Project Management	$198	$79	40.0%	$278	0.0%	$198	$79	$278	2023Q1	22.1%	$242	$97	$339
	CONTRACT COST TOTALS:	$18,804	$6,803		$25,607		$18,804	$6,803	**$25,607**			$20,708	$7,517	**$28,225**

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: PAJARO RIVER FLOOD RISK MANAGEMENT PROJECT
LOCATION: SANTA CRUZ AND MONTEREY COUNTIES, CA
This Estimate reflects the scope and schedule in report; PAJARO RIVER GRR

DISTRICT: SAN FRANCISCO DISTRICT
POC: CHIEF, COST ENGINEERING, SON T. HA

PREPARED: 4/11/2018

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: 4-Apr-18 Effective Price Level: 1-Oct-17				Program Year (Budget EC): 2018 Effective Price Level Date: 1 OCT 17								
WBS NUMBER *A*	Civil Works Feature & Sub-Feature Description *B*	COST ($K) *C*	CNTG ($K) *D*	CNTG (%) *E*	TOTAL ($K) *F*	ESC (%) *G*	COST ($K) *H*	CNTG ($K) *I*	TOTAL ($K) *J*	Mid-Point Date *P*	INFLATED (%) *L*	COST ($K) *M*	CNTG ($K) *N*	FULL ($K) *O*
	CONTRACT 3 (REACH 4)													
02	RELOCATIONS	$4,502	$1,801	40.0%	$6,303	0.0%	$4,502	$1,801	$6,303	2023Q3	11.6%	$5,023	$2,009	$7,032
11	LEVEES & FLOODWALLS	$41,345	$16,538	40.0%	$57,884	0.0%	$41,345	$16,538	$57,884	2023Q3	11.6%	$46,132	$18,453	$64,585
16	BANK STABILIZATION	$3,482	$1,393	40.0%	$4,874	0.0%	$3,482	$1,393	$4,874	2023Q4	12.1%	$3,904	$1,562	$5,466
	CONSTRUCTION ESTIMATE TOTALS:	$49,329	$19,732	40.0%	**$69,061**		$49,329	$19,732	$69,061			$55,059	$22,024	$77,083
01	LANDS AND DAMAGES	$5,600	$1,356	24.2%	$6,956	0.0%	$5,600	$1,356	$6,956	2022Q2	8.8%	$6,096	$1,476	$7,572
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	$493	$197	40.0%	$691	0.0%	$493	$197	$691	2022Q2	18.4%	$584	$234	$818
1.0%	Planning & Environmental Compliance	$493	$197	40.0%	$691	0.0%	$493	$197	$691	2022Q2	18.4%	$584	$234	$818
7.0%	Engineering & Design	$3,453	$1,381	40.0%	$4,834	0.0%	$3,453	$1,381	$4,834	2022Q2	18.4%	$4,090	$1,636	$5,726
0.5%	Reviews, ATRs, IEPRs, VE	$247	$99	40.0%	$345	0.0%	$247	$99	$345	2022Q2	18.4%	$292	$117	$409
0.5%	Life Cycle Updates (cost, schedule, risks)	$247	$99	40.0%	$345	0.0%	$247	$99	$345	2022Q2	18.4%	$292	$117	$409
0.5%	Contracting & Reprographics	$247	$99	40.0%	$345	0.0%	$247	$99	$345	2022Q2	18.4%	$292	$117	$409
1.0%	Engineering During Construction	$493	$197	40.0%	$691	0.0%	$493	$197	$691	2023Q3	24.6%	$615	$246	$860
0.5%	Planning During Construction	$247	$99	40.0%	$345	0.0%	$247	$99	$345	2023Q3	24.6%	$307	$123	$430
0.5%	Adaptive Management & Monitoring	$247	$99	40.0%	$345	0.0%	$247	$99	$345	2022Q2	18.4%	$292	$117	$409
0.5%	Project Operations	$247	$99	40.0%	$345	0.0%	$247	$99	$345	2022Q2	18.4%	$292	$117	$409
31	CONSTRUCTION MANAGEMENT													
6.0%	Construction Management	$2,960	$1,184	40.0%	$4,144	0.0%	$2,960	$1,184	$4,144	2023Q3	24.6%	$3,688	$1,475	$5,163
2.0%	Project Operation:	$987	$395	40.0%	$1,381	0.0%	$987	$395	$1,381	2023Q3	24.6%	$1,229	$492	$1,721
2.0%	Project Management	$987	$395	40.0%	$1,381	0.0%	$987	$395	$1,381	2023Q3	24.6%	$1,229	$492	$1,721
	CONTRACT COST TOTALS:	$66,275	$25,626		**$91,901**		$66,275	$25,626	**$91,901**			$74,941	$29,014	**$103,956**

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: PAJARO RIVER FLOOD RISK MANAGEMENT PROJECT
LOCATION: SANTA CRUZ AND MONTEREY COUNTIES, CA
This Estimate reflects the scope and schedule in report; PAJARO RIVER GRR

DISTRICT: SAN FRANCISCO DISTRICT
POC: CHIEF, COST ENGINEERING, SON T. HA

PREPARED: 4/11/2018

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: 4-Apr-18				Program Year (Budget EC): 2018				FULLY FUNDED PROJECT ESTIMATE				
		Effective Price Level: 1-Oct-17				Effective Price Level Date: 1 OCT 17								
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	CONTRACT 4 (REACH 5)													
02	RELOCATIONS	$17,790	$7,116	40.0%	$24,906	0.0%	$17,790	$7,116	$24,906	2023Q3	11.6%	$19,850	$7,940	$27,790
11	LEVEES & FLOODWALLS	$25,292	$10,117	40.0%	$35,409	0.0%	$25,292	$10,117	$35,409	2024Q2	13.2%	$28,641	$11,457	$40,098
16	BANK STABILIZATION	$1,102	$441	40.0%	$1,542	0.0%	$1,102	$441	$1,542	2024Q3	13.8%	$1,254	$501	$1,755
	CONSTRUCTION ESTIMATE TOTALS:	$44,184	$17,674	40.0%	**$61,858**		$44,184	$17,674	$61,858			$49,745	$19,898	$69,643
01	LANDS AND DAMAGES	$33,346	$10,935	32.8%	$44,281	0.0%	$33,346	$10,935	$44,281	2023Q2	11.0%	$37,021	$12,140	$49,161
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	$442	$177	40.0%	$619	0.0%	$442	$177	$619	2023Q2	23.3%	$545	$218	$763
1.0%	Planning & Environmental Compliance	$442	$177	40.0%	$619	0.0%	$442	$177	$619	2023Q2	23.3%	$545	$218	$763
7.0%	Engineering & Design	$3,093	$1,237	40.0%	$4,330	0.0%	$3,093	$1,237	$4,330	2023Q2	23.3%	$3,813	$1,525	$5,339
0.5%	Reviews, ATRs, IEPRs, VE	$221	$88	40.0%	$309	0.0%	$221	$88	$309	2023Q2	23.3%	$272	$109	$381
0.5%	Life Cycle Updates (cost, schedule, risks)	$221	$88	40.0%	$309	0.0%	$221	$88	$309	2023Q2	23.3%	$272	$109	$381
0.5%	Contracting & Reprographics	$221	$88	40.0%	$309	0.0%	$221	$88	$309	2023Q2	23.3%	$272	$109	$381
1.0%	Engineering During Construction	$442	$177	40.0%	$619	0.0%	$442	$177	$619	2024Q3	29.9%	$574	$230	$803
0.5%	Planning During Construction	$221	$88	40.0%	$309	0.0%	$221	$88	$309	2024Q3	29.9%	$287	$115	$402
0.5%	Adaptive Management & Monitoring	$221	$88	40.0%	$309	0.0%	$221	$88	$309	2023Q2	23.3%	$272	$109	$381
0.5%	Project Operations	$221	$88	40.0%	$309	0.0%	$221	$88	$309	2023Q2	23.3%	$272	$109	$381
31	CONSTRUCTION MANAGEMENT													
6.0%	Construction Management	$2,651	$1,060	40.0%	$3,711	0.0%	$2,651	$1,060	$3,711	2024Q3	29.9%	$3,443	$1,377	$4,820
2.0%	Project Operation:	$884	$353	40.0%	$1,237	0.0%	$884	$353	$1,237	2024Q3	29.9%	$1,148	$459	$1,607
2.0%	Project Management	$884	$353	40.0%	$1,237	0.0%	$884	$353	$1,237	2024Q3	29.9%	$1,148	$459	$1,607
	CONTRACT COST TOTALS:	$87,693	$32,674		**$120,366**		$87,693	$32,674	**$120,366**			$99,629	$37,183	**$136,812**

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: PAJARO RIVER FLOOD RISK MANAGEMENT PROJECT
LOCATION: SANTA CRUZ AND MONTEREY COUNTIES, CA
This Estimate reflects the scope and schedule in report; PAJARO RIVER GRR

DISTRICT: SAN FRANCISCO DISTRICT
POC: CHIEF, COST ENGINEERING, SON T. HA
PREPARED: 4/11/2018

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared:			4-Apr-18	Program Year (Budget EC):			2018	FULLY FUNDED PROJECT ESTIMATE				
		Effective Price Level:			1-Oct-17	Effective Price Level Date:			1 OCT 17					
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	CONTRACT 5 (REACH 6)													
02	RELOCATIONS	$12,896	$5,158	40.0%	$18,054	0.0%	$12,896	$5,158	$18,054	2024Q3	13.8%	$14,677	$5,871	$20,547
11	LEVEES & FLOODWALLS	$19,014	$7,606	40.0%	$26,620	0.0%	$19,014	$7,606	$26,620	2025Q3	16.1%	$22,072	$8,829	$30,901
16	BANK STABILIZATION	$1,676	$670	40.0%	$2,346	0.0%	$1,676	$670	$2,346	2025Q3	16.1%	$1,946	$778	$2,724
	CONSTRUCTION ESTIMATE TOTALS:	$33,586	$13,434	40.0%	**$47,020**		$33,586	$13,434	$47,020			$38,695	$15,478	$54,172
01	LANDS AND DAMAGES	$12,252	$4,105	33.5%	$16,356	0.0%	$12,252	$4,105	$16,356	2024Q2	13.2%	$13,874	$4,648	$18,522
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	$336	$134	40.0%	$470	0.0%	$336	$134	$470	2024Q2	28.5%	$431	$173	$604
1.0%	Planning & Environmental Compliance	$336	$134	40.0%	$470	0.0%	$336	$134	$470	2024Q2	28.5%	$431	$173	$604
7.0%	Engineering & Design	$2,351	$940	40.0%	$3,291	0.0%	$2,351	$940	$3,291	2024Q2	28.5%	$3,020	$1,208	$4,229
0.5%	Reviews, ATRs, IEPRs, VE	$168	$67	40.0%	$235	0.0%	$168	$67	$235	2024Q2	28.5%	$216	$86	$302
0.5%	Life Cycle Updates (cost, schedule, risks)	$168	$67	40.0%	$235	0.0%	$168	$67	$235	2024Q2	28.5%	$216	$86	$302
0.5%	Contracting & Reprographics	$168	$67	40.0%	$235	0.0%	$168	$67	$235	2024Q2	28.5%	$216	$86	$302
1.0%	Engineering During Construction	$336	$134	40.0%	$470	0.0%	$336	$134	$470	2025Q3	35.4%	$455	$182	$637
0.5%	Planning During Construction	$168	$67	40.0%	$235	0.0%	$168	$67	$235	2025Q3	35.4%	$227	$91	$318
0.5%	Adaptive Management & Monitoring	$168	$67	40.0%	$235	0.0%	$168	$67	$235	2024Q2	28.5%	$216	$86	$302
0.5%	Project Operations	$168	$67	40.0%	$235	0.0%	$168	$67	$235	2024Q2	28.5%	$216	$86	$302
31	CONSTRUCTION MANAGEMENT													
6.0%	Construction Management	$2,015	$806	40.0%	$2,821	0.0%	$2,015	$806	$2,821	2025Q3	35.4%	$2,729	$1,092	$3,821
2.0%	Project Operation:	$672	$269	40.0%	$940	0.0%	$672	$269	$940	2025Q3	35.4%	$910	$364	$1,274
2.0%	Project Management	$672	$269	40.0%	$940	0.0%	$672	$269	$940	2025Q3	35.4%	$910	$364	$1,274
	CONTRACT COST TOTALS:	$53,562	$20,629		**$74,191**		$53,562	$20,629	**$74,191**			$62,762	$24,203	**$86,965**