Fairfield and New Haven Counties, CT Coastal Storm Risk Management Feasibility Study

Feasibility Report
August 2020

Appendix E

Cost Engineering

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COST ENGINEERING

1.0 COST NARRATIVE

Corps of Engineers cost estimates for planning purposes are prepared in accordance with the following guidance:

- Engineer Technical Letter (ETL) 1110-2-573, Construction Cost Estimating Guide for Civil Works, 30 September 2008
- Engineer Regulation (ER) 1110-1-1300, Cost Engineering Policy and General Requirements, 26 March 1993
- ER 1110-2-1302, Civil Works Cost Engineering, 15 September 2008
- ER 1110-2-1150, Engineering and Design For Civil Works Projects, 31 August 1999
- ER 1105-2-100, Planning Guidance Notebook, 22 April 2000, as amended
- Engineer Manual (EM) 1110-2-1304 (Tables revised 30 March 2007), Civil Works Construction Cost Index System, 31 March 2013
- CECW-CP Memorandum For Distribution, Subject: Initiatives To Improve The Accuracy Of Total Project Costs In Civil Works Feasibility Studies Requiring Congressional Authorization, 19 Sep 2007
- CECW-CE Memorandum For Distribution, Subject: Application of Cost Risk Analysis Methods To Develop Contingencies For Civil Works Total Project Costs, 3 Jul 2007
- Cost and Schedule Risk Analysis Guidance, 17 May 2009

The goals of cost engineering for the Fairfield and New Haven Counties, CT Coastal Storm Risk Management Feasibility Study are to present a Total Project Cost (construction and non-construction costs) for the National Economic Development (NED) Plan at the current price level to be used for project justification/authorization and to project costs forward in time for budgeting purposes. In addition, the costing efforts are intended to produce a final product, or cost estimate, that is reliable and accurate and that supports the definition of the Government's and the non-Federal sponsor's obligations.

2.0 PROJECT DESCRIPTION

The feasibility study formulates, evaluates, and compares reasonable solutions to reduce the risk of coastal storm damages to property and infrastructure and minimize risk to public safety in the study area. Five primary damage areas (Stratford and Fairfield in Fairfield County and Milford, West Haven, and New Haven in New Haven County) were initially identified by the Regional Councils of Governments in Connecticut for assessment. Following discussions with the municipalities, the decision was made at the USACE Tentatively Selected Plan (TSP) milestone in June 2019 to focus the costal storm risk planning efforts and this IFR/EA on development, evaluation, comparison, and selection of a proposed Federal project for the New Haven, Long Wharf focused study area. The plan formulation process considered a range of structural and nonstructural measures to manage the risk of coastal storm damage in the Long Wharf study area. Through an iterative planning process, potential coastal storm risk management measures were identified, alternatives formulated, evaluated, and compared. Initial screening of alternatives identified structural, (floodwalls and closure structures) and nonstructural alternatives, (wet/dry flood proofing) that would reduce coastal storm risk for the Long Wharf

District and potentially provide sufficient damage reduction benefits to support justification of a Federal cost-shared coastal storm risk management project.

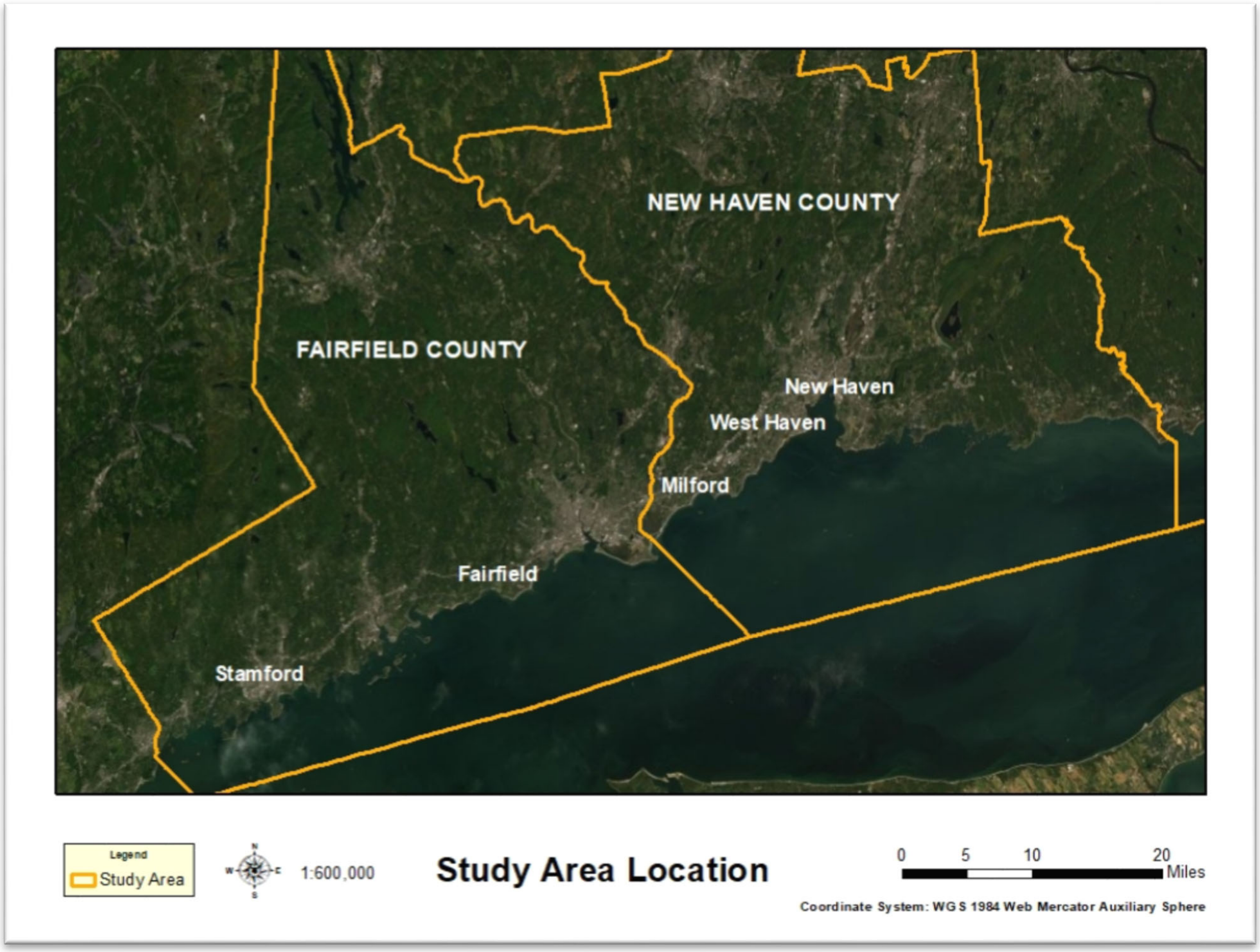

Figure E1: Authorized Study Area

A number of alternatives were considered by the PDT in order to accomplish the goals of reducing the risk of coastal storm damages and minimize risk to public safety. These alternatives consist of sheet pile flood walls, pump stations with interior drainage improvements, closure structures, nonstructural measures such as structure raising and wet/dry flood proofing and several combinations of these alternatives.

3.0 ALTERNATIVES

3.1 ALTERNATIVE 2 - NONSTRUCTURAL

The Nonstructural alternative for the Long Wharf focused study area consists of providing non-structural storm risk management benefits through a combination of elevating or floodproofing eligible structures within the study area. 138 structures were initially found to be eligible for potential floodproofing or elevation of the first floor. The majority of these structures are large commercial properties. There are 12 residential structures within the study area that are potential candidates for elevating the first floor. There are 126 commercial structures within the study area that are potential candidates for either wet or dry floodproofing. Most of the buildings are large commercial buildings that would be extremely difficult, if not impossible to properly floodproof. This option would not reduce the risk of coastal storm damage to the rail and highway infrastructure.

Figure E2: Alternative 2 Conceptal Design

3.2 ALTERNATIVE 3B - ENHANCED I-95 EMBANKMENT

Alternative 3B consists of: enhancement of the I-95 embankment with approximately 5,800 linear feet of "T-wall" type floodwall. The proposed floodwall is designed to be built upon a robust, pile-supported foundation, independent of the I-95 earthen embankment. Additionally, 5 deployable flood gates (closure structures) will be constructed with a combined length of 475 linear feet; one at Long Wharf Drive approximately 60 feet wide by 8 feet high, one at Canal Dock Road approximately 190 feet wide by 7 feet high, one at Brewery Street approximately 65 feet wide by 3 feet high, two at Exit 46, totaling 160 feet wide and 5 feet high; and one pump station designed to handle approximately 900 cubic feet of water per second (cfs). The proposed floodwall would be built to a height +15 feet NAVD88. This elevation was selected considering the local topography and future annual exceedance probability water levels under the low, intermediate and high sea level change scenarios. By the end of the project's 50 year period of economic analysis in 2074, the floodwall will have a 0.8-percent annual exceedance probability under the low sea level change scenario, a 1.2-percent annual exceedance probability under the intermediate sea level change scenario and a 3.5-percent annual exceedance probability under the high sea level change scenario. These levels of residual risk are considered to be low and tolerable.

Figure E3: Alternative 3B Conceptual Design

3.3 ALTERNATIVE 4A - SHORELINE FLOODWALL

This alternative uses an approximate 6,850 foot long pile supported floodwall along Long Wharf Drive (rather than along I-95). Due to the low elevations in the area, the floodwall would be as high as 9 feet above existing grade and would reduce the risk of coastal storm damage to the commercial and transportation facilities extending to the same endpoints as alternative 3B. At least 4 deployable structures would be required, one at Brewery Street, one crossing Long Wharf Drive roughly 65 feet wide and 7 feet high, one at the Canal Dock Boathouse Access approximately 35 feet long and 9 feet high and one at the Long Wharf Park parking area which would be roughly 50 foot wide and 5 foot high. Additional access doors and/or structures would be needed to make the Long Wharf Park access convenient to pedestrians and other users. This alternative would restrict access and views of Long Wharf Park and would require some tree removal.

This alternative would protect the commercial and railroad areas behind I-95 from storms and waves up to approximately elevation 15 NAVD88.

Pumps will be required to move any stormwater out of the protected area. See Chapter 6 of the Civil Engineering Appendix for more detail on the proposed pumping systems.

Figure E4: Alternative 4A Conceptual Design

3.4 ALTERNATIVE 4B - EXTENDED SHORELINE FLOODWALL

This alternative consists of all the structures in alternative 4A except the Long Wharf Drive closure structure and extends the floodwall around the Long Wharf Maritime Center extending the wall approximately 3,000 feet. Due to the low elevations in the area, the floodwall would be as high as 13 feet above existing grade. Part of this alignment would be along an existing seawall alignment and would pose difficult construction and design issues due to the available space to work around the existing wall.

In addition to the deployable structures in alternative 4A, structures would be needed at the entrance to the Tank Farm (55 foot long and 9 foot high), crossing East Street (90 feet long and 5 foot high), and crossing Water Street at the intersection with East Street (90 feet wide and 5 foot high).

At least one additional pump would be needed in the Long Wharf Maritime Center to handle stormwater behind the floodwalls.

This alternative would protect the commercial and railroad areas behind I-95 from storms and waves up to approximately elevation 15' NAVD88. The Long Wharf Maritime Center would be protected.

Figure E5: Alternative 4B Conceptual Design

4.0 ALTERNATIVES ROM CONSTRUCTION COST ESTIMATES

Rough Order of Magnitude (ROM) construction cost estimates for all five Alternatives were developed using quantities provided by the PDT, specifically the CENAE Civil Engineering Section. A set of typical cross sections were generated for the flood wall and the post & panel closure structure features of work. A quantity for each aspect of work for these two features was developed on a per-foot basis; these aspects of work include excavation, compaction, concrete, reinforcement, backfill, restoration, etc. These per-foot quantities were then multiplied by the length of each feature of work to generate final quantities. These final quantities were then applied to parametric unit costs that were based upon historical data and previously developed construction cost estimates for similar work or used along with RSMeans, MII Cost Libraries, and vendor quotations to create new parametric construction cost estimates. Due to schedule constraints, an Abbreviated Risk Analysis (ARA) was performed in leui of the more robust Cost and Schedule Risk Analysis (CSRA). Lands and Damages costs were also provided by NAE Real Estate Division to capture costs associated with temporary easements to facilitate construction activities and permanent easements to facilitate future operation and maintenance. Table E1 summarizes these ROM costs along with the contingency for the features of work, as determined by the ARA, in each alternative.

Table E1: Alternative ROM Cost Estimate Summary (Project First Costs)

	Account	Feature of Work	Cost ($k)	Cntg (%)	Cntg ($k)	Total ($k)
Alternative 2 - Nonstructural						
	19	Residential Structure Elevations	$3,764	33.6%	$1,265	$5,028
	19	Commercial Structure Floodproofing	$9,489	33.6%	$3,188	$12,678
	19	General Conditions	$17,142	25.9%	$4,442	$21,584
	30	PED	$3,058	37.7%	$1,151	$4,209
	31	Construction Management	$3,058	29.2%	$893	$3,951
		ALTERNATIVE 2 TOTAL	**$36,510**		**$10,939**	**$47,449**
Alternative 3B - Enhanced Embankment						
	11	T-Wall 1	$5,686	37.0%	$2,104	$7,790
	11	T-Wall 2	$36,449	37.0%	$13,486	$49,936
	11	Post & Panel Closure Structures	$3,725	37.0%	$1,378	$5,104
	15	Pump Stations	$41,009	37.0%	$15,174	$56,183
	11	General Conditions	$9,562	37.0%	$3,538	$13,100
	01	Lands and Damages	$356	11.4%	$41	$397
	30	PED	$5,875	37.0%	$2,174	$8,049
	31	Construction Management	$3,917	37.0%	$1,449	$5,366
		ALTERNATIVE 3B TOTAL	**$106,580**		**$39,343**	**$145,923**
Alternative 4A - Shoreline Floodwall						
	11	T-Wall 1	$13,710	46.2%	$6,330	$20,040
	11	T-Wall 2	$60,733	46.2%	$28,040	$88,773
	11	Post & Panel Closure Structures	$1,353	48.1%	$650	$2,003
	15	Pump Stations	$34,109	49.5%	$16,891	$51,000
	11	General Conditions	$10,818	25.9%	$2,803	$13,621
	01	Lands and Damages	$521	Included	Included	$521
	30	PED	$7,287	37.7%	$2,744	$10,030

	31	Construction Management	$4,858	29.2%	$1,419	$6,277
		ALTERNATIVE 4A TOTAL	**$133,389**		**$58,877**	**$192,265**
	Alternative 4B - Extended Shoreline Floodwall					
	11	T-Wall 1	$13,710	46.2%	$6,330	$20,040
	11	T-Wall 2	$105,895	46.2%	$48,892	$154,786
	11	Post & Panel Closure Structures	$2,604	48.1%	$1,252	$3,857
	15	Pump Stations	$43,293	49.5%	$21,438	$64,731
	11	General Conditions	$15,012	33.6%	$3,890	$18,902
	01	Lands and Damanges	$975	Included	Included	$975
	30	PED	$10,896	37.7%	$4,102	$14,998
	31	Construction Management	$7,264	29.2%	$2,122	$9,386
		ALTERNATIVE 4B TOTAL	**$199,649**		**$88,026**	**$287,675**

5.0 RECOMMENDED PLAN

Alternative 3B was identified as the Recommended Plan. Based on the initial Agency Technical Review (ATR) comments and following the Agency Decision Milestone (ADM), this plan was refined based on additional engineering analyses. The proposed layout consists of: enhancement of the I-95 embankment with approximately 5,800 linear feet of "T-wall" type floodwall. The proposed floodwall is designed to be built upon a robust, pile-supported foundation, independent of the I-95 earthen embankment. Additionally, 5 deployable flood gates (closure structures) will be constructed with a combined length of 475 linear feet; one at Long Wharf Drive approximately 60 feet wide by 8 feet high, one at Canal Dock Road approximately 190 feet wide by 7 feet high, one at Brewery Street approximately 65 feet wide by 3 feet high, two at Exit 46, totaling 160 feet wide and 5 feet high; and one pump station designed to handle approximately 900 cubic feet of water per second (cfs). The floodwall and closure structures would be built to a top elevation of +15 feet NAVD88.

Major changes to the plan include changes in the overall wall lengths, utilizing I-wall instead of T-wall for a 1,000 lf section of wall, installation of one larger pump station instead of two smaller stations, and changes to the typical cross sectios for both the T-wall and road closure structures. In addition, since the ADM, a Cost and Schedule Risk Analysis (CSRA) was completed, as required, due to the total project cost exceeding $40M.

Table E2 summarizes the costs for the Recommended Plan along with the contingency developed in the CSRA.

Table E2: Recommended Plan (Alt. 3B) Cost Estimate Summary (Project First Costs)

	Account	Feature of Work	Cost ($k)	Cntg (%)	Cntg ($k)	Total ($k)
Recommended Plan						
	11	General Conditions	$9,562	41.0%	$3,920	$13,482
	11	Wall Section 1	$5,686	41.0%	$2,331	$8,017
	11	Wall Section 2	$36,449	41.0%	$14,944	$51,394
	11	Post & Panel Closure Structures	$3,725	41.0%	$1,527	$5,253
	15	Pump Stations	$28,119	41.0%	$11,529	$39,647
	01	Lands and Damages	$356	11.4%	$41	$397
	30	PED	$6,362	41.0%	$2,608	$8,970

	31	Construction Management	$4,241	41.0%	$1,739	$5,980
		Recommended Plan TOTAL	**$94,501**		**$38,640**	**$133,141**

6.0 BASIS OF ESTIMATE

The construction cost estimate was developed using Micro-Computer Aided Cost Estimating System (MCACES), Second Generation (MII) using the appropriate Work Breakdown Structure (WBS). Quantities were developed from the typical sections of the sheet pile floodwalls and the road closure structures along with the anticipated lengths of each feature. These quantities were used to develop cost estimates for each feature utilizing cost resources such as RSMeans, MII Cost Libraries, and vendor quotations and are supported by the preferred labor, equipment, materials, and crew/production breakdown. The cost for the pump station is based on award data for pump stations obtained from Jacksonville District. This award data ranges from 2000 to 2017 and includes thirteen contracts and sixty-three pumps ranging from 25 cfs up to 960 cfs. Only two contracts from 2000 included pumps similar in size to the current scope; these two contracts averaged $12,300/cfs. The overall average of all pump stations over the seventeen years of award data was $34,834/cfs. It was decided to use those awards where all pumps were greater than 100 cfs in order to determine an approximate cost per cfs for this project. There were four contracts with an average of $21,869/cfs. Because this cost data was calculated in FY17, an escaclation was applied to bring this unit cost to be current for FY20. Interior drainage costs were estimated based on a conceptual cost estimate for a pump station and interior drainage created by Tighe & Bond for a potential future project in the Town of Fairfield known as the South Benson project. The PDT determined the likely drainage area for this project was 50% or less of what was included in the South Benson estimate; therefore, 50% of the interior drainage cost was applied to this project's cost estimate.

It is assumed the lengths where flood wall is to be constructed will be excavated as necessary to the bottom of the I-wall or T-wall. Pipe piles and sheeting will be installed via hammer or vibration. The necessary section of wall will be formed, reinforcement installed, and concrete placed and finished. The area adjacent to the wall will be backfilled with rip-rap installed for added toe protection and the site will be restored with loam and seed. A similar methodology will be used for the post & panel closure structures with installation of the steel channel embedded in the concrete slab for future installation, as necessary, of the post and panel system.

It is assumed the wall sections and the post & panel closure structures will be constructed consecutively. The pump station and interior drainage features are assumed to be installed concurrently along with the wall sections and post & panel structures.

The labor rates were adjusted to the local and current prevailing wage determinations. The most current MII Cost Book (2016) and Equipment database, Region 1 (2018) were utilized in developing the cost estimate. The Equipment database is based on EP 1110-1-8, Construction Equipment Ownership and Operation Expense Schedule. The direct costs are based on anticipated labor, equipment, and materials necessary to construct the project. This work was then applied to either the prime or a subcontractor. The contractor make-up assumes the prime contractor will act as a managing prime who will subcontract nearly all the construction activity.

Sales tax at 6.35% was applied to materials for the project. Overtime is assumed at 2 hours per day for a total of 10 hours per day, 5 days a week.

New Haven County, Connecticut prevailing wage rates were obtained from GSA and used for all craft labor (General Decision Number: CT20200013 06/05/2020 – Heavy). The base wage rate and taxable fringe were entered into MII and applied accordingly. The total labor rate was developed using the base wage, fringe benefits, FICA, FUTA, and Workers' Compensation rates for each craft computed by MII based on project location and contractor type.

Contingency for both the cost and schedule was established at the 80% confidence level using a risk-based Monte Carlo simulation. See section 8.0 CONTINGENCY DEVELOPMENT for additional details regarding the risk-based contingency development.

The civil works breakdown structure (CWBS) feature accounts associated with each contract were escalated to the program year and then to the mid-point of design or construction using the Civil Works Construction Cost Index System (CWCCIS) factors as contained in EM 1110-2-1304, dated 30 March 2020. See section 11.0 TOTAL PROJECT COST SUMMARY for additional details.

7.0 SCHEDULE

The total project schedule has been developed in Microsoft Excel using major construction activities and associated network logic to determine the project duration. The schedule assumes the months of December, January, and February are adverse weather months and no work is assumed to occur during this time period. The total project schedule is provided as Attachment 1 to this Cost Engineering Appendix.

8.0 CONTINGENCY DEVELOPMENT

8.1 PURPOSE

The purpose for a Cost and Schedule Risk Analysis (CSRA) is to identify potential events that could positively or negatively affect project cost or schedule, analyze their impacts, and then be used as a project management tool to plan, track and/or control these risks. This risk analysis report presents the cost and schedule contingencies at the 80% confidence level using the risk analysis process as mandated by ER 1110-2-1150, Engineering and Design for Civil Works; ER 1110-2-1302 Civil Works Cost Engineering; and ETL 1110-2-573, Construction Cost Estimating Guide for Civil Works. This report presents the contingency results for both cost and schedule risks for all project features. The study and presentation excludes consideration for operation and maintenance or life cycle costs.

8.2 RISK ANALYSIS PROCESS

The risk analysis process follows USACE Headquarters requirements as well as the guidance provided by the Cost MCX. The risk analysis process uses probabilistic cost and schedule risk analysis methods within the framework of the modeling software. The risk analysis results are intended to serve several functions, one being the establishment of reasonable contingencies reflective of an 80 percent confidence level to successfully accomplish the project work within that established contingency amount. Furthermore, the scope of the report includes the identification and communication of important steps, logic, key assumptions, limitations, and decisions to help ensure that risk analysis results can be appropriately interpreted. The results of the CSRA will be provided to the project manager for inclusion in the project management plan.

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

8.3 METHODOLOGY

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

The Cost MCX guidance for cost and schedule risk analysis generally recommend budgeting based on the 80-percent confidence level for cost contingency calculation. It should be noted that use of the 80-percent confidence level as a decision criteria is a risk adverse approach (whereas the use of the 50-percent confidence level would be a risk neutral approach, and use of levels less than 50 percent would be risk seeking). Thus, an 80-percent confidence level results in greater contingency as compared to a 50-percent 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. Cost estimates are packaged into an Excel format and used directly for cost risk analysis purposes. Because Crystal Ball is an Excel add-in, the schedules for each option are recreated in an Excel format from their native format. The level of detail recreated in the Excel-format schedule is sufficient for risk analysis purposes that reflect the established risk register.

Below is a brief step-by-step summary of the process performed during this analysis:

1. Development of Risk Register. In accordance with the PDT, a risk register was developed to identify the various risks associated with the project.

2. Determination of Risk. During the risk register meeting, risk events were identified along with their likelihood of occurance, impact to cost, and impact to schedule. These factors determined whether an event's risk level was low, moderate, or high.

Risk Matrix

Likelihood of Occurrence	Risk Level: Negligible	Marginal	Significant	Critical	Crisis
Certain	Low	Moderate	High	High	High
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 Consequences of Occurrence

3. Distribution Curves. Each risk item was then analyzed to determine what type of distribution curve would be used for each individual component. The most commonly used curves were the triangular distribution, uniform distribution, and yes/no distribution.

4. Summary of Results. Using the simulated variance costs of each event, a contingency s-curve is generated within the Crystal Ball software. The contingency value at the 80% confidence level is typically recommended to the applied to the base cost estimate. The same methodology was used to determine the 80% confidence level for the schedule.

5. Review/Adjust. After the first trial was complete, the results were reviewed by the estimator and, if necessary, adjusted and repeated.

6. Reporting. From the risk analysis results, various reports were generated summarizing cost/schedule contingencies and identifying key risk events driving project uncertainty.

8.3.1 Identify and Assess Risk Factors

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

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

Informal risk identification was initially performed by the cost engineering team member working through the base estimate and schedule development process. As scope uncertainty and constructability type issues were identified, they were submitted to a draft risk register to be presented to the larger team and presented in the formal PDT meetings.

A formal PDT meeting was held virtually on 5 May 2020 to discuss the risks/opportunities associated with the project. The meetings focused primarily on the identification, concerns, and discussions of the risk/opportunities along with some quantification of risks (best case, most likely, and worst case thresholds) when appropriate. Additionally, numerous telephone calls, informal meetings, and coordination through email were conducted throughout the risk analysis process on an as-needed basis to further facilitate risk factor identification, market analysis, and risk assessment. The PDT was represented by the following disciplines:

- Project management
- Civil engineering
- Coastal engineering
- Geotechnical engineering
- Structural engineering
- Construction support
- Cost engineering

Follow up meetings and/or discussions were also held to discuss risk thresholds and update the risk register. A full roster of participating team members at each risk meeting is included in

8.3.2 Risk Register

The risk register is a tool commonly used in project planning and risk analysis and serves as the basis for the Crystal Ball risk models. The risk register and identified events are included in Attachment 2. The risk register documents the PDT risk identification and assessment.

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

- Documenting risk mitigation strategies being pursued in response to the identified risks and their assessment in terms of probability and impact.

- Providing project sponsors, stakeholders, and leadership/management with a documented framework from which risk status can be reported in the context of project controls

- Communicating risk management issues.

- Providing a mechanism for eliciting risk analysis feedback and project control input.
- Identifying risk transfer, elimination, or mitigation actions required for implementation of risk management plans.

8.3.3 Quantify Risk Factor Impacts

The quantitative impacts of risk items on project plans are analyzed using a combination of professional judgment, empirical data, and analytical techniques. Risk factor impacts are quantified using probability distributions (density functions) as required by the Crystal Ball Monte Carlo Risk Simulation software. Based on Cost MCX guidance, both critical and near-critical path tasks are considered to be uncertain for the purposes of schedule contingency analysis. Care must be taken to ensure the risk events contribute impact to the critical path of the total project schedule and not just the completion of the individual contract.

Similar to the identification and assessment process, risk quantification involves multiple project team disciplines and functions. However, the quantification process relies more extensively on collaboration between cost, design, schedule, and risk team members with lesser inputs from the larger PDT.

The resulting event details as presented in Attachment 2 for both cost and schedule risks. Note that the risk register records the PDT's risk concerns, discussions related to those concerns, and potential impacts to the current cost and schedule estimates. The concerns and discussions are meant to support the team's decisions related to event likelihood, impact, and the resulting risk levels for each risk event.

8.3.4 Analyze Cost and Schedule Contingency

Contingency is analyzed using the Crystal Ball software. The software performs Monte Carlo simulations on the probability density functions quantified for each risk item with respect to the appropriate estimate and schedule WBS elements. The result of each simulation is then tallied in a forecast field. After a targeted 10,000 trial iterations, the forecast field is able to then present the results in a normalized histogram format (known as a "confidence-curve"). This curve presents the project cost/duration along with the percentage occurrence out of the 10,000 trials. The project cost/duration corresponding to the 80% cumulative confidence not to be exceeded is selected as the recommend value. The difference between the base project cost/duration and this 80% confidence value is presented as contingency cost/duration. Cost impacts associated with the duration contingency (time value of money and project delays) are included in the cost thresholds within the cost risk model and are presented within the total cost contingency.

8.3.5 Sensitivity Analysis

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

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

8.4 COST & SCHEDULE 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.

8.4.1 Cost Risk Analysis – Cost Contingency Results

The estimated cost without contingency is $81,115,001 at the current price level (July 2020). The 80% confidence level cost is $114,372,151; this yields a contingency amount of $33,257,150 (41%). The following tables and figures present the full results of the cost risk analysis.

Table E3: Project Cost Contingencies

Cost Risk Analysis*		
Project Cost	$	81,461,001
Land & Improvements	*$*	*346,000*
Other Project Cost	*$*	*81,115,001*
Contingency	$	33,297,150
Contingency for Land & Improvements	*$*	*40,000*
Contingency from CSRA	*$*	*33,257,150*
Contingency %		29.02%
Contingency % for Land & Improvements		11.56%
Contingency % from CSRA		41.00%
Cost @ 80% Confidence Level	**$**	**114,758,151**

** June 2020 Price Level*

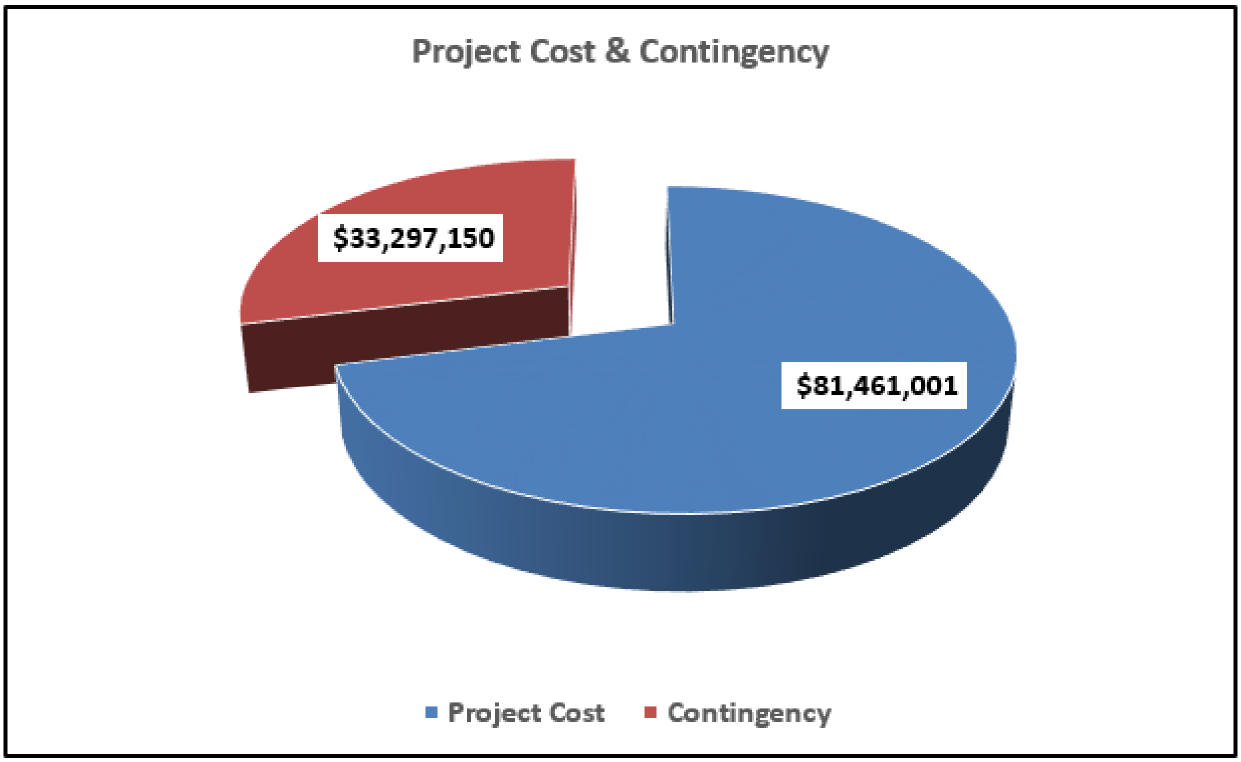

Table E4: Project Cost Confidence Levels

Base Case Estimate (Excluding 01)	$81,115,001	
Confidence Level	**Contingency Value**	**Contingency**
0%	-5,678,050	-7%
10%	14,600,700	18%
20%	17,845,300	22%
30%	21,089,900	26%
40%	23,523,350	29%
50%	25,956,800	32%
60%	27,579,100	34%
70%	30,823,700	38%
80%	33,257,150	41%
90%	37,312,900	46%
100%	60,025,101	74%

8.4.1.1 Key Cost Risk Items

The CSRA identified the following factors as major impacts to the cost for the project. These risks represent key areas for the PDT to focus on future risk management and mitigation. See Attachment 2 for additional details for these risks and further information regarding CSRA development.

- **ES1, Cost Estimate & Schedule Assumptions.** Assumptions in the cost estimate and the schedule may be incorrect.

- **CA1, Contract Acquisition.** Estimate assumes IFB, if another contract mechanism is used, it can affect the project.

- **CV2, Layout of Pump Station/Interior Drainage.** Layout and size of the pump station and interior drainage may be subject to change.

- **CA4, Market Conditions / Bidding Climate.** With the acquisition of the project at least 3 years in the future, it's difficult to predict what kind of market conditions / bidding climate there will be.

- **EX2, Project Funding.** Funding may be restricted due to the magnitude of the cost.

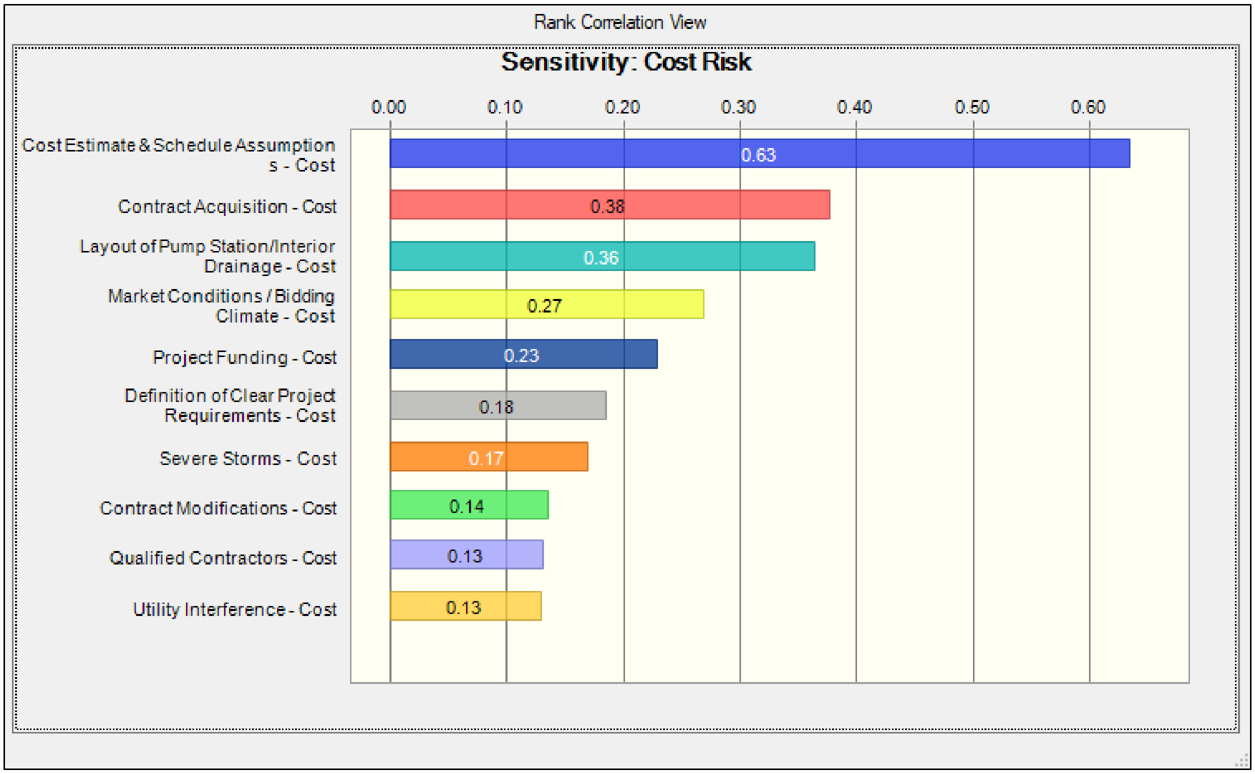

Figure E6: Cost Sensitivity Chart

8.4.2 Schedule Risk Analysis – Schedule Contingency Results

The total project schedule without contingency is 45.0 months beginning January 2024. Results of the Schedule Risk Analysis indicate that the 80% confidence level is 69 months (24 months contingency). Schedule risk is high because historically General Investigations have had difficulty with funding, negotiations with sponsors, and public input. The schedule risk results are presented in the following table and figures.

Table E5: Project Schedule Contingencies

Schedule Risk Analysis			
Description	Start Date	Finish Date	Duration
Project Schedule	1-Jan-24	30-Sep-27	45.0 Months
Contingency			24.3 Months
Schedule Duration @ 80% Confidence Level			**69.3 Months**

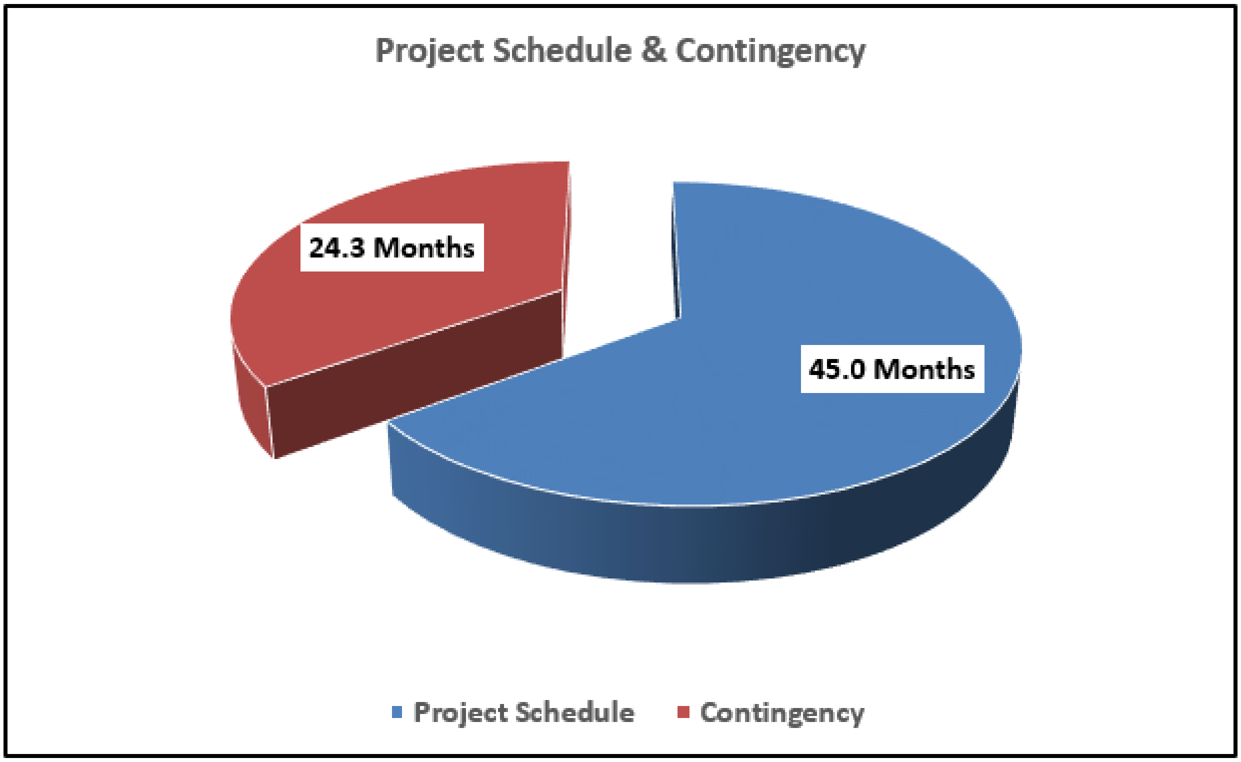

Table E6: Project Schedule Confidence Levels

Base Case Schedule	45.0 Months	
Confidence Level	**Contingency Value**	**Contingency**
0%	-1 Months	-3%
10%	12 Months	26%
20%	14 Months	32%
30%	16 Months	36%
40%	18 Months	40%
50%	19 Months	43%
60%	21 Months	46%
70%	22 Months	50%
80%	24 Months	54%
90%	27 Months	60%
100%	41 Months	91%

8.4.2.1 Key Project Schedule Risk Items

The CSRA identified the following factors as major impacts to the project schedule. These risks represent the key areas for PDT to focus on future risk management and mitigation for the project. See Attachment 2 for additional details for these risks and further information regarding CSRA development.

- **CV3, Pump Station Outfall.** Currently assuming pump station use existing outfall.
- **TR4, Stabilization of the Embankment.** I-95 embankment is considered poor stability.
- **CA1, Contract Acquisition.** Estimate assumes IFB, if another contract mechanism is used, it can affect the project.
- **ES1, Cost Estimate & Schedule Assumptions.** Assumptions in the cost estimate and the schedule may be incorrect.

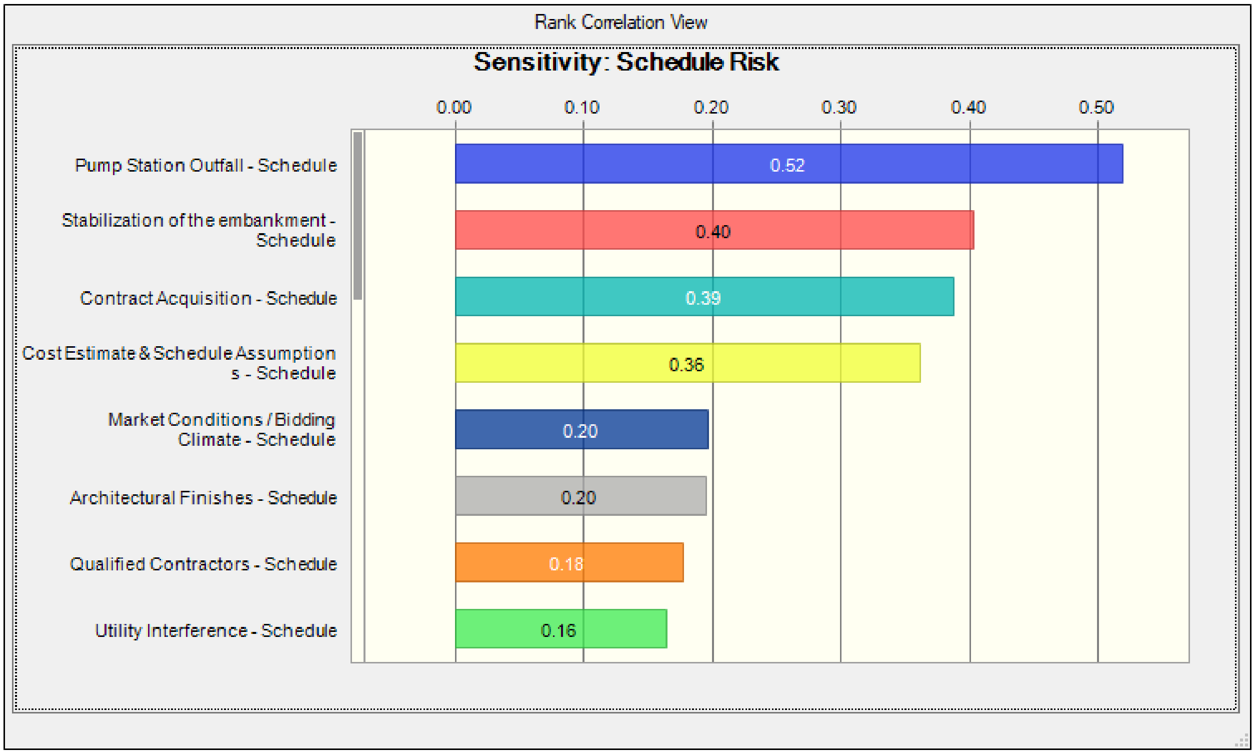

Figure E7: Schedule Sensitivity Chart

8.5 RECOMMENDATIONS

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

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

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

The CSRA study serves as a “road map” towards project improvements and reduced risks over time. The PDT should include the recommended cost and schedule contingencies and incorporate risk monitoring and mitigation on those identified risks. Further iterative study and update of the risk analysis throughout the project life-cycle is important in support of remaining within an approved budget and appropriation.

8.5.1 Risk Management

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

8.5.2 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 reevaluated (using qualitative measures, 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).

9.0 PLANNING, ENGINEERING, AND DESIGN (PED)

The costs were developed for all activities associated with the planning, engineering and design effort. The cost for this account includes the preparation of Design Documentation Reports and plans and specifications for each construction contract and engineering support during construction through project completion. It includes all the in-house labor based upon work-hour requirements, material and facility costs, travel and overhead. The percentage breakout in the Total Project Cost Summary (TPCS), was developed based with input from respective offices in accordance with the CWBS as well as historical prices.

10.0 CONSTRUCTION MANAGEMENT (S&A)

The costs were developed for all construction management activities from pre-award requirements through final contract closeout. These costs include the in-house labor based upon work-hour requirements, materials, facility costs, support contracts, travel and overhead. Costs were developed based on the input from the construction division in accordance with the CWBS and include, but are not limited to, anticipated items such as the salaries of the resident engineer and staff, survey men, inspectors, draftsmen, clerical, and custodial personnel; operation, maintenance and fixed charges for transportation and for other field equipment; field supplies; construction management, general construction supervision; project office administration, distributive cost of area office and general overhead charged to the project. The work items and activities would include, but not be limited to: the salaries of all supervisory, engineering (including resident geologist and geological staff), office and safety field personnel; all on site expenses.

11.0 TOTAL PROJECT COST SUMMARY

The Total Project Cost Summary (TPCS) addresses the inflation through project completion; accomplished by escalation to the mid-point of construction per CWCCIS as required by ER 1110-2-1302 and ETL 1110-2-573. The TPCS includes Federal and non-Federal costs for all construction features of the project, lands and damages, as well as PED and S&A, along with the appropriate contingencies and escalation associated with each of these activities. The TPCS is formatted according to the CWWBS. The TPCS was prepared using the MCACES/MII cost estimate, contingencies developed by the ARA/CSRA, the project design and construction schedule, and estimates of PED and S&A prepared by others. The TPCS is provided as Attachment 3 to this Cost Engineering Appendix.

Table E7: Total Project Cost Summary

CWBS	Feature Account	ESTIMATED COST	PROJECT FIRST COST	FULLY FUNDED COST
CONSTRUCTION				
11	LEVEES & FLOODWALLS	$114,372,000	$117,793,000	$133,990,000
	CONSTRUCTION SUBTOTAL	**$114,372,000**	**$117,793,000**	**$133,990,000**
NON-CONSTRUCTION				
01	LANDS AND DAMAGES	$385,000	$397,000	$420,000
30	PLANNING, ENGINEERING & DESIGN	$8,578,000	$8,970,000	$9,676,000
31	CONSTRUCTION MANAGEMENT (S&A)	$5,719,000	$5,980,000	$7,194,000
	NON-CONSTRUCTON SUBTOTAL	**$14,682,000**	**$15,347,000**	**$17,290,000**
	TOTAL	**$129,054,000**	**$133,140,000**	**$151,280,000**

12.0 COST MCX CERTIFICATION

Project obtained cost certification from the Walla Walla Cost MCX on 30 July 2020.

WALLA WALLA COST ENGINEERING MANDATORY CENTER OF EXPERTISE

COST AGENCY TECHNICAL REVIEW

CERTIFICATION STATEMENT

For Project No. 395890

NAE – Fairfield and New Haven Counties, Connecticut
Coastal Storm Risk Management
Feasibility Study and Environmental Assessment

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

As of July 30, 2020, the Cost MCX certifies the estimated total project cost:

FY21 Project First Cost: $133,141,000
Fully Funded Amount: $151,279,000

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

HILL.DAVID.E.1384235731 Digitally signed by HILL.DAVID.E.1384235731 Date: 2020.07.30 12:12:08 -07'00'

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

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

PROJECT: CT Coastal Storm Damage Reduction Study
PROJECT NO: P2 395890
LOCATION: Fairfield / New Haven, CT

DISTRICT: NAE District
POC: CHIEF, COST ENG., Jeffrey Gaeta

PREPARED: 7/29/2020
UPDATED: 7/29/2020

This Estimate reflects the scope and schedule in report; Fairfield / New Haven, CT CSRM Feasibility Study and EA

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)						TOTAL PROJECT COST (FULLY FUNDED)			
New Haven Recommended Plan						Program Year (Budget EC): 2021 Effective Price Level Date: 1 OCT 20									
WBS NUMBER A	Civil Works Feature & Sub-Feature Description B	COST ($K) C	CNTG ($K) D	CNTG (%) E	TOTAL ($K) F	ESC (%) G	COST ($K) H	CNTG ($K) I	TOTAL ($K) J	Spent Thru: 1-Oct-19 ($K)	TOTAL FIRST COST ($K) K	INFLATED (%) L	COST ($K) M	CNTG ($K) N	FULL ($K) O
11	LEVEES & FLOODWALLS	$81,115	$33,257	41.0%	$114,372	3.0%	$83,541	$34,252	$117,793	$0	$117,793	13.8%	$95,028	$38,962	$133,990
	CONSTRUCTION ESTIMATE TOTALS:	$81,115	$33,257		$114,372	3.0%	$83,541	$34,252	$117,793	$0	$117,793	13.8%	$95,028	$38,962	$133,990
01	LANDS AND DAMAGES	$346	$40	11.4%	$385	3.0%	$356	$41	$397	$0	$397	5.8%	$377	$43	$420
30	PLANNING, ENGINEERING & DESIGN	$6,084	$2,494	41.0%	$8,578	4.6%	$6,362	$2,608	$8,970	$0	$8,970	7.9%	$6,862	$2,814	$9,676
31	CONSTRUCTION MANAGEMENT	$4,056	$1,663	41.0%	$5,719	4.6%	$4,241	$1,739	$5,980	$0	$5,980	20.3%	$5,102	$2,092	$7,194
	PROJECT COST TOTALS:	$91,600	$37,454	40.9%	$129,054		$94,501	$38,640	$133,141	$0	$133,141	13.6%	$107,369	$43,910	$151,279

______________ CHIEF, COST ENG., Jeffrey Gaeta

______________ PROJECT MANAGER, Byron Rupp

______________ CHIEF, REAL ESTATE, Gaelen Daly

______________ CHIEF, PLANNING, John Kennelly

______________ CHIEF, ENGINEERING, David Margolis

______________ CHIEF, OPERATIONS, Eric Pedersen

______________ CHIEF, CONSTRUCTION, Sean Dolan

______________ CHIEF, CONTRACTING, Sheila Winston-Vincuilla

______________ CHIEF, PM-PB, Janet Harrington

______________ CHIEF, DPM, Scott Acone

ESTIMATED TOTAL PROJECT COST: $151,279

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

**** CONTRACT COST SUMMARY ****

PROJECT: CT Coastal Storm Damage Reduction Study
LOCATION: Fairfield / New Haven, CT
This Estimate reflects the scope and schedule in report; Fairfield / New Haven, CT CSRM Feasibility Study and EA

DISTRICT: NAE District
POC: CHIEF, COST ENG., Jeffrey Gaeta

PREPARED: 7/29/2020
UPDATED: 7/29/2020

New Haven Recommended Plan

Estimated Cost — Estimate Prepared: 29-Jul-20; Effective Price Level: 1-Oct-19
Project First Cost (Constant Dollar Basis) — Program Year (Budget EC): 2021; Effective Price Level Date: 1 OCT 20

WBS NUMBER A		Civil Works Feature & Sub-Feature Description B	ESTIMATED COST: COST ($K) C	CNTG ($K) D	RISK BASED CNTG (%) E	TOTAL ($K) F	PROJECT FIRST COST: ESC (%) G	COST ($K) H	CNTG ($K) I	TOTAL ($K) J	TOTAL PROJECT COST (FULLY FUNDED): Mid-Point Date P	INFLATED (%) L	COST ($K) M	CNTG ($K) N	FULL ($K) O
		Recommended Plan													
11		**General Conditions**	$9,284	$3,806	41.0%	$13,091	3.0%	$9,562	$3,920	$13,482	2026Q1	15.3%	$11,026	$4,521	$15,546
11		**T-Wall 1**	$5,521	$2,264	41.0%	$7,784	3.0%	$5,686	$2,331	$8,017	2024Q4	11.3%	$6,328	$2,595	$8,923
11		**T-Wall 2**	$35,391	$14,510	41.0%	$49,901	3.0%	$36,449	$14,944	$51,394	2025Q4	14.5%	$41,744	$17,115	$58,859
11		**Post & Panel Closure Structures**	$3,617	$1,483	41.0%	$5,100	3.0%	$3,725	$1,527	$5,253	2027Q1	18.7%	$4,420	$1,812	$6,233
15		**Pump Station**	$27,302	$11,194	41.0%	$38,496	3.0%	$28,119	$11,529	$39,647	2025Q1	12.1%	$31,510	$12,919	$44,429
		CONSTRUCTION ESTIMATE TOTALS:	$81,115	$33,257	41.0%	**$114,372**		$83,541	$34,252	$117,793			$95,028	$38,962	$133,990
01		LANDS AND DAMAGES	$346	$40	11.4%	$385	3.0%	$356	$41	$397	2023Q1	5.8%	$377	$43	$420
30		PLANNING, ENGINEERING & DESIGN													
	7.5%	Project Management	$6,084	$2,494	41.0%	$8,578	4.6%	$6,362	$2,608	$8,970	2023Q1	7.9%	$6,862	$2,814	$9,676
	0.0%	Planning & Environmental Compliance	$0	$0	41.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	0.0%	Engineering & Design	$0	$0	41.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	0.0%	Reviews, ATRs, IEPRs, VE	$0	$0	41.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	0.0%	Life Cycle Updates (cost, schedule, risks)	$0	$0	41.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	0.0%	Contracting & Reprographics	$0	$0	41.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	0.0%	Engineering During Construction	$0	$0	41.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	0.0%	Planning During Construction	$0	$0	41.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	0.0%	Adaptive Management & Monitoring	$0	$0	41.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	0.0%	Project Operations	$0	$0	41.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
31		CONSTRUCTION MANAGEMENT													
	5.0%	Construction Management	$4,056	$1,663	41.0%	$5,719	4.6%	$4,241	$1,739	$5,980	2026Q1	20.3%	$5,102	$2,092	$7,194
	0.0%	Project Operation:	$0	$0	41.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	0.0%	Project Management	$0	$0	41.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
		CONTRACT COST TOTALS:	$91,600	$37,454		$129,054		$94,501	$38,640	**$133,141**			$107,369	$43,910	**$151,279**

Attachment 1

Project Schedule

Fairfield & New Haven Conneticut Coastal Study - General Investigation

Construction Activity - Projected Time Schedule By: JAG & APJ

01 October 2019 Revised: 29 July 2020

SUMMARY

WBS Line Item Description - Major Feature of Work	Duration (Months)	FY24Q2			FY24Q3			FY24Q4			FY25Q1			FY25Q2			FY25Q3			FY25Q4			FY26Q1		
		2024												2025											
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Fairfield & New Haven Counties																									
New Haven County																									
Recommended Plan	36	1	2	3	4	5	6	7	8	9	10	11				12	13	14	15	16	17	18	19	20	
General Conditions	4	1	2	3	4																				
Wall 1																									
I-Wall Section	3					1	2	3																	
T-Wall Section	2								1	2															
Wall 2	13										1	2				3	4	5	6	7	8	9	10	11	
Post & Panel Closure Structures	10																								
Pump Station	12					1	2	3	4	5	6	7				8	9	10	11	12					
General Conditions	4																								

WBS Line Item Description - Major Feature of Work	Duration (Months)	FY26Q2			FY26Q3			FY26Q4			FY27Q1			FY27Q2			FY27Q3			FY27Q4			FY28Q1		
		2026												2027											
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
		25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
Fairfield & New Haven Counties																									
New Haven County																									
Recommended Plan	36			21	22	23	24	25	26	27	28	29				30	31	32	33	34	35	36			
General Conditions	4																								
Wall 1																									
I-Wall Section	3																								
T-Wall Section	2																								
Wall 2	13			12	13																				
Post & Panel Closure Structures	10					1	2	3	4	5	6	7				8	9	10							
Pump Station	12																								
General Conditions	4																							1	2	3	4			

Attachment 2

Cost & Schedule Risk Analysis

CSRA I

Cost Summary for Risk Register Development

Project: Fairfield/New Haven CSRM

Project Development Stage/Alternative: Feasibility Milestone #4 - CWRB

Risk Category: Moderate Risk: Typical Project or Possible Life Safety

Meeting Date: 5/5/2020

Schedule Duration: Jan-2024 (From (Month/Year)) – Sep-2027 (From (Month/Year))

Schedule Duration: 45.0 Months — 54% (Schedule Contingency)

80% Finish Date: Oct-2029

	WBS	Feature of Work	Contract Cost	% Contingency	$ Contingency	Total
	Risk Not included within CSRA Model					
	01 LANDS AND DAMAGES	Real Estate	$ 346,000	12%	$ 40,000	$ 386,000
	Risk included within CSRA Model					
1	11 02 FLOODWALLS	General Conditions	$ 9,284,146	41%	$ 3,806,500	$ 13,090,646
2	11 02 FLOODWALLS	Wall 1	$ 5,520,811	41%	$ 2,263,533	$ 7,784,344
3	11 02 FLOODWALLS	Wall 2	$ 35,390,811	41%	$ 14,510,233	$ 49,901,044
4	D Services	Post & Panel Closure Structures	$ 3,617,143	41%	$ 1,483,029	$ 5,100,172
5	E Equipment and Furnishings	Pump Station	$ 27,302,090	41%	$ 11,193,857	$ 38,495,947
6			$ -	0%	$ -	$ -
7			$ -	0%	$ -	$ -
8			$ -	0%	$ -	$ -
9			$ -	0%	$ -	$ -
10			$ -	0%	$ -	$ -
11			$ -	0%	$ -	$ -
12			$ -	0%	$ -	$ -
13			$ -	0%	$ -	$ -
14			$ -	0%	$ -	$ -
15			$ -	0%	$ -	$ -
16			$ -	0%	$ -	$ -
17			$ -	0%	$ -	$ -
18			$ -	0%	$ -	$ -
19			$ -	0%	$ -	$ -
20			$ -	0%	$ -	$ -
21			$ -	0%	$ -	$ -
22			$ -	0%	$ -	$ -
23	30 PLANNING, ENGINEERING, AND DESIGN	Planning, Engineering, & Design	$ 6,084,000	41%	$ 2,494,440	$ 8,578,440
24	31 CONSTRUCTION MANAGEMENT	Construction Management	$ 4,056,000	41%	$ 1,662,960	$ 5,718,960
XX	FIXED DOLLAR RISK ADD (EQUALLY DISPERSED TO ALL, MUST INCLUDE JUSTIFICATION SEE BELOW)				$ -	

Totals	Contract Cost	% Contingency	$ Contingency	Total
Real Estate	$ 346,000	12%	$ 40,000	$ 386,000.00
Total Construction Estimate	$ 81,115,001	41%	$ 33,257,150	$ 114,372,151
Total Planning, Engineering & Design	$ 6,084,000	41%	$ 2,494,440	$ 8,578,440
Total Construction Management	$ 4,056,000	41%	$ 1,662,960	$ 5,718,960
Fixed Dollar Risk Equally Distributed	$ -	0%	$ -	$ -
Total	**$ 91,601,001**	**0%**	**$ 37,454,550**	**$ 129,055,551**

Cost and Schedule Risk Analysis **Fairfield/New Haven CSRM**

Risk Facilitator: Jeffrey Gaeta

Risk Register Meeting

Date: 5/5/2020

Attendance	Name	Office	Representing
Full	Byron Rupp	CENAE-PDP	Planning/Economics
Full	Henry Phillips	CENAE-EDD	Civil
Full	Lisa Winter	CENAE-EDW	Coastal
Full	Doug Fransioli	CENAE-EDW	Geotech
Full	Thuyen Nguyen	CENAE-EDD	Structural
Full	Cesar Lopez	CENAE-CDS	Construction
Full			
Full			
Full			
Full			
Full			
Full			
Full			
Full			
Full			

Follow-Up Discussions - Individual or group discussions

Date: 5/19/2020 **through**

Attendance	Name	Office	Representing
Full	Byron Rupp	CENAE-PDP	Planning/Economics
Full	Henry Phillips	CENAE-EDD	Civil
Full	Lisa Winter	CENAE-EDW	Coastal
Full	Doug Fransioli	CENAE-EDW	Geotech
Full	Thuyen Nguyen	CENAE-EDD	Structural
Full	Cesar Lopez	CENAE-CDS	Construction

Follow-Up Meeting Notes

PDT members provided comments on risk register details in a follow-up webinar on 5/19/2020. Comments were mostly grammatical.

				Project Cost			Project Schedule			Other Information						
CREF	Risk/Opportunity Event	Risk Event Description	PDT Discussions on Impact and Likelihood	Likelihood ©	Impact ©	Risk Level ©	Likelihood (S)	Impact (S)	Risk Level (S)	Cost Variance Distribution	Schedule Variance Distribution	Correlation to Other(s)	Responsibility/ POC	Affected Project Component	Risk Quantification Discussions	Suggested Risk Reduction Measures
Organizational and Project Management Risks (PM)																
PM1	Approvals of Critical Items	There are likely approvals required by other agencies that may affect project moving forward.	Other agencies (CTDOT for example) will have input/approval on aspects of the project. Approvals from others will happen during PED. No cost impact is expected. It is likely to impact project schedule and the impact could be significant due to "critical" item discussion.	Unlikely	Negligible	Low	Likely	Significant	High	Uniform	Uniform		Project Management	Project Schedule	It is estimated these additional approval periods could add as much as 3 months to the design schedule.	Design charettes, establish data gaps and coordinate with DOT/others to fill gaps. Additional mitigation measure is to build approval schedule into PED schedule. Additional mitigation possible due to high visibility of project for the State.
PM2	Definition of Clear Project Requirements	Final location of walls, design of walls, location/design of pump station(s)	Some major features of work are still in flux and subject to change. Some features of work such as the wall are in discussions to have length reduced, however pump station requirements are still unknown. Since the initial meeting, additional design was done to tighten up design of the wall and pump station quantity and size.	Possible	Moderate	Medium	Possible	Moderate	Medium	Triangular	Triangular		PDT	Contract Cost & Schedule	COST and SCHEDULE: Selection of Alternative 3B, which is now the recommended plan, was selected as it provided by greatest net benefits. There are no additional benefits to be gained by extending the wall lengths further north as was the case with Alternative 4A and 4B. In fact, it is possible the wall length for this alternative, now the recommended plan, could be reduced on the northern end by as much as 10-20%. The low variance has been calculated as a 15% reduction of cost and schedule for Wall 2 while the high variance has been calculated as 5% increase to cost	Conceptual "final" layout/locations will be used in the feasibility study. Final layout/locations will be set during PED phase.
PM3	Establishing Formal Non-Federal Sponsor		Letter of support is necessary in order to complete the study. CTDEEP is the study sponsor but is not an adequate funding source to cost-share the project. No risk to cost or schedule because if no sponsor is identified the study will not be approved.	Unlikely	Negligible	Low	Unlikely	Negligible	Low	N/A -Not Modeled	N/A -Not Modeled		Project Management	N/A -Not Modeled	Risk not modeled.	Risk not modeled.
Contract Acquisition Risks (CA)																
CA1	Contract Acquisition	Estimate assumes IFB, if another contract mechanism is used, it can affect the project.	This will be a large contract, there is potential for it go Best Value, where project cost is not the most important selection factor. There is potential to affect project cost. The BV process also has the potential to delay contract award. The PDT feels the likelihood is possible while the impact is moderate for both cost and schedule	Possible	Moderate	Medium	Possible	Moderate	Medium	Yes-No	Yes-No		PDT	Project Cost & Schedule	SCHEDULE: The best value process has the potential to add anywhere from 3 to 12 months to the procurement schedule. For the sake of this exercise, after discussion with the NAE Chief of Contracts Branch, we have used 6 months as the additional schedule delay. COST: There is also additional cost to PED if a best value procurement were used in addition to the increase in escalation from the delay in construction contract award. The biggest issue concerning the cost of the project would be the best value procurement where cost is not the most important factor and the construction cost increases. The PDT agrees this could add ~10% to the construction cost. LIKELIHOOD: It should be noted that the likelihood of a best value procurement is not an even selection with IFB. Cost Engineer assumes 20% chance of a best value procurement being selected as there is not much specialized construction or any otherwise extremely difficult features of work that would necessitate the need for best value besides coordination and the total value of the project.	No risk reduction measures applicable. If the PDT determines a best value procurement is the best path forward then so be it.
CA2	Qualified Contractors	With a project of this size at a point in the future, it is unclear if an adequate pool of qualified contractors will be available.	Unqualified contractors are always a risk, however the PDT feels this is mitigated by the large construction cost which will require a construction firm with a large bond who has successfully completed similar work in the past. Also, the project consists of fairly standard features of work and there should be no issue finding qualified contractors.	Possible	Marginal	Low	Possible	Marginal	Low	Uniform	Uniform		Contracting	Contract Cost & Schedule	The cost and schedule both currently assume a qualified contractor will be performing the work. COST: The likely value is zero as is the low variance value. The high variance has been calculated as 5% of the construction cost. SCHEDULE: The likely value is zero as is the low variance value. the high variance has been estimated at 3.6 months of the total duration.	The best value procurement is one way to ensure the project is awarded to a qualified contractor. Conducting proper market research and taking time with acquisition strategy are more risk reduction measures.
CA3	Contract Modifications	Uncovering unforeseen conditions.	There is always the possibility of unforeseen issues in the field. These issues have the potential to affect project cost and schedule.	Possible	Significant	Medium	Possible	Significant	Medium	Triangular	Triangular		Construction	Contract Cost & Schedule	COST: The likely value has been calculated as 5% of the construction cost while the low and high variance have been calculated as 2% and 10%, respectively. SCHEDULE: The likely value has been estimated at 4 months of the total duration while the low and high variance have been estimated at 2 and 6 months, respectively.	Contract modificiations are almost a certainly in a project of this magnitude. Producing clear and understandable plans and specifications will go far in reducing potential contract modifications but unforeseen site conditions is always a possibility.
CA4	Market Conditions / Bidding Climate	With the acquisition of the project at least 3 years in the future, it's difficult to predict what kind of market conditions/bidding climate there will be.	There is always the possibility of a change in market conditions/bidding climate. There's an equal chance of it improving or worsening over time; even more so the farther into the future we look. It is possible this risk could have a significant impact on both cost and schedule.	Possible	Significant	Medium	Possible	Significant	Medium	Triangular	Triangular		Cost Engineering	Project Cost & Schedule	COST: The likely value is zero while the low and high variance have been calculated as -5% and +10% of the construction cost, respectively. SCHEDULE: The likely value is zero while the low and high variance have been estimated as -/+3 months, respectively.	Conduct market research during PED as soon as possible in the acquisition process.
General Technical Risks (TR)																
TR1	Pump Station(s) Controls	Identifying control packages for pump stations	Pump stations will need alarms, instrumentation, and controls to be designed and incorporated. These details will likely be designed during the PED phase. It is possible the control package(s) for this specific project will require something different than the average pump station included in the award data however the impact is expected to be marginal given the total cost of the pump station.	Possible	Marginal	Low	Unlikely	Negligible	Low	Uniform	N/A -Not Modeled		Mechanical Design	Contract Cost	The pump station cost has been calculated based on actual award cost data from Jacksonville District and is likely to include all necessary appertances. If there is something abnormal thas is necesary for this specific project, it is estimated the high variance would be an additional 2% of the pump station cost, while the low variance would be zero (i.e. everything specific to this project is included in the source data).	Refined requirements of the pump station will be established during the PED phase.
TR2	Utility Availability	Pump station will require connection to power/comms/existing drainage system	It is unclear where we can tie into power, comms, and existing drainage system for the proposed pump stations. It is possible the connections for this specific project will require longer runs than the average pump station included in the award data.	Possible	Moderate	Medium	Unlikely	Negligible	Low	Uniform	N/A -Not Modeled		Mechanical Design	Contract Cost	The pump station cost has been calculated based on actual award cost data from Jacksonville District and is likely to include all required connections. It is, however, unclear of the number of connections and distances required in both the award data used and the specifics of this project. It is possible additional connections and distances will be necesary for this specific project, it is estimated the high variance would be an additional 10% of the pump station cost, while the low variance would be zero (i.e. everything specific to this project is included in the source data).	Refined requirements of the pump station will be established during the PED phase.
TR3	Utility Interference	The area is littered with utilities that will need to be incorporated into the design of the features of work	In the design phase, a full capturing of existing utilties is going to be necessary to ensure we are working around them and not interfering with them. Identifying tie-in locations with owners will also be necessary.	Very Likely	Significant	High	Very Likely	Significant	High	Uniform	Uniform		Project Management	Contract Cost & Schedule	Since all features of work include subsurface sheeting and/or pipe piles, there will be some interference with existing utilities. COST: The likely value has been calculated as 5% of the construction cost while the low and high variance have been calculated as 2% and 10% of the construction cost, respectively. SCHEDULE: The likely value has been estimated at 3 months while the low and high variance has been estimated at 1 month and 6 months, respectively.	An investigation of the site will be conducted during the PED phase to identify the location utilities in the study area. The construction will need to accommodate all existing utilities.
TR4	Stabilization of the embankment	I-95 embankment is considered poor stability	To protect the embankment, we will install T-Wall at the toe of the embankment. There is the possiblity of requiring stone protection along the embankment and at the toe of the T-Wall. Since the initial meeting, it was noted that the existing estimate already includes rip rap along all I-wall and T-wall lengths. It is possible the need for stabilization will be reduced or eliminated but is also equally possible the quantity of rip-rap will need to be increased.	Possible	Marginal	Low	Possible	Marginal	Low	Triangular	Triangular		Geotechnical/Civil Design	Contract Cost & Schedule	COST: The likely value is zero while the low variance represents a 50% decrease in the current cost for stablization and the high variance represents a 50% increase in the current cost for stablization. SCHEDULE: The likely value is zero while the low variance represents a 50% decrease in the current schedule for installation of the stablization and the high variance represents a 50% increase in teh current schedule for installation.	Further refinement of the site and additional study of the requirements during PED will determine the best course of action for stabilization and the ability to remove or need to increase the existing assumption of necessary rip rap.
Architectural and Interior (AI)																
AI1	Architectural Finishes	Sponsor requiring "fancy" finishes to make permanent features more appealing to the eye.	Project area is highly visible to the public and may require some added asthetic appeal.	Possible	Moderate	Medium	Possible	Moderate	Medium	Yes-No	Yes-No		Structural Design	Contract Cost & Schedule	COST: The low variance cost impact is zero assuming no additional work is necessary to the faces of the walls while the high variance cost impact assumes both sides of the wall will require stamping. SCHEDULE: The low variance schedule impact is zero assuming no additional work is necessary while the high variance schedule impact assumes both sides fo the wall will require stamping. LIKELIHOOD: The Cost Engineer assumes the likelihood of having to include stamping in the design is 20%.	The additional cost is likely to deter the local sponsor for these requirements given the project is cost shared, however items like these will be flushed out and decided on during the PED phase.
AI2	Building Construction for Closure Structure/Pump Station features	Potential for requirement to construction structure to house features in during non-use.	City or DOT likely have existing storage areas for these features. No additional structures are anticipated to be required.	Unlikely	Negligible	Low	Unlikely	Negligible	Low	N/A -Not Modeled	N/A -Not Modeled		Local Sponsor	N/A -Not Modeled	Risk not modeled.	Risk not modeled.

				Project Cost			Project Schedule			Other Information						
CREF	Risk/Opportunity Event	Risk Event Description	PDT Discussions on Impact and Likelihood	Likelihood ©	Impact ©	Risk Level ©	Likelihood (S)	Impact (S)	Risk Level (S)	Cost Variance Distribution	Schedule Variance Distribution	Correlation to Other(s)	Responsibility/ POC	Affected Project Component	Risk Quantification Discussions	Suggested Risk Reduction Measures
Civil/Site Design (CV)																
CV1	Layout of Wall	Layout may be subject to change	The existing wall layout is nearly at the maximum extent possible. The tie-ins to existing is the only area that is likely to change based on topography. There is a possibility of ~1,000 ft of 0-2 ft wall that may be unneccesary or can be constructed with something other than T-Wall. Overall, very little cost and schedule impact is anticipated with these two possibilities.	Possible	Negligible	Low	Possible	Negligible	Low	N/A -Not Modeled	N/A -Not Modeled		Geotechnical/Civil Design	Included within Other Risk/Model Item	Risk is already being modeled in Risk PM2 :: Definition of Clear Project Requirements	Risk is already being modeled in Risk PM2 :: Definition of Clear Project Requirements
CV2	Layout of Pump Station/Interior Drainage	Layout may be subject to change	Analysis of interior drainage and pump requirements is going to be required in PED. Existing pump station sizing is hopefully conservative and as new information becomes available, the sizing can be refined. Interior drainage design is lacking but will modeled and refined in design phase. It is likely the cost for the pump station has been overestimated but just as likely the cost is slightly underestimated. The schedule for the pump station is not as important as it's assumed to be off the critical path and can be done concurrently with the wall construction.	Possible	Significant	Medium	Possible	Marginal	Low	Triangular	N/A -Not Modeled		PDT	Contract Cost	The source data provides a range of CFS costs. The minimum value is ~65% less than the average while the maximum value is ~59% higher. Splitting the difference, the likely value is zero while the low variance represents a 30% decrease in the current pump station cost and the high variance represents a 30% increase in the current pump station cost (approximately half the difference between the average and min and max).	
CV3	Pump Station Outfall	Currently assuming pump station can use existing outfall	Unsure if existing outfall can be used for proposed pump station, current assumption is capacity will be available. Alternatives include new outfall or modifying existing outfall. Schedule impact is significant due to additional environmental coordination.	Possible	Marginal	Low	Possible	Significant	Medium	Yes-No	Yes-No		Project Management	Project Cost & Schedule	COST: The low variance is zero assuming the current assumption of using the existing outfall is acceptable while the high variance represents the cost for installation of a new outfall. SCHEDULE: The low variance is zero assuming the current assumption is acceptable while the high variance represents anticipated schedule impact due to additional environmental coordination as well as the assumed installation time. LIKELIHOOD: The Cost Engineer assumes the likelihood of being able to use the existing outfall is 50%.	
CV4	Basis of Design	Height of Features (height above ground)	Some risk exists that we may have to increase the height of the wall based on the final location vs existing elevations. The PDT feels the height of protection is conservative but changes to the model and/or sea level rise may alter the height of protection during PED.	Possible	Moderate	Medium	Possible	Marginal	Low	Uniform	Uniform		PDT	Project Cost & Schedule	COST: The low variance is zero assuming the current height is acceptable while the high variance represents the cost for an additional 2 feet of wall height. 2 feet of height increase is equal to approximately 7% more volume of concrete, therefore the cost increase is assumed to be 7%. SCHEDULE: The low variance is zero assumingi the current height is acceptable while the high variance represents the schedule increase due to an additional 2 foot of wall height.	
Structural (SD)																
SD1	Wall foundation design	Wall foundation design is based on existing geotechnical information	More robust design and additional existing site condition information will affect the layout and size of wall. Existing conceptual design is considered "middle of the road" as there is just not enough subsurface information.	Likely	Moderate	Medium	Likely	Moderate	Medium	Triangular	Triangular		Geotechnical/Civil Design	Contract Cost & Schedule	COST: The likely value is zero while the low variance represents a 2% reduction in cost and the high variance represents a 5% increase. SCHEDULE: The likely value is zero while the low variance represents a 2% reduction in schedule and the high variance represents a 5% increase.	Additional subsurface exploration will be done in PED and the wall foundation design will be refined at that time.
SD2	Foundation for Closure sttructures	Foundation for closure structures is likely to interfere with existing utilities	The affected utilities will either need to be temporarily rerouted and reinstalled after construction or the foundation design changed to accommoate those utilities.	Very Likely	Significant	High	Very Likely	Significant	High	N/A -Not Modeled	N/A -Not Modeled		Project Management	Included within Other Risk/Model Item	Risk is already being modeled in Risk TR3 :: Utility Interference	Risk is already being modeled in Risk TR3 :: Utility Interference
SD3	Structure Types	Additional structure types could be considered with additional information	If we had more information, the design could include additional structure types that could be cheaper and faster to install. These additional structure types, such as a berm, may require additional footprint to construct.	Possible	Negligible	Low	Possible	Negligible	Low	N/A -Not Modeled	N/A -Not Modeled		PDT	Project Cost & Schedule	Risk will not be modeled. PDT does not want to take "credit" for potential alternative designs at this point without additional information. Current design is more "conservative" than alternatives so no risk reduction will be included in the risk assessment.	
SD4	Pump Station	Type/Size/Location of actual pump station(s) will affect structural requirements.	Due to the lack of information on the pump station(s), the conceptual cost estimates may not include the necessary structural requirements.	Possible	Significant	Medium	Possible	Marginal	Low	N/A -Not Modeled	N/A -Not Modeled		PDT	Included within Other Risk/Model Item	Risk is already being modeled in Risk CV2 :: Layout of Pump Station/Interior Drainage	Risk is already being modeled in Risk CV2 :: Layout of Pump Station/Interior Drainage
Electrical (EE)																
EE1				Unlikely	Negligible	Low	Unlikely	Negligible	Low							
Mechanical (ME)																
ME1				Unlikely	Negligible	Low	Unlikely	Negligible	Low							
Fire Protection (FE)																
FE1				Unlikely	Negligible	Low	Unlikely	Negligible	Low							
Equipment (EQ)																
EQ1	Crane Availabilty	Cranes will likely be necessary to install closure structures when needed.	The sponsor may need to acquire cranes for this work. Cost for crane purchase will be included in the cost estimate.	Very Likely	Negligible	Low	Unlikely	Negligible	Low	N/A -Not Modeled	N/A -Not Modeled		Local Sponsor	N/A -Not Modeled	Risk not modeled.	Risk not modeled.
Commissioning/Certification (CC)																
CC1				Unlikely	Negligible	Low	Unlikely	Negligible	Low							
Lands and Damages (LD)																

				Project Cost			Project Schedule			Other Informatio						
CREF	Risk/Opportunity Event	Risk Event Description	PDT Discussions on Impact and Likelihood	Likelihood ©	Impact ©	Risk Level ©	Likelihood (S)	Impact (S)	Risk Level (S)	Cost Variance Distribution	Schedule Variance Distribution	Correlation to Other(s)	Responsibility/ POC	Affected Project Component	Risk Quantification Discussions	Suggested Risk Reduction Measures
LD1	Real Estate	Adequate real estate	A vast majority of property necessary for the project is either State or City owned. It is unlikely the project will experience any cost or schedule impact due to real estate issues. The estimate does include real estate costs as well as a contingency established by NAE Real Estate Division. It is possible the extension of the project could result in additional real estate issues but the impact is expected to be marginal at best.	Possible	Marginal	Low	Possible	Marginal	Low	Uniform	Uniform		Real Estate	Project Cost & Schedule	COST: The low variance is zero assuming the current real estate costs are accurate while the high variance represents a 25% increase in real estate costs. SCHEDULE: The low variance is zero assuming the current timeline for real estate is accurate while the high variance is estimated as a one month increase in project schedule to address the additional real estate requirements.	
LD2				Unlikely	Negligible	Low	Unlikely	Negligible	Low							
Regulatory Environmental Risks (RG)																
RG1	Environmental Issues		Environmental being addressed with EA/FONSI. Minor issues exist related to scour which is being addressed.	Unlikely	Negligible	Low	Unlikely	Negligible	Low	Uniform	Uniform		Environmental Compliance	Project Cost & Schedule		
Construction Risks (CO)																
CO1	Restricted Work Hours	Possibility of restricted hours of work?	Very few residential areas impacted (save for southerly end) and the wall is being pulled down the embankment away from I-95. Little to no additional restricted work hours anticipated. The schedule includes no work from December through February due to the winter months and does not include weekend work. It does include 10-hour days Monday through Friday. The PDT feels this is an acceptable work schedule given the location and project specifics at this time.	Unlikely	Negligible	Low	Unlikely	Negligible	Low	N/A -Not Modeled	N/A -Not Modeled		Project Management	N/A -Not Modeled	Risk not modeled.	Risk not modeled.
Estimate and Schedule Risks (ES)																
ES1	Cost Estimate & Schedule Assumptions	Assumptions in the cost estimate and the schedule may be incorrect.	There are many assumptions carried in the cost estimate and the schedule. It is possible some could be scewed due to unforeseen conditions in the future. A majority of these have been accounted for elsewhere in the risk analysis. There are heavy productivity reductions assumed in the cost estimate and schedule that, favorably, may be mitigated by the final location of the wall layout. Unfortuntely, no quotes were obtained for any material on the project (including concrete, pipe piles, or sheeting). Considering materials make up 50% of the direct costs, not including subbid costs from the pump station, any variability in material costs will greatly affect the contract cost.	Possible	Significant	Medium	Possible	Significant	Medium	Triangular	Triangular		Construction	Contract Cost & Schedule	COST: The likely value is zero assuming all assumptions in the cost estimate and schedule are accurate while the low variance is calculated as a 15% cost reduction on the total construction cost if productivity can be increased and the high variance is calculated as a 20% cost increase if material pricing increases or certain aspects of the scope are missing. SCHEDULE: The likely value is zero assuming all assumptions in the schedule are accurate while the low variance is estimated to represent a 15% reduction in duration and the high variance is estimated to represent a 15% increase to account for any missing scope items.	
ES2				Unlikely	Negligible	Low	Unlikely	Negligible	Low							
External Risks (EX)																
EX1	Severe Storms	Ability of severe storms to disrupt construction progress	Project is located in NE along the coast is subject to severe weather events. It is possible there would be storms severe enough to affect the cost and schedule of the project, especially given the 3 year construction duration.	Possible	Moderate	Medium	Possible	Moderate	Medium	Uniform	Uniform		Project Management	Contract Cost & Schedule	COST: The low variance is zero assuming no severe storms hit the project site. The high variance has been calculated as 6% of the construction cost; this represents 2% cost impact per year over the 3 year construction duration. SCHEDULE: The low variance is zero assuming no severe storms hit the project site. The high variance has been estimated as 3 months; this represents 1 month per year over the 3 year construction duration.	There is no ability to mitigate severe storms occuring. The contractor will be monitoring the weather to prevent additional damages to equipment and personnel as much as possible.
EX2	Project Funding	Funding may be restricted due to magnitude of cost.	Possibility of delays in obtaining project funding or having to phase the project may result in schedule delays. With the low BCR the project currently has, it is likely the project will have to fight for funding amongst the other GI projects across the country. It would not be	Likely	Significant	High	Unlikely	Negligible	Low	Uniform	N/A -Not Modeled		Project Management	Project Cost & Schedule	It is likely this project will have to fight for funding due to the relatively low BCR. It is possible for delays up to 3 years or longer before funding is received. This translates into cost impacts due to pushing the midpoint of construction 3 years to the right.	There is no ability to mitigate funding concerns. Hopefully the local representatives will be able to push and advocate for the project to move it ahead in the process to ensure funding is available as soon as possible.
EX3	Public Support	There is a risk the public will not support the project.	The project is currently supported by the public. With limited private property concerns and current support by the public and State of CT, there is little cost and/or schedule delays associated with this risk. It's unlikely that would change in the future, but a nominal cost and schedule impact is included in the risk analysis nonetheless. The impact is moderate, however, as public support, especially by the non-federal sponsor, is crucial to the success of the project.	Unlikely	Marginal	Low	Unlikely	Negligible	Low	Yes-No	N/A -Not Modeled		Project Management	Project Cost & Schedule	If public support wains for the project, it may delay the project. It is estimated this could add up to 3 months of delay to the project schedule during PED phase. This translates into cost impacts due to pushing the midpoint of construction 3 months to the right. LIKELIHOOD: The Cost Engineer assumes the likelihood of the public not supporting the project is 5%.	Start working with the public as soon as possible to ensure the process is smooth and any objections or issues can be dealt with as soon as possible to avoid delays.
EX4	Living Shoreline Project	Adjacent project may affect contractor's ability to work in same general area.	Living shoreline project is funded and will likely start, if not complete, construction before we begin construction. Design of features currently assume shoreline project is complete (i.e. no erosion protection was considered). If shoreline project falls through, additional design may be necessary.	Possible	Marginal	Low	Possible	Marginal	Low	N/A -Not Modeled	N/A -Not Modeled		Project Management	N/A -Not Modeled	Risk not modeled.	Risk not modeled.