US Army Corps
of Engineers®

# Hamilton City
# Flood Damage Reduction and Ecosystem Restoration Project
# Glenn County, CA

## Project Cost and Schedule Risk Analysis Report

*Prepared for:*

U.S. Army Corps of Engineers,
Sacramento District

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U.S. Army Corps of Engineers
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December 24, 2014

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## EXECUTIVE SUMMARY

The US Army Corps of Engineers (USACE), Sacramento District, presents this cost and schedule risk analysis (CSRA) report regarding the risk findings and recommended contingencies for the Hamilton City Flood Damage Reduction and Ecosystem Restoration Project. In compliance with Engineer Regulation (ER) 1110-2-1302 CIVIL WORKS COST ENGINEERING, dated September 15, 2008, a formal risk analysis, *Monte-Carlo* based-study 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 Hamilton City feasibility study was accomplished as part of the Central Valley Integrated Flood Management Study (formerly Sacramento and San Joaquin River Basins Comprehensive Study) with the state of California as the non-Federal sponsor. The project unlocks potential for integrated, multiple-purpose projects developed in accordance with existing USACE policy and will manage flood risk for the town of Hamilton City and adjacent agricultural lands while providing significant habitat acreage in the floodplain.

The project will construct a setback levee about 6.8 miles long and degrade an existing "J" levee, actively restoring 1,145 acres of riparian woodland, 261 acres of riparian shrub, and 70 acres of floodplain meadow now cut off by that levee. To accomplish ecosystem restoration, most of an existing "J" levee will be removed to reconnect the river to the floodplain and allow for overbank flooding. In areas where the "J" levee reduces velocities of the Sacramento River, the "J" levee will remain in place.

Specific to the Hamilton City risk analysis, the project base cost for the remaining work approximates $57.4M:

01 - Lands and Damages: $16.9M
02 - Relocations: $1.4M
06 - Fish & Wildlife: $20.0M
11 - Levees: $13.3M
18 - Cultural Resource Preservation: $0.4M
30 - PED: $2.3M
31 - Construction Management: $3.1M

When studying the PDT established risks, the greater focus was placed on the construction activities: Relocations, Fish & Wildlife, Levees and Cultural Resources Preservation. These categories total an estimated $35.1M or 61% of the base costs. The Real Estate estimate (29%) and respective contingencies were provided by the Real Estate Office. Since the PED and Construction Management costs are a

percentage calculation of the estimated construction, and no significant risks were directly assigned to these two cost categories, the construction contingency per cent value was assigned directly to these two accounts. This is considered a more conservative approach in contingency assignment.

The result of this study is a risk analysis on $35.1M construction cost. The resulting contingency of an added $7.1M equates to 20.1% of the construction costs. This same percentage was then applied to both the PED and construction Management estimated base costs. The total resulting base cost contingency for all accounts is estimated at $8.5M ore 15% contingency at the 80% confidence level. The amount includes cost impacts related to schedule delays. The drop to the 15% contingency for total is due to the low contingency on the Real estate costs.

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 per cent values. Should cost vary to a slight degree with similar scope and risks, contingency per cent values will be reported and cost values rounded.

**Table ES-1. Construction Cost and Schedule Contingency Results**

| **Construction Cost Estimate** | **$35,111,900*** | |
|---|---|---|
| **Confidence Level** | **Construction Value ($$)** | **Contingency (%)** |
| 5% | $3,266,000 | 9.3% |
| 50% | $5,611,000 | 16.0% |
| **80%** | **$7,067,000** | **20.1%** |
| 95% | $9,072,000 | 25.8% |

Base cost is construction only, excluding Real Estate, PED and Construction Management.

## KEY FINDINGS/OBSERVATIONS RECOMMENDATIONS

The PDT worked through the risk register on 10 April 2014 with follow-up meetings on 21 May 2014. Another slate of PDT risk meeting was held mid December 2014. It became evident that risk identification had changed during that period and that some risks have lessened. The team understands the project, the experienced risks and those risks already incorporated into the current designs and estimated costs (i.e., the major risks have already been identified, experienced and mitigated through various means). The key risk drivers identified through sensitivity analysis suggest an 80% confidence level total contingency of some $7.1M for construction activities, $8.5M for total base cost. When reviewing the risk register, many of the remaining risks are considered moderate risks. In part, this is a result of a 90% design, indicative of the PDTs understanding and confidence in the project.

**Cost Risks**: Note that since the estimate is based on a 90% design, technical risks are not apparent. The remaining greater cost risks resulting from the CSRA suggest 20% contingency including time growth impacts:

- CA-1 Small Business Contracts: The district Contracting has established that the levee work will be advertised as full and open competition. The Fish & Wildlife – Re-vegetation will likely go competitive small business. The risk concern is that small businesses typically incur higher home office overheads, engage in more subcontracts (double tired contractor markups), more equipment rentals, etc. This could raise the Re-vegetation contracts above that currently estimated.

- CA-4 Market Conditions, Bidding Competition: The concern with this risk is that, if the economy has an upswing, lesser competition and higher pricing could be realized. The Corps of Engineers is allowed to award contracts up to 25% above the Government estimate, excluding profit. The CSRA assumed just 5% greater impact because the estimates are adjusted to a counter some such possibility; plus, the Re-vegetation is not a complicated effort, attracting bidders.

- CON-2 Construction Modifications: Almost all projects experience construction modifications during the life of the project and will require set aside contingency funds to pay for those added, unanticipated cost and time impacts.

- EST-3 and EST-4 Estimate Uncertainty: The estimate uncertainty for both the levees and the re-vegetation is based mostly on assumed crews, productivities, contractor and subcontractor assignments and markups. The estimate has assumed a fairly “neutral” approach, plus and minus impacts.

**Schedule Risks**: From the CSRA, the key or greater Schedule Risk items could impact schedule growth by as much as 3.5% and an added 5% contingency:

- PPM-6 and PR-4 Exceeding Authorized Funding and Federal Funding Delays: These risks are more critical to the viability of the project. Simply put, the lack of funding and resulting protracted schedule places the project at risk of completion. As time is extended, there is greater likelihood of unexpected scoping changes due to regulatory or Sponsor, local escalation exceeding the national projections, added PDT efforts competing for funds, adjusting contract packages, etc.

- RE-2 Regulatory Compliance: Certain schedule risks, if realized, can result in a year-long schedule shift, even if the apparent risk is just 3 months. This is due to the sequential nature of the work: planting and growing season, as well as a reasonable construction period competing with protected species such as the Swanson’s Hawk.

- PPM-1 Aggressive Schedule: In the very near term, FY15, contracts must be awarded sequentially, beginning in January for plantings. Schedule slip can impact follow-on contracts. Schedule slips can also result in a greater number of contracts, design and management efforts.

- CON-2 Construction Modifications: Construction modifications are a settlement of time and money, time translated to contractor cost impacts such as added work, extended overheads, etc. The effort to resolve those modifications also requires added PED and Construction Management efforts.

Recommendations, as detailed within the main report, include the implementation of cost and schedule contingencies, further iterative study of risks throughout the project life-cycle, potential mitigation throughout the PED phase, and proactive monitoring and control of risk identified in this study.

# MAIN REPORT

## 1.0 PURPOSE

Under the authority of the US Army Corps of Engineers (USACE), Sacramento District presents this cost and schedule risk analysis, identified major risks and recommendations for the total project cost and schedule contingencies for the Hamilton City Flood Damage Reduction and Ecosystem Restoration Project, Glenn County, CA.

## 2.0 BACKGROUND

The Hamilton City feasibility study was accomplished as part of the Central Valley Integrated Flood Management Study (formerly Sacramento and San Joaquin River Basins Comprehensive Study) with the state of California as the non-Federal sponsor. The project unlocks potential for integrated, multiple-purpose projects developed in accordance with existing USACE policy and will manage flood risk for the town of Hamilton City and adjacent agricultural lands while providing significant habitat acreage in the floodplain.

The project will construct a setback levee about 6.8 miles long and degrade an existing "J" levee, actively restoring 1,145 acres of riparian woodland, 261 acres of riparian shrub, and 70 acres of floodplain meadow now cut off by that levee. To accomplish ecosystem restoration, most of an existing "J" levee will be removed to reconnect the river to the floodplain and allow for overbank flooding. In areas where the "J" levee reduces velocities of the Sacramento River, the "J" levee will remain in place.

The new setback levee will begin 2 miles north of Hamilton City. It will tie into high ground near the end of the "J" levee to prevent flows greater than 250 year event from wrapping around the setback levee and over County Road 203 and into populated areas. County Road 203 will be ramped approximately 2.5 feet from its current height over the setback levee. Glenn County constructed a short setback levee near the northern end of the "J" levee in 2003, which is serving as a "training dike" for the new setback levee. Entrenched rock will be placed on either the waterside or landside of this training dike to direct flows and potential river migration away from the new setback levee. The setback levee will run SE along County Road 203 then turn easterly and run parallel to the Sacramento River for about 1,300 feet. A seepage berm will be constructed on the landside of the setback levee from the northern end of the levee to Dunning Slough. The levee will have a 90 percent reliability of passing the 75 year event. At Highway 32, the levee will turn east and run parallel to the highway until tying into the approach at Gianella Bridge. The highway will not need to be raised, but rock riprap will be placed to protect the levee embankment and bridge from floodwaters. South of Highway 32, the alignment follows the existing "J" levee adjacent to Irvine Finch River Access. South of this access, the levee will be aligned away from the river

to open up the floodplain. The alignment will cut across a portion of Dunning Slough and provide protection to the Hamilton City wastewater treatment plant. An existing ditch within Dunning Slough will be used to drain runoff from the agricultural fields and Hamilton City. This drain will connect to the floodplain via a culvert in the setback levee south of Dunning Slough. The alignment will follow the western edge of the habitat restoration area before turning east and merging with the southern end of the "J" levee at Road 23. As the levee turns east, the levee height will gradually decrease from 9 feet to approximately 2 feet. At this point the new setback levee will transition into a "training dike". This height reduction will avoid negative hydraulic effects to downstream property owners. The training dike continues a mile south of Road 23, running west of the USFWS boundary. This project will manage flood risk for the town of Hamilton City and adjacent agricultural lands while providing significant habitat acreage in the floodplain.

As a part of this effort, Sacramento District requested that the USACE Cost Engineering Mandatory Center of Expertise for Civil Works (Cost Engineering MCX) provide risk analysis assistance for the Project Plan.

## 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 Sacramento 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 Sacramento District staff to provide expertise and information gathering. The initial risk identification meeting also included qualitative analysis to produce a risk register that served as the draft framework for the risk analysis. Follow on meetings updated project development and refined risk modeling. Participants in the risk identification meeting included:

## Initial Risk Register Development Meeting – APRIL 2014

| Attendance | Name | Representing |
|---|---|---|
| Landscape Architect | James Lee | Sacramento District |
| Chief – Cost Engineering | Jerry Frost | Sacramento District |
| Cost Engineer | Joe Reynolds | Sacramento District |
| Ecosystem Restoration | Scott Miner | Sacramento District |
| Chief – Civil Engineering | Mark Boedtker | Sacramento District |
| Project Manager | Jimmy Myers | Sacramento District |
| Hydraulic Engineer | Morgan Marlatt | Sacramento District |
| Civil Engineer | Hans Carota | Sacramento District |
| Risk Facilitator | William Bolte | Cost Engineering MCX |

## Project Update Risk Register Refinement Meeting

| Attendance | Name | Representing |
|---|---|---|
| Landscape Architect | James Lee | Sacramento District |
| Chief – Cost Engineering | Jerry Frost | Sacramento District |
| Cost Engineer | Joe Reynolds | Sacramento District |
| Chief – Project Management | Nicole Ortega | Sacramento District |
| Chief – Water Resources | Mark Cowan | Sacramento District |
| Project Manager | Jimmy Myers | Sacramento District |
| Hydraulic Engineer | Morgan Marlatt | Sacramento District |
| Civil Engineer | Hans Carota | Sacramento District |
| Risk Facilitator | William Bolte | Cost Engineering MCX |

## December Risk Register Update – DECEMBER 2014

| Attendance | Name | Representing |
|---|---|---|
| Tech Lead, Ecosystem Restoration | James Lee | Sacramento District |
| Chief - Cost Engineering | Jerry Frost | Sacramento District |
| Cost Engineer | Joe Reynolds | Sacramento District |
| Planner | Scott Miner | Sacramento District |
| Real Estate | Liz Youn | Sacramento District |
| Project Manager | Eric Stevens | Sacramento District |
| Environmental | Brad Johnson | Sacramento District |
| Tech Lead, Civil Design & FRM | Hans Carota | Sacramento District |
| Chief - PPMD, Civil Works Branch | Nicole Ortega-Jewell | Sacramento District |
| Attorney | Bill Paris | Non-Federal Sponsor (NFS) |
| Nature Conservancy Consultant | Ryan Luster | NFS |
| Engineering Consultant | Eric Nagy | NFS |

| | | |
|---|---|---|
| Chief – Geotechnical Branch | April Fontaine | Sacramento District |
| Geotechnical Engineer | Jane Bolton | Sacramento District |
| Engineering | Richard Stauber | Sacramento District |
| Engineering | Derek Morley | Sacramento District |
| Engineering | Lynn Moquette | Sacramento District |
| Chief - Real Estate | Paul Zianno | Sacramento District |
| Chief - Contracting | Ray Greenheck | Sacramento District |
| Chief - Engineering | Greg Kukas | Sacramento District |
| Chief - Water Resources Branch | Mark Cowan | Sacramento District |
| Chief - Contracting, Construction Br | Nikole May | Sacramento District |
| Resident Engineer - Construction Br | Cathy Wise | Sacramento District |

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

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

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

### 4.1 Identify and Assess Risk Factors

Identifying the risk factors via the 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.

Formal PDT meetings were held in April and December 2014. The PDT included capable and qualified representatives from multiple project team disciplines and functions, including project management, cost engineering, design, environmental compliance, real estate, Contracting and Construction.

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, 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.

### 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 Appendix A for both cost and schedule risk concerns. Note that the risk register records the PDT's risk concerns, discussions related to those concerns, and potential impacts to the current cost and schedule estimates. The concerns and discussions 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 determining the cost and schedule risks.

a. The Sacramento District provided the final, ATR approved, MII-MCACES estimate (Micro-Computer Aided Cost Estimating Software) files electronically on 23 December 2014. The CSRA was performed on the final MII estimate. For the PED and Construction Management, the same 20% contingency was applied, because those two accounts are a percent calculation of the estimated construction costs; therefore the same percent risk was carried forward.

b. The Sacramento Real Estate office provided separate cost data with separate contingency value, so the real estate, Lands and Damages, was excluded from the risk analysis. Since a good portion of real estate has already been purchased, the remaining risks and contingencies are considered residual.

c. The cost comparisons and risk analyses performed and reflected within this report are based on project experience related to the spent costs. The project scoping is well understood, fairly simple construction and the bulk of risks have been incorporated into more recent design and estimated construction costs. The contingency outcome of 20-25% was expected to be lower than a standard Feasibility Report of 25-35%.

d. 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.

e. 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 project cost contingencies for the P5, P50, P80 and P95 confidence levels are also provided for illustrative purposes only.

Contingency was quantified as approximately $9.3 Million at the P80 confidence level (23% of the baseline cost estimate). For comparison, the cost contingency at the P50 and P95 confidence levels was quantified as 18% and 28% of the baseline cost estimate, respectively.

**Table 1. Construction Cost and Schedule Contingency Results**

| **Construction Cost Estimate** | **$35,111,900*** | |
|---|---|---|
| **Confidence Level** | **Construction Value ($$)** | **Contingency (%)** |
| 5% | $3,266,000 | 9.3% |
| 50% | $5,611,000 | 16.0% |
| **80%** | **$7,067,000** | **20.1%** |
| 95% | $9,072,000 | 25.8% |

Base cost is construction only, excluding Real Estate, PED and Construction Management.

#### 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,

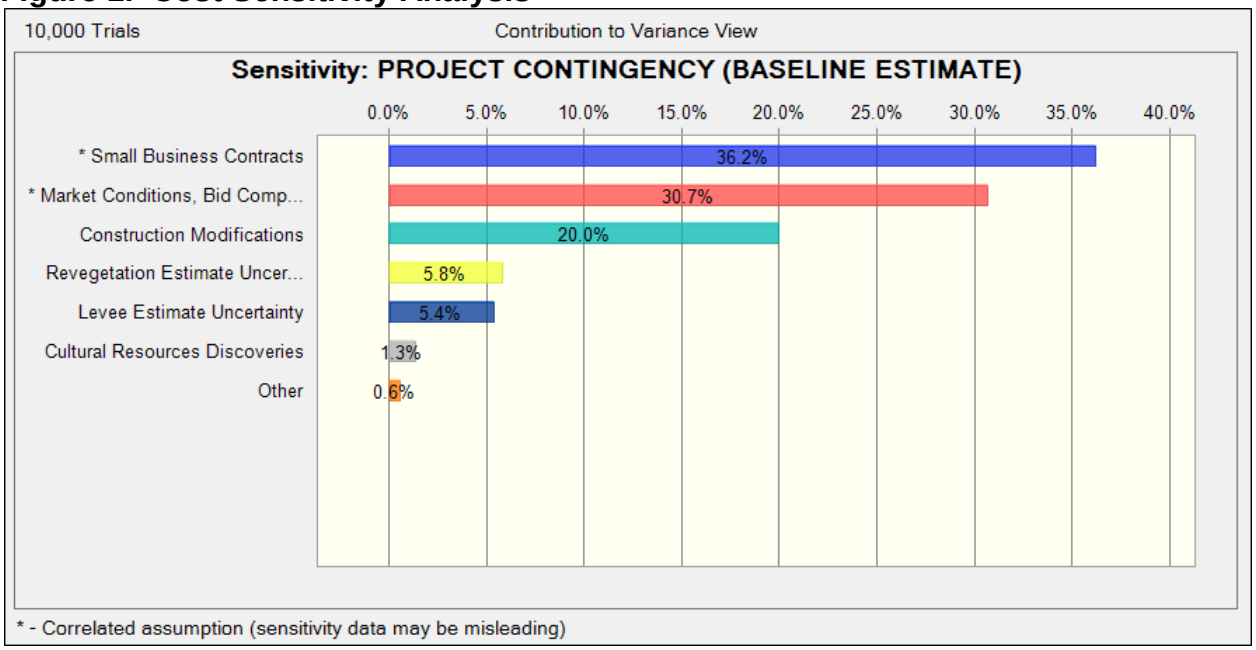
sensitivity analysis results can also be used to support development of strategies to eliminate, mitigate, accept or transfer key risks.

### 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

Table 2 provides the schedule duration contingencies calculated for the P80 confidence level. The schedule duration contingencies for the P50 and P100 confidence levels are also provided for illustrative purposes.

Schedule duration contingency was quantified as 66 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.

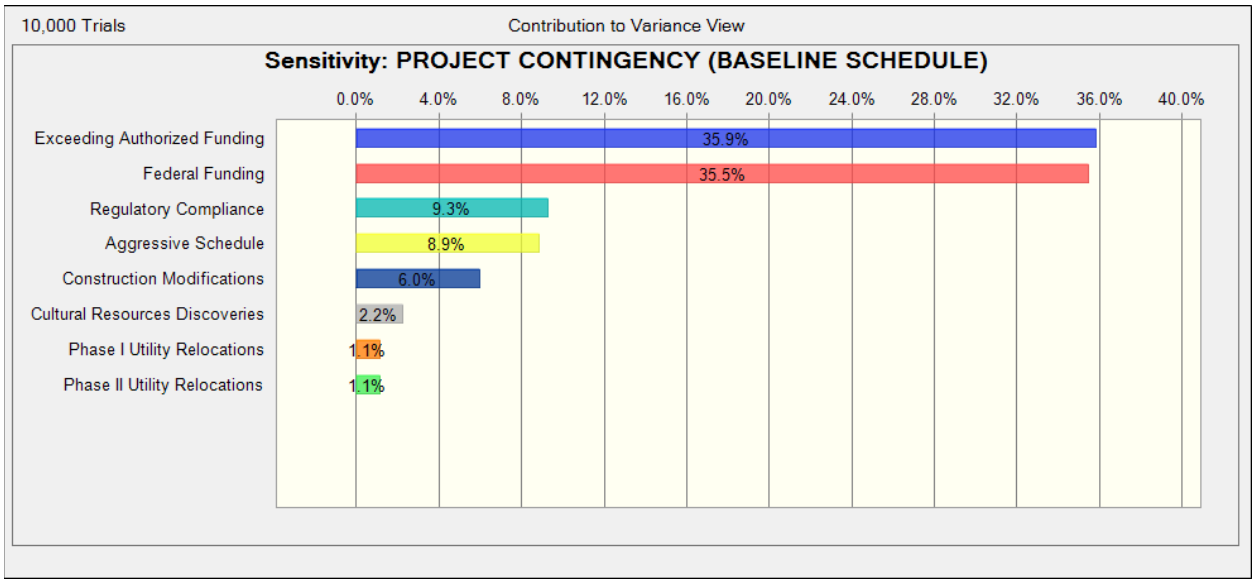
The schedule was not resource loaded and contained open-ended tasks and non-zero lags (gaps in the logic between tasks) that limit the overall utility of the schedule risk analysis. These issues should be considered as limitations in the utility of the schedule contingency data presented. Schedule contingency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

### Table 2. Schedule Duration Contingency Summary

| Risk Analysis Forecast on 38 Month Duration | Baseline Schedule Duration w/ Contingency (months) | Contingency[1] (months) |
|---|---|---|
| 50% Confidence Level | 70 | 32 |
| 80% Confidence Level | 80 | 42 |
| 95% Confidence Level | 103 | 65 |

Notes:
1) 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 in Table 2.

### 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

The PDT worked through the risk register on 10 April 2014 with follow-up meetings on 21 May 2014. Another slate of PDT risk meeting was held mid December 2014. It became evident that risk identification had changed during that period and that some risks have lessened. The team understands the project, the experienced risks and those risks already incorporated into the current designs and estimated costs (i.e., the major risks have already been identified, experienced and mitigated through various means). The key risk drivers identified through sensitivity analysis suggest an 80% confidence level total contingency of some $7.1M for construction activities, $8.5M for total base cost. When reviewing the risk register, many of the remaining risks are considered moderate risks. In part, this is a result of a 90% design, indicative of the PDTs understanding and confidence in the project.

**Cost Risks**: Note that since the estimate is based on a 90% design, technical risks are not apparent. The remaining greater cost risks resulting from the CSRA suggest 20% contingency including time growth impacts:

- CA-1 Small Business Contracts: The district Contracting has established that the levee work will be advertised as full and open competition. The Fish & Wildlife – Re-vegetation will likely go competitive small business. The risk concern is that small businesses typically incur higher home office overheads, engage in more subcontracts (double tired contractor markups), more equipment rentals, etc. This could raise the Re-vegetation contracts above that currently estimated.

- CA-4 Market Conditions, Bidding Competition: The concern with this risk is that, if the economy has an upswing, lesser competition and higher pricing could be realized. The Corps of Engineers is allowed to award contracts up to 25% above the Government estimate, excluding profit. The CSRA assumed just 5% greater impact because the estimates are adjusted to a counter some such possibility; plus, the Re-vegetation is not a complicated effort, attracting bidders.

- CON-2 Construction Modifications: Almost all projects experience construction modifications during the life of the project and will require set aside contingency funds to pay for those added, unanticipated cost and time impacts.

- EST-3 and EST-4 Estimate Uncertainty: The estimate uncertainty for both the levees and the re-vegetation is based mostly on assumed crews, productivities, contractor and subcontractor assignments and markups. The estimate has assumed a fairly "neutral" approach, plus and minus impacts.

**Schedule Risks**: From the CSRA, the key or greater Schedule Risk items could impact schedule growth by as much as 3.5% and an added 5% contingency:

- PPM-6 and PR-4 Exceeding Authorized Funding and Federal Funding Delays: These risks are more critical to the viability of the project. Simply put, the lack of funding and resulting protracted schedule places the project at risk of completion. As time is extended, there is greater likelihood of unexpected scoping changes due to regulatory or Sponsor, local escalation exceeding the national projections, added PDT efforts competing for funds, adjusting contract packages, etc.

- RE-2 Regulatory Compliance: Certain schedule risks, if realized, can result in a year-long schedule shift, even if the apparent risk is just 3 months. This is due to the sequential nature of the work: planting and growing season, as well as a reasonable construction period competing with protected species such as the Swanson's Hawk.

- PPM-1 Aggressive Schedule: In the very near term, FY15, contracts must be awarded sequentially, beginning in January for plantings. Schedule slip can impact follow-on contracts. Schedule slips can also result in a greater number of contracts, design and management efforts.

- CON-2 Construction Modifications: Construction modifications are a settlement of time and money, time translated to contractor cost impacts such as added work, extended overheads, etc. The effort to resolve those modifications also requires added PED and Construction Management efforts.

**Table 3. Project Cost Comparison Summary (Uncertainty Analysis)**

| Most Likely Construction Estimate | $35,111,900 | | |
|---|---|---|---|
| **Confidence Level** | **Project Cost** | **Contingency** | **Contingency %*** |
| 0% | **$36,211,012** | **$1,099,000** | **3.13%** |
| 5% | **$38,378,293** | **$3,266,000** | **9.30%** |
| 10% | **$38,838,649** | **$3,727,000** | **10.61%** |
| 15% | **$39,151,567** | **$4,040,000** | **11.51%** |
| 20% | **$39,426,853** | **$4,315,000** | **12.29%** |
| 25% | **$39,690,087** | **$4,578,000** | **13.04%** |
| 30% | **$39,911,909** | **$4,800,000** | **13.67%** |
| 35% | **$40,117,873** | **$5,006,000** | **14.26%** |
| 40% | **$40,320,438** | **$5,209,000** | **14.83%** |
| 45% | **$40,510,304** | **$5,398,000** | **15.37%** |
| 50% | **$40,722,923** | **$5,611,000** | **15.98%** |
| 55% | **$40,947,204** | **$5,835,000** | **16.62%** |
| 60% | **$41,159,411** | **$6,048,000** | **17.22%** |
| 65% | **$41,399,004** | **$6,287,000** | **17.91%** |
| 70% | **$41,636,175** | **$6,524,000** | **18.58%** |
| 75% | **$41,899,420** | **$6,788,000** | **19.33%** |
| **80%** | **$42,178,477** | **$7,067,000** | **20.13%** |
| 85% | **$42,538,405** | **$7,427,000** | **21.15%** |
| 90% | **$43,012,248** | **$7,900,000** | **22.50%** |
| 95% | **$44,184,225** | **$9,072,000** | **25.84%** |
| 100% | **$46,000,159** | **$10,888,000** | **31.01%** |

**Contingency values include the schedule impact costs.**

## 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.

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).

Project Specific:

a. The PDT must continue to monitor and update project designs, project costs and associated current risks in relationship to authorized and appropriated project funds.

**b.** Timely coordination and risk resolution between the Sponsor and USACE is needed; however, the out year markets will have the greatest risk bearing for both parties. Funding and bidding competition must be periodically re-evaluated to ensure sufficient budget is available to perform the work objectives as authorized. Means of mitigating these risks could include quantity revisions, cost estimate updates, enhanced competition through contract strategies, such as multiple years, tailored bid schedules to support volume variables.

**c.** Continued coordination must continue with the critical regulatory agencies to ensure that the sequential efforts, levee construction and revegetation, can occur unimpeded and without a major annual loss in activities and progress.

# APPENDIX A – RISK REGISTER

| Risk No. | Risk/Opportunity Event | Concerns | PDT Discussions & Conclusions | Project Cost | | | Schedule | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Likelihood* | Impact* | Risk Level* | Likelihood* | Impact* | Risk Level* |
| | **PROJECT & PROGRAM MGMT** | | | | | | | | |
| PPM-1 | Aggressive Schedule | New Start congressional commitment. Last Year to request funding is 2019. | Funding verses schedule is very tight. The Elderberry Transplant service contract must be awarded NLT 5 January 15 and elderberries transplanted by 15 Feb 2015. Contingent upon gaining CCB to award, on track to meet this. The award of Ph 1 Levee contract by 15 May: SAR contract is awarded, SAR review, ATR and BCOES on schedule and have AAPB approval. The award of Ph1 restoration in June 2015, and everything on schedule. After 2015, there are three more contracts to award for implementation in FY16. | Very Unlikely | Marginal | LOW | Unlikely | Critical | MODERATE |
| PPM-2 | FY14 Funding | Construction funding for FY14 could be revoked. | Conclusion: PPA was executed prior to August deadline and Fed and Non-Fed funding were received in time, so this is no longer a risk for carrying the funds over. | Very Unlikely | Negligible | LOW | Very Unlikely | Negligible | LOW |
| PPM-3 | Carryover funding | Carryover Funds into FY15 to be obligated during FY15-Q1 or revoked. | 90% Design was completed approximately 5 years ago. Design funding has been delayed but is anticipated to begin June 2014. Conclusion: Funds were not taken away. Schedule has been communicated with SPD. Carryover and FY15 funding will be sufficient to award FY15 contracts. | Very Unlikely | Negligible | LOW | Very Unlikely | Significant | LOW |
| PPM-4 | Insufficient Staffing | If the SPK PDT encounters insufficient staffing to maintain the project schedule, SPD will coordinate regionally for additional team support. Multiple outside sources could impact quality and schedule. | Although SPK is receiving short-term, limited help on cultural resources, it is not relying on outside help. Also, Hamilton City is currently one of the highest SPK priorities for resourcing. The District has assembled a complete PDT staffed with SPK employees since execution of the PPA in July. In cases where District resources have been over allocated (i.e. cultural resources), the District has successfully leveraged available technical expertise from other Districts. | Very Unlikely | Negligible | LOW | Unlikely | Marginal | LOW |
| PPM-5 | Sufficient PDT Involvement | Insufficient funding has prevented availability of PDT to be engaged in schedule development and review. | Conclusion: This original concern was from May 14 prior to executing the PPA and receiving funding. We are now adequately funded and staffed; schedule is developed. Risk is not unlikely. | Very Unlikely | Negligible | LOW | Very Unlikely | Significant | LOW |
| PPM-6 | Exceeding Authorized Funding | If the Total Project Cost exceeds the congressionally authorized amount (AKA 902 limit), funding and project might not move forward. Additional authorization and appropriations would be required if scope-reduction is not achieved. | Our estimate is nearing the 902 limit. Any cost increases to the estimate or the CSRA could put the TPCS over the 902 limit. The PDT has had several meetings to discuss ways to reduce costs and are implementing them. Cost reducing measures and value engineering processes have been incorporated. We now have a high level of confidence that we are not going to exceed the 902 limit. Should it be exceeded and added congressional funds needed, the schedule could be delayed in 1-yr increments. | Unlikely | Negligible | LOW | Unlikely | Critical | MODERATE |

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| | **CONTRACT ACQUISITION RISKS** | | | | | | | | |
| CA-1 | Small Business Contracts | Contracts could go small business, possibly sole source. Awarding to 8A sole source contracts have shown to increase cost 15-20% more when compared to competitive bids. | Conclusion: All contracts will be competitive awards, even if small business. The Ph 1 restoration contract does not quality for 8A because estimated to be $8.2M. The estimate assumes competitive large business for the levee construction, small competitive business for the vegetation. Since the work is not complicated, small business should be able to successfully complete the requirements. | Unlikely | Significant | MODERATE | Very Unlikely | Marginal | LOW |
| CA-2 | Safety Assurance Review | Contracting is concerned about ability to solicit and award A/E contract in a timely manner for SAR. | The SAR contract was awarded on 12/15/2014, on schedule and under budget. While this contract award does not eliminate this risk, it does reduce the uncertainty surrounding the timing and cost risks associated with this project activity. This risk was far more relevant in the July timeframe than today. | Very Unlikely | Marginal | LOW | Unlikely | Negligible | LOW |
| CA-3 | Separate Propagation Contracts | Separate propagation contracts for plant purchasing, planting and maintaining will complicate the contract process. There is greater potential for Gov't liability for any failures by multiple contractors. | Conclusion: This item is no longer a risk. The District decision has been made to maintain single vegetation contracts through the planting and maintenance period, not solicit separate propagation contracts. | Very Unlikely | Negligible | LOW | Very Unlikely | Significant | LOW |
| CA-4 | Market Conditions, Bid Competition | Lack of sufficient local bidding interest could increase contract costs. | Conversation: Bidding competition has historically been strong, but it is possible limited competition could result in increased costs. Conclusion: Estimated contract costs exceed sole source threshold of $4M.Contract Awards will be competitive, not sole source. The economy is turning around, resulting in less competition and higher prices than we have experienced in the last five years. | Unlikely | Significant | MODERATE | Likely | Negligible | LOW |
| CA-5 | Safety Assurance Review | SAR process could result in changes to the levee design. | Update: It is the PDT's opinion that the SAR will result in minimal levee changes and impacts. | Likely | Negligible | LOW | Likely | Negligible | LOW |

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| | **TECHNICAL RISKS** | | | | | | | | |
| TL-1 | 95% Design Review Impacts | The 90% ATR review comments could change the final plans and specification. | 90% design was completed in 2009 and ATR review comments were received but due to funding limitations never incorporated. Small elements and features of design will need to be finalized for the 95% design review effort as indicated in the review plan. It is anticipated minimal changes will be made to the design. The Dec 2014 estimate is including some of those changes. | Very Unlikely | Negligible | LOW | Very Unlikely | Negligible | LOW |
| TL-2 | Levee Borrow Material | Sufficient levee fill quantity from Glenn Colusa Irrigation District (GCID) borrow material is in question. | Borrow material is planned to come from Glenn Colusa Irrigation District (GCID) Canal and is available. Material quantity needs have not changed since original estimates during PED. Preliminary tests indicate material is suitable for use. However, additional testing is in progress. If material is not suitable, material will come from other currently known areas within the restoration area. Impacts related to any royalty costs, haul distance and levee construction productivity is limited. | Unlikely | Marginal | LOW | Unlikely | Marginal | LOW |
| TL-3 | Herbivore Browse of Plantings | Higher plant losses could be experienced, increasing revegetation costs. | Such an uncontrollable, natural event could result in additional restoration and replanting costs. But the large scale of the restoration over multiple years tends to diffuse herbivore browse and potential impacts. | Likely | Negligible | LOW | Very Unlikely | Negligible | LOW |
| TL-4 | HTRW Impacts | Encountering HTRW on the project sites. | Much of this area is farm land. USACE is inspecting, testing soils to minimize issues. Preliminary tests indicate no issues. Risk of encountering HTRW material is considered only minimal. | Unlikely | Marginal | LOW | Very Unlikely | Negligible | LOW |
| TL-5 | Levee Material Availability on Site | Existing Levee Material will be reused to construct new levee but likely not enough on site. A more confident borrow source will be needed. | It is assumed existing levee material, while not sufficient to construct a levee on its own can be used in conjunction with new barrow material to construct. No cost or schedule risks are anticipated. | Very Unlikely | Negligible | LOW | Very Unlikely | Negligible | LOW |
| TL-6 | Levee Height Change | Potential to reduce costs by lowering levee height | Reduction of levee height is not proposed because it would adversely impact the required (authorized) project flood risk management outputs or results. | Very Unlikely | Negligible | LOW | Very Unlikely | Negligible | LOW |
| TL-7 | Planting Reductions | Potential to reduce planting or acreage to reduce costs | Planting reduction is not proposed because it would reduce required (authorized) project outputs or results for ecosystem restoration justification. | Very Unlikely | Negligible | LOW | Very Unlikely | Negligible | LOW |
| TL-8 | Wastewater Lagoons impact Levees | Two wastewater lagoons within 200 feet of existing levee design that could increase levee seepage sufficient enough to cause levee failure | PDT identified potential design mitigation options. One option is the sponsor could abandoned the lagoons. Three of the most viable options are low-cost risk. There is adequate time to address design and perform environmental work and coordination because this only impacts Phase II. | Likely | Negligible | LOW | Very Likely | Negligible | LOW |

| | LANDS AND DAMAGES RISKS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| LD-1 | Property Acquisition, PH I | Non Federal Sponsor has procured some 85% of all properties. Procuring the Jensen Property is questionable. | Were unable to acquire the Jensen property, negotiations are still ongoing for Jensen property and expected to be acquired by the end of the project. Redesign has already occurred so this isn't an impact to phase 1 and will be part of Phase 2. All other Phase I properties will be procured. Conclusion: Failure to acquire a single property within Phase 1 resulted in a negligible cost impact. No schedule impact is expected. | Likely | Negligible | LOW | Likely | Negligible | LOW |
| LD-2 | Phase I Utility Relocations | Ability for non-federal sponsor to secure real estate before contract award. | Coordination conducted with PG&E to date, indicates that the required utility (power) relocations can be done within the project schedule. The estimated cost is within the nonfederal partners budget. Little impact to cost, some impact to schedule. | Likely | Marginal | MODERATE | Unlikely | Significant | MODERATE |
| LD-3 | Phase II Utility Relocations | Power and Gas utility relocations will be required prior to Phase II contract award. | Coordination conducted with PG&E to date, indicates that the required utility relocations can be done within the project schedule. The estimated cost is within the nonfederal partners budget. Little impact to cost, some impact to schedule. | Likely | Marginal | MODERATE | Unlikely | Significant | MODERATE |

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| | **REGULATORY AND ENVIRONMENTAL RISKS** | | | | | | | | |
| RE-1 | Cultural Resources Discoveries | Encountering Cultural Resource Sites could impacts costs and schedule. | Although unanticipated discovery of human remains or significant archaeological resources could delay construction where found, the PDT is mitigating risks by the following: (1) implementing a historic preservation treatment plant (HPTP) for discoveries; (2) updating the existing programmatic agreement (PA); and (3) using a tribal liaison to initiate early coordinating with tribal governments to reduce the risk of political challenges. Most of the cultural resources impacts are likely to occur during Phase 2, so there is more time to address potential risks and prepare mitigation measures. Risks still remain to cost and schedule. | Likely | Marginal | MODERATE | Likely | Marginal | MODERATE |
| RE-2 | Regulatory Compliance | Migratory impacts could cause some cost and schedule impacts. Compliance with migratory regulatory laws. | Compliance with other agency regulatory laws would pose a low risk. According to the amended Swanson's hawk protocols, work cannot occur within 0.25 mile of any active hawk nest from March 1 to Sept 15, which may delay work in the immediate vicinity of the nest site. A smaller buffer could be negotiated with FWS and CDFW, based upon the support of these agencies for this project. Regardless, work would proceed throughout the remainder of the project. Work within the affected nest area would resume after the nesting period. Surveys will be conducted prior to construction to determine the presence of listed nesting avian species. The Corps will formally consult with FWS regarding listed federal avian species to eliminate the risk of a work shutdown. Actively engaged with the resource agencies . The resource agencies strongly support this project. Concern about the Swanson's Hawk but confident that impact to the construction schedule is minor because we will perform the survey and consult with the resource agencies on sequencing the construction sequence. | Likely | Marginal | MODERATE | Likely | Marginal | MODERATE |
| RE-3 | Agency Support | Other agencies may not have the same level of urgency as USACE. | This project continues to receive positive support from other agencies. Also, the NFS's involvement has been timely and helpful. | Very Unlikely | Negligible | LOW | Very Unlikely | Negligible | LOW |

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| | **CONSTRUCTION RISKS** | | | | | | | | |
| CON-1 | Construction Complexities | Complex projects carry greater design and construction risks. | On this multipurpose project, both the levee and re-vegetation construction is relatively simple. With the near final design, construction risks would be related more to bid competition and construction mods, both covered under separate risks, and environmental restoration, with minimal anticipated cost or schedule risks. | Unlikely | Negligible | LOW | Unlikely | Negligible | LOW |
| CON-2 | Construction Modifications | There is inherent risk of construction modifications and claims that arise after contract award due to issues such as weather, schedules dictated by O&M cycles, differing site conditions, user directed changes or omissions, inaccurate surveys, and variations in estimated quantities (minor). | Post-award construction contract modifications and claims could impact the ultimate contract costs. The PDT is working to reduce the potential for contract modifications through refining the plans and specifications from 90% to final design and updating the DDR accordingly. Schedule could be impacted by the Swanson's hawk protocols and probability of encountering cultural resource issues. Recommend changing schedule to very likely and impact marginal. | Very Likely | Marginal | MODERATE | Likely | Marginal | MODERATE |
| | **ESTIMATE AND SCHEDULE RISKS** | | | | | | | | |
| EST-1 | Levee Quantities | Uncertainty of quantities required for levee construction. | Uncertainty of quantities required is very low since land configuration has not changed and detailed land surveys have been done. There is even some chance of lowering the levee height. (Borrow material is discussed in item TL-2). | Unlikely | Marginal | LOW | Very Unlikely | Negligible | LOW |
| EST-2 | Revegetation Quantities | Quantity confidence can influence cost impacts. | We have high confidence in planting quantities and high level of detail due to our partners experience (The Nature Conservancy) and work done next to restoration site. | Very Unlikely | Negligible | LOW | Very Unlikely | Negligible | LOW |
| EST-3 | Levee Estimate Uncertainty | Estimates carry uncertainty inherent with any budgetary cost estimates. Estimate productivity may not reflect actual field work, plus or minus. | Crews, assemblies, productivities, and methodologies in the current estimate, while acceptable and reasonable, may not adequately capture ultimate actual contractor technique and costs. The cost estimate has been reviewed, updated. The cost estimate will have greater confidence after the review; however, there are always some risks related to assumed crews, productivity rates, contractor assignments and markups. | Likely | Marginal | MODERATE | Very Unlikely | Negligible | LOW |
| EST-4 | Revegetation Estimate Uncertainty | Estimates carry uncertainty inherent with any budgetary cost estimates. The lower labor rates could be questioned. Estimate productivity may not reflect actual field work. | The vegetation estimate remains nearly the same as the previous submittal. The cost estimate uncertainty relates to productivities and labor rates (applied service labor rates under separate contracts as recommended by the Contracting Officer) . | Likely | Marginal | MODERATE | Very Unlikely | Negligible | LOW |

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| | **ECONOMICS RISKS** | | | | | | | | |
| FL-1 | Economic Justification | Economic viability of Flood Risk Management costs to warrant Federal participation and funding. | Any large cost increases for Flood Risk Management (FRM) could lead to economic re-evaluation and potential changes to solicitation packages and schedule timelines. Construction costs will be capped at an economic justification limit, but PED rework costs could increase in order to design to budget. With an economic "bust" schedule delays and rework will delay schedule. Economic analysis could result in some of the flood protection being pushed to optional work or to scope reductions. Conclusion: Large cost increases in FRM features (e.g. levee final design and construction) are not expected. | Unlikely | Marginal | LOW | Unlikely | Marginal | LOW |
| | **Programmatic Risks** | (External Risk Items are those that are generated, caused, or controlled exclusively outside the PDT's sphere of influence.) | | | | | | | |
| PR-1 | Training Dike | Sponsor is adamant Training Dike must be included in project scope. | Recent Recalculations have shown project to be economically justifiable and removal or rework of the Training Dike will not be required. | Very Unlikely | Negligible | LOW | Very Unlikely | Negligible | LOW |
| PR-2 | Acts of God, Flood Events | Any likely acts of god would be heavy rains or flooding which would impact earthwork and plantings. | Planting establishments could be lost and irrigation systems could be damaged. Levee construction would be delayed due to saturated soils and inability to meet compaction requirements. Conclusion: revegetation contracts will require Contractor to bury irrigation lines to protect them from possible flood events. [In 27 years, TNC has not had to extend contracts due to flood.] Contractor impa cts are included under modifications risk CON-2. | Likely | Negligible | LOW | Unlikely | Negligible | LOW |
| PR-3 | High Water Events | Start of Construction could be delayed to allow high water events to subside and borrow material to dry. | It is anticipated this event is unlikely to happen and at most delay project start a few weeks (similar to risk PR-2). | Very Unlikely | Negligible | LOW | Very Unlikely | Negligible | LOW |
| PR-4 | Federal Funding | Out year funding may not be sufficient for optimum schedule. | FY15 work plan and FY16 budget will not be released until Feb. 2015 to project needs for out years. Could result in increase in number of contracts, more contract packages, added mobilization costs and increase in schedule. | Unlikely | Significant | MODERATE | Unlikely | Significant | MODERATE |
| PR-5 | Sponsor Funding | Availability of Sponsor Funds | Sponsor is relying on State grant money for majority of sponsor project funding. State has given grant funds to The Nature Conservancy (TNC) for purchase of properties that will be donated to the sponsor. Additional funding needs remain for utility relocations and other sponsor funding obligations remain. NFS has sufficient funding for cost outlined in PPA. | Very Unlikely | Negligible | LOW | Very Unlikely | Marginal | LOW |