LCA TERREBONNE BASIN BARRIER SHORELINE RESTORATION STUDY

ANNEX L-5
RISK ANALYSES FOR THE INITIAL RESTORATION OF THE NER PLAN AND FIRST COMPONENT OF CONSTRUCTION

US Army Corps of Engineers

Louisiana Coastal Authority
Terrebonne Basin Barrier Shoreline Restoration

Integrated Feasibility Study and
Environmental Impact Statement

Project Cost and Schedule Risk Analysis Report
National Ecosystem Restoration Plan

Prepared for:

U.S. Army Corps of Engineers,
New Orleans District

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Under contract from Louisiana Office of Coastal Protection and Restoration

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EXECUTIVE SUMMARY

This report presents a recommendation for the total project cost and schedule contingencies for initial restoration of the National Ecosystem Restoration (NER) Plan of the Louisiana Coastal Authority, Terrebonne Basin Barrier Shoreline Restoration Study in Terrebonne and Lafourche Parishes, Louisiana. The NER Plan includes the initial restoration of Whiskey Island to a design of Plan C with renourishment events in Target Year (TY) 20 and 40; Trinity Island to a design of Plan C with renourishment event in TY25; Raccoon Island to a design of Plan E with Terminal Groin with terminal groin O&M in TY10 and renourishment in TY30; and Timbalier Island to a design of Plan E with renourishment in TY30. The renourishment in TY20 and TY40 for Whiskey Island would be to add a design of Plan C and Plan B, respectively. The renourishment of Trinity Island in TY25 would be to add a design of Plan C. The renourishment of Raccoon Island and Timbalier in TY30 would be to restore to a design of Plan B. In compliance with Engineer Regulation (ER) 1110-2-1302 Civil Works Cost Engineering, dated September 15, 2008, a formal risk analysis study was conducted for the development of contingency on the total project cost for the initial restoration and none of the operation and maintenance construction activities. The purpose of this risk analysis study was to establish project contingencies by identifying and measuring the cost and schedule impact of project uncertainties with respect to the estimated project cost for the initial restoration of the four islands.

The most likely program year (2012) baseline project cost for initial restoration of the four islands is estimated to be approximately $517.6 Million. Based on the results of the analysis it is recommended that a contingency and escalation value of approximately $171.5 Million, or 33.1%, be added to the total project cost for a fully funded cost of $689.0 Million.

The following tables ES-1 and ES-2 present both the baseline cost and fully funded project cost, respectively, of the initial restoration component for the NER Plan based on the anticipated contract. The cost is intended to address the congressional request of project cost estimates to implement the project. The contingency is based on an 80% confidence level, as per U.S. Army Corps of Engineers Civil Works guidance.

Table ES-1. NER Plan Cost Summary - Program Year (2012)
Initial Restoration Project Cost

LCA TBBSR NER Plan Total Project Costs		Program Year Cost	Contingency[1]	Program Year Total Cost[2]
01	Lands & Damages	$545,489	$163,647	$709,136
06	Fish & Wildlife (Adaptive Management Plan)	$5,821,200	Included	$5,821,200
10	Breakwaters & Seawalls	$1,833,379	$500,239	$2,332,618
17	Beach Replenishment	$462,893,681	$129,859,981	$592,753,662
30	Planning, Engineering & Design	$23,234,414	$6,594,157	$29,828,571
31	Construction Management	$23,236,463	$6,594,739	$29,831,202
	Total Project Costs	$517,564,626	$143,712,763	$661,276,389

Notes: 1. Adaptive Management Plan cost includes prior escalation & contingency and is subjected to the Total Contingency and Escalation.
2. Costs taken from TPCS

Table ES-2. NER Plan Cost Summary
Fully Funded Initial Restoration Project Cost

LCA TBBSR NER Plan Total Project Costs		Program Year Cost	Total Contingencies & Escalations[1]	Fully Funded Total[2]
01	Lands & Damages	$545,489	$169,355	$714,844
06	Fish & Wildlife (Adaptive Management Plan)	$5,821,200	Included	$5,821,200
10	Breakwaters & Seawalls	$1,833,379	$661,017	$2,494,396
17	Beach Replenishment	$462,893,681	$155,985,226	$618,878,907
30	Planning, Engineering & Design	$23,234,414	$6,845,778	$30,080,192
31	Construction Management	$23,236,463	$7,804,553	$31,041,016
	Total Project Costs	$517,564,626	$171,465,929	$689,030,555

Notes: 1. Adaptive Management Plan cost includes prior escalation & contingency and is subjected to the Total Contingency and Escalation.
2. Costs taken from TPCS

KEY FINDINGS/OBSERVATIONS/RECOMMENDATIONS

The key cost risk drivers identified through sensitivity analysis for the initial restoration component of the NER Plan Contract No. 1 (Whiskey, Trinity, and Raccoon Islands) are Internal Risks PED-11 (Geotechnical Issues Beach/Dune - Ship Shoal Borrow Area) in additional to External Risks PR-2 (Fuel Prices), PR-3 (Severe Weather/Downtime), PR-5 (Long Pipeline to Island for Beach Fill), PR-7 (Bidder's Risk in Volatile Market), and

PR-8 (Pipeline Steel Prices) which together contribute 99.3% of the statistical cost variance.

The key cost risk drivers identified through sensitivity analysis for the initial restoration component of the NER Plan Contract No. 2 (Timbalier Island) are Internal Risks PED-11 (Geotechnical Issues Beach/Dune - South Pelto Borrow Area) in additional to External Risks PR-2 (Fuel Prices), PR-3 (Severe Weather/Downtime), PR-5 (Long Pipeline to Island for Beach Fill), PR-7 (Bidder's Risk in Volatile Market), and PR-8 (Pipeline Steel Prices) which together contribute 99.3% of the statistical cost variance.

The key schedule risk drivers identified through sensitivity analysis for the initial restoration component of the NER Plan are External Risks PR-1 (Sponsor's Ability to Fund its Share), PR-3 (Severe Weather/Downtime), PR-5 (Long Pipeline to Island for Beach Fill), PR-4 (Delays due to Design Modifications), and PR-10 (Dredge Acquisition), which together contribute 96.4% and 97.4% of the statistical schedule variance for Contracts No. 1 and No 2, respectively.

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 Planning, Engineering & Design phase, and proactive monitoring and control of risk identified in this study.

1.0 Purpose

The purpose of this report is to present the findings and results of the Cost and Schedule Risk Analysis for the Louisiana Coastal Authority, Terrebonne Basin Barrier Shoreline Restoration Study (LCA TBBSR). The results presented in this report include the recommended contingencies to be added to the base estimate cost for the initial restoration component of the National Ecosystem Restoration (NER) Plan. Additionally, to provide confidence that the actual project execution costs will be within the resulting estimated budget value. 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. The results presented herein are intended to provide project leadership with contingency information for scheduling, budgeting, and project control purposes, as well as, provide tools to support decision making and risk management as the project progresses through Planning, Engineering & Design and project implementation.

2.0 STUDY BACKGROUND

2.1 PARTICIPATING AGENCIES

The responsible lead Federal agency for this study is the U. S. Army Corps of Engineers (USACE) - Mississippi Valley, New Orleans District. The non-Federal sponsor for the study is Louisiana Office of Coastal Protection and Restoration.

2.2 STUDY AUTHORIZATION

Title VII of the Water Resources Development Act (WRDA) 2007 authorizes the LCA ecosystem restoration program. Included within that authority are requirements for comprehensive coastal restoration planning, program governance, a Science and Technology Program, a program for the beneficial use of dredged material, feasibility studies for restoration plans, project modification investigations, and restoration project construction, in addition to other program elements. This authorization was recommended by the Chief of Engineer’s Report, dated January 31, 2005.

Under the 2007 WRDA Section 7006, the LCA program has authority for feasibility-level reports of six near-term critical restoration features of which includes the LCA TBBSR Study.

2.3 Study Purpose

The purpose of the proposed action is to address the goal of the 2004 LCA Plan; specifically, to address the critical near-term needs for shoreline restoration in Terrebonne Basin through simulation of historical conditions, which will be achieved by enlarging the existing barrier islands (width and dune crest) and reducing the current number of breaches. Additional objectives include analyzing the current conditions of the barrier islands, assessing impacts from the hurricanes of 2005 and 2008, and reaffirming the validity of the findings of the Final Environmental Impact Statement. The Integrated Feasibility Study and Environmental Impact Statement is based on a thorough review of existing scientific and engineering reports, as well as geospatial, survey, and geotechnical data.

2.4 Study Location

The LCA TBBSR, located in LCA Subprovince 3, provides for the restoration of the Timbalier and Isles Dernieres barrier island reaches located in Terrebonne and Lafourche Parishes, Louisiana. The Study area is located in the 3rd Congressional District.

The Isles Dernieres Reach

The Isles Dernieres reach represents a barrier island arc approximately 22 miles long in Terrebonne Parish and extends from Caillou Bay east to Cat Island Pass. Raccoon Island, Whiskey Island, Trinity Island, East Island, and Wine Island, the primary islands that comprise the Isles Dernieres barrier island chain, are backed by Bay Blanc, Bay Round, Caillou Bay, and Terrebonne Bay, and bordered by the Gulf of Mexico on the seaward side. The islands range from approximately 0.1 to 1.2 miles wide and are generally composed of a thin sand cap over a thick mud platform. Elevations are generally low and the islands are frequently over washed.

The Isles Dernieres have been and continue to be an important commercial and recreational resource for Louisiana and the nation for more than 150 years. The islands support habitats that are critical to the State's commercial fishing industry. Furthermore, the mineral-rich subsurface of the island range supports a high concentration of active oil and gas wells.

The first major coastal resort in Louisiana was located here and was washed away by the great hurricane of 1856. The Isles Dernieres have also been the location of five Coastal Wetland Planning, Protection, and Restoration Act projects. These projects included:

Raccoon Island (TE-29), Whiskey Island (TE-27), Trinity Island (TE-24), East Island (TE-20), and New Cut (TE-37).

The Timbalier Islands Reach

The Timbalier Islands reach is comprised of Timbalier Island and East Timbalier Island. The two islands are on the western edge of the Lafourche barrier shoreline and are located about 60 miles southwest of New Orleans, Louisiana. This barrier island shoreline is approximately 20 miles long and backed by Terrebonne and Timbalier Bay to the north and delimited by Raccoon Pass to the east and Cat Island Pass to the west. The islands range from 0.1 to 0.6 miles wide and have low elevations. The Timbalier Islands support onshore and offshore oil and gas development and production. Oil and gas production facilities are prevalent along East Timbalier Island, while only a few scattered facilities are present along Timbalier Island.

2.5 NATIONAL ECOSYSTEM RESTORATION PLAN

The NER Plan restores the geomorphologic form and ecologic function of the four islands in the Terrebonne Basin barrier system. Immediately after construction (TY1), the NER Plan will add 3,283 acres of habitat (dune, intertidal, and supratidal) to the existing island footprints of Raccoon, Whiskey, Trinity, and Timbalier Islands, increasing the total size of the islands to 5,840 acres. This includes approximately 472 acres of dune, 4,320 acres of supratidal habitat, and 1,048 acres of intertidal habitat. Raccoon Island will be renourished at TY30 by adding adequate sediment such that the dune and supratidal beach acres would be equivalent to that of a newly constructed Plan B template. Whiskey Island will require two renourishment intervals. The first will occur at TY20 and will include the addition of the same amount of dune and supratidal beach habitat that was originally created in TY1. The second renourishment interval will occur at TY40 and will include the addition of the same amount of dune and supratidal beach habitat needed to construct a Plan B template. Trinity Island will be renourished at TY25 by adding the same amount of dune and supratidal beach habitat that was originally added in TY1. Timbalier Island will be renourished at TY30 by adding adequate sediment such that the dune and supratidal beach habitat acres would be equivalent to the acres of a newly constructed Plan B template. The renourishment events were not evaluated in this risk analysis.

The barrier island restoration features of the initial restoration would achieve the planning objectives by maximizing the barrier island’s ability to provide geomorphic and hydrologic form and ecological function, as well as, improve critical barrier island habitats for fish, migratory birds, and other terrestrial and aquatic species. Sediment would be placed into the system to supplement long-shore sediment transport processes along the gulf shoreline by mechanically introducing compatible sediment, and increasing the ability of the restored area to continue to function and provide habitat with minimum continuing intervention.

The NER Plan is the best and meets the goal of the 2004 LCA Plan to address critical near-term needs for shoreline restoration for Terrebonne Basin through simulating historical conditions by enlarging the barrier islands (width and dune crest) and reducing the current number of breaches to ensure the continuing geomorphic and ecological form and function of the barrier islands. The selection of the NER Plan was based on a thorough review of existing scientific and engineering reports, as well as geospatial, survey, and geotechnical data which reaffirmed that the findings of the Final Environmental Impact Statement remained valid.

The NER Plan is also the plan that best meets the USACE Principles and Guidelines of completeness, effectiveness, efficiency, and acceptability, as well as the Environmental Operating Principles of environmental sustainability, interdependence, balance and synergy, accountability, knowledge, respect, and assessing and mitigating cumulative impacts.

3.0 REPORT SCOPE

3.1 PROJECT SCOPE

Engineering Circular Bulletin (ECB) 2007-17, Application of Cost Risk Analysis Methods to Develop Contingencies for Civil Works Total Project Costs (Sept. 10, 2007) requires that a formal risk analysis be prepared for all decision documents requiring Congressional authorization whose total costs are in excess of forty million dollars.

In addition to broadly defined risk analysis standards and recommended practices, a risk analysis is to be 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 Directory of Expertise for Civil Works (Cost Engineering Dx), dated May 17, 2009.

- Engineer Regulation (ER) 1110-2-1302 Civil Works Cost Engineering, dated Sept. 15, 2008.

- Engineer Technical Letter (ETL) 1110-2-573 Construction Cost Estimating Guide for Civil Works, dated Sept. 30, 2008.

3.2 USACE Risk Analysis Process

A risk analysis is performed to determine the probability of various cost and schedule variances that could affect the total project cost. The analyses of the cost risk factors associated with the project will determine the required contingency needed in the cost estimate to achieve any desired level of cost confidence. A similar analysis is also used to determine the probability of various project schedule duration impacts and then quantify the required schedule contingency needed in the schedule to achieve any desired level of schedule confidence. Together the contingency for both cost and schedule will provide a total project cost and schedule at the desired confidence level.

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. The software determines contingency amounts based on specific 'confidence levels'. These confidence levels express the probability that the corresponding contingency amount will cover the cost of the project being studied.

In general, the amount of contingency included in project control plans depends 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 that should be applied in the project control plans. This risk of overrun is expressed by Crystal Ball in a probabilistic context using confidence levels. The Cost Engineering Dx guidance for cost and schedule risk analysis focuses on risk and opportunity potential, all project features, internal and external risks to the project. The Cost Engineering Dx recommends budget presentation with a contingency value at the eighty-percent level of confidence (80%) for successful project execution within the established budget. This 80% confidence level is the standard normally provided to Congress by USACE and other Government agencies.

4.0 METHODOLOGY / PROCESS

A risk analysis begins with the identification of risk factors for the restoration. The risk identification process includes the major PDT members knowledgeable with the potential impacts. The risks are then compared for commonalities with other risk factors and a preliminary risk register is developed for risk level assignment. Following risk level evaluation and assignment, those risk factor found to have 'moderate' or 'high' impact risks are carried forward to the final risk register and quantified. The final risk register serves as the risk models used within the Crystal Ball software. These primary steps of the risk analysis process, in functional terms, are described in the following subsections.

4.1 IDENTIFY POTENTIAL RISK FACTORS

The risk analysis process began with a brainstorming session to identify any and all potential risk factors associated with the project. These potential risks were then evaluated to determine if correlations existed between any of the potential risk factors. Risk factors that were determined to have correlations were analyzed to determine the nature of the correlation. If strong correlations existed then the factors were combined into a single risk factor. If correlations were determined wherein the risk factors had similarities but contained inherent differences, the factors were revised and/or additional risk factors were added such that all risks could be evaluated individually.

The risks developed and refined during the brainstorming sessions were transferred into a risk register template in Microsoft Excel as the Initial Risk Register (ATTACHMENT A).

4.2 REFINE RISK REGISTER AND ASSIGN RISK LEVELS

The initial risk register was structured such that elements of risk were assigned under a topic and feature code and given a risk factor number allowing traceability throughout the process. Similar to the identification and assessment process, risk factor quantification involved the evaluation of the impact of the risk on the project. The risk factors were assigned a likelihood of occurrence and a level of impact the risk would have on the project cost or schedule. Table 1 provides a listing of the topics and feature codes evaluated in this risk assessment.

Table 1. Topics and Work Breakdown Structure Analyzed

PPM	Project and Program Management
01	Lands and Damages
06	Fish & Wildlife (Adaptive Management Plan)
10	Breakwaters & Seawalls
17	Beach Replenishment
30	Planning, Engineering & Design
31	Construction Management
PR	Programmatic Risks

4.3 DEVELOP FINAL RISK REGISTER AND QUANTIFY RISK FACTORS

Those risk factors determined to have a 'moderate' or 'high' impact on the project cost or schedule were carried forward to the final risk register and quantified.

The quantification process involved collaboration between the ATR review lead, District cost engineers, and the A/E cost estimators. This process used an iterative approach to estimate the following elements of each risk factor:

- Maximum possible value for the risk factor (high value, worst-case)
- Minimum possible value for the risk factor (low value, best-case)
- Most likely value (the original estimate value, if applicable)
- Nature of the probability density function used to approximate risk factor uncertainty
- Correlations between risk factors
- Affected cost and/or schedule elements

Information was extracted from the cost estimates and placed into the final cost risk register for cost risk analysis purposes (Attachment A). For the schedule risk analysis, the durations for each risk (if applicable) were placed into a final schedule risk register (Attachment A).

4.3.1 Contingency Risk Factors

The following are those elements analyzed in the cost and schedule risk models to determine the appropriate contingencies.

4.3.1.1 Beach/Dune and Marsh Fill Design Quantities (Cost & Schedule)

The island design was developed utilizing survey data collected in 2006 as part of the Louisiana Barrier Island Comprehensive Monitoring Program (UNO and USGS, 2009). Through the use of shoreline erosion and landloss rates in the above referenced program, the fill volumes required in 2012 for beach/dune and marsh were calculated. A risk variance of +/-10% of the required volume was used to evaluate the risk associated with a decrease or increase in the erosional effects experienced by the island during this six year period in addition to a storm event proceeding or during construction. The variances in beach/dune and marsh required volumes were analyzed as separate risk elements so as to assess the risk if the beach/dune and marsh fill template experience differing erosional influences.

4.3.1.2 Geotechnical Issues with the Beach/Dune and Marsh Fill Borrow Areas (Cost and Schedule)

The sediment characteristics of the proposed borrow areas for beach/dune and marsh construction were analyzed from data collected within these borrow sources as part of designs for other restoration projects. Projected dredge-to-fill ratios were established and used in the production estimates for the dredge during construction of the beach/dune and marsh fill templates. To quantify variances induced by differing sediment characteristics that could be experienced within the borrow areas proposed for beach/dune fill and the marsh fill, differing ratios better than and worse than the most likely dredge-to-fill were evaluated for their affect on the construction cost. Sediment characteristics are one of three driving forces in determining production rates for the dredging equipment.

4.3.1.3 Sponsor's Ability to Fund Its Share (Schedule)

A delay of eighteen months in the procurement of funds to begin construction of the project was evaluated. The low risk was assumed to be the same as the most likely schedule for construction. The high risk was analyzed as a delay for the beginning of construction.

4.3.1.4 Fuel Prices (Cost)

Overall affects of fuel prices on construction cost were analyzed. The most likely fuel price was derived from an average of fuel prices for 2009. A lower risk assumes the price of fuel would fall by as much as 25% from the 2009 average. A higher risk assumes that a volatile market could increase fuel prices by as much as 60% above the 2009 average price.

4.3.1.5 Severe Weather Downtime (Cost & Schedule)

The effects of dredging material in the open Gulf of Mexico on the dredge's effective operational hours per day were evaluated. A dredge may experience higher average operational time per day during periods of favorable weather and conversely experience lower than average operational time during periods of increases sea state such as during winter months. The most likely, worst case, and best case operational time per day were established by review of USACE prior dredging projects. Operational time of the dredging equipment is one of three driving forces in determining production rates for the dredging equipment.

4.3.1.6 Delays due to Design Modifications (Schedule)

Following pre-construction surveys of the fill templates, design modification may be required to adjust the fill templates to maximize effectiveness of the island restoration. Through prior restoration project experience of the design team, a two month delay in beginning construction was considered as the high risk variance for the project schedule.

4.3.1.7 Long Pipeline to Island for Beach/Dune Fill (Cost & Schedule)

In development of the dredging production rates, it was determined that it was feasible to construct the beach/dune fill template using as few as two boosters from the borrow area to the fill template. The most likely number of boosters the contractor would use is three to maintain higher production rates. The number of booster pumps utilized in the delivery of sediment to the fill template is one of three driving forces in determining the production rates for the dredging equipment. Construction cost and schedule variances were calculated to evaluate the affects on project cost and schedule if the contractor chose to utilize only two booster pumps during the construction of the beach/dune fill template.

4.3.1.8 Bidder's Risk in a Volatile Market (Cost)

The affects on construction cost of based on the risk assumed by the contractor were analyzed. These risks are those carried by the contractors that are not analyzed in other risk elements of this model. Those risks analyzed elsewhere include fuel prices, pipeline steel prices, weather delays, dredge acquisition, and additional mobilizations due to hurricanes. Examples of volatile market risk include, but are not limited to, other projects out for bid requiring the contractor's resources, labor force prices, and construction equipment availability. A low risk assumes the contractor is eager for the contract and would bid 10% less than the most likely and conversely a high risk indicates the contractor may be over extending his resources and submits a bid 25% higher than the most likely construction cost.

4.3.1.9 Pipeline Steel Prices (Cost)

The risk associated with the changing price per pound of steel was analyzed to determine it's affect on the cost of the sediment delivery pipeline. Utilizing pricing from prior USACE projects, the assumed current cost per pound for steel was set a $0.60, the low price at $0.45, and the high price at $1.50. These prices were used in the determination of unit cost variances for beach/dune and marsh fill.

4.3.1.10 Dredge Acquisition (Schedule)

The risk associated with the availability of dredges for restoration construction at the time of notice to proceed for the contractor was considered. The delay to the construction schedule, while awaiting a dredge to become available from another project, was determined to be 6 months.

4.3.1.11 Hurricane Demobilization/Re-mobilization (Cost & Schedule)

For the possibility of a hurricane affecting the project during construction, an additional demobilization/re-mobilization of the crew, equipment, and dredge to safe harbor was evaluated.

4.4 RUN CRYSTAL BALL SIMULATIONS AND ANALYZE CONTINGENCIES

Once the risk factors were refined into the final risk resisters for cost and schedule, the final quantitative impacts of risk factors served as the risk model and were analyzed using a combination of professional judgment, empirical data and analytical techniques. The software uses the most likely, low, and high values for various risks. The most likely value is usually the value used in the cost estimate. The low and high values, or best-case and worst-case values, are quantified based off a number of factors, including, but not limited to, the cost estimate. The software uses these values in conjunction with the associated probability distribution assigned to each risk to run its Monte Carlo simulations. Once the software has finished its simulation the total cost of the project with contingency is forecast for specific confidence levels. The resulting 80% confidence level contingency amount is the difference between the 80% cost forecast and the base cost estimate. For schedule contingency analysis, the contingency was calculated as the difference between the 80% level duration forecast and the base schedule duration, shown in months. These new durations suggested by the 80% confidence level were then incorporated into the escalation calculation, i.e., the escalation of the baseline estimate of cost in the Total Project Cost Summary (TPCS) of the initial restoration of the NER Plan.

The forecasts for cost and/or schedule risk can then be analyzed to determine the recommended level of contingency for the project. As stated earlier, the contingencies suggested by the higher confidence levels will account for more risk in the project; conversely, the amounts suggested by the lower confidence levels could possible leave the project without sufficient funding if some events do not go as planned.

5.0 KEY ASSUMPTIONS

Key assumptions are those that are most likely to affect the determinations and/or estimates of risk presented in the risk analysis. The key assumptions are important to help ensure that project leadership and other decision makers understand the steps, logic, limitations, and decisions made in the risk analysis, as well as any resultant limitations on the use of outcomes and results. For this project, the assumptions include:

1. Level of Design: The cost comparisons and risk analyses performed and reflected within this report are based upon design scope and estimates that are considered to be well developed and designed.
2. Design Scope: The prescribed scope satisfies the requirements of this acquisition.
3. Operation and Maintenance: Operation and maintenance activities were not included in the cost estimate or schedules, because none were planned for the selected alternative.
4. Contract Acquisition Strategy: Consistent with cost estimate and schedule assumptions, it is assumed that the contract acquisition strategy is firm fixed price.
5. Confidence Levels: The Wall Walla Cost Engineering Dx guidance generally focuses on the eighty-percent level of confidence (80%) for cost contingency calculation. For this risk analysis, the eighty-percent level of confidence (80%) was used. It should be noted that the use of 80% as a decision criteria is a moderately risk averse approach, generally resulting in higher cost contingencies. However, the 80% level of confidence also assumes a small degree of risk that the recommended contingencies may be inadequate to completely capture actual project costs.

6.0 RISK ANALYSIS 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 COST RISK ANALYSIS CONTINGENCY RESULTS

The construction cost contingencies calculated for the 80% confidence level and rounded to the nearest thousand are shown in Table 2 for Contract No. 1 and Table 3 for Contract No. 2. The construction cost contingencies for the 50% and 100% confidence levels are also provided for illustrative purposes.

The MII cost estimate produced by USACE-MVN Cost Engineering and A/E cost estimators with review by the ATR review lead provide initial construction costs of $505.2 Million for the initial restoration with a price level of the estimate in the 1st quarter 2010. At the 80% confidence level, the base estimate construction cost contingency was quantified as approximately $141.7 Million, with a baseline cost of $646.9 Million.

Table 2. Initial Restoration Project Cost Estimate with Contingencies Summary for NER Plan Contract No. 1 (Whiskey, Trinity, and Raccoon Islands)

Contingency Level	Mii Cost Estimate ($1,000)	Contingency Percentage	Total Contingency ($1,000) [1]	Baseline Cost Estimate ($1,000) [2]
50% Confidence Level - Initial Restoration Project Cost	$260,137	17.9%	$46,650	$306,787
80% Confidence Level - Initial Restoration Project Cost	$260,137	27.4%	$71,156	$331,293
100% Confidence Level - Initial Restoration Project Cost	$260,137	60.3%	$156,892	$417,029

Notes: 1. Adaptive Management Plan cost includes prior escalation & contingency and is subjected to the Total Contingency and Escalation.
2. Costs taken from Risk Analysis Forecast

Table 3. Initial Restoration Project Cost Estimate with Contingencies Summary for NER Plan Contract No. 2 (Timbalier Island)

Contingency Level	Mii Cost Estimate ($1,000)	Contingency Percentage	Total Contingency ($1,000) [1]	Baseline Cost Estimate ($1,000) [2]
50% Confidence Level - Initial Restoration Project Cost	$245,063	19.3%	$47,193	$292,256
80% Confidence Level - Initial Restoration Project Cost	$245,063	29.4%	$71,914	$316,977
100% Confidence Level - Initial Restoration Project Cost	$245,063	66.0%	$161,831	$406,894

Notes: 1. Adaptive Management Plan cost includes prior escalation & contingency and is subjected to the Total Contingency and Escalation.
2. Costs taken from Risk Analysis Forecast

6.2 SCHEDULE RISK ANALYSIS CONTINGENCY RESULTS

The original estimate of PED and construction duration for the initial restoration in Contract No.1 is 64.5 months and Contract No. 2 is 55.8 months. At the 80% confidence level, the projected duration for construction for Contract No. 1 is 93.5 months – an increase of 45%. Similarly, for Contract No. 2 the 80% confidence level of the projected duration of construction is 82.9 months - an increase of 48%. The schedule contingency was calculated by applying the moderate and high level schedule risks identified in the risk register for each option to the durations of critical path and near critical path tasks.

Table 4. Initial Restoration Project Construction Schedule with Contingencies Summary for NER Plan Contract No. 1

Risk Analysis Forecast	Forecast Schedule	Total Contingency	Crystal Ball Forecast Schedule
50% Confidence Level - Initial Restoration Project Duration	64.5 months	35%	86.9 months
80% Confidence Level- Initial Restoration Project Duration	64.5 months	45%	93.5 months
100% Confidence Level - Initial Restoration Project Duration	64.5 months	75%	113.1 months

Table 5. Initial Restoration Project Construction Schedule with Contingencies Summary for NER Plan Contract No. 2

Risk Analysis Forecast	Forecast Schedule	Total Contingency	Crystal Ball Forecast Schedule
50% Confidence Level - Initial Restoration Project Duration	55.8 months	37%	76.6 months
80% Confidence Level- Initial Restoration Project Duration	55.8 months	48%	82.9 months
100% Confidence Level - Initial Restoration Project Duration	55.8 months	84%	102.5 months

6.3 Sensitivity Analysis Results

Sensitivity analysis 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 or opportunity contributing to variability of cost outcomes during the Monte Carlo simulations.

The risks or opportunities that are considered as key drivers are ranked in the order of significance to the total project costs variances. Risks are shown with a positive sign to reflect the potential to increase project cost. Opportunities that have a potential to reduce project cost and are shown with a negative sign. A longer bar in the sensitivity analysis chart indicates the risk has a greater potential impact to total project cost.

Figures 1 and 2 presents the sensitivity analyses for cost growth for those risks identified in the risk register as having a moderate to high level of impact. Similarly, Figures 3 and 4 present the sensitivity analyses for schedule growth risk.

The key cost risk drivers identified through sensitivity analysis for the initial restoration component of the NER Plan Contract No. 1 (Whiskey, Trinity, and Raccoon Islands) are Internal Risks PED-11 (Geotechnical Issues Beach/Dune - Ship Shoal Borrow Area) in additional to External Risks PR-2 (Fuel Prices), PR-3 (Severe Weather/Downtime), PR-5 (Long Pipeline to Island for Beach Fill), PR-7 (Bidder’s Risk in Volatile Market), and PR-8 (Pipeline Steel Prices) which together contribute 99.3% of the statistical cost variance.

The key cost risk drivers identified through sensitivity analysis for the initial restoration component of the NER Plan Contract No. 2 (Timbalier Island) are Internal Risks PED-11 (Geotechnical Issues Beach/Dune - South Pelto Borrow Area) in additional to External Risks PR-2 (Fuel Prices), PR-3 (Severe Weather/Downtime), PR-5 (Long Pipeline to Island for Beach Fill), PR-7 (Bidder’s Risk in Volatile Market), and PR-8 (Pipeline Steel Prices) which together contribute 99.3% of the statistical cost variance.

The key schedule risk drivers identified through sensitivity analysis for the initial restoration component of the NER Plan are External Risks PR-1 (Sponsor’s Ability to Fund its Share), PR-3 (Severe Weather/Downtime), PR-5 (Long Pipeline to Island for Beach Fill), PR-4 (Delays due to Design Modifications), and PR-10 (Dredge Acquisition), which together contribute 96.4% and 97.4% of the statistical schedule variance for Contracts No. 1 and No 2, respectively.

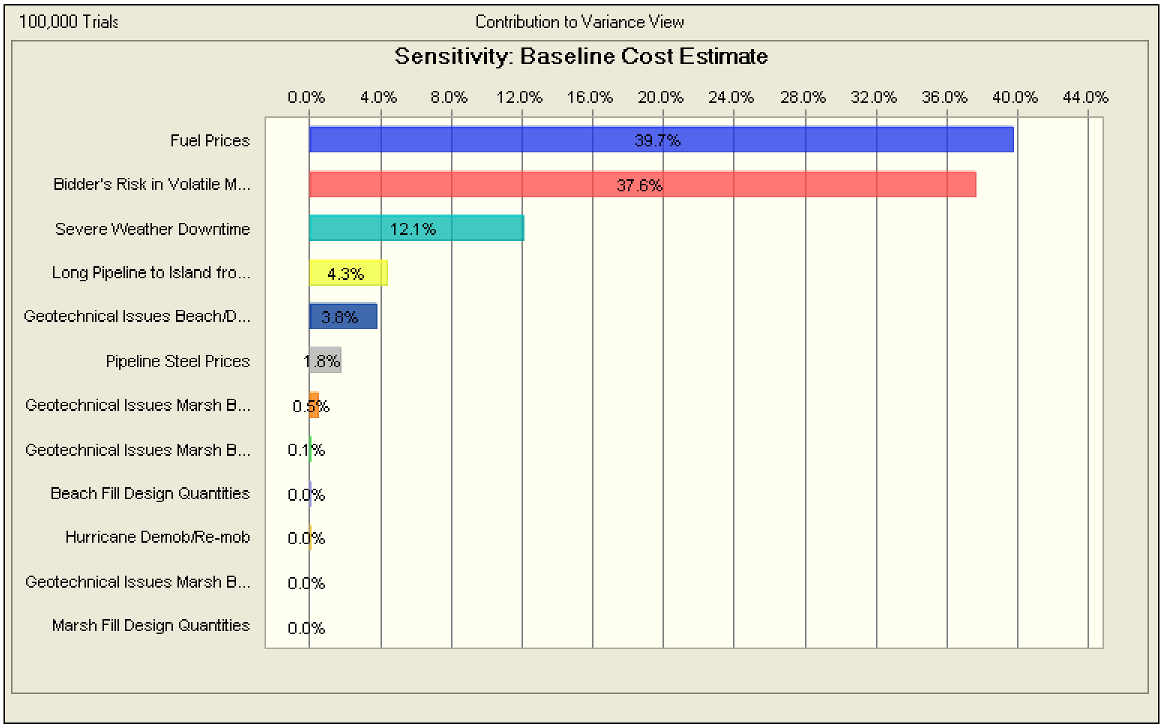

Figure 1. Cost Sensitivity Analysis - NER Plan Contract No. 1 (Whiskey, Trinity, Raccoon Islands)

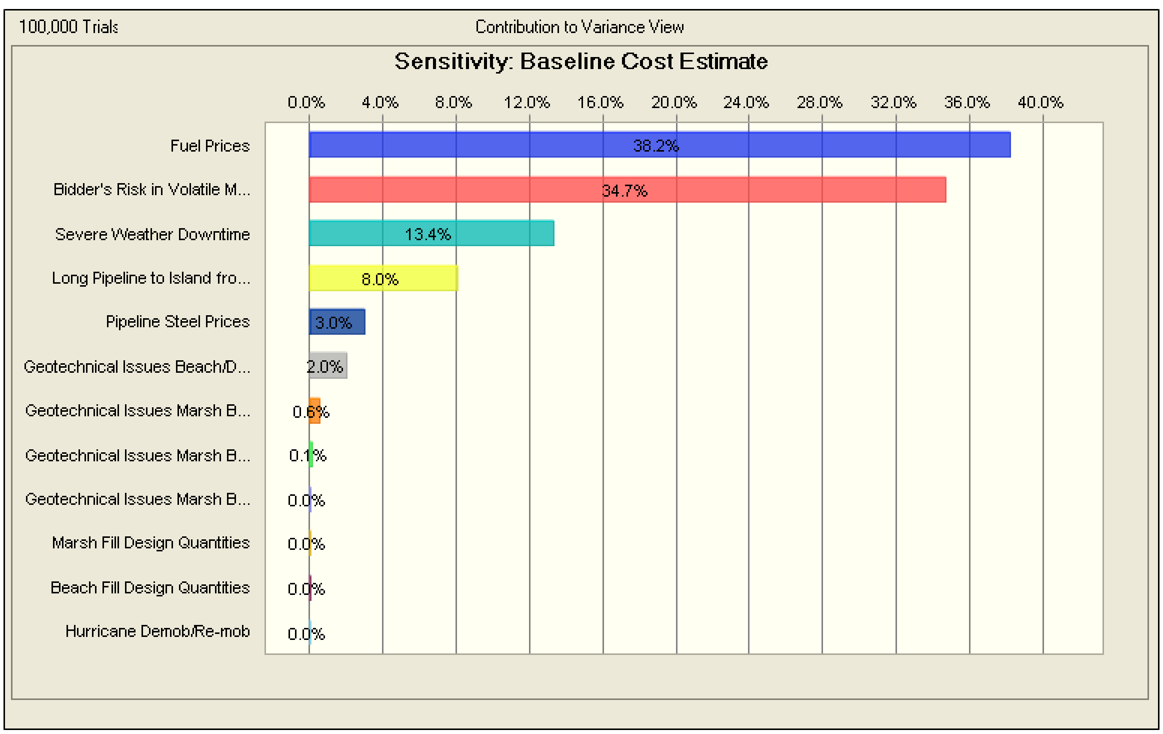

Figure 2. Cost Sensitivity Analysis - NER Plan Contract No. 2 (Timbalier Island)

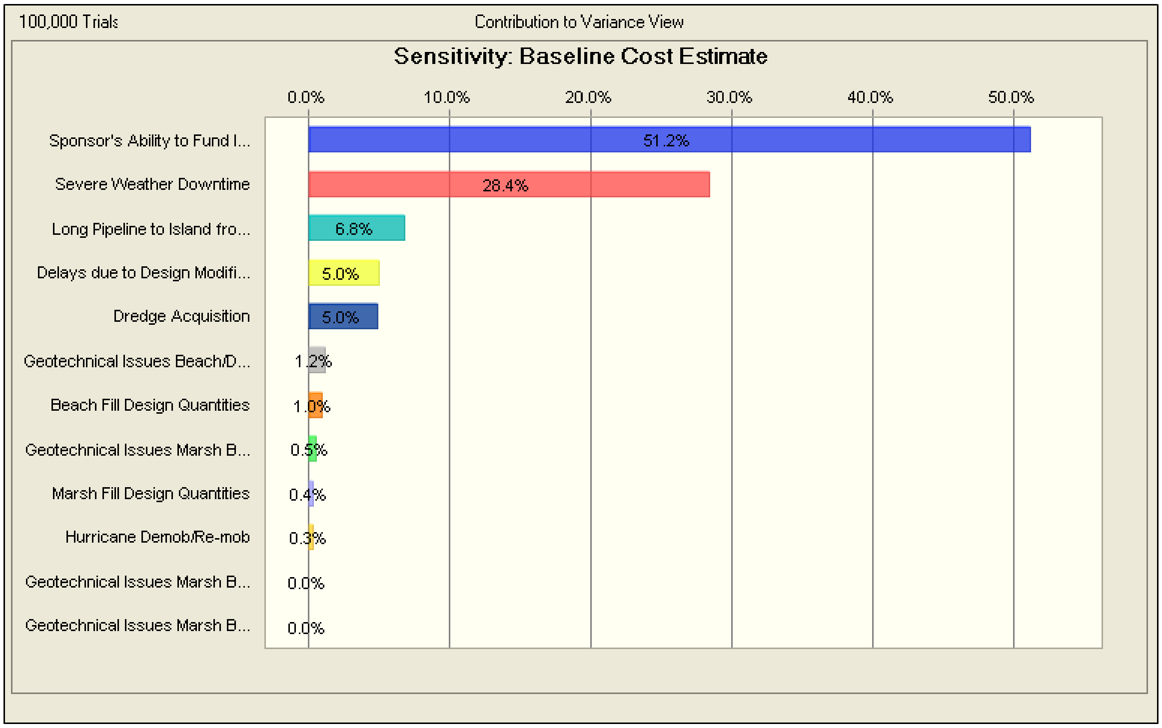

Figure 3. Schedule Sensitivity Analysis - NER Plan Contract No. 1 (Whiskey, Trinity, Raccoon Islands)

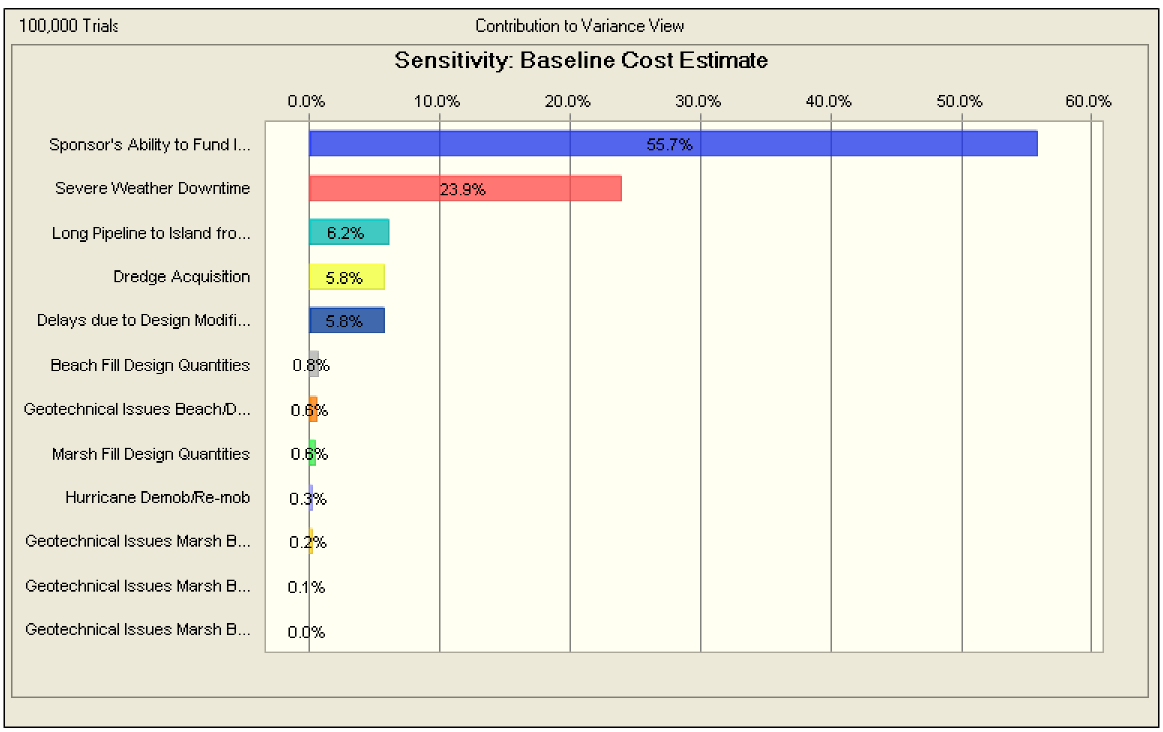

Figure 4. Schedule Sensitivity Analysis - NER Plan Contract No. 2 (Timbalier Island)

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 Planning, Engineering & Design phase, and proactive monitoring and control of risk identified in this study.

7. 0 MAJOR FINDINGS / OBSERVATIONS / RECOMMENDATION

This section provides a summary of the significant risk analysis results that were 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 total construction cost and schedule comparison summaries from Crystal Ball are provided in Tables 5 and 6, respectively. Additional major findings and observations of the risk analysis are listed below.

1. Base cost contingency recommended for the initial restoration of the NER Plan in Contract No. 1 is approximately $69.7 Million, for a total Contract No. 1 cost of approximately $329.8 Million. Base cost contingency recommended for the initial restoration of the NER Plan in Contract No. 2 is approximately $72.1 Million, for a total Contract No. 2 cost of approximately $317.1 Million. The combined total cost for the NER Plan initial restoration is $646.9 Million These figures are derived from the TPCS with contingencies calculated by Crystal Ball (Tables 6 and 7). It should be noted that the contingency cost and base cost calculated by the TPCS are slightly lower than that of Crystal Ball because the cost contingency and escalation are inclusive in the program cost provided by the Adaptive Management Plan development team and therefore not applied in the TPCS.

2. Schedule duration contingency recommended for the initial restoration of the NER Plan in Contract No. 1 is 29 months, for a total duration of 93.5 months for this contract. Schedule duration contingency recommended for the initial restoration of the NER Plan in Contract No. 2 is 27.1 months, for a total duration of 82.9 months for this contract. The monthly duration contingencies are

reflective of the 80% confidence level values calculated by Crystal Ball (Table 8 and 9).

3. As shown in Figures 1 through 4, the cost risk and schedule risk for initial restoration of the NER Plan are mostly dependent on two risk factors each.

4. Operation and maintenance activities were not included in the presented cost estimate or schedules. Therefore, a full lifecycle risk analysis could not be performed. Risk analysis results or conclusions could be significantly different if operation and maintenance activities were included.

Table 6. Baseline Construction Cost Comparison Summary for the Initial Restoration of the NER Plan Contract No. 1

Forecast: TOTAL PROJECT COST	Percentile	Forecast values
	0%	$214,615,435
	5%	$263,758,287
	10%	$272,321,941
	15%	$278,579,778
	20%	$283,578,321
	25%	$287,986,952
	30%	$292,113,720
	35%	$295,970,432
	40%	$299,616,675
	45%	$303,187,426
	50%	$306,787,355
	55%	$310,347,522
	60%	$314,014,886
	65%	$317,876,733
	70%	$322,008,589
	75%	$326,376,077
	80%	$331,293,014
	85%	$337,070,819
	90%	$344,246,778
	95%	$354,951,791
	100%	$417,028,799
	Minimum	$214,615,435
	Maximum	$417,028,799
	80% Confidence Level:	$331,293,014
	Original Project Cost:	$260,137,358
	Total Contingency Based on 80%	**27.4%**

Confidence:

Table 7. Baseline Construction Cost Comparison Summary for the Initial Restoration of the NER Plan Contract No. 2

Forecast: TOTAL PROJECT COST	Percentile	Forecast values
	0%	$190,536,325
	5%	$248,620,024
	10%	$257,548,301
	15%	$263,775,469
	20%	$268,883,315
	25%	$273,386,225
	30%	$277,368,117
	35%	$281,291,544
	40%	$285,029,931
	45%	$288,595,226
	50%	$292,255,790
	55%	$295,876,247
	60%	$299,641,907
	65%	$303,483,364
	70%	$307,543,774
	75%	$312,038,011
	80%	$316,976,563
	85%	$322,828,115
	90%	$330,114,325
	95%	$340,616,898
	100%	$406,894,479
	Minimum	$190,536,325
	Maximum	$406,894,479
	80% Confidence Level:	$316,976,563
	Original Project Cost:	$245,062,710
	Total Contingency Based on 80% Confidence:	**29.4%**

Table 8. Baseline Construction Schedule Comparison Summary for the Initial Restoration of the NER Plan Contract No. 1

Forecast: TOTAL PROJECT SCHEDULE	Percentile	Forecast values
	0%	61.21
	5%	74.81
	10%	77.24
	15%	78.99
	20%	80.43
	25%	81.71
	30%	82.87
	35%	83.93
	40%	84.95
	45%	85.96
	50%	86.92
	55%	87.91
	60%	88.92
	65%	89.94
	70%	91.04
	75%	92.21
	80%	93.50
	85%	94.92
	90%	96.72
	95%	99.29
	100%	113.14
	Minimum	61.21
	Maximum	113.14
	80% Confidence Level:	93.50
	Original Project Cost:	64.51
	Total Contingency Based on 80% Confidence:	**44.9%**

Table 9. Baseline Construction Schedule Comparison Summary for the Initial Restoration of the NER Plan Contract No. 2

Forecast: TOTAL PROJECT SCHEDULE	Percentile	Forecast values
	0%	52.54
	5%	64.88
	10%	67.19
	15%	68.85
	20%	70.23
	25%	71.44
	30%	72.54
	35%	73.62
	40%	74.61
	45%	75.60
	50%	76.58
	55%	77.55
	60%	78.52
	65%	79.54
	70%	80.57
	75%	81.66
	80%	82.85
	85%	84.26
	90%	85.92
	95%	88.28
	100%	102.53
	Minimum	52.54
	Maximum	102.53
	80% Confidence Level:	82.85
	Original Project Cost:	55.82
	Total Contingency Based on 80% Confidence:	**48.4%**

Through utilization of the TPCS, the base cost estimate for the initial restoration from the MII escalated to the project year of the 1st quarter 2012 equals approximately $517.6 Million. Adding the cost and schedule influence contingencies provides a project cost of approximately $661.3 Million. A breakdown of the program year cost by work feature is presented in Table 10.

Table 10. NER Plan Cost Summary - Program Year (2012) Initial Restoration Project Cost

LCA TBBSR NER Plan Total Project Costs		Program Year Cost[2]	Contingency[1]	Program Year Total Cost[2]
01	Lands & Damages	$545,489	$163,647	$709,136
06	Fish & Wildlife (Adaptive Management Plan)	$5,821,200	Included	$5,821,200
10	Breakwaters & Seawalls	$1,833,379	$500,239	$2,332,618
17	Beach Replenishment	$462,893,681	$129,859,981	$592,753,662
30	Planning, Engineering & Design	$23,234,414	$6,594,157	$29,828,571
31	Construction Management	$23,236,463	$6,594,739	$29,831,202
	Total Project Costs	$517,564,626	$143,712,763	$661,276,389

Notes: 1. Adaptive Management Plan cost includes prior escalation & contingency and is subjected to the Total Contingency and Escalation.
2. Costs taken from TPCS

Expanding on the program year cost estimate, escalation to midpoint of work features can be calculated. The results provide a fully funded project cost of approximately $689.0 Million. A breakdown of the fully funded project cast is presented in Table 11.

Table 11. NER Plan Cost Summary - Fully Funded Initial Restoration Project Cost

LCA TBBSR NER Plan Total Project Costs		Program Year Cost[2]	All Contingencies & Escalations[1]	Fully Funded Total[2]
01	Lands & Damages	$545,489	$169,355	$714,844
06	Fish & Wildlife (Adaptive Management Plan)	$5,821,200	Included	$5,821,200
10	Breakwaters & Seawalls	$1,833,379	$661,017	$2,494,396
17	Beach Replenishment	$462,893,681	$155,985,226	$618,878,907
30	Planning, Engineering & Design	$23,234,414	$6,845,778	$30,080,192
31	Construction Management	$23,236,463	$7,804,553	$31,041,016
	Total Project Costs	$517,564,626	$171,465,929	$689,030,555

Notes: 1. Adaptive Management Plan cost includes prior escalation & contingency and is subjected to the Total Contingency and Escalation.
2. Costs taken from TPCS

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.

This section provides a list of recommendations for continued management of the risks identified and analyzed in this study. (Note: this list is not all-inclusive)

1. Cost Estimate Quality: The cost estimate was developed for the restoration of Whiskey Island based on feasibility level surveys and designs. Risks associated with the information utilized in the designs have been analyzed within this risk assessment. It is recommended that the project leadership, restoration design team, and project cost estimators work closely in re-evaluating the project cost elements and associated cost risks during the Planning, Engineering, & Design phase of the project as more detailed design information becomes available.

2. Schedule Quality: As with the project costs, the schedule was developed based on feasibility level information; the assumption of initiation date of Planning, Engineering, & Design; and the appropriation construction funding date anticipated by the WRDA legislation. It is recommended that project leadership use the results of the schedule risk analysis in re-evaluating the schedule risk as the project progresses forward and more definitive timeline of events becomes available.

3. Risk Management: The outputs created during the risk analysis effort are recommended to be used 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. As an example, recommended uses of the risk register 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, leadership, and 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 risk analysis feedback and project control input.

- Identifying risk transfer, elimination or mitigation actions required for implementation of risk management plans.

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

8. 0 REFERENCES

University of New Orleans and United States Geological Survey (UNO and USGS). 2009. Louisiana Barrier Island Comprehensive Monitoring Program (BICM) Volume 3: Bathymetry and Historical Seafloor Change 1869-2007. Part 1: South-Central Louisiana and Northern Chandeleur Islands, Bathymetry Methods and Uncertainty Analysis. Final Report. January 2009.

ATTACHMENT A

Detailed Risk Registers

LCA TBBSR - NER Plan PDT Preliminary Risk Register

Risk Level

Likelihood of Occurrence					
Very Likely	Low	Moderate	High	High	High
Likely	Low	Moderate	High	High	High
Unlikely	Low	Low	Moderate	Moderate	High
Very Unlikely	Low	Low	Low	Low	High
	Negligible	Marginal	Significant	Critical	Crisis

Impact or Consequence of Occurrence

Risk No.	Risk/Opportunity Event	Discussion and Concerns	Project Cost: Likelihood*	Project Cost: Impact*	Project Cost: Risk Level*	Project Cost: Rough Order Impact ($)	Project Schedule: Likelihood*	Project Schedule: Impact*	Project Schedule: Risk Level*	Project Schedule: Rough Order Impact (mo)	Variance Distribution	Correlation to Other(s)	Notes
Contract Risks (Internal Risk Items are those that are generated, caused, or controlled within the PDT's sphere of influence.)													
Project and Program Management													
PPM-1	Available and Timely Funding	Available funding from the Federal government.	Very Unlikely	Negligible	Low		Very Unlikely	Significant	Low				
PPM-2	Changes in priority	Pulling funding for this project for other immediate needs. Competition for resources.	Very Unlikely	Marginal	Low		Very Unlikely	Critical	Low				Whiskey BA 3 for marsh creation is not currently considered in any other island restorations. The TSP would utilize Ship Shoal material that was previously considered for TE-47 Whiskey West Flank project of which the TSP would replace.
PPM-3	Estimating/Scheduling Errors	Chance for oversights, errors, etc., as the schedule and scope of work ar driving the estimate and schedule quality.	Unlikely	Marginal	Low		Unlikely	Marginal	Low				
PPM-5	Functional Resources Overloaded/Shift of Staff Priorities	Lack of internal human resources to execute project due to heavy workload, overloaded staff, and shifting priorities.	Unlikely	Marginal	Low		Unlikely	Marginal	Low				
PPM-8	Contract Acquisition Risks	Decreasing competition	Unlikely	Marginal	Low		Unlikely	Negligible	Low				It is likely that it will be a FFP large business, based on historical, and small business does not have the capibility.
Feature Code 01 - Real Estate													
Feature Code 06 - Fish & Wildlife (Adaptive Management Plan & Monitoring)													
FW-1	Adaptive Management Plan & Monitoring (AMP) shortened duration	AMP may not require the full 10 years budgeted to determine ecologica success (opportunity)	Unlikely	Marginal	Low		Unlikely	Negligible	Low				A reduction in the AMP to 7 years equates to a reduction in total project cost of 2%. However due to the significance of the aquired data during this period it is unlikely that the program would be shortened.
FW-2	Survey cost escalation	Cost of field survey crews may be greater or less than budgeted. If greate than budgeted, survey coverage would have to be reduced. If less than budgeted, survey coverage could be expanded.	Likely	Negligible	Low		Likely	Negligible	Low				An increase of annual survey cost of 10% equates to 0.5% of total project cost.
Feature Code 17 - Beach Replenishment (Beach and Marsh Construction)													
Environmental & Cultural													
BR-1	MMS Survey Issues (30-m spacing)	Borrow areas in Federal Waters are under the jurisdiction of the MMS which may enforce new survey spacing requirements, infrastructure offsets etc. resulting in less available material or increased data acquisiti and permitting costs. Although 50-m surveys were already conducted, th 30-m surveys might reveal additional CRs.	Unlikely	Negligible	Low		Unlikely	Marginal	Low				
BR-2	Cultural Resources Island Specific	Raccoon, Whiskey, and Timbalier Island include high, medium, medium probability area (respectively) and will require remote sensing.	Likely	Negligible	Low		Likely	Negligible	Low				A cultural resource survey is planned and will be conducted shortly for Whiskey Island (TSP).
BR-4	Regulatory and Environmental Risks	Ship Shoal dredging impacts, reviewing agency requires higher-level review than assumed, permits take longer than expected, pressure to compress the study and permitting activities	Unlikely	Marginal	Low		Unlikely	Negligible	Low				
Construction													
BR-8	Permitted Activities	Activities such as pipeline construction, canal maintenance and construction on or near the project area that could affect project design, access, or exacerbate current land loss rates.	Unlikely	Negligible	Low		Unlikely	Negligible	Low				There are no oil and gas infrastructure or pipeline within the Whiskey Island fill templates.
BR-9	Pipeline from Borrow Area	Navigation Issues, oyster issues.	Unlikely	Negligible	Low		Unlikely	Negligible	Low				
BR-10	General Dredge Cost Estimating Assumptions	Distance between island and borrow areas, weather days, dredge mob/demob costs, plant costs	Unlikely	Marginal	Low		Unlikely	Marginal	Low				
BR-13	Risk of Restoration Activates Damaging oil and gas facilities	Risk associated with oil and gas facilities including pipelines being damaged during project activities. Spills associated with damages to pipelines	Unlikely	Marginal	Low		Unlikely	Marginal	Low				Review of USGS and MMS pipeline databases revealed that there are no known pipelines withir the borrow area or fill sites. There is one oil/gas structure to the north of the island and one pipelin leading to this structure from offshore through Whiskey Pass.
BR-14	Contractor and other Construction-related Risks	Inefficient contractor, conflicts with other contracts, site access, adequat staging areas, special equipment availability	Unlikely	Negligible	Low		Unlikely	Negligible	Low				

Feature Code 30 - Planning, Engineering & Design													
Design													
PED-1	Marsh Fill Design Quantities	Material volumes required under or over estimated due to survey coverag / quality and or storms prior to or during construction.	Likely	Marginal	Moderate		Likely	Marginal	Moderate			PR-12	
PED-2	Beach Fill Design Quantities	Material volumes required under or over estimated due to survey coverag / quality and or storms prior to or during construction.	Likely	Marginal	Moderate		Likely	Marginal	Moderate			PR-12	
PED-3	Model Selection	If models applied do not take into account or were not developed to the site-specific conditions of the Terrebonne Basin Barrier Shoreline, outpu may result in under predicting or over predicting effectiveness of project	Very Unlikely	Marginal	Low		Very Unlikely	Marginal	Low			PED-4	
PED-4	Model Input Error	If model inputs including bathymetry, topography, erosion, land change historic wave data, sediment grain size aren't representative of current conditions, modeling output could result in flawed island templates.	Unlikely	Marginal	Low		Unlikely	Marginal	Low			PED-3	
Geotechnical & Survey													
PED-11	Geotechnical Issues Beach/Dune Borrow Area - South Pelto Borrow Area	Geotechnical conditions in the borrow areas and restoration areas may differ from data reviewed during feasibility stage. Dredge volumes to mee required fill volumes could differ.	Unlikely	Significant	Moderate		Unlikely	Significant	Moderate				
PED-12	Geotechnical Issues Marsh Borrow Area South Pelto Borrow Area	Geotechnical conditions in the borrow areas and restoration areas may differ from data reviewed during feasibility stage. Dredge volumes to mee required fill volumes could differ.	Unlikely	Significant	Moderate		Unlikely	Significant	Moderate				
PED-13	Geotechnical Issues Marsh Borrow Area Whiskey 3A Borrow Area Upper	Geotechnical conditions in the borrow areas and restoration areas may differ from data reviewed during feasibility stage. Dredge volumes to mee required fill volumes could differ.	Unlikely	Negligible	Low		Unlikely	Negligible	Low				
PED-14	Geotechnical Issues Marsh Borrow Area Whiskey 3A Borrow Area Lower	Geotechnical conditions in the borrow areas and restoration areas may differ from data reviewed during feasibility stage. Dredge volumes to mee required fill volumes could differ.	Unlikely	Significant	Moderate		Unlikely	Significant	Moderate				
PED-15	Geotechnical Issues Marsh Borrow Area New Cut Borrow Area	Geotechnical conditions in the borrow areas and restoration areas may differ from data reviewed during feasibility stage. Dredge volumes to mee required fill volumes could differ.	Unlikely	Significant	Moderate		Unlikely	Significant	Moderate				
PED-16	Geophysical Data: All Borrow Areas	Borrow area volume calculations are based on existing surveys. Poor data quality could result in volume shortages.	Unlikely	Marginal	Low		Unlikely	Marginal	Low				
PED-18	Petroleum Infrastructure	Infrastructure could be installed within the borrow areas before construction reducing the available material volumes	Unlikely	Marginal	Low		Unlikely	Marginal	Low			BR-8	
Feature Code 31 - Construction Management													
CM-1													
Programmatic Risks (External Risk Items are those that are generated, caused, or controlled exclusively outside the PDT's sphere of influence.)													
PR-1	Sponsor's Ability to Fund Its Share	Procuring funds from the non-federal sponser has been known to take long periods of time in the past.	Likely	Negligible	Low		Likely	Significant	High				
PR-2	Fuel Prices	Fluctuations in fuel costs could have an impact on the project cost.	Likely	Significant	High		Likely	Negligible	Low				
PR-3	Severe Weather Downtime	Risks associated with dredging operations in open Gulf especially during winter season and during a severe tropical storm season. Effects on dredge operational hours/day.	Likely	Significant	High		Likely	Significant	High				
PR-4	Delays due to Design Modifications	Modifications to design could be required at time of construction.	Likely	Negligible	Low		Likely	Marginal	Moderate				
PR-5	Long Pipeline to Island from South Pelto	Risk in Productivity/efficiency with long pipeline and required number boosters.	Likely	Significant	High		Likely	Significant	High				
PR-7	Bidder's Risk in Volatile Market	Risk associated with bidders responding to volatile markets with higher b prices.	Likely	Significant	High		Likely	Negligible	Low				
PR-8	Pipeline Steel Prices	Risks associated with changing steel prices increasing the cost of pipe.	Likely	Significant	High		Likely	Negligible	Low				
PR-10	Dredge Acquisition	Dredges for the project may not be available at all times.	Unlikely	Marginal	Low		Unlikely	Significant	Moderate				
PR-11	Oil and Gas facilities damage (storms, accidental releases) resulting in damage to barrier resources	Adverse impacts to existing resources (baseline conditions) resulting fror accidental releases, ongoing activities.	Unlikely	Marginal	Low		Unlikely	Marginal	Low				Review of USGS and MMS pipeline databases revealed that there are no known pipelines withir the borrow area or fill sites. There is one oil/gas structure to the north of the island and one pipelin leading to this structure from offshore through Whiskey Pass.
PR-13	Shore equipment mechanical issues	Dozers etc. may experience mechanical issues causing downtime an reducing productivity.	Unlikely	Negligible	Low		Unlikely	Negligible	Low				
PR-14	Hurricane Demob/Re-mob	Dredge and Construction equipment may need to be moved off of an island during construction due to a hurricane event	Likely	Marginal	Moderate		Likely	Marginal	Moderate				

*Likelihood, Impact, and Risk Level to be verified through market research and analysis (conducted by cost engineer).

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

LCA TBBSR - NER Plan Contract #1 (Whiskey Is., Trinity Is., Raccoon Is.) Cost Risk Analysis Simulation

Risk Level

Likelihood of Occurrence	Negligible	Marginal	Significant	Critical	Crisis
Very Likely	Low	Moderate	High	High	High
Likely	Low	Moderate	High	High	High
Unlikely	Low	Low	Moderate	Moderate	High
Very Unlikely	Low	Low	Low	Low	High

Impact or Consequence of Occurrence

Risk No.	Risk Event	Issues	Likelihood	Impact	Cost Risk Level	Distribution	Crystal Ball Simulation Low	Crystal Ball Simulation Likely	Crystal Ball Simulation High
Internal Risks (Internal Risk Items are those that are generated, caused, or controlled within the PDT's sphere of influence.)									
PED-1	Marsh Fill Design Quantities	Material volumes required under or over estimated due to survey coverage / quality and or storms prior to construction.	Likely	Marginal	Moderate	Triangular	-$5,705,251	$0	$5,637,530
PED-2	Beach Fill Design Quantities	Material volumes required under or over estimated due to survey coverage / quality and or storms prior to construction.	Likely	Marginal	Moderate	Triangular	-$13,506,679	$0	$16,055,143
PED-11	Geotechnical Issues Beach/Dune Borrow Area - Ship Shoal Borrow Area	Geotechnical conditions in the borrow areas and restoration areas may differ from data reviewed during feasibility stage. Dredge volumes to meet required fill volumes could differ.	Unlikely	Significant	Moderate	Triangular	-$3,649,948	$0	$21,040,482
PED-12	Geotechnical Issues Marsh Borrow Area - Ship Shoal Borrow Area	Geotechnical conditions in the borrow areas and restoration areas may differ from data reviewed during feasibility stage. Dredge volumes to meet required fill volumes could differ.	Unlikely	Significant	Moderate	Triangular	-$535,093	$0	$3,139,480
PED-13	Geotechnical Issues Marsh Borrow Area - Whiskey 3A Borrow Area Upper	Geotechnical conditions in the borrow areas and restoration areas may differ from data reviewed during feasibility stage. Dredge volumes to meet required fill volumes could differ.	Unlikely	Significant	Moderate	Triangular	-$3,711,136	$0	$7,282,898
PED-14	Geotechnical Issues Marsh Borrow Area - Raccoon Island Borrow Area	Geotechnical conditions in the borrow areas and restoration areas may differ from data reviewed during feasibility stage. Dredge volumes to meet required fill volumes could differ.	Unlikely	Significant	Moderate	Triangular	-$739,839	$0	$739,839
External Risks (External Risk Items are those that are generated, caused, or controlled exclusively outside the PDT's sphere of influence.)									
PR-2	Fuel Prices	Fluctuations in fuel costs could have an impact on the project cost.	Likely	Significant	High	Triangular	-$26,016,068	$0	$58,328,428
PR-3	Severe Weather Downtime	Risks associated with dredging operations in open Gulf especially during winter season and during a severe tropical storm season.	Likely	Significant	High	Triangular	-$18,309,377	$0	$29,242,651
PR-5	Long Pipeline to Island from Ship Shoal	Risk in Productivity/efficiency with long pipeline and required number boosters.	Likely	Significant	High	Uniform	$0	$0	$19,882,759
PR-7	Bidder's Risk in Volatile Market	Risk associated with bidders responding to volatile markets with higher bid prices.	Likely	Significant	High	Triangular	-$22,934,818	$0	$57,337,045
PR-8	Pipeline Steel Prices	Risks associated with changing steel prices increasing the cost of pipe.	Likely	Significant	High	Triangular	-$4,397,173	$0	$13,813,006
PR-14	Hurricane Demob/Re-mob	Dredge and Construction equipment may need to be moved off of an island during construction due to a hurricane event	Likely	Marginal	Moderate	Uniform	$0	$0	$1,539,351
	All Other Project Cost (Placeholder)	Placeholder to return to forcast value	N/A	N/A	N/A			$260,222,247	
								$260,222,247	

LCA TBBSR - NER Plan Contract #2 (Timbalier Island) Cost Risk Analysis Simulation

Risk Level

Likelihood of Occurrence	Negligible	Marginal	Significant	Critical	Crisis
Very Likely	Low	Moderate	High	High	High
Likely	Low	Moderate	High	High	High
Unlikely	Low	Low	Moderate	Moderate	High
Very Unlikely	Low	Low	Low	Low	High

Impact or Consequence of Occurrence

Risk No.	Risk Event	Issues	Likelihood	Impact	Cost Risk Level	Distribution	Crystal Ball Simulation Low	Crystal Ball Simulation Likely	Crystal Ball Simulation High
Internal Risks (Internal Risk Items are those that are generated, caused, or controlled within the PDT's sphere of influence.)									
PED-1	Marsh Fill Design Quantities	Material volumes required under or over estimated due to survey coverage / quality and or storms prior to construction.	Likely	Marginal	Moderate	Triangular	-$549,894	$0	$621,297
PED-2	Beach Fill Design Quantities	Material volumes required under or over estimated due to survey coverage / quality and or storms prior to construction.	Likely	Marginal	Moderate	Triangular	-$761,717	$0	$761,717
PED-11	Geotechnical Issues Beach/Dune - South Pelto Borrow Area	Geotechnical conditions in the borrow areas and restoration areas may differ from data reviewed during feasibility stage. Dredge volumes to meet required fill volumes could differ.	Unlikely	Significant	Moderate	Triangular	-$2,815,404	$0	$15,599,928
PED-12	Geotechnical Issues Marsh Borrow Area - South Pelto Borrow Area	Geotechnical conditions in the borrow areas and restoration areas may differ from data reviewed during feasibility stage. Dredge volumes to meet required fill volumes could differ.	Unlikely	Significant	Moderate	Triangular	-$763,475	$0	$4,484,990
PED-14	Geotechnical Issues Marsh Borrow Area - Whiskey 3A Borrow Area Lower	Geotechnical conditions in the borrow areas and restoration areas may differ from data reviewed during feasibility stage. Dredge volumes to meet required fill volumes could differ.	Unlikely	Significant	Moderate	Triangular	-$5,284,472	$0	$5,381,994
PED-15	Geotechnical Issues Marsh Borrow Area - New Cut Borrow Area	Geotechnical conditions in the borrow areas and restoration areas may differ from data reviewed during feasibility stage. Dredge volumes to meet required fill volumes could differ.	Unlikely	Significant	Moderate	Triangular	-$1,158,579	$0	$1,158,579
External Risks (External Risk Items are those that are generated, caused, or controlled exclusively outside the PDT's sphere of influence.)									
PR-2	Fuel Prices	Fluctuations in fuel costs could have an impact on the project cost.	Likely	Significant	High	Triangular	-$25,815,596	$0	$56,827,221
PR-3	Severe Weather Downtime	Risks associated with dredging operations in open Gulf especially during winter season and during a severe tropical storm season.	Likely	Significant	High	Triangular	-$21,105,860	$0	$29,690,244
PR-5	Long Pipeline to Island from South Pelto	Risk in Productivity/efficiency with long pipeline and required number boosters.	Likely	Significant	High	Uniform	$0	$0	$27,416,784
PR-7	Bidder's Risk in Volatile Market	Risk associated with bidders responding to volatile markets with higher bid prices.	Likely	Significant	High	Triangular	-$22,243,673	$0	$55,609,182
PR-8	Pipeline Steel Prices	Risks associated with changing steel prices increasing the cost of pipe.	Likely	Significant	High	Triangular	-$5,523,994	$0	$17,651,136
PR-14	Hurricane Demob/Re-mob	Dredge and Construction equipment may need to be moved off of an island during construction due to a hurricane event	Likely	Marginal	Moderate	Uniform	$0	$0	$875,272
	All Other Project Cost (Placeholder)	Placeholder to return to forcast value	N/A	N/A	N/A			$245,062,710	
								$245,062,710	

LCA TBBSR - NER Plan Contract #1 (Whiskey Is., Trinity Is., Raccoon Is.) Schedule Risk Analysis Simulation

Risk Level

Likelihood of Occurrence	Negligible	Marginal	Significant	Critical	Crisis
Very Likely	Low	Moderate	High	High	High
Likely	Low	Moderate	High	High	High
Unlikely	Low	Low	Moderate	Moderate	High
Very Unlikely	Low	Low	Low	Low	High

Impact or Consequence of Occurrence

Risk No.	Risk Event	Issues	Likelihood	Impact	Cost Risk Level	Distribution	Crystal Ball Simulation: Low	Likely	High
Internal Risks (Internal Risk Items are those that are generated, caused, or controlled within the PDT's sphere of influence.)									
PED-1	Marsh Fill Design Quantities	Material volumes required under or over estimated due to survey coverage / quality and or storms prior to construction.	Likely	Marginal	Moderate	Triangular	-1.23	0.00	1.21
PED-2	Beach Fill Design Quantities	Material volumes required under or over estimated due to survey coverage / quality and or storms prior to construction.	Likely	Marginal	Moderate	Triangular	-1.50	0.00	2.29
PED-11	Geotechnical Issues Beach/Dune Borrow Area - Ship Shoal Borrow Area	Geotechnical conditions in the borrow areas and restoration areas may differ from data reviewed during feasibility stage. Dredge volumes to meet required fill volumes could differ.	Unlikely	Significant	Moderate	Triangular	-0.61	0.00	3.45
PED-12	Geotechnical Issues Marsh Borrow Area - Ship Shoal Borrow Area	Geotechnical conditions in the borrow areas and restoration areas may differ from data reviewed during feasibility stage. Dredge volumes to meet required fill volumes could differ.	Unlikely	Significant	Moderate	Triangular	-0.09	0.00	0.54
PED-13	Geotechnical Issues Marsh Borrow Area - Whiskey 3A Borrow Area Upper	Geotechnical conditions in the borrow areas and restoration areas may differ from data reviewed during feasibility stage. Dredge volumes to meet required fill volumes could differ.	Unlikely	Significant	Moderate	Triangular	-0.89	0.00	1.75
PED-14	Geotechnical Issues Marsh Borrow Area - Raccoon Island Borrow Area	Geotechnical conditions in the borrow areas and restoration areas may differ from data reviewed during feasibility stage. Dredge volumes to meet required fill volumes could differ.	Unlikely	Significant	Moderate	Triangular	-0.18	0.00	0.18
External Risks (External Risk Items are those that are generated, caused, or controlled exclusively outside the PDT's sphere of influence.)									
PR-1	Sponsor's Ability to Fund Its Share	Procuring funds from the non-federal sponser has been known to take long periods of time in the past.	Likely	Significant	High	Uniform	0.00	0.00	18.00
PR-3	Severe Weather Downtime	Risks associated with dredging operations in open Gulf especially during winter season and during a severe tropical storm season.	Likely	Significant	High	Triangular	-7.36	0.00	12.29
PR-4	Delays due to Design Modifications	Modifications to design could be required at time of construction.	Likely	Marginal	Moderate	Uniform	0.00	0.00	6.00
PR-5	Long Pipeline to Island from Ship Shoal	Risk in Productivity/efficiency with long pipeline and required number boosters.	Likely	Significant	High	Uniform	0.00	0.00	6.84
PR-10	Dredge Acquisition	Dredges for the project may not be available at all times.	Unlikely	Significant	Moderate	Uniform	0.00	0.00	6.00
PR-14	Hurricane Demob/Re-mob	Dredge and Construction equipment may need to be moved off of an island during construction due to a hurricane event	Likely	Marginal	Moderate	Uniform	0.00	0.00	1.48
	All Other Project Cost (Placeholder)	Placeholder to return to forcast value	N/A	N/A	N/A			64.51	
								64.51	

LCA TBBSR - NER Plan Contract #2 (Timbalier Island) Schedule Risk Analysis Simulation

Risk Level

Likelihood of Occurrence	Negligible	Marginal	Significant	Critical	Crisis
Very Likely	Low	Moderate	High	High	High
Likely	Low	Moderate	High	High	High
Unlikely	Low	Low	Moderate	Moderate	High
Very Unlikely	Low	Low	Low	Low	High

Impact or Consequence of Occurrence

Risk No.	Risk Event	Issues	Likelihood	Impact	Cost Risk Level	Distribution	Crystal Ball Simulation Low	Crystal Ball Simulation Likely	Crystal Ball Simulation High
Internal Risks (Internal Risk Items are those that are generated, caused, or controlled within the PDT's sphere of influence.)									
PED-1	Marsh Fill Design Quantities	Material volumes required under or over estimated due to survey coverage / quality and or storms prior to construction.	Likely	Marginal	Moderate	Triangular	-1.43	0.00	1.43
PED-2	Beach Fill Design Quantities	Material volumes required under or over estimated due to survey coverage / quality and or storms prior to construction.	Likely	Marginal	Moderate	Triangular	-1.56	0.00	1.56
PED-11	Geotechnical Issues Beach/Dune - South Pelto Borrow Area	Geotechnical conditions in the borrow areas and restoration areas may differ from data reviewed during feasibility stage. Dredge volumes to meet required fill volumes could differ.	Unlikely	Significant	Moderate	Triangular	-0.41	0.00	2.35
PED-12	Geotechnical Issues Marsh Borrow Area - South Pelto Borrow Area	Geotechnical conditions in the borrow areas and restoration areas may differ from data reviewed during feasibility stage. Dredge volumes to meet required fill volumes could differ.	Unlikely	Significant	Moderate	Triangular	-0.12	0.00	0.68
PED-14	Geotechnical Issues Marsh Borrow Area - Whiskey 3A Borrow Area Lower	Geotechnical conditions in the borrow areas and restoration areas may differ from data reviewed during feasibility stage. Dredge volumes to meet required fill volumes could differ.	Unlikely	Significant	Moderate	Triangular	-0.81	0.00	0.82
PED-15	Geotechnical Issues Marsh Borrow Area - New Cut Borrow Area	Geotechnical conditions in the borrow areas and restoration areas may differ from data reviewed during feasibility stage. Dredge volumes to meet required fill volumes could differ.	Unlikely	Significant	Moderate	Triangular	-0.23	0.00	0.23
External Risks (External Risk Items are those that are generated, caused, or controlled exclusively outside the PDT's sphere of influence.)									
PR-1	Sponsor's Ability to Fund Its Share	Procuring funds from the non-federal sponser has been known to take long periods of time in the past.	Likely	Significant	High	Uniform	0.00	0.00	18.00
PR-3	Severe Weather Downtime	Risks associated with dredging operations in open Gulf especially during winter season and during a severe tropical storm season.	Likely	Significant	High	Triangular	-7.23	0.00	10.21
PR-4	Delays due to Design Modifications	Modifications to design could be required at time of construction.	Likely	Marginal	Moderate	Uniform	0.00	0.00	6.00
PR-5	Long Pipeline to Island from South Pelto	Risk in Productivity/efficiency with long pipeline and required number boosters.	Likely	Significant	High	Uniform	0.00	0.00	6.34
PR-10	Dredge Acquisition	Dredges for the project may not be available at all times.	Unlikely	Significant	Moderate	Uniform	0.00	0.00	6.00
PR-14	Hurricane Demob/Re-mob	Dredge and Construction equipment may need to be moved off of an island during construction due to a hurricane event	Likely	Marginal	Moderate	Uniform	0.00	0.00	1.48
	All Other Project Cost (Placeholder)	Placeholder to return to forcast value	N/A	N/A	N/A			55.82	
								55.82	

Louisiana Coastal Authority
Terrebonne Basin Barrier Shoreline Restoration

Integrated Feasibility Study and
Environmental Impact Statement

Project Cost and Schedule Risk Analysis Report
First Component of Construction

Prepared for:

U.S. Army Corps of Engineers,
New Orleans District

Prepared by:

SJB Group, LLC. & Coastal Engineering Consultants, Inc.
Under contract from Louisiana Office of Coastal Protection and Restoration

August 2010

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EXECUTIVE SUMMARY

This report presents a recommendation for the total project cost and schedule contingencies for initial restoration of the first component of construction of the Louisiana Coastal Authority, Terrebonne Basin Barrier Shoreline Restoration Study in Terrebonne and Lafourche Parishes, Louisiana. The first component of construction includes the initial restoration of Whiskey Island to a design of Plan C with renourishment events in Target Year (TY) 20 and 40 following the initial restoration. The renourishment in TY20 would be to a design of Plan C and in TY40 to a design of Plan B. In compliance with Engineer Regulation (ER) 1110-2-1302 Civil Works Cost Engineering, dated September 15, 2008, a formal risk analysis study was conducted for the development of contingency on the total project cost for the initial restoration exclusive of the operation and maintenance construction activities. The purpose of this risk analysis study was to establish project contingencies by identifying and measuring the cost and schedule impact of project uncertainties with respect to the estimated project cost for the initial restoration of Whiskey Island.

The most likely program year (2012) baseline project cost for initial restoration is estimated to be approximately $92.2 Million. Based on the results of the analysis it is recommended that a contingency and escalation value of approximately $23.9 Million, or 28%, be added to the total project cost for a fully funded cost of $119.3 Million.

The following tables ES-1 and ES-2 present both the baseline cost and fully funded project cost, respectively, of the initial restoration component for the first component of construction based on the anticipated contract. The cost is intended to address the congressional request of project cost estimates to implement the project. The contingency is based on an 80% confidence level, as per U.S. Army Corps of Engineers Civil Works guidance.

Table ES-1. Cost Summary - Program Year (2012)
First Component of Construction Initial Restoration Project Cost

LCA TBBSR First Component of Construction Total Project Costs		Program Year Cost	Contingency [1]	Program Year Total Cost [2]
01	Lands & Damages	$51,238	$15,371	$66,609
06	Fish & Wildlife (Adaptive Management Plan)	$5,821,200	Included	$5,821,200
17	Beach Replenishment	$78,457,696	$21,732,782	$100,190,478
30	Planning, Engineering & Design	$3,924,836	$1,087,180	$5,012,016
31	Construction Management	$3,922,786	$1,086,612	$5,009,398
	Total Project Costs	$92,177,756	$23,921,945	$116,099,701

Notes: 1. Adaptive Management Plan cost includes prior escalation & contingency and is subjected to the Total Contingency and Escalation.
2. Costs taken from TPCS

Table ES-2. Cost Summary - Fully Funded First Component of Construction
Initial Restoration Project Cost

LCA TBBSR First Component of Construction Total Project Costs		Program Year Cost	Total Contingencies & Escalations [1]	Fully Funded Total [2]
01	Lands & Damages	$51,238	$15,908	$67,146
06	Fish & Wildlife (Adaptive Management Plan)	$5,821,200	Included	$5,821,200
17	Beach Replenishment	$78,457,696	$24,773,119	$103,230,815
30	Planning, Engineering & Design	$3,924,836	$1,118,110	$5,042,946
31	Construction Management	$3,922,786	$1,235,170	$5,157,956
	Total Project Costs	$92,177,756	$27,142,306	$119,320,062

Notes: 1. Adaptive Management Plan cost includes prior escalation & contingency and is subjected to the Total Contingency and Escalation.
2. Costs taken from TPCS

KEY FINDINGS/OBSERVATIONS/RECOMMENDATIONS

The key cost risk drivers identified through sensitivity analysis for the initial restoration component of the first component of construction are Internal Risk PED-11 Geotechnical Issues Beach/Dune Borrow Area) and External Risks PR-2 (Fuel Prices), PR-3 (Severe Weather/Downtime), PR-5 (Long Pipeline to Island for Beach Fill), PR-7 (Bidder's Risk in Volatile Market) which together contribute 96.4% of the statistical cost variance.

The key schedule risk drivers identified through sensitivity analysis for the initial restoration component of the first component of construction are External Risks PR-1

(Sponsor's Ability to Fund its Share), PR-3 (Severe Weather/Downtime), PR-5 (Long Pipeline to Island for Beach Fill), and PR-10 (Dredge Acquisition), which together contribute 91.8% of the statistical schedule variance.

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 Planning, Engineering & Design phase, and proactive monitoring and control of risk identified in this study.

1.0 PURPOSE

The purpose of this report is to present the findings and results of the Cost and Schedule Risk Analysis for the Louisiana Coastal Authority, Terrebonne Basin Barrier Shoreline Restoration Study (LCA TBBSR). The results presented in this report include the recommended contingencies to be added to the base estimate cost for the initial restoration component of the first component of construction. Additionally, to provide confidence that the actual project execution costs will be within the resulting estimated budget value. 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. The results presented herein are intended to provide project leadership with contingency information for scheduling, budgeting, and project control purposes, as well as, provide tools to support decision making and risk management as the project progresses through Planning, Engineering & Design and project implementation.

2.0 Study BACKGROUND

2.1 PARTICIPATING AGENCIES

The responsible lead Federal agency for this study is the U. S. Army Corps of Engineers (USACE) - Mississippi Valley, New Orleans District. The non-Federal sponsor for the study is Louisiana Office of Coastal Protection and Restoration.

2.2 STUDY AUTHORIZATION

Title VII of the Water Resources Development Act (WRDA) 2007 authorizes the LCA ecosystem restoration program. Included within that authority are requirements for comprehensive coastal restoration planning, program governance, a Science and Technology Program, a program for the beneficial use of dredged material, feasibility studies for restoration plans, project modification investigations, and restoration project construction, in addition to other program elements. This authorization was recommended by the Chief of Engineer’s Report, dated January 31, 2005.

Under the 2007 WRDA Section 7006, the LCA program has authority for feasibility-level reports of six near-term critical restoration features of which includes the LCA TBBSR Study.

2.3 STUDY PURPOSE

The purpose of the proposed action is to address the goal of the 2004 LCA Plan; specifically, to address the critical near-term needs for shoreline restoration in Terrebonne Basin through simulation of historical conditions, which will be achieved by enlarging the existing barrier islands (width and dune crest) and reducing the current number of breaches. Additional objectives include analyzing the current conditions of the barrier islands, assessing impacts from the hurricanes of 2005 and 2008, and reaffirming the validity of the findings of the Final Environmental Impact Statement. The Integrated Feasibility Study and Environmental Impact Statement is based on a thorough review of existing scientific and engineering reports, as well as geospatial, survey, and geotechnical data.

2.4 STUDY LOCATION

The LCA TBBSR, located in LCA Subprovince 3, provides for the restoration of the Timbalier and Isles Dernieres barrier island reaches located in Terrebonne and Lafourche Parishes, Louisiana. The Study area is located in the 3rd Congressional District.

The Isles Dernieres Reach

The Isles Dernieres reach represents a barrier island arc approximately 22 miles long in Terrebonne Parish and extends from Caillou Bay east to Cat Island Pass. Raccoon Island, Whiskey Island, Trinity Island, East Island, and Wine Island, the primary islands that comprise the Isles Dernieres barrier island chain, are backed by Bay Blanc, Bay Round, Caillou Bay, and Terrebonne Bay, and bordered by the Gulf of Mexico on the seaward side. The islands range from approximately 0.1 to 1.2 miles wide and are generally composed of a thin sand cap over a thick mud platform. Elevations are generally low and the islands are frequently over washed.

The Isles Dernieres have been and continue to be an important commercial and recreational resource for Louisiana and the nation for more than 150 years. The islands support habitats that are critical to the State’s commercial fishing industry. Furthermore, the mineral-rich subsurface of the island range supports a high concentration of active oil and gas wells.

The first major coastal resort in Louisiana was located here and was washed away by the great hurricane of 1856. The Isles Dernieres have also been the location of five Coastal Wetland Planning, Protection, and Restoration Act projects. These projects included: Raccoon Island (TE-29), Whiskey Island (TE-27), Trinity Island (TE-24), East Island (TE-20), and New Cut (TE-37).

The Timbalier Islands Reach

The Timbalier Islands reach is comprised of Timbalier Island and East Timbalier Island. The two islands are on the western edge of the Lafourche barrier shoreline and are located about 60 miles southwest of New Orleans, Louisiana. This barrier island shoreline is approximately 20 miles long and backed by Terrebonne and Timbalier Bay to the north and delimited by Raccoon Pass to the east and Cat Island Pass to the west. The islands range from 0.1 to 0.6 miles wide and have low elevations. The Timbalier Islands support onshore and offshore oil and gas development and production. Oil and gas production facilities are prevalent along East Timbalier Island, while only a few scattered facilities are present along Timbalier Island.

2.5 FIRST COMPONENT OF CONSTRUCTION

Whiskey Island Plan C was selected as initial restoration of the first component of construction. The plan will create a total of 1,272 acres of barrier island habitat The initial restoration includes the construction of 65 acres of dune, 830 acres of supratidal habitat, and 377 acres of intertidal habitat. The initial restoration will be constructed on the existing island footprint, which consists of 377 acres of supratidal habitat and 443 acres of intertidal habitat at TY0. Renourishment events are planned for Target Year (TY) 20 and 40 following initial restoration. The renourishment events were not evaluated in this risk analysis.

The barrier island restoration features of the initial restoration would achieve the planning objectives by maximizing the barrier island's ability to provide geomorphic and hydrologic form and ecological function, as well as, improve critical barrier island habitats for fish, migratory birds, and other terrestrial and aquatic species. Sediment would be placed into the system to supplement long-shore sediment transport processes along the gulf shoreline by mechanically introducing compatible sediment, and increasing the ability of the restored area to continue to function and provide habitat with minimum continuing intervention.

The selection of the first component of construction was based on a thorough review of existing scientific and engineering reports, as well as geospatial, survey, and geotechnical data which reaffirmed that the findings of the Final Environmental Impact Statement remained valid.

3.0 REPORT SCOPE

3.1 STUDY SCOPE

Engineering Circular Bulletin (ECB) 2007-17, Application of Cost Risk Analysis Methods to Develop Contingencies for Civil Works Total Project Costs (Sept. 10, 2007) requires that a formal risk analysis be prepared for all decision documents requiring Congressional authorization whose total costs are in excess of forty million dollars.

In addition to broadly defined risk analysis standards and recommended practices, a risk analysis is to be 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 Directory of Expertise for Civil Works (Cost Engineering Dx), dated May 17, 2009.

- Engineer Regulation (ER) 1110-2-1302 Civil Works Cost Engineering, dated Sept. 15, 2008.

- Engineer Technical Letter (ETL) 1110-2-573 Construction Cost Estimating Guide for Civil Works, dated Sept. 30, 2008.

3.2 USACE RISK ANALYSIS PROCESS

A risk analysis is performed to determine the probability of various cost and schedule variances that could affect the total project cost. The analyses of the cost risk factors associated with the project will determine the required contingency needed in the cost estimate to achieve any desired level of cost confidence. A similar analysis is also used to determine the probability of various project schedule duration impacts and then quantify the required schedule contingency needed in the schedule to achieve any desired level of schedule confidence. Together the contingency for both cost and schedule will provide a total project cost and schedule at the desired confidence level.

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. The software determines contingency amounts based on specific 'confidence levels'. These confidence levels express the probability that the corresponding contingency amount will cover the cost of the project being studied.

In general, the amount of contingency included in project control plans depends 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 that should be applied in the project control plans. This risk of overrun is expressed by Crystal Ball in a probabilistic context using confidence levels. The Cost Engineering Dx guidance for cost and schedule risk analysis focuses on risk and opportunity potential, all project features, internal and external risks to the project. The Cost Engineering Dx recommends budget presentation with a contingency value at the eighty-percent level of confidence (80%) for successful project execution within the established budget. This 80% confidence level is the standard normally provided to Congress by USACE and other Government agencies.

4.0 METHODOLOGY / PROCESS

A risk analysis begins with the identification of risk factors for the restoration. The risk identification process includes the major PDT members knowledgeable with the potential impacts. The risks are then compared for commonalities with other risk factors and a preliminary risk register is developed for risk level assignment. Following risk level evaluation and assignment, those risk factor found to have 'moderate' or 'high' impact risks are carried forward to the final risk register and quantified. The final risk register serves as the risk models used within the Crystal Ball software. These primary steps of the risk analysis process, in functional terms, are described in the following subsections.

4.1 IDENTIFY POTENTIAL RISK FACTORS

The risk analysis process began with a brainstorming session to identify any and all potential risk factors associated with the project. These potential risks were then evaluated to determine if correlations existed between any of the potential risk factors. Risk factors that were determined to have correlations were analyzed to determine the nature of the correlation. If strong correlations existed then the factors were combined into a single risk factor. If correlations were determined wherein the risk factors had similarities but contained inherent differences, the factors were revised and/or additional risk factors were added such that all risks could be evaluated individually.

The risks developed and refined during the brainstorming sessions were transferred into a risk register template in Microsoft Excel as the Initial Risk Register (Attachment A).

4.2 REFINE RISK REGISTER AND ASSIGN RISK LEVELS

The initial risk register was structured such that elements of risk were assigned under a topic and feature code and given a risk factor number allowing traceability throughout the process. Similar to the identification and assessment process, risk factor quantification involved the evaluation of the impact of the risk on the project. The risk factors were assigned a likelihood of occurrence and a level of impact the risk would have on the project cost or schedule. Table 1 provides a listing of the topics and feature codes evaluated in this risk assessment.

Table 1. Topics and Work Breakdown Structure Analyzed

PPM	Project and Program Management
01	Lands and Damages
06	Fish & Wildlife (Adaptive Management Plan)
17	Beach Replenishment
30	Planning, Engineering & Design
31	Construction Management
PR	Programmatic Risks

4.3 Develop Final Risk Register and Quantify Risk Factors

Those risk factors determined to have a 'moderate' or 'high' impact on the project cost or schedule were carried forward to the final risk register and quantified.

The quantification process involved collaboration between the ATR review lead, District cost engineers, and the A/E cost estimators. This process used an iterative approach to estimate the following elements of each risk factor:

- Maximum possible value for the risk factor (high value, worst-case)
- Minimum possible value for the risk factor (low value, best-case)
- Most likely value (the original estimate value, if applicable)
- Nature of the probability density function used to approximate risk factor uncertainty
- Correlations between risk factors
- Affected cost and/or schedule elements

Information was extracted from the cost estimates and placed into the final cost risk register for cost risk analysis purposes (Attachment A). For the schedule risk analysis, the durations for each risk (if applicable) were placed into a final schedule risk register (Attachment A).

4.3.1 Contingency Risk Factors

The following are those elements analyzed in the cost and schedule risk models to determine the appropriate contingencies.

4.3.1.1 Beach/Dune and Marsh Fill Design Quantities (Cost & Schedule)

The island design was developed utilizing survey data collected in 2006 as part of the Louisiana Barrier Island Comprehensive Monitoring Program (UNO and USGS, 2009). Through the use of shoreline erosion and landloss rates in the above referenced program, the fill volumes required in 2012 for beach/dune and marsh were calculated. A risk variance of +/-10% of the required volume was used to evaluate the risk associated with a decrease or increase in the erosional effects experienced by the island during this six year period in addition to a storm event proceeding or during construction. The variances in beach/dune and marsh required volumes were analyzed as separate risk elements so as to assess the risk if the beach/dune and marsh fill template experience differing erosional influences.

4.3.1.2 Geotechnical Issues with the Beach/Dune and Marsh Fill Borrow Areas (Cost and Schedule)

The sediment characteristics of the proposed borrow areas for beach/dune and marsh construction were analyzed from data collected within these borrow sources as part of designs for other restoration projects. Projected dredge-to-fill ratios were established and used in the production estimates for the dredge during construction of the beach/dune and marsh fill templates. To quantify variances induced by differing sediment characteristics that could be experienced within the borrow areas proposed for beach/dune fill and the marsh fill, differing ratios better than and worse than the most likely dredge-to-fill were evaluated for their affect on the construction cost. Sediment characteristics are one of three driving forces in determining production rates for the dredging equipment.

4.3.1.3 Sponsor's Ability to Fund Its Share (Schedule)

A delay of six months in the procurement of funds to begin construction of the project was evaluated. The low risk was assumed to be the same as the most likely schedule for construction. The high risk was analyzed at a delay of six months for the beginning of construction.

4.3.1.4 Fuel Prices (Cost)

Overall affects of fuel prices on construction cost were analyzed. The most likely fuel price was derived from an average of fuel prices for 2009. A lower risk assumes the price of fuel would fall by as much as 25% from the 2009 average. A higher risk assumes that a volatile market could increase fuel prices by as much as 60% above the 2009 average price.

4.3.1.5 Severe Weather Downtime (Cost & Schedule)

The effects of dredging material in the open Gulf of Mexico on the dredge's effective operational hours per day were evaluated. A dredge may experience higher average operational time per day during periods of favorable weather and conversely experience lower than average operational time during periods of increases sea state such as during winter months. The most likely, worst case, and best case operational time per day were established by review of USACE prior dredging projects. Operational time of the dredging equipment is one of three driving forces in determining production rates for the dredging equipment.

4.3.1.6 Delays due to Design Modifications (Schedule)

Following pre-construction surveys of the fill templates, design modification may be required to adjust the fill templates to maximize effectiveness of the island restoration. Through prior restoration project experience of the design team, a two month delay in beginning construction was considered as the high risk variance for the project schedule.

4.3.1.7 Long Pipeline to Island for Beach/Dune Fill (Cost & Schedule)

In development of the dredging production rates, it was determined that it was feasible to construct the beach/dune fill template using as few as two boosters from the borrow area to the fill template. The most likely number of boosters the contractor would use is three to maintain higher production rates. The number of booster pumps utilized in the delivery of sediment to the fill template is one of three driving forces in determining the production rates for the dredging equipment. Construction cost and schedule variances were calculated to evaluate the affects on project cost and schedule if the contractor chose to utilize only two booster pumps during the construction of the beach/dune fill template.

4.3.1.8 Bidder's Risk in a Volatile Market (Cost)

The affects on construction cost of based on the risk assumed by the contractor were analyzed. These risks are those carried by the contractors that are not analyzed in other risk elements of this model. Those risks analyzed elsewhere include fuel prices, pipeline steel prices, weather delays, dredge acquisition, and additional mobilizations due to hurricanes. Examples of volatile market risk include, but are not limited to, other projects out for bid requiring the contractor's resources, labor force prices, and construction equipment availability. A low risk assumes the contractor is eager for the contract and would bid 10% less than the most likely and conversely a high risk indicates the contractor may be over extending his resources and submits a bid 25% higher than the most likely construction cost.

4.3.1.9 Pipeline Steel Prices (Cost)

The risk associated with the changing price per pound of steel was analyzed to determine it's affect on the cost of the sediment delivery pipeline. Utilizing pricing from prior USACE projects, the assumed current cost per pound for steel was set a $0.60, the low price at $0.45, and the high price at $1.50. These prices were used in the determination of unit cost variances for beach/dune and marsh fill.

4.3.1.10 Dredge Acquisition (Schedule)

The risk associated with the availability of dredges for restoration construction at the time of notice to proceed for the contractor was considered. The delay to the construction schedule, while awaiting a dredge to become available from another project, was determined to be 6 months.

4.3.1.11 Hurricane Demobilization/Re-mobilization (Cost & Schedule)

For the possibility of a hurricane affecting the project during construction, an additional demobilization/re-mobilization of the crew, equipment, and dredge to safe harbor was evaluated.

4.4 RUN CRYSTAL BALL SIMULATIONS AND ANALYZE CONTINGENCIES

Once the risk factors were refined into the final risk resisters for cost and schedule, the final quantitative impacts of risk factors served as the risk model and were analyzed using a combination of professional judgment, empirical data and analytical techniques. The software uses the most likely, low, and high values for various risks. The most likely value is usually the value used in the cost estimate. The low and high values, or best-case and worst-case values, are quantified based off a number of factors, including, but not limited to, the cost estimate. The software uses these values in conjunction with the associated probability distribution assigned to each risk to run its Monte Carlo simulations. Once the software has finished its simulation the total cost of the project with contingency is forecast for specific confidence levels. The resulting 80% confidence level contingency amount is the difference between the 80% cost forecast and the base cost estimate. For schedule contingency analysis, the contingency was calculated as the difference between the 80% level duration forecast and the base schedule duration, shown in months. These new durations suggested by the 80% confidence level were then incorporated into the escalation calculation, i.e., the escalation of the baseline estimate of cost in the Total Project Cost Summary (TPCS) of the initial restoration of the first component of construction.

The forecasts for cost and/or schedule risk can then be analyzed to determine the recommended level of contingency for the project. As stated earlier, the contingencies suggested by the higher confidence levels will account for more risk in the project; conversely, the amounts suggested by the lower confidence levels could possible leave the project without sufficient funding if some events do not go as planned.

5.0 KEY ASSUMPTIONS

Key assumptions are those that are most likely to affect the determinations and/or estimates of risk presented in the risk analysis. The key assumptions are important to help ensure that project leadership and other decision makers understand the steps, logic, limitations, and decisions made in the risk analysis, as well as any resultant limitations on the use of outcomes and results. For this project, the assumptions include:

1. Level of Design: The cost comparisons and risk analyses performed and reflected within this report are based upon design scope and estimates that are considered to be well developed and designed.
2. Design Scope: The prescribed scope satisfies the requirements of this acquisition.
3. Operation and Maintenance: Operation and maintenance activities were not included in the cost estimate or schedules, because none were planned for the selected alternative.
4. Contract Acquisition Strategy: Consistent with cost estimate and schedule assumptions, it is assumed that the contract acquisition strategy is firm fixed price.
5. Confidence Levels: The Wall Walla Cost Engineering Dx guidance generally focuses on the eighty-percent level of confidence (80%) for cost contingency

calculation. For this risk analysis, the eighty-percent level of confidence (80%) was used. It should be noted that the use of 80% as a decision criteria is a moderately risk averse approach, generally resulting in higher cost contingencies. However, the 80% level of confidence also assumes a small degree of risk that the recommended contingencies may be inadequate to completely capture actual project costs.

6.0 RISK ANALYSIS 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 COST RISK ANALYSIS CONTINGENCY RESULTS

The construction cost contingencies calculated for the 80% confidence level and rounded to the nearest thousand are shown in Table 2. The construction cost contingencies for the 50% and 100% confidence levels are also provided for illustrative purposes.

The Mii cost estimate produced by USACE-MVN Cost Engineering and A/E cost estimators with review by the ATR review lead provide initial construction costs of $90.1 Million for the initial restoration with a price level of the estimate in the 1st quarter 2010. At the 80% confidence level, the base estimate construction cost contingency was quantified as approximately $23.3 Million, with a baseline cost of $113.4 Million.

Table 2. First Component of Construction Initial Restoration Project Cost Estimate with Contingencies Summary

Contingency Level	MII Cost Estimate ($1,000)	Contingency Percentage	Total Contingency ($1,000) [1]	Baseline Cost Estimate ($1,000) [2]
50% Confidence Level - Initial Restoration Project Cost	$90,091	18.4%	$16,602	$106,693
80% Confidence Level - Initial Restoration Project Cost	$90,091	27.7%	$24,988	$115,079
100% Confidence Level - Initial Restoration Project Cost	$90,091	59.2%	$53,320	$143,411

Notes: 1. Adaptive Management Plan cost includes prior escalation & contingency and is subjected to the Total Contingency and Escalation.
2. Costs taken from Risk Analysis Forecast

6.2 SCHEDULE RISK ANALYSIS CONTINGENCY RESULTS

The original estimate of PED and construction duration for the initial restoration was 34.6 months. At the 80% confidence level, the projected duration for construction was 46.3 months – an increase of 34%. The schedule contingency was calculated by applying the moderate and high level schedule risks identified in the risk register for each option to the durations of critical path and near critical path tasks.

Table 3. First Component of Construction Initial Restoration Project Construction Schedule with Contingencies Summary

Risk Analysis Forecast	Forecast Schedule	Total Contingency	Crystal Ball Forecast Schedule
50% Confidence Level - Initial Restoration Project Duration	34.6 months	26%	43.7 months
80% Confidence Level- Initial Restoration Project Duration	34.6 months	34%	46.3 months
100% Confidence Level - Initial Restoration Project Duration	34.6 months	55%	53.5 months

6.3 SENSITIVITY ANALYSIS RESULTS

Sensitivity analysis 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 or opportunity contributing to variability of cost outcomes during the Monte Carlo simulations.

The risks or opportunities that are considered as key drivers are ranked in the order of significance to the total project costs variances. Risks are shown with a positive sign to reflect the potential to increase project cost. Opportunities that have a potential to reduce project cost and are shown with a negative sign. A longer bar in the sensitivity analysis chart indicates the risk has a greater potential impact to total project cost.

Figure 1 presents the sensitivity analyses for cost growth for those risks identified in the risk register as having a moderate to high level of impact. Similarly, Figure 2 presents a sensitivity analysis for schedule growth risk.

The key cost risk drivers identified through sensitivity analysis for the initial restoration component of the first component of construction are Internal Risk PED-11 Geotechnical

Issues Beach/Dune Borrow Area) and External Risks PR-2 (Fuel Prices), PR-3 (Severe Weather/Downtime), PR-5 (Long Pipeline to Island for Beach Fill), PR-7 (Bidder's Risk in Volatile Market) which together contribute 96.4% of the statistical cost variance.

The key schedule risk drivers identified through sensitivity analysis for the initial restoration component of the first component of construction are External Risks PR-1 (Sponsor's Ability to Fund its Share), PR-3 (Severe Weather/Downtime), PR-5 (Long Pipeline to Island for Beach Fill), and PR-10 (Dredge Acquisition), which together contribute 91.8% of the statistical schedule variance.

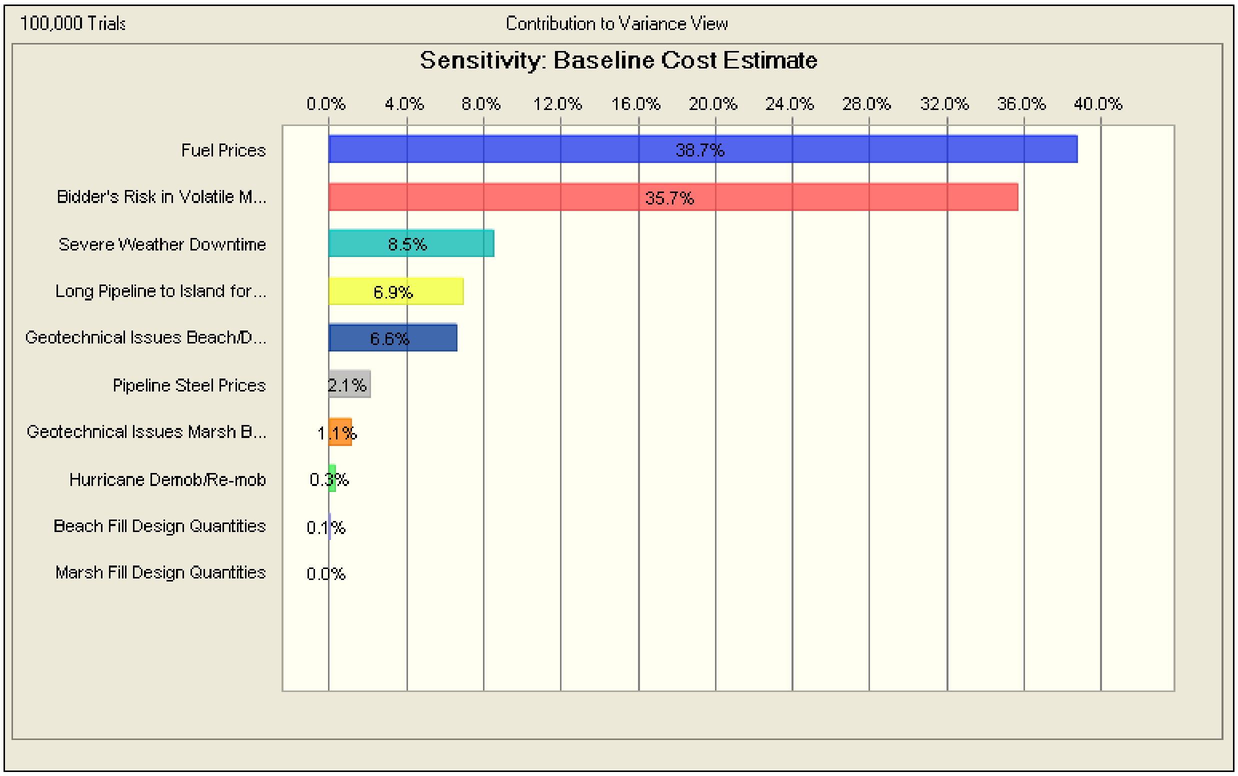

Figure 1. First Component of Construction Initial Restoration Cost Sensitivity Analysis

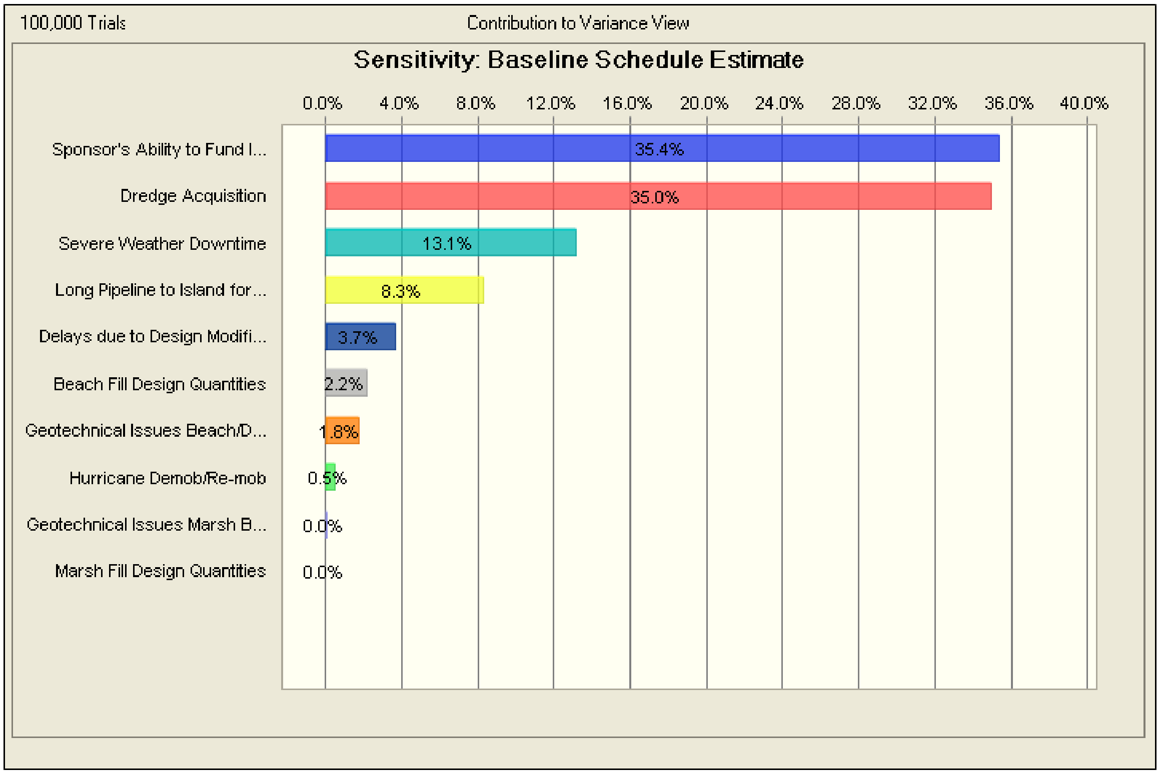

Figure 2. First Component of Construction Initial Restoration Schedule Sensitivity Analysis

7. 0 MAJOR FINDINGS / OBSERVATIONS / RECOMMENDATION

This section provides a summary of the significant risk analysis results that were 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 total construction cost and schedule comparison summaries from Crystal Ball are provided in Tables 5 and 6, respectively. Additional major findings and observations of the risk analysis are listed below.

1. Base cost contingency recommended for the initial restoration of the first component of construction is approximately $23.3 Million, for a total cost of approximately $113.4 Million. This figure is derived from the 80% confidence level values calculated by Crystal Ball (Table 4). It should be noted that the contingency cost calculated by the TPCS are slightly lower because the cost contingency and escalation are inclusive in the program cost provided by the Adaptive Management Plan development team and therefore not calculated by the TPCS.

2. Schedule duration contingency recommended for the initial restoration of the first component of construction is 11.6 months, for a total duration of 46.3 months. This monthly duration contingency is reflective of the 80% confidence level values calculated by Crystal Ball (Table 5).

3. As shown in Figures 1 and 2, the cost risk and schedule risk for initial restoration of the first component of construction are mostly dependent on two risk factors each.

4. Operation and maintenance activities were not included in the presented cost estimate or schedules. Therefore, a full lifecycle risk analysis could not be performed. Risk analysis results or conclusions could be significantly different if operation and maintenance activities were included.

Table 4. Baseline Construction Cost Comparison Summary for the Initial Restoration of the First Component of Construction

Forecast: TOTAL PROJECT COST	Percentile	Forecast values
	0%	$74,800,821
	5%	$91,873,811
	10%	$94,897,412
	15%	$96,990,201
	20%	$98,741,687
	25%	$100,219,322
	30%	$101,587,141
	35%	$102,919,229
	40%	$104,242,060
	45%	$105,478,621
	50%	$106,693,400
	55%	$107,926,332
	60%	$109,192,163
	65%	$110,504,078
	70%	$111,882,252
	75%	$113,402,851
	80%	$115,078,520
	85%	$117,028,899
	90%	$119,521,613
	95%	$123,159,649
	100%	$143,410,786
	Minimum	$74,800,821
	Maximum	$143,410,786
	80% Confidence Level:	$115,078,520
	Original Project Cost:	$90,089,312
	Total Contingency Based on 80% Confidence:	**27.7%**

Table 5. Baseline Construction Schedule Comparison Summary for the Initial Restoration of the First Component of Construction

Forecast: TOTAL PROJECT SCHEDULE	Percentile	Forecast values
	0%	33.1
	5%	38.8
	10%	39.8
	15%	40.6
	20%	41.1
	25%	41.6
	30%	42.1
	35%	42.5
	40%	42.9
	45%	43.3
	50%	43.7
	55%	44.1
	60%	44.5
	65%	44.9
	70%	45.3
	75%	45.8
	80%	46.3
	85%	46.8
	90%	47.6
	95%	48.6
	100%	53.5
	Minimum	33.1
	Maximum	53.5
	80% Confidence Level:	46.3
	Original Project Cost:	34.6
	Total Contingency Based on 80% Confidence:	**33.7%**

Through utilization of the TPCS, the base cost estimate for the initial restoration from the Mii escalated to the project year of the 1st quarter 2012 equals approximately $92.1 Million. Adding the cost and schedule influence contingencies provides a project cost of approximately $116.1 Million. A breakdown of the program year cost by work feature is presented in Table 6.

Table 6. Cost Summary - Program Year (2012)
First Component of Construction Initial Restoration Project Cost

LCA TBBSR First Component of Construction Total Project Costs		Program Year Cost [2]	Contingency [1]	Program Year Total Cost [2]
01	Lands & Damages	$51,238	$15,371	$66,609
06	Fish & Wildlife (Adaptive Management Plan)	$5,821,200	Included	$5,821,200
17	Beach Replenishment	$78,457,696	$21,732,782	$100,190,478
30	Planning, Engineering & Design	$3,924,836	$1,087,180	$5,012,016
31	Construction Management	$3,922,786	$1,086,612	$5,009,398
	Total Project Costs	$92,177,756	$23,921,945	$116,099,701

Notes: 1. Adaptive Management Plan cost includes prior escalation & contingency and is subjected to the Total Contingency and Escalation.
2. Costs taken from TPCS

Expanding on the program year cost estimate, escalation to midpoint of work features can be calculated. The results provide a fully funded project cost of approximately $119.3 Million. A breakdown of the fully funded project cast is presented in Table 7.

Table 7. Cost Summary - Fully Funded First Component of Construction Initial Restoration Project Cost

LCA TBBSR First Component of Construction Total Project Costs		Program Year Cost [2]	All Contingencies & Escalations [1]	Fully Funded Total [2]
01	Lands & Damages	$51,238	$15,908	$67,146
06	Fish & Wildlife (Adaptive Management Plan)	$5,821,200	Included	$5,821,200
17	Beach Replenishment	$78,457,696	$24,773,119	$103,230,815
30	Planning, Engineering & Design	$3,924,836	$1,118,110	$5,042,946
31	Construction Management	$3,922,786	$1,235,170	$5,157,956
	Total Project Costs	$92,177,756	$27,142,306	$119,320,062

Notes: 1. Adaptive Management Plan cost includes prior escalation & contingency and is subjected to the Total Contingency and Escalation.
2. Costs taken from TPCS

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.

This section provides a list of recommendations for continued management of the risks identified and analyzed in this study. (Note: this list is not all-inclusive)

1. Cost Estimate Quality: The cost estimate was developed for the restoration of Whiskey Island based on feasibility level surveys and designs. Risks associated with the information utilized in the designs have been analyzed within this risk assessment. It is recommended that the project leadership, restoration design team, and project cost estimators work closely in re-evaluating the project cost elements and associated cost risks during the Planning, Engineering, & Design phase of the project as more detailed design information becomes available.

2. Schedule Quality: As with the project costs, the schedule was developed based on feasibility level information; the assumption of initiation date of Planning, Engineering, & Design; and the appropriation construction funding date anticipated by the WRDA legislation. It is recommended that project leadership use the results of the schedule risk analysis in re-evaluating the schedule risk as the project progresses forward and more definitive timeline of events becomes available.

3. Risk Management: The outputs created during the risk analysis effort are recommended to be used 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. As an example, recommended uses of the risk register 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, leadership, and 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 risk analysis feedback and project control input.

- Identifying risk transfer, elimination or mitigation actions required for implementation of risk management plans.

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

8. 0 REFERENCES

University of New Orleans and United States Geological Survey (UNO and USGS). 2009. Louisiana Barrier Island Comprehensive Monitoring Program (BICM) Volume 3: Bathymetry and Historical Seafloor Change 1869-2007. Part 1: South-Central Louisiana and Northern Chandeleur Islands, Bathymetry Methods and Uncertainty Analysis. Final Report. January 2009.

ATTACHMENT A

Detailed Risk Registers

LCA TBBSR - First Component of Construction PDT Preliminary Risk Register

Risk Level

Likelihood of Occurrence	Negligible	Marginal	Significant	Critical	Crisis
Very Likely	Low	Moderate	High	High	High
Likely	Low	Moderate	High	High	High
Unlikely	Low	Low	Moderate	Moderate	High
Very Unlikely	Low	Low	Low	Low	High

Impact or Consequence of Occurrence

Risk No.	Risk/Opportunity Event	Discussion and Concerns	Project Cost				Project Schedule				Correlation to Other(s)	Notes
			Likelihood*	Impact*	Risk Level*	Rough Order Impact ($)	Likelihood*	Impact*	Risk Level*	Rough Order Impact (mo)		
Contract Risks (Internal Risk Items are those that are generated, caused, or controlled within the PDT's sphere of influence.)												
Project and Program Management												
PPM-1	Available and Timely Funding	Available funding from the Federal government.	Very Unlikely	Negligible	Low		Very Unlikely	Significant	Low			
PPM-2	Changes in priority	Pulling funding for this project for other immediate needs. Competition for resources.	Very Unlikely	Marginal	Low		Very Unlikely	Critical	Low			Whiskey BA 3 for marsh creation is not currently considered in any other island restorations. The TSP would utilize Ship Shoal material that was previously considered for TE-47 Whiskey West Flank project of which the TSP would replace.
PPM-3	Estimating/Scheduling Errors	Chance for oversights, errors, etc., as the schedule and scope of work are driving the estimate and schedule quality.	Unlikely	Marginal	Low		Unlikely	Marginal	Low			
PPM-5	Functional Resources Overloaded/Shift of Staff Priorities	Lack of internal human resources to execute project due to heavy workload, overloaded staff, and shifting priorities.	Unlikely	Marginal	Low		Unlikely	Marginal	Low			
PPM-8	Contract Acquisition Risks	Decreasing competition	Unlikely	Marginal	Low		Unlikely	Negligible	Low			It is likely that it will be a FFP large business, based on historical, and small business does not have the capibility.
Feature Code 01 - Real Estate												
Feature Code 06 - Fish & Wildlife (Adaptive Management Plan & Monitoring)												
FW-1	Adaptive Management Plan & Monitoring (AMP) shortened duration	AMP may not require the full 10 years budgeted to determine ecological success (opportunity)	Unlikely	Marginal	Low		Unlikely	Negligible	Low			A reduction in the AMP to 7 years equates to a reduction in total project cost of 2%. However due to the significance of the aquired data during this period it is unlikely that the program would be shortened.
FW-2	Survey cost escalation	Cost of field survey crews may be greater or less than budgeted. If greater than budgeted, survey coverage would have to be reduced. If less than budgeted, survey coverage could be expanded.	Likely	Negligible	Low		Likely	Negligible	Low			An increase of annual survey cost of 10% equates to 0.5% of total project cost.
Feature Code 17 - Beach Replenishment (Beach and Marsh Construction)												
Environmental & Cultural												
BR-1	MMS Survey Issues (30-m spacing)	Borrow areas in Federal Waters are under the jurisdiction of the MMS which may enforce new survey spacing requirements, infrastructure offsets etc. resulting in less available material or increased data acquisition and permitting costs. Although 50-m surveys were already conducted, the 30-m surveys might reveal additional CRs.	Unlikely	Negligible	Low		Unlikely	Marginal	Low			
BR-2	Cultural Resources Island Specific	Raccoon, Whiskey, and Timbalier Island include high, medium, medium-probability area (respectively) and will require remote sensing.	Likely	Negligible	Low		Likely	Negligible	Low			A cultural resource survey is planned and will be conducted shortly for Whiskey Island (TSP).
BR-4	Regulatory and Environmental Risks	Ship Shoal dredging impacts, reviewing agency requires higher level review than assumed, permits take longer than expected, pressure to compress the study and permitting activities	Unlikely	Marginal	Low		Unlikely	Negligible	Low			
BR-6	Threatened & Endangered Species	Local birds and turtles could pose some threat to cost/schedule. Piping Plover	Very Unlikely	Negligible	Low		Very Unlikely	Marginal	Low			USFW letter supporting project and willingness to work through nesting issues. TSP one island therefore providing nesting relocation.
Construction												
BR-8	Permitted Activities	Activities such as pipeline construction, canal maintenance and construction on or near the project area that could affect project design, access, or exacerbate current land loss rates.	Unlikely	Negligible	Low		Unlikely	Negligible	Low			There are no oil and gas infrastructure or pipelines within the Whiskey Island fill templates.
BR-9	Pipeline from Borrow Area	Navigation Issues, oyster issues.	Unlikely	Negligible	Low		Unlikely	Negligible	Low			
BR-10	General Dredge Cost Estimating Assumptions	Distance between island and borrow areas, weather days, dredge mob/demob costs, plant costs	Unlikely	Marginal	Low		Unlikely	Marginal	Low			

BR-13	Risk of Restoration Activates Damaging oil and gas facilities	Risk associated with oil and gas facilities including pipelines being damaged during project activities. Spills associated with damages to pipelines	Very Unlikely	Significant	Low		Very Unlikely	Marginal	Low			Review of USGS and MMS pipeline databases revealed that there are no known pipelines within the borrow area or fill sites. There is one oil/gas structure to the north of the island and one pipelin leading to this structure from offshore through Whiskey Pass.
BR-14	Contractor and other Construction-related Risks	Inefficient contractor, conflicts with other contracts, site access, adequate staging areas, special equipment availability	Unlikely	Negligible	Low		Unlikely	Negligible	Low			
Feature Code 30 - Planning, Engineering & Design												
Design												
PED-1	Marsh Fill Design Quantities	Material volumes required under or over estimated due to survey coverage / quality and or storms prior to or during construction.	Likely	Marginal	Moderate		Likely	Marginal	Moderate		PR-12	
PED-2	Beach Fill Design Quantities	Material volumes required under or over estimated due to survey coverage / quality and or storms prior to or during construction.	Likely	Marginal	Moderate		Likely	Significant	High		PR-12	
PED-3	Model Selection	If models applied do not take into account or were not developed to the site-specific conditions of the Terrebonne Basin Barrier Shoreline, output may result in under predicting or over predicting effectiveness of project.	Very Unlikely	Marginal	Low		Very Unlikely	Marginal	Low		PED-4	
PED-4	Model Input Error	If model inputs including bathymetry, topography, erosion, lan change, historic wave data, sediment grain size aren't representative of current conditions, modeling output could result in flawed island templates.	Unlikely	Marginal	Low		Unlikely	Marginal	Low		PED-3	
Geotechnical & Survey												
PED-11	Geotechnical Issues Beach/Dune Borrow Area	Geotechnical conditions in the borrow areas and restoration areas may differ from data reviewed during feasibility stage. Dredge volumes to meet required fill volumes could differ.	Unlikely	Significant	Moderate		Unlikely	Significant	Moderate			
PED-12	Geotechnical Issues Marsh Borrow Area	Geotechnical conditions in the borrow areas and restoration areas may differ from data reviewed during feasibility stage. Dredge volumes to meet required fill volumes could differ.	Unlikely	Significant	Moderate		Unlikely	Significant	Moderate			
PED-13	Geophysical Data: Borrow Area	Borrow area volume calculations are based on existing survey Poor data quality could result in volume shortages.	Unlikely	Marginal	Low		Unlikely	Marginal	Low			
PED-15	Petroleum Infrastructure	Infrastructure could be installed within the borrow areas before construction reducing the available material volumes	Unlikely	Marginal	Low		Unlikely	Marginal	Low		BR-8	
Feature Code 31 - Construction Management												
CM-1												
Programmatic Risks (External Risk Items are those that are generated, caused, or controlled exclusively outside the PDT's sphere of influence.)												
PR-1	Sponsor's Ability to Fund Its Share	Procuring funds from the non-federal sponser has been know to take long periods of time in the past.	Likely	Negligible	Low		Likely	Significant	High			
PR-2	Fuel Prices	Fluctuations in fuel costs could have an impact on the projec cost.	Likely	Significant	High		Likely	Negligible	Low			
PR-3	Severe Weather Downtime	Risks associated with dredging operations in open Gulf especially during winter season and during a severe tropical storm season. Effects on dredge operational hours/day.	Likely	Significant	High		Likely	Significant	High			
PR-4	Delays due to Design Modifications	Modifications to design could be required at time of construction.	Likely	Negligible	Low		Likely	Significant	High			
PR-5	Long Pipeline to Island for Beach Fill	Risk in Productivity/efficiency with long pipeline and required number boosters.	Likely	Significant	High		Likely	Significant	High			
PR-7	Bidder's Risk in Volatile Market	Risk associated with bidders responding to volatile markets with higher bid prices.	Likely	Significant	High		Likely	Negligible	Low			
PR-8	Pipeline Steel Prices	Risks associated with changing steel prices increasing the cos of pipe.	Likely	Significant	High		Likely	Negligible	Low			
PR-10	Dredge Acquisition	Dredges for the project may not be available at all times.	Unlikely	Negligible	Low		Likely	Significant	High			
PR-11	Oil and Gas facilities damage (storms, accidental releases) resulting in damage to barrier resources	Adverse impacts to existing resources (baseline conditions) resulting from accidental releases, ongoing activities.	Unlikely	Marginal	Low		Unlikely	Marginal	Low			Review of USGS and MMS pipeline databases revealed that there are no known pipelines within the borrow area or fill sites. There is one oil/gas structure to the north of the island and one pipelin leading to this structure from offshore through Whiskey Pass.
PR-13	Shore equipment mechanical issues	Dozers etc. may experience mechanical issues causing downtime and reducing productivity.	Unlikely	Negligible	Low		Unlikely	Negligible	Low			
PR-14	Hurricane Demob/Re-mob	Dredge and Construction equipment may need to be moved o of an island during construction due to a hurricane event	Likely	Marginal	Moderate		Likely	Marginal	Moderate			

*Likelihood, Impact, and Risk Level to be verified through market research and analysis (conducted by cost engineer).

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

LCA TBBSR - First Component of Construction - Initial Restoration Cost Risk Analysis Simulation

Risk Level

Likelihood of Occurrence	Negligible	Marginal	Significant	Critical	Crisis
Very Likely	Low	Moderate	High	High	High
Likely	Low	Moderate	High	High	High
Unlikely	Low	Low	Moderate	Moderate	High
Very Unlikely	Low	Low	Low	Low	High

Impact or Consequence of Occurrence

							Crystal Ball Simulation		
Risk No.	Risk Event	Issues (See Element Tabs for more detailed descriptions)	Likelihood	Impact	Cost Risk Level	Distribution	Low	Likely	High
Internal Risks (Internal Risk Items are those that are generated, caused, or controlled within the PDT's sphere of influence.)									
PED-1	Marsh Fill Design Quantities	Material volumes required under or over estimated due to survey coverage / quality and or storms prior to construction.	Likely	Marginal	Moderate	Triangular	-$47,997	$0	$6,584
PED-2	Beach Fill Design Quantities	Material volumes required under or over estimated due to survey coverage / quality and or storms prior to construction.	Likely	Marginal	Moderate	Triangular	-$522,459	$0	$629,590
PED-11	Geotechnical Issues Beach/Dune Borrow Area	Geotechnical conditions in the borrow areas and restoration areas may differ from data reviewed during feasibility stage. Dredge volumes to meet required fill volumes could differ. (Component 1 of 3 for Production Risk)	Unlikely	Significant	Moderate	Triangular	-$1,636,537	$0	$9,570,786
PED-12	Geotechnical Issues Marsh Borrow Area	Geotechnical conditions in the borrow areas and restoration areas may differ from data reviewed during feasibility stage. Dredge volumes to meet required fill volumes could differ. (Component 1 of 3 for Production Risk)	Unlikely	Significant	Moderate	Triangular	-$809,217	$0	$4,119,075
External Risks (External Risk Items are those that are generated, caused, or controlled exclusively outside the PDT's sphere of influence.)									
PR-2	Fuel Prices	Fluctuations in fuel costs could have an impact on the project cost.	Likely	Significant	High	Triangular	-$8,736,365	$0	$19,371,247
PR-3	Severe Weather Downtime	Risks associated with dredging operations in open Gulf especially during winter season and during a severe tropical storm season. (Component 2 of 3 for Production Risk)	Likely	Significant	High	Triangular	-$7,670,195	$0	$5,864,012
PR-5	Long Pipeline to Island for Beach Fill	Risk in Productivity/efficiency with long pipeline and required number boosters. (Component 3 of 3 for Production Risk)	Likely	Significant	High	Uniform	$0	$0	$8,522,783
PR-7	Bidder's Risk in Volatile Market	Risk associated with bidders responding to volatile markets with higher bid prices.	Likely	Significant	High	Triangular	-$7,656,192	$0	$19,140,480
PR-8	Pipeline Steel Prices	Risks associated with changing steel prices increasing the cost of pipe.	Likely	Significant	High	Triangular	-$1,559,463	$0	$5,022,145
PR-14	Hurricane Demob/Re-mob	Dredge and Construction equipment may need to be moved off of an island during construction due to a hurricane event	Likely	Marginal	Moderate	Uniform	$0	$0	$1,887,415
	All Other Project Cost (Placeholder)	Placeholder to return to forecast value	N/A	N/A	N/A			$90,089,312	
								$90,089,312	

LCA TBBSR - First Component of Construction - Initial Restoration Schedule Risk Analysis Simulation

Risk Level

Likelihood of Occurrence					
Very Likely	Low	Moderate	High	High	High
Likely	Low	Moderate	High	High	High
Unlikely	Low	Low	Moderate	Moderate	High
Very Unlikely	Low	Low	Low	Low	High
	Negligible	Marginal	Significant	Critical	Crisis

Impact or Consequence of Occurrence

							Schedule Crystal Ball Simulation		
Risk No.	**Risk Event**	**Issues**	**Likelihood**	**Impact**	**Schedule Risk Level**	**Distribution**	**Low**	**Likely**	**High**
Internal Risks (Internal Risk Items are those that are generated, caused, or controlled within the PDT's sphere of influence.)									
PED-1	Marsh Fill Design Quantities	Material volumes required under or over estimated due to survey coverage / quality and or storms prior to or during construction.	Likely	Marginal	Moderate	Triangular	-0.08	0.00	0.07
PED-2	Beach Fill Design Quantities	Material volumes required under or over estimated due to survey coverage / quality and or storms prior to or during construction.	Likely	Significant	High	Triangular	-1.07	0.00	1.07
PED-11	Geotechnical Issues Beach/Dune Borrow Area	Geotechnical conditions in the borrow areas and restoration areas may differ from data reviewed during feasibility stage. Dredge volumes to meet required fill volumes could differ. (Component 1 of 3 for Production Risk)	Unlikely	Significant	Moderate	Triangular	-0.28	0.00	1.61
PED-12	Geotechnical Issues Marsh Borrow Area	Geotechnical conditions in the borrow areas and restoration areas may differ from data reviewed during feasibility stage. Dredge volumes to meet required fill volumes could differ. (Component 1 of 3 for Production Risk)	Unlikely	Significant	Moderate	Triangular	-0.10	0.00	0.19
External Risks (External Risk Items are those that are generated, caused, or controlled exclusively outside the PDT's sphere of influence.)									
PR-1	Sponsor's Ability to Fund Its Share	Procuring funds from the non-federal sponsor has been known to take long periods of time in the past.	Likely	Significant	High	Uniform	0.00	0.00	6.00
PR-3	Severe Weather Downtime	Risks associated with dredging operations in open Gulf especially during winter season and during a severe tropical storm season. (Component 2 of 3 for Production Risk)	Likely	Significant	High	Triangular	-3.04	0.00	2.33
PR-4	Delays due to Design Modifications	Modifications to design could be required at time of construction.	Likely	Significant	High	Uniform	0.00	0.00	2.00
PR-5	Long Pipeline to Island for Beach Fill	Risk in Productivity/efficiency with long pipeline and required number boosters. (Component 3 of 3 for Production Risk)	Likely	Significant	High	Uniform	0.00	0.00	2.97
PR-10	Dredge Acquisition	Dredges for the project may not be available at all times.	Likely	Significant	High	Uniform	0.00	0.00	6.00
PR-14	Hurricane Demob/Re-mob	Construction equipment may need to be moved off of an island during construction due to a hurricane event	Likely	Marginal	Moderate	Uniform	0.00	0.00	0.74
	All Other Project Time (Placeholder)	Placeholder to return to forcast value						34.60	
								34.60	