Rio Grande, Sandia Pueblo to Isleta Pueblo, CO, NM, TX Ecosystem Restoration Feasibility Study and Environmental Assessment

Appendix J

Cost Engineering

U. S. Army Corps of Engineers

Albuquerque District

US Army Corps of Engineers ®
Albuquerque District

WALLA WALLA COST ENGINEERING MANDATORY CENTER OF EXPERTISE

COST AGENCY TECHNICAL REVIEW

CERTIFICATION STATEMENT

For Project No. 445232

SPA – Sandia Pueblo to Isleta Pueblo, New Mexico
Ecosystem Restoration Feasibility Study

The Sandia Pueblo to Isleta Pueblo, New Mexico Ecosystem Restoration Feasibility Study, as presented by Albuquerque 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 February 14, 2019, the Cost MCX certifies the estimated total project cost:

FY20 Project First Cost: $ 25,353,000
Fully Funded Amount: $ 27,680,000

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: 2019.02.14 13:10:36 -08'00'

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

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

PROJECT: **MRG Sandia to Isleta Eco-System Restoration Feasibility Study and Environmental Assessment**
PROJECT NO: P2 445232
LOCATION: Bernalillo County, New Mexico

DISTRICT: Albuquerque District
POC: Michael Prudhomme, PE

PREPARED: 1/22/2019

This Estimate reflects the scope and schedule in report; Sandia Pueblo to Isleta Pueblo, New MexicoEcosystem Restoration ProjectJanuary 2019

Civil Works Work Breakdown Structure		**ESTIMATED COST**				**PROJECT FIRST COST (Constant Dollar Basis)**						**TOTAL PROJECT COST (FULLY FUNDED)**			
						Program Year (Budget EC): 2020									
						Effective Price Level Date: 1 OCT 19									
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*	Spent Thru: **1-Oct-18** ($K)	**TOTAL FIRST COST** ($K) *K*	INFLATED (%) *L*	COST ($K) *M*	CNTG ($K) *N*	FULL ($K) *O*
06	FISH & WILDLIFE FACILITIES	$15,796	$4,265	27.0%	$20,061	2.5%	$16,197	$4,373	$20,571	$0	$20,571	10.0%	$17,809	$4,808	$22,618
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:	$15,796	$4,265		$20,061	2.5%	$16,197	$4,373	$20,571	$0	$20,571	10.0%	$17,809	$4,808	$22,618
01	LANDS AND DAMAGES	$501	$200	40.0%	$701	2.5%	$514	$205	$719	$0	$719	4.5%	$537	$215	$752
30	PLANNING, ENGINEERING & DESIGN	$1,817	$490	27.0%	$2,307	3.9%	$1,887	$509	$2,396	$0	$2,396	5.1%	$1,982	$535	$2,518
31	CONSTRUCTION MANAGEMENT	$1,264	$341	27.0%	$1,605	3.9%	$1,313	$354	$1,667	$0	$1,667	7.6%	$1,412	$381	$1,793
	PROJECT COST TOTALS:	$19,377	$5,297	27.3%	$24,674		$19,911	$5,443	**$25,353**	$0	**$25,353**	9.2%	$21,741	$5,940	$27,680

ESTIMATED TOTAL PROJECT COST: $27,680

____________________________ **Michael Prudhomme, PE**

____________________________ **Brian Sanchez**

____________________________ **Leslie Molina**

____________________________ **Ryan Gronewold, PE**

____________________________ **Ben Alanis, PE**

____________________________ **Mark Yuska, PE**

____________________________ **Carlos Salazar, PE**

____________________________ **Leslie Malina**

____________________________ **CHIEF, PM-PB, xxxx**

____________________________ **CHIEF, DPM, xxx**

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

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

PROJECT: MRG Sandia to Isleta Eco-System Restoration Feasibility Study and Environmental Assessment
DISTRICT: Albuquerque District
PREPARED: 1/22/2019
LOCATION: Bernalillo County, New Mexico
POC: Michael Prudhomme, PE
This Estimate reflects the scope and schedule in report; Sandia Pueblo to Isleta Pueblo, New MexicoEcosystem Restoration ProjectJanuary 2019

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared:			**7-Jan-19**	Program Year (Budget EC):			2020					
		Effective Price Level:			1-Oct-18	Effective Price Level Date:			1 OCT 19					
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	RISK BASED 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***
	PHASE 1 or CONTRACT 1													
06	FISH & WILDLIFE FACILITIES	$8,576	$2,315	27.0%	$10,891	2.5%	$8,794	$2,374	$11,168	2022Q4	8.5%	$9,538	$2,575	$12,113
	#N/A	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:	$8,576	$2,315	27.0%	**$10,891**		$8,794	$2,374	$11,168			$9,538	$2,575	$12,113
01	LANDS AND DAMAGES	$250	$100	40.0%	$351	2.5%	$257	$103	$360	2021Q4	5.3%	$270	$108	$379
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	$86	$23	27.0%	$109	3.9%	$89	$24	$113	2020Q1	0.0%	$89	$24	$113
0.5%	Planning & Environmental Compliance	$43	$12	27.0%	$54	3.9%	$45	$12	$57	2020Q1	0.0%	$45	$12	$57
5.0%	Engineering & Design	$429	$116	27.0%	$545	3.9%	$445	$120	$566	2020Q1	0.0%	$445	$120	$566
0.5%	Reviews, ATRs, IEPRs, VE	$43	$12	27.0%	$54	3.9%	$45	$12	$57	2020Q1	0.0%	$45	$12	$57
0.5%	Life Cycle Updates (cost, schedule, risks)	$43	$12	27.0%	$54	3.9%	$45	$12	$57	2020Q1	0.0%	$45	$12	$57
0.5%	Contracting & Reprographics	$43	$12	27.0%	$54	3.9%	$45	$12	$57	2020Q1	0.0%	$45	$12	$57
1.0%	Engineering During Construction	$86	$23	27.0%	$109	3.9%	$89	$24	$113	2021Q4	6.7%	$95	$26	$121
0.5%	Planning During Construction	$43	$12	27.0%	$54	3.9%	$45	$12	$57	2021Q4	6.7%	$48	$13	$60
1.5%	Adaptive Management & Monitoring	$129	$35	27.0%	$163	3.9%	$134	$36	$170	2024Q2	16.9%	$156	$42	$198
0.5%	Project Operations	$43	$12	27.0%	$54	3.9%	$45	$12	$57	2020Q1	0.0%	$45	$12	$57
31	CONSTRUCTION MANAGEMENT													
5.0%	Construction Management	$429	$116	27.0%	$545	3.9%	$445	$120	$566	2021Q4	6.7%	$475	$128	$604
1.5%	Project Operation:	$129	$35	27.0%	$163	3.9%	$134	$36	$170	2021Q4	6.7%	$143	$38	$181
1.5%	Project Management	$129	$35	27.0%	$163	3.9%	$134	$36	$170	2021Q4	6.7%	$143	$38	$181
	CONTRACT COST TOTALS:	$10,498	$2,867		$13,366		$10,787	$2,946	**$13,733**			$11,625	$3,174	**$14,798**

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

**** CONTRACT COST SUMMARY ****

PROJECT: MRG Sandia to Isleta Eco-System Restoration Feasibility Study and Environmental Assessment
DISTRICT: Albuquerque District
PREPARED: 1/22/2019
LOCATION: Bernalillo County, New Mexico
POC: Michael Prudhomme, PE
This Estimate reflects the scope and schedule in report; Sandia Pueblo to Isleta Pueblo, New MexicoEcosystem Restoration ProjectJanuary 2019

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared:			7-Jan-19	Program Year (Budget EC):			2020						
		Effective Price Level:			1-Oct-18	Effective Price Level Date:			1 OCT 19						
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*
		PHASE 2 or CONTRACT 2													
06		FISH & WILDLIFE FACILITIES	$7,220	$1,950	27.0%	$9,170	2.5%	$7,404	$1,999	$9,403	2023Q4	11.7%	$8,271	$2,233	$10,505
		#N/A	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
		CONSTRUCTION ESTIMATE TOTALS:	$7,220	$1,950	27.0%	**$9,170**		$7,404	$1,999	$9,403			$8,271	$2,233	$10,505
01		LANDS AND DAMAGES	$250	$100	40.0%	$351	2.5%	$257	$103	$360	2021Q2	3.7%	$266	$107	$373
30		PLANNING, ENGINEERING & DESIGN													
	1.0%	Project Management	$72	$19	27.0%	$92	3.9%	$75	$20	$95	2021Q2	4.8%	$79	$21	$100
	0.5%	Planning & Environmental Compliance	$36	$10	27.0%	$46	3.9%	$38	$10	$48	2021Q2	4.8%	$39	$11	$50
	5.0%	Engineering & Design	$361	$97	27.0%	$459	3.9%	$375	$101	$476	2021Q2	4.8%	$393	$106	$499
	0.5%	Reviews, ATRs, IEPRs, VE	$36	$10	27.0%	$46	3.9%	$38	$10	$48	2021Q2	4.8%	$39	$11	$50
	0.5%	Life Cycle Updates (cost, schedule, risks)	$36	$10	27.0%	$46	3.9%	$38	$10	$48	2021Q2	4.8%	$39	$11	$50
	0.5%	Contracting & Reprographics	$36	$10	27.0%	$46	3.9%	$38	$10	$48	2021Q2	4.8%	$39	$11	$50
	1.0%	Engineering During Construction	$72	$19	27.0%	$92	3.9%	$75	$20	$95	2022Q2	8.6%	$81	$22	$103
	0.5%	Planning During Construction	$36	$10	27.0%	$46	3.9%	$38	$10	$48	2022Q2	8.6%	$41	$11	$52
	1.5%	Adaptive Management & Monitoring	$108	$29	27.0%	$138	3.9%	$113	$30	$143	2025Q2	21.3%	$136	$37	$173
	0.5%	Project Operations	$36	$10	27.0%	$46	3.9%	$38	$10	$48	2021Q2	4.8%	$39	$11	$50
31		CONSTRUCTION MANAGEMENT													
	5.0%	Construction Management	$361	$97	27.0%	$459	3.9%	$375	$101	$476	2022Q2	8.6%	$407	$110	$517
	1.5%	Project Operation:	$108	$29	27.0%	$138	3.9%	$113	$30	$143	2022Q2	8.6%	$122	$33	$155
	1.5%	Project Management	$108	$29	27.0%	$138	3.9%	$113	$30	$143	2022Q2	8.6%	$122	$33	$155
		CONTRACT COST TOTALS:	$8,879	$2,430		$11,309		$9,123	$2,497	**$11,620**			$10,116	$2,766	**$12,882**

US Army Corps
of Engineers®

MRG Sandia to Isleta Eco-System Restoration Feasibility Study and Environmental Assessment
Project Cost and Schedule Risk Analysis Report

Prepared for:

U.S. Army Corps of Engineers,
Albuquerque District

Prepared by:

Albuquerque District

22 January 2019

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

EXECUTIVE SUMMARY

The US Army Corps of Engineers (USACE), Albuquerque District, presents this cost and schedule risk analysis (CSRA) report regarding the risk findings and recommended contingencies for the MRG Sandia to Isleta Eco-System Restoration Feasibility Study and Environmental Assessment, New Mexico. 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 U.S. Army Corps of Engineers (USACE), Albuquerque District, proposes to restore approximately 216 acres of the Middle Rio Grande Bosque (1) improving hydrologic function by constructing high-flow channels, willow swales, and wetlands, and (2) by restoring native vegetation and habitat from exotic species/fuel reduction and restoring the riparian gallery forest.

Specific to the Middle Rio Grande Bosque and Tributaries, New Mexico, the current project base cost estimate, pre-contingency and pre-escalation and excludes code of account 30 - Planning, Engineering and Design (PED), code of account 31 - Construction Management (CM) and real estate costs, is approximately $16M. Since the Albuquerque District Cost Section, performed the study on the estimated construction costs only of $15.796M. Based on the results of the analysis, the Cost Engineering Albuquerque District, recommends a contingency value of $4.264M or approximately 27% of base project cost at an 80% confidence level for successful execution.

Cost estimates can 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 cost vary to a slight degree with similar scope and risks, contingency percent values will be reported, cost values rounded.

Table ES-1. Construction Contingency Results

Base Case Construction Cost Estimate	**$15,796,203.00**	
Confidence Level	**Construction Value ($$) w/ Contingencies**	**Contingency (%)**
50%	$3,475,165	22%
80%	**$4,264,975**	**27%**
90%	$4,738,861	30%

KEY FINDINGS/OBSERVATIONS RECOMMENDATIONS

The PDT worked through the risk register on 10 December 2018. That period of time allowed improved project scope definition, investigations, design and cost information, and resulted in reduced risks in certain project areas. The key risk drivers identified through sensitivity analysis suggest a cost contingency of $4.264M at an 80% confidence level.

Cost Risks: From the CSRA, the key or greater Cost Risk item in terms of cost variability potential include:

- CA-3: Specialized Contractor– Contractor does not have the capability to self-perform most of the work. Selected best value contractor is not capable of self-performing. The cost increases due to additional markups for a Sub Contractor.
- LD-1: Assumed Waste Area– Assumption is that excavated materials remain on site. The risk is that the material will be hauled off more than 10 mile.
- CO-2: Equipment Rates– Equipment Rates based on 2016 Rates and do not reflect current rates
- CO-6: Warranty/Plant Replacement– Some plants may die and contractor has to replace under the contract warranty period. The Base Line estimate does not account for replacing plants that die under a warranty period. The assumption is that warranty guarantees 80% survival rate. The risk accounts for replacing 20% of plants in order to guarantee 80% survival rate.
- CO-8: Material Cost– Material Rates based on current quotes and inflation could increase the cost of material.
- EX-3: Market Conditions/ Bid Competition– Market conditions will be differ every year that a new phase is awarded.

Moderate risks, when combined, can also become a cost impact.

- PM-2: Funding Obligations– The intermittent funding stream (fed, non-fed). Unknown how much money the sponsor can support each year for their non-fed cost support. If they can't support their financial obligation this could prolong the project schedule and increase the cost to the project.
- PM-4: Adaptive Management & Monitoring– The risk is that when the contractor closes out the project, the Plantings that was under warranty by the contractor fails and dies so the government will have to start a new contract to re-vegetate the project site.
- TR-1: Earthwork (cut) quantities – The quantities used for the cost estimate are based on historical data. The quantities must be verified with current existing conditions and due to potential high run off over the course of 2 to 3 years to complete, the PDT agrees that it is likely to happen and the impact is moderate

that the quantities used for the cost estimate may increase by 20% above the baseline estimate.

- TR-8: Planting Quantities– The concern is that the quantities are too high or too low due to lack of surveys and information. The PDT decided to use the same quantities per acre that was used in MRG Restoration Phase II project. The cost estimate will reflect an increase and a decrease of 3% and an increase of 10% of plantings.
- CO-8: Construction Changes- Scope of work may change throughout the life of the project causing contract modifications and claims.
- ES-2: Production Concerns- The production could be slowed to a crawl for different reasons.

Schedule Risks: The significantly 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:

- PM-3: Project Schedule– SPA will miss the current Project Schedule. This would push the construction starting date out and that would increase the project cost per inflation.

Moderate risks, when combined, can also become a time and resulting cost impact.

- PM-2: Funding Obligations– The intermittent funding stream (fed, non-fed). Unknown how much money the sponsor can support each year for their non-fed cost support. If they can't support their financial obligation this could prolong the project schedule and increase the cost to the project.
- PM-4: Adaptive Management & Monitoring– The risk is that when the contractor closes out the project, the Plantings that was under warranty by the contractor fails and dies so the government will have to start a new contract to re-vegetate the project site.

- ES-2: Production Concerns- The production could be slowed to a crawl for different reasons.

- EXT-1: Natural Disasters– Wild fires or flooding may cause construction delays and extend the project schedule up to 4 months.

Recommendations:
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

The US Army Corps of Engineers (USACE), Albuquerque District presents the results of the cost and schedule risk analysis for Espanola Valley, Rio Grande and Tributaries. 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 for successful execution.

2.0 BACKGROUND

The U.S. Army Corps of Engineers (USACE) proposes to restore the Northern extent of the Pueblo of Sandia forms the north boundary of the study area, whereas the southern boundary is formed by the southern limits of the Pueblo of Isleta (Figure 1). The area is defined on the east and west by the Albuquerque Levee system, although the areas outside and adjacent to the levees within the original floodplain have also been considered in the study high-flow channels, terrace lowering, willow swales, ponds, and wetlands, and (2) restoring native vegetation and habitat by removing exotic species, and restoring riparian gallery forest (*Bosque*).

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 Albuquerque 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 Section at the Albuquerque District performed a formal Cost Risk Analysis, relying on local Albuquerque District staff to provide expertise and information gathering. The Albuquerque District PDT conducted initial risk identification on December 10, 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 of December 10, 2018 included:

Name	Organization	Title
Brian Sanchez	USACE - SPA	Project Management
Stacy Samuelson	USACE - SPA	Study Manager
Danielle Galloway	USACE - SPA	Environmental
Jonathon Van Hoose	USACE - SPA	Hydrology & Hydraulics
Otis Dickey	USACE - SPA	Engineering Division: Geotechnical
Phil Lovato	USACE - SPA	Engineering Division: General Engineering
Tim Tetrick	USACE - SPA	Cost Engineering
Justin Reale	USACE - SPA	Biology
Christine Sinkovec	USACE - SPA	

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 Albuquerque District office for the purposes of identifying and assessing risk factors. The meeting (conducted March 9, 2015) 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. A meeting was held on December 10, 2018 for finalization of the risk register, resulting CSRA model, findings and results.

4.2 Quantify Risk Factor Impacts

The quantitative impacts (putting it to numbers for 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. The Albuquerque District provided MII MCACES (Micro-Computer Aided Cost Estimating Software) files electronically. The MII and supporting documents where transmitted and downloaded on January 25, 2019 was the basis for the updated cost and schedule risk analyses. The MII and supporting documents dated January 18, 2019 serve as the basis for the updated final CSRA.

b. 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.

c. 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. The cost for 80% confident schedule increase is captured in the TPCS.

d. Per the CWCCIS Historical State Adjustment Factors in EM 1110-2-1304, State Adjustment Factor for the State of New Mexico is .92, meaning that the average inflation for the project area is assumed to be 8% lower than the national average for inflation. Therefore, it is assumed that the project inflations experienced are similar (or better) to OMB inflation factors for future construction. Thus, the risk analyses accounted for no escalation over and above the national average.

e. Per the data in the estimate, the Job Office Overhead (JOOH) percentage for the Prime Contractor is 18% and 10% for home office overhead (HOOH).

f. 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.

g. 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 P50, P80 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 $4.264 Million at the P80 confidence level (27% of the baseline construction cost estimate).

Table 1. Construction Cost Contingency Summary

Base Case Construction Cost Estimate	**$15,796,203.00**	
Confidence Level	**Construction Value ($$) w/ Contingencies**	**Contingency (%)**
50%	$3,475,165	22%
80%	**$4,264,975**	**27%**
90%	$4,738,861	30%

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.

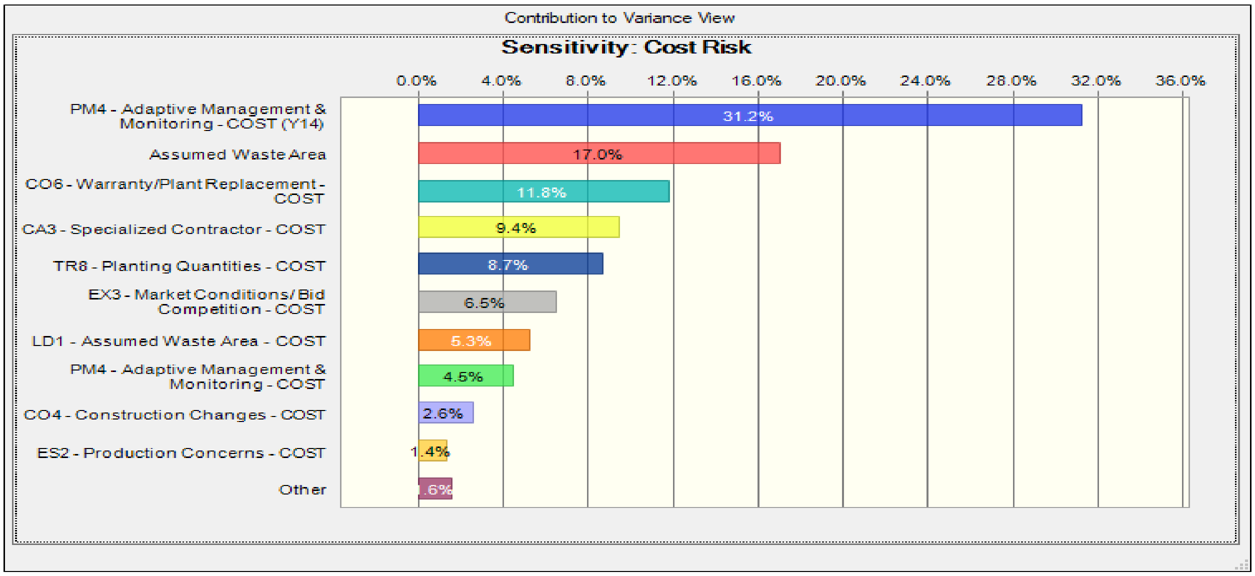
6.2.2 Sensitivity Analysis Results

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).

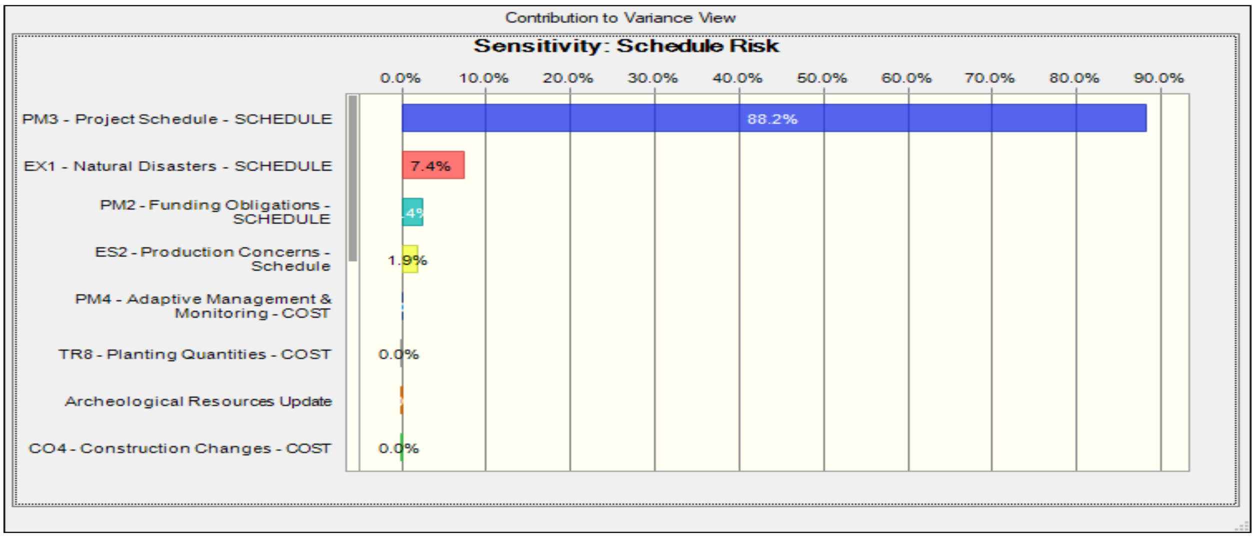
Table 2 provides the schedule duration contingencies calculated for the P80 confidence level. The schedule duration contingencies for the P50 and P90 confidence levels are also provided for illustrative purposes.

Schedule duration contingency was quantified as 46.7 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. 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 46.4 months)	Duration w/ Contingencies (months)	Contingency[1] (months)
50% Confidence	53.4	7
80% Confidence	57.1	11
90% Confidence	58.4	12

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 one separate occasion: December 10, 2018. This allowed improved project scope definition, investigations, design and cost information, and resulted in reduced risks in certain project areas. The key risk drivers identified through sensitivity analysis suggest a cost contingency of $4.345M at an 80% confidence level.

Cost Risks: From the CSRA, the key or greater Cost Risk item in terms of cost variability potential include:

- CA-3: Specialized Contractor– Contractor does not have the capability to self-perform most of the work. Selected best value contractor is not capable of self-performing. The cost increases due to additional markups for a Sub Contractor.
- LD-1: Assumed Waste Area– Assumption is that excavated materials remain on site. The risk is that the material will be hauled off more than 10 mile.
- CO-2: Equipment Rates– Equipment Rates based on 2016 Rates and do not reflect current rates
- CO-6: Warranty/Plant Replacement– Some plants may die and contractor has to replace under the contract warranty period. The Base Line estimate does not account for replacing plants that die under a warranty period. The assumption is that warranty guarantees 80% survival rate. The risk accounts for replacing 20% of plants in order to guarantee 80% survival rate.
- CO-8: Material Cost– Material Rates based on current quotes and inflation could increase the cost of material.
- EX-3: Market Conditions/ Bid Competition– Market conditions will be differ every year that a new phase is awarded.

Moderate risks, when combined, can also become a cost impact.

- PM-2: Funding Obligations– The intermittent funding stream (fed, non-fed). Unknown how much money the sponsor can support each year for their non-fed cost support. If they can't support their financial obligation this could prolong the project schedule and increase the cost to the project.

- PM-4: Adaptive Management & Monitoring– The risk is that when the contractor closes out the project, the Plantings that was under warranty by the contractor fails and dies so the government will have to start a new contract to re-vegetate the project site.
- TR-1: Earthwork (cut) quantities – The quantities used for the cost estimate are based on historical data. The quantities must be verified with current existing conditions and due to potential high run off over the course of 2 to 3 years to complete, the PDT agrees that it is likely to happen and the impact is moderate that the quantities used for the cost estimate may increase by 20% above the baseline estimate.
- TR-8: Planting Quantities– The concern is that the quantities are too high or too low due to lack of surveys and information. The PDT decided to use the same quantities per acre that was used in MRG Restoration Phase II project. The cost estimate will reflect an increase and a decrease of 3% and an increase of 10% of plantings.
- CO-8: Construction Changes- Scope of work may change throughout the life of the project causing contract modifications and claims.
- ES-2: Production Concerns- The production could be slowed to a crawl for different reasons.

Schedule Risks: The significantly 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:

- PM-3: Project Schedule– SPA will miss the current Project Schedule. This would push the construction starting date out and that would increase the project cost per inflation.

Moderate risks, when combined, can also become a time and resulting cost impact.

- PM-2: Funding Obligations– The intermittent funding stream (fed, non-fed). Unknown how much money the sponsor can support each year for their non-fed cost support. If they can't support their financial obligation this could prolong the project schedule and increase the cost to the project.
- PM-4: Adaptive Management & Monitoring– The risk is that when the contractor closes out the project, the Plantings that was under warranty by the contractor fails and dies so the government will have to start a new contract to re-vegetate the project site.

- ES-2: Production Concerns- The production could be slowed to a crawl for different reasons.

- <u>EXT-1: Natural Disasters</u>– Wild fires or flooding may cause construction delays and extend the project schedule up to 4 months.

Table 3. Construction Cost Comparison Summary (Uncertainty Analysis)

Base Case Estimate (Excluding 01)	$14,984,358	
Confidence Level	**Contingency Value**	**Contingency**
0%	**1,348,592**	**9%**
10%	**2,847,028**	**19%**
20%	**3,146,715**	**21%**
30%	**3,296,559**	**22%**
40%	**3,596,246**	**24%**
50%	**3,746,090**	**25%**
60%	**3,895,933**	**26%**
70%	**4,045,777**	**27%**
80%	**4,345,464**	**29%**
90%	**4,645,151**	**31%**
100%	**6,143,587**	**41%**

Table 4. Construction Schedule Comparison Summary (Uncertainty Analysis)

Base Case Schedule	46.4 Months	
Confidence Level	**Contingency Value**	**Contingency**
0%	**1 Months**	**2%**
10%	**4 Months**	**9%**
20%	**5 Months**	**11%**
30%	**6 Months**	**13%**
40%	**6 Months**	**14%**
50%	**7 Months**	**16%**
60%	**8 Months**	**18%**
70%	**9 Months**	**20%**
80%	**11 Months**	**23%**

90%	**12 Months**	**26%**
100%	**18 Months**	**38%**

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.

The CSRA study serves as a "road map" towards project improvements and reduced risks over time. 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.

<u>Risk Management</u>: 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.

<u>Risk Analysis Updates</u>: 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) that could increase or decrease the cost to the project. Future Cost and Schedule Risk Analysis will be addressed throughout the entire project life cycle in order to update any

mitigation to existing risks or implementing any new risks that have been identified during the PED phase.

APPENDEX A

RISK REGISTER

														Cost Model			Schedule Model				Cost due to Schedule Risk							
				Project Cost			Project Schedule			Other Information				COST			Schedule Model			Cost From Schedule				TOTAL Cost	TOTAL Schedule			
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	Low Variance (Min)	Likely (C)	High Variance (80%H)	Low Variance (S) (Min)	Likely (S)	High Variance (S) (80%H)	LowVariance(CS)(Mi	LikelyAddedCost(C	HighVariance(CS)(8	Event Prob (PC)	SimulatedCost(C)+(	EventProb(PS)	Simulated Sched (S)	Risk Quantification Discussions	

																				n)	S)	0 % H)		C S)				
Organizational and Project Management Risks (PM)																												
PM2	Funding Obligations	The intermittent funding stream (fed, non-fed). Unknown how much money the sponsor can support each year for their non-fed cost support. If they can't support their financial obligation this could prolong the project schedule and increase the cost to the project.	The project will require a continuous funding stream of approximately $7 million every year during construction. Throughout the life of the project, the sponsor will need to provide their share of the cost. This includes both sunk costs and construction costs. If the local sponsor cannot meet cost sharing obligations the project cost and schedule will be impacted Significantly. It is likely that this project could be extended up to 1 year or 12 months due to lack of funds and the impact would be significant. The escalation increase is 3% times the construction cost. This project is broken into 2 separate contracts. The PDT assumption is that it is possible and would have a significant cost increase and schedule delay.	Possible	Significant	**Medium**	Likely	Marginal	**Medium**	Triangular	Triangular	Construction	Project Schedule				0 Months	0 Months	24 Months				100 %	$ 0	100%	0 Mo	The LOW variance is based on the government having the funds to start this project on schedule. The Likely variance has the government not having funds 24 months after assumed starting date and that would extend the project 12 months. The HIGH variance has the government not having funds for 24 months after assumed starting date and that would extend the project 2 years. The "Cost from Schedule delay" is not modeled in the CSRA, as we prefer to capture the 80% confident schedule in the TPCS project duration that will account for the increase in escalation.	
PM3	Project Schedule	SPA will miss the current Project Schedule. This would push the construction starting date out and that would increase the project cost per inflation.	Our schedule is very optimistic that the PDT will accomplish all required tasks to award the first phase of construction before the end of FY22. If there is a slip in the schedule for any of the activities that follow the critical path then the planned date for the start of construction could be pushed 24 months. PDT agrees that it is possible and would have a marginal cost increase. The likelyhood of a schedule delay is possible and would have a critical impact.	Possible	Marginal	**Low**	Possible	Critical	**High**	N/A -Not Modeled	Yes-No	Construction	Project Schedule				0 Months	0 Months	12 Months				100 %	$ 0	100%	0 Mo	The LOW variance is based on the government completing all requirement to award phase 1 on approved schedule for no schedule delay. The Likely variance has the government not completing all requirement to award phase 1 on approved schedule and that would extend the project 12 months. The High variance has the government not completing all requirement to award phase 1 on approved schedule and that would extend the project 24 months. The "Cost from Schedule delay" is not modeled in the CSRA, as	

																											we prefer to capture the 80% confident schedule in the TPCS project duration that will account for the increase in escalation.
PM4	Adaptive Management & Monitoring	The risk is that when the contractor closes out the projec, the Plantings that was under waranty by the contractor fails and dies so the government will have to start a new contract to revegitate the project site.	If this risk accurs the government would need to issue another contract to plant a minimum of 10% of plant and high of 20% in order to meet success criteria. The PDT agrees that this is possible to occur and the impact would be significant for a cost increase and unlikely and possible schedule delay. This resulted in a medium cost risk and a low schedule risk.	Possible	Significant	**Medium**	Unlikely	Marginal	**Low**	Triangular	Triangular	Environmental Compliance	Project Cost	$0	$880,842	#######							50%	$440,421	100%	0 Mo	The LOW variance is based on the government CWE and has a zero change. The LIKELY variance is based on having to replace 10% of plantings that increases the overall project planting cost of $8,808,418.45 to $9,689,260.30 for a increase of $880,841.85. The HIGH variance is based on having to replace 20% of plantings that increases the overall project planting cost of $8,808,418.45 to $10,570,102.14 for an increase of $1,761,683.69.
PM5	Scope Evolution	Over time the scope of the project may evolve and increase in scope potentially resulting in a cost increase.	Future surveys and investigations will show additional design refinements which tend to increase cost. Possible refinements may include additional areas requiring restoration and additional material requiring excavation and disposal. Post contract award. The PDT agrees that this risk is very unlikely to occur and the impact would be significant if it did occur. This resulted in a low risk.	Unlikely	Moderate	**Low**	Unlikely	Marginal	**Low**														100%	$0	100%	0 Mo	

PM6	Staffing Turnover (internal)	Post Chief's report there will be inexperienced or new staff.	It is assumed that the project will require no less than 2 years to complete. Throughout the life of the project PDT members will likely change. Adding new members to the project may reduce efficiency in the design process the will impact the schedule. The PDT agrees that this risk is very unlikely to occur and the impact would be marginal if it did occur for a cost increase and schedule delay. This resulted in a low risk for both cost and schedule.	Unlikely	Marginal	**Low**	Unlikely	Marginal	**Low**														100%	$0	100%	0 Mo		
PM7	Staff Turnover (sponsors)	Post PPA there will be new decision makers and they may have a different opinion on where they should focus their funding.	The new sponsors decisions makers need time to diside if they want to fund this project, which may affect completion of the project schedule and cost. The PDT agrees that this risk is unlikely to occur and the impact would be moderate if it did occur for a cost increase and schedule delay. This resulted in a low risk for both cost and schedule.	Unlikely	Moderate	**Low**	Unlikely	Moderate	**Low**														100%	$0	100%	0 Mo		
PM8	Coordination/ Communication Concerns	The project requires many parties to communicate effectively.	The PDT stated that there is a low risk to cost and schedule. The PDT agrees that this risk is unlikely to occur and the impact would be negligible if it did occur for a cost increase and schedule delay. This resulted in a low risk for both cost and schedule.	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**														100%	$0	100%	0 Mo		
PM9	Evolving Guidance (EM, ETL, EC & EP)	New guidance being applied retroactively to current projects.	Technical guidance may change throughout the life of the project that may require change in design. The PDT agrees that this risk is very likely to occur and the impact would be negligible if it did occur for a cost increase and schedule delay. This resulted in a low risk for both cost and schedule.	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**														100%	$0	100%	0 Mo		
PM10				Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**														100%	$0	100%	0 Mo		

Contract Acquisition Risks (CA)

CA1	Defined Acquisition Strategy	The acquisition assumption is that this will be a design/bid/build best value.	Requires 120 days for best value. Likely to delay the first contract award by this acquisition strategy. These 2 phases (Separate Contracts) will go small business competitive. The PDT agrees that this risk is unlikely to occur and the impact would be marginal if it did occur. This resulted in a low risk for both cost and schedule.	Unlikely	Marginal	**Low**	Unlikely	Marginal	**Low**														100 %	$ 0	100 %	0 Mo		
CA2	Small Business Acquisition	Small business acquisition might drive up bid cost and possibly decrease competition. Based on the size it is likely to be small business acquisition.	Small business acquisition might drive up bid cost and possibly decrease competition. PDT assumption is that this will be an IFB open competition, and will not be limited to small business. The estimates are constructed for small business acquisition. The PDT agrees that it is likely to be small business and the impact is negligible due to the cost estimate being constructed for small business. it is possible and the impact to any schedule risk is marginal. These equal to a low cost and schedule risk.	Unlikely	Negligible	**Low**	Unlikely	Marginal	**Low**															$ 0	100 %	0 Mo		
CA3	Specialized Contractor	Contractor does not have the capability to self-perform most of the work.	Selected best value contractor is not capable of self-performing. The cost increases due to additional markups for a Sub Contractor. This was looked at again and there is no change due to unknown contract acquisition. This line item was looked at again by the PDT and we came to the decision that there is not enough special type of work to be performed and that it is likely that the prime contractor would not be able to perform this work and the impact would be significant for cost increase and is unlikely to have any schedule delays and the impact if occured would be negligible.	Likely	Significant	**High**	Unlikely	Negligible	**Low**	Triangular	N/A - Not Modeled	Cost Engineering		#####	$0	#######							100 %	$ 0	100 %	0 Mo	The low Variance is based on the Prime Contractor completing all of the construction work accept plantings. The baseline estimate is 15,037,463.05 decreased to $14,819,807.22, for a total decrease of $217,655.83. Variance is based on the contractor subcontracting out all of the construction work. The baseline estimate is 15,037,463.05 increased to $16,068, for a total increase of $1,030,936.03.	

General Technical Risks (TR)

TR1	Earthwork (cut) quantities	The earthwork quantities used for the estimate are based on historical data.	The quantities used for the cost estimate are based on historical data. The quantities must be verified with current existing conditions and due to potential high run off over the course of 2 to 3 years to complete, the PDT agrees that it is likely to happen and the impact is moderate that the quantities used for the cost estimate may increase by 20% above the baseline estimate. The PDT agrees that it is likely to occur and the impact would be moderate for a cost impact and it is unlikely to occur a schedule delay but if it did the impact would be marginal. This resulted in a medium risk for cost and a low risk for schedule.	Likely	Moderate	**Medium**	Unlikely	Marginal	**Low**	Triangular	N/A - Not Modeled	Geotechnical /Civil Design	Project Cost	$0	$156,337	$312,673							100%	$156,337	100%	0 Mo	The LOW variance is based on the government CWE and has a zero change. The LIKELY variance is based on having to increase the excavated quantity by 10% that increases the overall project excavation cost of $1,563,366.21 to $1,719,702.83 for an increase of $156,336.62. The HIGH variance is based on having to increase the excavated quantity by 20% that increases the overall project excavation cost of $1,563,366.21 to $1,876,039.45 for an increase of $312,673.24.
TR4	Final location of proposed measures (cultural)	Have we identified the correct proposed sites?	Per Cultural Recourses Section, locations may need to be changed due to cultural concerns. Any relocations would not result in increased cost or extended schedule. The PDT agrees that it is likely to occur and the impact would be negligible for a cost impact and a schedule delay. This resulted in a low risk for cost and a low risk for schedule.	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**														100%	$0	100%	0 Mo	
TR5	Final location of proposed measures (ground survey)	Have we identified the correct proposed sites?	We have proposed sites based on existing LIDAR and cross sections. Any relocations would not result in increased cost or extended schedule. The PDT feels very confident that the risk is Low.	Likely	Negligible	**Low**	Likely	Negligible	**Low**														100%	$0	100%	0 Mo	
TR7	Rip Rap Quantities	The concern is that Rip Rap would be added to the water features.	The PDT decided that it is possible that Rip Rap could could be added and the impact would be negligible for a cost impact and it is unlikely to occur a schedule delay but if it did the impact would be negligible.	Likely	Negligible	**Low**	Unlikely	Negligible	**Low**														100%	$0	100%	0 Mo	

TR8	Planting Quantities	The quantities in the estimate are too high or too low due to lack of surveys and information.	The PDT decided to use the same quantities per acre that was used in MRG Restoration Phase II project. The cost estimate will reflect an increase and a decrease of 3% and an increase of 10% of plantings. The Planting quantities were discussed in September of 2017and was addressed to account for the design requirements in the Preferred plan estimate. The PDT agrees that it is likely to occur and the impact would be marginal for a cost impact and it is unlikely to occur a schedule delay but if it did the impact would be negligible. This resulted in a moderate risk for cost and a low risk for schedule.	Likely	Marginal	**Medium**	Unlikely	Negligible	**Low**	Triangular	N/A - Not Modeled	Environmental Compliance	Project Cost	#####	$440,421	$880,842							100 %	$440,421	100 %	0 Mo	The LOW variance is based on having to reduce the amount of plantings by 3% that decreases the overall project planting cost of $8,808,418.45 to $8,544,165.90 for a total decrease of $264,252.55. The LIKELY variance is based on having to replace 5% of plantings that increases the overall project planting cost of $8,808,418.45 to $9,248,839.37 for an increase of $440,420.92. The HIGH variance is based on having to replace 10% of plantings that increases the overall project planting cost of $8,808,418.45 to $9,689,260.30 for an increase of $880,841.85.
TR10	Usable Fill	The existing excavated dirt does not meet the requirements for Fill.	The Fill material will be processed from existing excavated materials on site. If not all of the excavated material is suitable for fill then the rest would have to be purchased from an offsite commercial source. The PDT agrees that it is unlikely to occur and the impact would be Moderate for a cost impact and it is unlikely to occur a schedule delay but if it did the impact would be negligible. This resulted in a Low risk for cost and a low risk for schedule.	Unlikely	Moderate	**Low**	Unlikely	Negligible	**Low**														100 %	$0	100 %	0 Mo	
TR11				Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**														100 %	$0	100 %	0 Mo	

Lands and Damages (LD)

LD1	Assumed Waste Area	Assumption is that excavated materials remain on site. The risk is that the material will be hauled off more than 10 mile.	The current estimate assumes the waste will not be trucked more than 1 mile of project site and disposed of on-site. This is not conservative in respect to haul distances. A different waste area located approx. 20 miles off site will result in a significant cost increase. The PDT agrees that it is likely to occur and the impact would be significant for a cost impact and it is possible to occur a schedule delay but if it did the impact would be marginal. This resulted in a moderate risk for cost and a low risk for schedule.	Likely	Significant	**High**	Possible	Marginal	**Low**	Triangular	N/A - Not Modeled	Geotechnical /Civil Design	Project Cost	$0	$495,788	#######							100%	$495,788	100%	0 Mo	The LOW variance is based on the government CWE and has a zero change. The LIKELY variance is based on the disposal site being 10 miles away and that would increase the hauling from the baseline estimate of $15,037,463.05 to $15,533,250.94 for a increase of $495,787.89.The HIGH variance is based on the disposal site being 20 miles away and that would increase the hauling from the baseline estimate of $15,037,463.05 to $16,535,645.65 for an increase of $1,498,182.6.
LD2	Other Federal Agencies	Will various permits be required from different government agencies	The required permits will demand coordination with different agencies. A delay with any of the required permits might have impacts on schedule. The PDT agrees that it is unlikely to occur and the impact would be negligible for a cost impact and it is unlikely to occur a schedule delay but if it did the impact would be negligible. This resulted in a low risk for cost and a low risk for schedule.	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**														100%	$0	100%	0 Mo	
LD3	Unknown Utilities	The construction site may contain unidentified underground utilities that must be avoided.	The construction of this project may require excavation activities that may damage existing utilities. The construction site must be surveyed to identify existing utilities. A suitable excavation method should be implemented to avoid damaging the utilities. The PDT agrees that it is very unlikely to occur and the impact would be marginal for a cost impact and it is very unlikely to occur a schedule delay but if it did the impact would be marginal. This resulted in a low risk for cost and a low risk for schedule.	Unlikely	Marginal	**Low**	Unlikely	Marginal	**Low**														100%	$0	100%	0 Mo	

LD4	Real Estate Contingency	Real estate acquisitions may contain unforeseen risks not covered by contingency.	Project is on Federal land and land acquisition is not likely to be needed or an issue. The PDT agrees that it is very unlikely to occur and the impact would be negligible for a cost impact and it is very unlikely to occur a schedule delay but if it did the impact would be negligible. This resulted in a low risk for cost and a low risk for schedule.	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**														100 %	$0	100%	0 Mo		
LD5	O&M LERRD	LERRD O&M needs have not been identified.	Easements for O&M work may be needed once LERRD O&M requirements are identified. At this point there isn't much information about possible requirements, however this is on Tribal land and will likely not be an issue for access to perform O&M functions. The PDT agrees that it is unlikely to occur and the impact would be negligible for a cost impact and it is unlikely to occur a schedule delay but if it did the impact would be negligible. This resulted in a low risk for cost and a low risk for schedule.	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**														100 %	$0	100%	0 Mo		
LD6	Incomplete Real Estate Data based on GIS	Do not have an up to date real estate survey.	The real estate land is federaly owned and there is no LERRD value. The updated Real Estate property values have been addressed in the base estimate and the risk is unlikely and would have a Negligible cost or schedule increase or decrease.	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**														100 %	$0	100%	0 Mo		
LD7				Unlikely	Marginal	**Low**	Unlikely	Marginal	**Low**														100 %	$0	100%	0 Mo		
Regulatory Environmental Risks (RG)																												
RG1	Archeological Resources Update	existing surveys are only for existing project sites. Future surveys will be required as plans become	Cultural clearance will be required for staging areas, access, borrow and disposal areas as identified. There is flexibility in locating these areas to avoid resources. The PDT agrees that it is unlikely to pick an access or staging area that affects cultural resources.	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**														100 %	$0	100%	0 Mo		

		more complete																										
RG2	Unknown Cultural Impacts	The proposed project might affect cultural resources in unforeseen ways.	Additional surveys to determine what the impacts will be to any existing cultural resources caused by unforeseen impacts. Potential cultural mitigation if there are impacts. The PDT has stated that project sites are located in the flood plain and have already been surveyed and cleared for any cultural impacts; therefore it is unlikely and the impact would be negligible for any cost impact or schedule delays.	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**														100 %	$ 0	100 %	0 Mo		
RG3	Tradition cultural restrictions	More than one (TCP) possible areas of concern. That would limit construction activities	Work in TCP area(s) might require limitation in work allowable in those areas. Hand work vs. mechanized work or personal restriction. Work in kind may be a method of resolution. This is a low risk because tribal consultation will identify TCP issues prior to design efforts. The PDT agrees that it is very unlikely to occur and the impact would be negligible for a cost impact and it is very unlikely to occur a schedule delay but if it did the impact would be negligible. This resulted in a low risk for cost and a low risk for schedule.	Likely	Negligible	**Low**	Likely	Negligible	**Low**														100 %	$ 0	100 %	0 Mo		
RG4	Endangered Species?	The risk is the adverse impact to the Rio Grande Silvery Minnow, Southwestern willow fly catcher and Yellow Billed Cuckoo critical habitat	Consultation has determined there is adverse impact for the New Mexico Rio Grande Silvery Minnow, Southwestern willow fly catcher and Yellow Billed Cuckoo with implementation of the measure. The PDT agrees that it is very unlikely to occur and the impact would be marginal for a cost impact and it is unlikely to occur a schedule delay but if it did the impact would be negligible due to the Environmental Consultation has been	Unlikely	Marginal	**Low**	Unlikely	Negligible	**Low**														100 %	$ 0	100 %	0 Mo		

			completed. This resulted in a low risk for cost and unlikely to occur and the impact would be significant for schedule.																									
RG5	cultural survey	cultural survey results may be delayed	Should be sufficient time to get this issue cleared prior to completion of any Plans and Specs, or possible start on other phases first. The PDT has stated that project sites are located in the flood plain and the Pueblo has determined that the project would not adversely impact cultural resources. The PDT agrees that it is unlikely to occur and the impact would be marginal for a cost impact and it is very unlikely to occur a schedule delay but if it did the impact would be negligible. This resulted in a low risk for cost and a low risk for schedule.	Unlikely	Marginal	**Low**	Unlikely	Negligible	**Low**														100 %	$ 0	100 %	0 Mo		
RG6	Migratory Birds	Limit to some construction activities during 15 April to 15 August	There is a possibility that the population can move to other project locations. Construction activities are not allowed from April 15 through August 15 when the species is present. The project area will be surveyed yearly before the start of any construction activity. The Clear and Grubbing for each phase would need to be completed prior to April 15. If the clear and grubbing is not completed by April 15 then this would push the construction schedule out moderately. Construction work can take place if the clearing and grubbing is completed on time so that the migratory birds will not be affected by construction. The PDT agrees that it is possible to occur and the impact would be marginal for a cost impact and it is possible to occur a schedule delay but if it did the impact would be marginal. This resulted in a low risk for cost and a	Possible	Marginal	**Low**	Possible	Marginal	**Low**														100 %	$ 0	100 %	0 Mo		

			moderate risk for schedule.																									
RG7				Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**														100 %	$ 0	100 %	0 Mo		
Construction Risks (CO)																												
CO1	Equipment Fuel	Fueling staging locations are not identified.	Heavy equipment will be utilized for every aspect of this project. The excavation activities require the use of a large tracked hydraulic excavator with limited mobility. It is essential that a safe and efficient refueling operation is established so that productivity rates are not affected. Additional time and cost for fueling equipment is necessary and this was addressed in the MII estimate. The PDT agrees that it is likely to occur and the impact would be negligible for a cost impact and it is unlikely to occur a schedule delay but if it did the impact would be negligible. This resulted in a low risk for cost and a low risk for schedule.	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**														100 %	$ 0	100 %	0 Mo		

CO2	Equipment Rates	Equipment Rates based on 2016 Rates and do not reflect current rates	The equipment rates should be inflated to today's cost. This could increase the equipment cost for the most likely by 5% and the high of 7%. The PDT agrees that it is likely to occur and the impact would be significant for a cost impact and it is unlikely to occur a schedule delay but if it did the impact would be negligible. This resulted in a High risk for cost and a low risk for schedule.	Likely	Significant	**High**	Unlikely	Negligible	**Low**	Triangular	N/A - Not Modeled	Cost Engineering	Project Cost	$0	$142,687	$285,374							100 %	$142,687	100%	0 Mo	The LOW variance is based on the government CWE and has a zero change. The LIKELY variance is based on a 5% cost addition to the Equipment cost in the government estimate of $2,853,742.48 to $2,996,429.60 for an increase of $142,687.12.The HIGH variance is based on a 5% cost addition to the Equipment cost in the government estimate of $2,853,742.48 to $3,139,116.73 for an increase of $285,374.25.
CO3	Trucking Operations	Double handling of material will likely be required (articulated dump trucks and Highway dump trucks). Articulated dump trucks were not in the baseline estimate.	The Base Line estimate did not include any off-road trucks. Off-road trucks and additional loaders were added to this estimate to haul material to a location that is close to road-worthy access point for transferring to Highway haulers. By adding this equipment the risk is reduced to unlikely and Negligible for cost and schedule impacts.	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**														100 %	$0	100%	0 Mo	
CO4	Construction Changes	Scope of work may change throughout the life of the project causing contract modifications and claims.	Construction modifications or claims are possible throughout the life of the project and impact the schedule. These will bring additional contracting efforts and may increase the total project cost. The work in general is not complex and is repetitive. A change of condition that would create a marginal impact to the cost is likely. The PDT agrees that it is likely to occur and the impact would be marginal for a cost impact and it is very unlikely to occur a schedule delay but if it did the impact would be marginal. This resulted in a moderate risk for cost and a low risk for schedule. Per	Likely	Marginal	**Medium**	Unlikely	Marginal	**Low**	Triangular	N/A - Not Modeled	Construction	Project Cost	#####	$607,954	$911,931							100 %	$607,954	100%	0 Mo	The LOW variance is based on 2% cost increase on the baseline estimate of $15,198,858.22 to $15,502,835.38 for an increase of $303,977.16. The LIKELY variance is based on 4% cost increase on the baseline estimate of $15,198,858.22 to $15,806,812.55 for an increase of $607954.33. The HIGH variance is based on 6% cost increase on the baseline estimate of

			Construction Branch the cost could increase as high as 4% the most likely is 2% and the low would be .5%.																								$15,198,858.22 to $16,110,789.71 for an increase of $911,931.49.	
CO5	Access and staging areas	Assume access is readily available.	The PDT addressed this issue and the only problem would be if they changed the location for the access road and staging areas. If the relocated the site then cultural clearance would need to be completed. The PDT agrees that it is likely to occur and the impact would be negligible for a cost impact and it is unlikely to occur a schedule delay but if it did the impact would be negligible. This resulted in a low risk for cost and a low risk for schedule.	Likely	Negligible	**Low**	Unlikely	Negligible	**Low**														100%	$0	100%	0 Mo		
CO6	Warranty /Plant Replacement	some plants may die and contractor has to replace under the contract warranty period	The Base Line estimate does not account for replacing plants that die under a warranty period. Assume 15% Markup for vegetation replacement to the High estimate. The PDT agrees that it is likely to occur and the impact would be significant for a cost impact and it is unlikely to occur a schedule delay but if it did the impact would be negligible. This resulted in a Significant risk for cost and a low risk for schedule.	Likely	Significant	**High**	Unlikely	Negligible	**Low**					$0	$704,673	#######							100%	$704,673	100%	0 Mo	The LOW variance is based on the government CWE and has a zero change. The LIKELY variance is based on having to replace 8% of plantings that increases the overall project planting cost of $8,808,418.45 to $9,513,091.93 for an increase of $704,673.48. The HIGH variance is based on having to replace 15% of plantings that increases the overall project planting cost of $8,808,418.45 to $10,129,681.22 for an	

																											increase of $1,321,262.77.	
CO7	Materials Limited Market	There is a limited amount of suppliers for construction materials.	The cost of materials is at the discretion of the supplier due to lack of competition in the surrounding areas. The cost estimate utilizes the latest cost for Plantings and has remained approximately the same for the past two years. We have constructed several projects in the approximate area that this project presides in. The PDT agrees that it is unlikely to occur and the impact would be marginal for a cost impact and it is unlikely to occur a schedule delay but if it did the impact would be negligible. This resulted in a low risk for cost and a low risk for schedule.	Unlikely	Marginal	**Low**	Unlikely	Negligible	**Low**														100%	$0	100%	0 Mo		
CO8	Material Cost	Material Rates based on current quotes and inflation could increase the cost of material.	Inflation could increase the material cost for the most likely by 5% and the high of 10%. The PDT agrees that it is possible to occur and the impact would be critical for a cost impact and it is unlikely to occur a schedule delay but if it did the impact would be negligible. This resulted in a High risk for cost and a low risk for schedule.	Possible	Critical	**High**	Unlikely	Negligible	**Low**					#####	$86,436	$144,060							100%	$86,436	100%	0 Mo	The LOW variance is based on 2% cost decrease on the baseline estimate of $2,881,202.33 to $2,823,578.28 for a decrease of $57,624.05. The LIKELY variance is based on 3% cost increase on the baseline estimate of $2,881,202.33 to $2,967,638.40 for an increase of $86,436.07. The HIGH variance is based on 5% cost increase on the baseline estimate of $2,881,202.33 to $3,025,262.45 for an increase of $144,060.12.	

Estimate and Schedule Risks (ES)

ES1	Estimate Assumption	The assumptions pertaining to the quantities in the estimate are based on historical data due to lack of information.	Assumptions were derived from historical data from ongoing Eco System Restoration projects on the Rio Grande River of the same type of work. The PDT agrees that it is unlikely to occur and the impact would be marginal for a cost impact and it is unlikely to occur a schedule delay but if it did the impact would be negligible. This resulted in a low risk for cost and a low risk for schedule.	Unlikely	Marginal	**Low**	Unlikely	Negligible	**Low**														100%	$0	100%	0 Mo		
ES2	Production Concerns	The concern is that production could be slowed to a crawl for different reasons.	The PDT discussed the production concerns due to not having the equipment lay down areas identified and how far they need to move the equipment for re-fueling. The Baseline estimate accounts for a 90% production rate and if these risks could decrease the production rate as much as 7% bringing the production rate to 83% and this could extend the schedule out 2 months. The PDT agrees that it is likely to occur and the impact would be marginal for a cost impact and it is likely to occur a schedule delay but if it did the impact would be marginal. This resulted in a moderate risk for cost and a moderate risk for schedule.	Likely	Marginal	**Medium**	Likely	Marginal	**Medium**	Triangular	Triangular	Cost Engineering	Project Cost & Schedule	$0	$251,895	$514,775	0 Months	1 Months	2 Months				100%	$251,895	100%	1 Mo	The LOW variance is based on the government CWE and has a zero change at 90% production. The LIKELY variance is based on 87%% cost increase on the baseline estimate of $15,037,463.05 to $15,289,358.24 for a increase of $251,895.19. The HIGH variance is based on 85%% cost increase on the baseline estimate of $15,037,463.05 to $15,552,237.79 for a increase of $514,774.74.	
ES3	Locally Preferred Plan	Sponsor might want a different plan.	We do not anticipate that the sponsor would want a different option than the tentative selected plan provided by the Army Corps of Engineers. Changing the selected plan would have negligible schedule and cost impact and is very unlikely due to the close coordination and review done by the Corps and sponsor. This resulted in a low risk for cost and a low risk for schedule impacts.	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**														100%	$0	100%	0 Mo		

ES4	Future Fuel Costs	The cost for fuel will fluctuate during the life of the project.	Fuel plays a vital role in the majority of the construction activities for the project. It is expected that throughout the life of the project the cost for fuel will fluctuate. The Fuel prices in the cost estimate is considerably high compared to the fuel rates we are seeing at this time in New Mexico. Still, it is assumed that escalation will account for some of the increase in cost. The PDT agrees that it is likely to occur and the impact would be negligible for a cost impact and it is unlikely to occur a schedule delay but if it did the impact would be negligible. This resulted in a low risk for cost and a low risk for schedule.	Likely	Negligible	**Low**	Unlikely	Negligible	**Low**	N/A -Not Modeled	N/A - Not Modeled	Cost Engineering	Project Cost										100%	$0	100%	0 Mo		
ES5	Employee Salaries (external)	The current inflation index could be unrealistic with salary rates.	Throughout the duration of the project employee salaries are expected to change. If the inflation index continues to rise then employee salaries might reach a level that could impact the total project cost. Overall project cost increases in time are considered in escalation applied therefore; the PDT agrees that it is likely to occur and the impact would be negligible for a cost impact and it is unlikely to occur a schedule delay but if it did the impact would be negligible. This resulted in a low risk for cost and a low risk for schedule.	Likely	Negligible	**Low**	Unlikely	Negligible	**Low**														100%	$0	100%	0 Mo		
ES7	Employee Salaries (internal)	The current inflation index could be unrealistic with salary rates.	Throughout the duration of the project employee salaries are expected to change. If the inflation index continues to rise then employee salaries might reach a level that could impact the total project cost. Overall project cost increases in time are considered in escalation applied therefore; the PDT agrees that it is likely to occur and the impact would be negligible for a cost impact and it is unlikely to occur a schedule delay but if it did the impact would be	Likely	Negligible	**Low**	Unlikely	Negligible	**Low**														100%	$0	100%	0 Mo		

			negligible. This resulted in a low risk for cost and a low risk for schedule.																								
ES8	Riprap Stone Source	The commercial source for the required rip rap and larger material has not been confirmed. The commercial source distance is ~25 miles.	There is a known source in Espanola but if they at the time cannot support the quantities that are required then the materials would have to truck in from another source. The PDT agrees that it is likely to occur and the impact would be negligible for a cost impact and it is very unlikely to occur a schedule delay but if it did the impact would be marginal. This resulted in a moderate low risk for cost and a low risk for schedule.	Likely	Negligible	**Low**	Unlikely	Negligible	**Low**														100%	$0	100%	0 Mo	
ES9				Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**														100%	$0	100%	0 Mo	
ES10				Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**														100%	$0	100%	0 Mo	
External Risks (EX)																											
EX1	Natural Disasters	Extreme weather events may affect the construction of the project pertaining to cost and schedule delays.	Wild fires or flooding may cause construction delays and extend the project schedule up to 4 months. Potential exists for marginal cost and schedule impact, the likelihood of such a catastrophic event is possible. This resulted in a low risk for cost and a medium risk for schedule.	Possible	Marginal	**Low**	Possible	Moderate	**Medium**	N/A -Not Modeled	Triangular	Hydrology/Hydraulic Design	Project Schedule				0 Months	2 Months	4 Months				100%	$0	100%	2 Mo	The LOW variance is based on the government project schedule and accounts for no schedule delay. The Likely variance has the government schedule extending the project 4 months. The High variance has the government schedule extending the project 8 months. The "Cost from Schedule delay" is not modeled in the CSRA, as we prefer to capture the 80% confident schedule in the TPCS project duration

																											that will account for the increase in escalation.
EX2	Internal Resource Availability	Other district priorities could impact design schedule.	Issues for meeting the design schedule may surface depending on different USACE District priorities. Team member might be working on various projects and some may take precedence. Understaffing of the project could have a marginal impact on cost and schedule, but it is unlikely that District priorities would change in such a way as to create this situation. This resulted in a low risk for cost and a low risk for schedule.	Unlikely	Marginal	**Low**	Unlikely	Marginal	**Low**														100%	$0	100%	0 Mo	
EX3	Market Conditions/ Bid Competition	Market conditions will be differ every year that a new phase is awarded.	The cost for constructing the project will depend on existing market trends. Some years may bring more aggressive bidding climates which will lower the overall project costs by 3%. Others will offer a less aggressive climate which may drive up the costs by 5%. It is likely given the long duration (2 years of construction) of the project that overall economic climate will vary and cost impact could be significant. A marginal impact to the schedule is possible, but unlikely as most of the risk is associated with cost to do the work as opposed to speed of construction. This resulted in a Significant risk for cost and a low risk for schedule.	Likely	Significant	**High**	Unlikely	Marginal	**Low**	Triangular	N/A - Not Modeled	Cost Engineering	Project Cost	#####	$0	$601,499							100%	$0	100%	0 Mo	Problems that arise from changes in market conditions either contractor fear of the unknown during performance of this contract or things that happen in the world post contract award and the contractor is able to be compensated. For the LOW variance it is assumed that the current schedule does not change, but that there is a decrease in the cost by $375,936.57 (2.5% of construction cost). The likely is the baseline estimate that has a total cost of $15,037,463.05 or $0.00. The HIGH

																											variance is that the project construction cost could increase by 4% = $601,498.52.	
EX4	Weather	Project operations may be delayed due to unfavorable weather conditions.	The estimate and construction schedule do not account for any weather delays. Delays caused by winter months and rain event are expected throughout the project site. These are expected to affect the project cost and schedule. Some weather days are likely, but the local project climate is very conducive to year round construction. Overall cost or schedule impact is negligible, as this is primarily ecosystem restoration. This resulted in a low risk for cost and a low risk for schedule.	Likely	Negligible	**Low**	Likely	Negligible	**Low**														100%	$0	100%	0 Mo		
EX5	Labor Resources	Local area does not have labor resources to construct the project	The project requires a labor force that is commonly found in the local area. This will not create labor shortages and the need for subsistence and per diem allowances for various labor elements. This is very unlikely to impact the cost of the project. The impact to the cost and schedule is negligible. This resulted in a low risk for cost and a low risk for schedule.	Very Likely	Negligible	**Low**	Unlikely	Negligible	**Low**														100%	$0	100%	0 Mo		
EX6				Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**														100%	$0	100%	0 Mo		

EX7				Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**														100%	$0	100%	0 Mo		