Appendix G. Cost Estimate TSP – 3B

US Army Corps
of Engineers

TABLE OF CONTENTS

1.0	Introduction	…….	**3**
2.0	Cost Methodology	…….	**3**
2.1	Basis of Design	…….	**3**
2.2	Basis of Quantities	…….	**4**
3.0	Construction Schedule	…….	**4**
4.0	Acquisition Plan	…….	**5**
5.0	Operation and Maintenance Cost	…….	**5**
6.0	References	…….	**6**
	Attachments		

1.0 Introduction

The purpose of this appendix is to summarize the assumptions and basis of the cost estimate for the Tar Pamlico River Basin FRM. This includes the costs of the construction as well as the risk-based contingency resulting from the CSRA facilitated by Brandon Scott.

2.0 Cost Methodology

The preparation of the cost estimate is in accordance with guidelines and policies included in: "ER 1110-1-1300 - Cost Engineering Policy and General Requirements, (26 March 1993)"; "ER 1110-2-1302 - Civil Works Cost Engineering, (30 June 2016)"; "EI 01D010, Construction Cost Estimates (1 Sept 1997)"; "EM 1110-1-8, Construction Equipment Ownership and Operating Expense Schedule, Region 11, (November 2016)"; and "EM 1110-2-1304, Civil Works Construction Cost Index System (CWCCIS), (30 March 2023)."

Templates for pricing the scope of work and performing quantity take-offs using the structure data on the individually identified homes and commercial buildings was provided by USACE National Non-structural Committee (NNC). The MII templates were updated to 2024Q1 pricing and used to price the effort.

2.1 Basis of Design

A CLASS 3 Estimate is required for pricing the recommended plan for cost certification based on ER 1110-2-1302. Design of the work is based upon data provided by the economist for each residential structure identified within each floodplain reach. Data provided is as follows:

1. current building elevations,
2. foundation wall height required to protect to the 1% AEP flood elevation plus 2 feet, and
3. perimeter of foundation wall (all structures have crawl space foundations).
4. The MII templates created by National Non-structural Committee (NNC) provided the major features of work for elevating crawl space structures.

Cost was established for 8 structures identified as requiring flood vents added to the existing foundation walls, 18 structures identified as requiring construction of elevated foundation walls with flood vents installed for every 100-SF of foundation wall, and 35 structures identified as requiring extension of an existing vented foundation wall. To capture the cost of the identified structures the following calculations were made:

EQ1.	Square Foot of Required Foundation Wall per Individual Structure
EQ2.	Sum of Foundation Wall Square Footage
EQ3.	Sum of Perimeters
EQ4.	Divide Sum of Wall SF by Sum of Perimeters = Elevation Height (weighted average)
EQ5.	Using a rounded Elevation Height: Divide the Sum of Foundation Wall Square Footages by the Calculated Elevation Height and Divided by the number of Structures yields the Calculated Weighted Average Perimeter.
EQ6.	The Calculated Elevation Height X The Calculated Perimeter X The Number of Structures = The Sum of Foundation Wall Square Footage calculated.

Dry Floodproofing of identified commercial structures require protected to the 1% AEP floodplain plus 2 feet with a limited maximum height of 4 feet. To price the major features of work to dry floodproof the identified structures, data on each structure provided by the economist was inputted into a Quantity Take Off spread sheet template provided by NNC. The data was used in the MII pricing template also provided by NNC to determine a final cost for 94 structures.

Total Project Costs includes the cost of construction of the project items CWWBS 19, Buildings, Grounds, & Utilities; CWWBS 30, Planning, Engineering, and Design (PED); and CWWBS 31, Construction Management (CM); and CWWBS 01, Lands and Damages.

PED – 30 Account estimated cost is based on 29.5% of construction and CM – 31 Account estimated cost is based on 14.5% of construction. Lands and Damages – 01, Real Estate cost is provided by the Real Estate PDT.

All items in this cost estimate are presented in 2024-Q1 dollars.

2.2 Basis of Quantities

Data on the identified structures receiving flood proofing efforts and provided by the economists and MII and Quantity Take Off templates provided by NNC established the design and quantities for pricing the major features of work.

Bare Costs and Mark Ups

- MII 2023 Q1 English Cost Book was used for general cost data.
- Equipment rates are based on the Department of the Army EP 1110-1-8 "Construction Equipment MII 2022 Q4 Library
- Fuel costs were checked against "My-Gas-Buddy" website and DOE averages.
- Prime contractor markups include 24.36% Job Office Overhead, 10% Home Office Overhead, 8% profit, 1% performance and payment bond.
- Subcontractor markup is 26.57%.
- It is assumed that all of the work is subcontracted.
- Sales tax of 7.25% is included.
- Labor rates were based on North Carolina Bureau of Labor and Statistics data and checked against Davis-Bacon Rates for the region. BLS May 2023 Rates were escalated 11% for holidays and vacation and sick leave; 10% for COLA; 25% for fringe; and 5% for PLA. Rates were checked to assure the minimum rate of $17.20 per Davis-Bacon was met.

3.0 Construction Schedule

For the tentatively selected alternative a 36 - month period is assumed for design, solicitation and award. Construction is anticipated to take approximately 8-years based on the assumption that dry floodproofing will be the critical path work, there will be up to 3 crews working concurrently, and duration is approximately 97 months. Holidays, weather, and job coordination time are included.

4.0 Acquisition Plan

It is assumed that all work will be subcontracted.

5.0 Operation and Maintenance Cost

O&M costs is assumed to be none considering that construction involves personal residents and buildings.

6.0 References

U.S. Army Corps of Engineers, 1993, *Engineering and Design Cost Engineering Policy and General Requirements,*
Engineering Regulation 1110-1-1300, Department of the Army, Washington D.C., 26 March 1993.

U.S. Army Corps of Engineers, 1999, *Engineering and Design for Civil Works Projects, Engineering Regulation 1110-2-1150,* Department of the Army, Washington D.C., 31 August 1999.

U.S. Army Corps of Engineers, 2008a, *Civil Works Cost Engineering, Engineering Regulation*
1110-2-1302, Department of the Army, Washington D.C., 15 September 2008.

U.S. Army Corps of Engineers, 2008b, *Construction Cost Estimating Guide For Civil Works, Engineering Technical Letter 1110-2-573,* Department of the Army, Washington D.C., 30 September 2008.

ATTACHMENTS

MII Estimate

RESPONSE: PLA WAGES: Rates = BLS escalated for hol, sl, vac, cola, union avg labor

TSP Alternative;

1.) 3B: Comprehensive Benefits Plan: which reasonably maximized benefits across all categories.

2.) To estimate the cost of the recommended plan. MII Templates from the USACE National Nonstructural Committee (NNC) and the Economist's field data on the included structures was the estimated design. A BOE workbook titled, "BOE for Dry FP_QTY Take-Off - TSP-3B" for determining estimate quantities is also included in the package.

3.) It is assumed that a contract will be awarded to a Prime Contractor who will subcontract the work to specialty contractors.

4.) Prime Markups: JOOH = 24.36%; HOOH = 10%; Profit = 8%; Bond = 1%.

5.) Sub Contractor Overhead: JOOH = 5%; HOOH = 10%; Profit = 10%

6.) Project Markups: 95% Productivity; 7.25% Sales Tax; 3.38 Inflation for EQ; 1.34% Inflation on Material (CB)

Estimated by	Debra A Hunter
Designed by	NNC Templates; EconReport - FRM;
Prepared by	Debra A Hunter
Preparation Date	3/28/2024
Effective Date of Pricing	3/28/2024
Estimated Construction Time	2,920 Days

Description	ProjectCost
New Section	**44,951,217.74**
ALTERNATIVE 3B - - NON-STRUCTURAL FLOODPROOFING 155 Structures	**44,951,217.74**
19 BUILDINGS, GROUNDS, AND UTILITIES - Flood Vents - 8 structures	**115,877.81**
19 BUILDINGS, GROUNDS, AND UTILITIES - Elevate18 Structures with Flood Vents	**4,397,253.64**
19 BUILDINGS, GROUNDS, AND UTILITIES - Elevate 35 Structures _wall height extended	**5,979,634.00**
19 BUILDINGS, GROUNDS, AND UTILITIES DRY FP 94 Structures.	**34,458,452.29**

Project Schedule

SCHEDULE - 3B	2026																	20
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
PED																		
ELEVATIONS 3B																		
DRY FLOODPROOFING 3B																		
CLOSE OUT 3B																		

P1

The schedule assumes the following:

3-4 Dry Floodproofing Crews
2-3 Elevation Crews
40-hour, 5-days/week
43 weeks/year (acct for hol & usw)
Elevations & Dry FP occur concurrently
There is a staggering of work among structures

SCHEDULE - 3B	27						2028											
	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
PED																		
ELEVATIONS 3B																		
DRY FLOODPROOFING 3B																		
CLOSE OUT 3B																		

P2

The schedule assumes the following:

- 3-4 Dry Floodproofing Crews
- 2-3 Elevation Crews
- 40-hour, 5-days/week
- 43 weeks/year (acct for hol & usw)
- Elevations & Dry FP occur concurrently
- There is a staggering of work among structures

SCHEDULE - 3B	2029												2030					
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J
	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
PED																		
ELEVATIONS 3B																		
DRY FLOODPROOFING 3B																		
CLOSE OUT 3B																		

P3

The schedule assumes the following:

3-4 Dry Floodproofing Crews
2-3 Elevation Crews
40-hour, 5-days/week
43 weeks/year (acct for hol & usw)
Elevations & Dry FP occur concurrently
There is a staggering of work among structures

SCHEDULE - 3B	2030						2031											
	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72
PED																		
ELEVATIONS 3B																		
DRY FLOODPROOFING 3B																		
CLOSE OUT 3B																		

The schedule assumes the following:

3-4 Dry Floodproofing Crews
2-3 Elevation Crews
40-hour, 5-days/week
43 weeks/year (acct for hol & usw)
Elevations & Dry FP occur concurrently
There is a staggering of work among structures

SCHEDULE - 3B	2032												2033		2033			
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J
	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
PED																		
ELEVATIONS 3B																		
DRY FLOODPROOFING 3B																		
CLOSE OUT 3B																		

The schedule assumes the following:

- 3-4 Dry Floodproofing Crews
- 2-3 Elevation Crews
- 40-hour, 5-days/week
- 43 weeks/year (acct for hol & usw)
- Elevations & Dry FP occur concurrently
- There is a staggering of work among structures

SCHEDULE - 3B							2034									
	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O
	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106
PED																
ELEVATIONS 3B																
DRY FLOODPROOFING 3B																
CLOSE OUT 3B																

P6

The schedule assumes the following:

3-4 Dry Floodproofing Crews
2-3 Elevation Crews
40-hour, 5-days/week
43 weeks/year (acct for hol & usw)
Elevations & Dry FP occur concurrently
There is a staggering of work among structures

SCHEDULE - 3B			2035				2035							
	N	D	J	F	M	A	M	J	J	A	S	O	N	D
	107	108	109	110	111	112	113	114	115	116	117	118	119	120
PED														
ELEVATIONS 3B														
DRY FLOODPROOFING 3B														
CLOSE OUT 3B														

The schedule assumes the following:

- 3-4 Dry Floodproofing Crews
- 2-3 Elevation Crews
- 40-hour, 5-days/week
- 43 weeks/year (acct for hol & usw)
- Elevations & Dry FP occur concurrently
- There is a staggering of work among structures

SCHEDULE - 3B	2036												2037	
	J	F	M	A	M	J	J	A	S	O	N	D	J	F
	121	122	123	124	125	126	127	128	129	130	131	132	133	134
PED														
ELEVATIONS 3B														
DRY FLOODPROOFING 3B														
CLOSE OUT 3B														

The schedule assumes the following:

- 3-4 Dry Floodproofing Crews
- 2-3 Elevation Crews
- 40-hour, 5-days/week
- 43 weeks/year (acct for hol & usw)
- Elevations & Dry FP occur concurrently
- There is a staggering of work among structures

SCHEDULE - 3B	2037								
	M	A	M	J	J	A	S	O	N
	135	136	137	138	139	140	141	142	143
PED									
ELEVATIONS 3B									
DRY FLOODPROOFING 3B									
CLOSE OUT 3B									

P9

The schedule assumes the following:

- 3-4 Dry Floodproofing Crews
- 2-3 Elevation Crews
- 40-hour, 5-days/week
- 43 weeks/year (acct for hol & usw)
- Elevations & Dry FP occur concurrently
- There is a staggering of work among structures

Feature	30 Planning Engineering and Design				
	Month	Day	Year		CWCCIS
Construction Start	1	3	2026		2026Q2
Construction End	5	2	2029		2029Q3
Midpoint	9	2	2027		2027Q4
Feature	19 BUILDINGS, GROUNDS & UTILITIES				
	Month	Day	Year		CWCCIS
Construction Start	5	3	2029		2029Q3
Construction End	6	8	2037		2037Q3
Midpoint	5	21	2033		2033Q3
Feature	31 Construction Management				
	Month	Day	Year		CWCCIS
Construction Start	5	3	2029		2029Q3
Construction End	6	8	2038		2038Q3
Midpoint	11	19	2033		2034Q1

CSRA

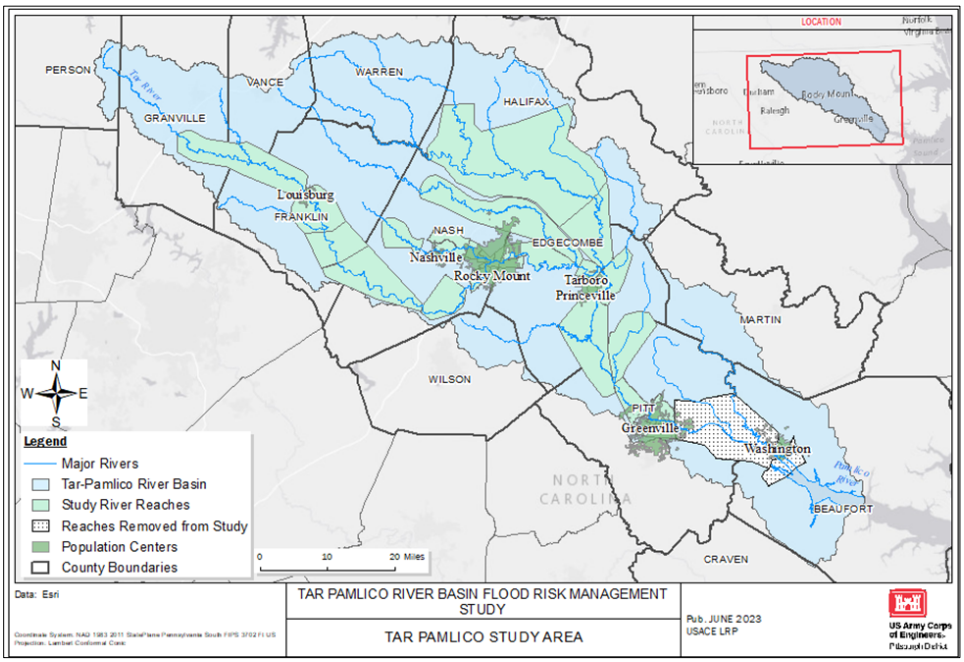
US Army Corps of Engineers

Prepared for:
U.S. Army Corps of Engineers
Pittsburgh District

Tar-Pamlico River Basin – Flood Risk Management (FRM)

Tar-Pamlico River Basin, North Carolina

CSRA for Alternative 3B – Tentatively Selected Plan (TSP)



Prepared by:
U.S. Army Corps of Engineers
Cost Engineering Technical Center of Expertise, Walla Walla, WA

June 2024

Table of Contents

1. Purpose 1
2. Project Scope 1
3. Key Assumptions 1
4. Cost & Schedule Risk Analysis Process 1
5. Base Estimate 2
6. Base Schedule 2
7. Cost & Schedule Risk Analysis 2
   7.1. Summary of Results 2
   7.2. Cost Risk Analysis 3
   7.3. Schedule Risk Analysis 5
8. Recommendations, Risk Management, & Updates 7
   8.1. Recommendations 7
   8.2. Risk Management 7
   8.3. Risk Analysis Updates 7

Figures

Figure 1. Cost Contingency Levels 3
Figure 2. Top Cost Risks 4
Figure 3. Schedule Contingency Levels 5
Figure 4. Top Schedule Risks 6

Tables

Table 1. Summary of CSRA Results 2
Table 2. Cost Confidence Levels 3
Table 3. Schedule Confidence Levels 5

Appendixes

Appendix A: Base Estimate

Appendix B: Base Schedule

Appendix C: Cost & Schedule Risk Analysis Details

1. Purpose

The U.S. Army Corps of Engineers (USACE), Pittsburgh District, presents this Cost and Schedule Risk Analysis (CSRA) report regarding the risk findings and recommended contingencies for the Tar-Pamlico River Basin – Flood Risk Management (FRM) Alternative 3B – Tentatively Selected Plan (TSP). A *Monte-Carlo* based risk analysis was conducted by the Project Development Team (PDT) on remaining costs in compliance with ER 1110-2-1302, Construction Cost Estimating. The purpose of this risk analysis study is to present the cost and schedule risks considered and respective project contingencies at a recommended 80% confidence level of successful execution to project completion. This CSRA Report is reflective of the June 2024 agency technical review (ATR) comments which resulted in a change to the deterministic cost estimate and schedule.

2. Project Scope

The Tar-Pamlico River Basin Flood Risk Management Feasibility Study is a U.S. Army Corps of Engineers (USACE) feasibility study focused on evaluating potential flood risk management (FRM) alternatives to reduce flood and life safety risks in the Tar-Pamlico River Basin. The State of North Carolina Department of Environmental Quality is the non-federal sponsor for the subject study.

The study area is subject to severe flooding, particularly during the Atlantic hurricane season, which runs from June to November. In recent years, hurricanes caused severe flooding and federally recognized natural disasters were declared. Particularly severe impacts from Hurricane Florence (2018) and Hurricane Matthew (2016) were witnessed in North Carolina in the past decade. In addition, Hurricane Floyd (1999) and Fran (1996) caused significant flooding within the past 30 years. In addition, large rain events in June 2019, June 2020, and July 2023 caused significant flooding in the specific communities within the watershed.

The Alternative 3B – Tentatively Selected Plan (TSP) scope includes the following:

- Residential Elevate with Flood Vents – 18 Structures
- Residential Elevate without Flood Vents – 35 Structures
- Residential Addition of Flood Vents Only – 8 Structures
- Commercial Dry Flood Proofing – 94 Structures

3. Key Assumptions

Below are some key assumptions regarding the analysis.

- This CSRA assumes 100% participation, no opportunities have been modeled as savings for reduced homeowner/business owner participation or non-participation in the risk analysis model.
- TSP Alternative 3B serves as the basis of cost and schedule.
- 1-D/Steady State Hydraulic modeling was utilized for most structures. Associated risks have been included to account for design uncertainty.
- The National Economic Development (NED) waiver was granted.
- Assume October 2025 for authorization in the Water Resources Development Act (WRDA) 2026, funding appropriated.
- The assumed construction period of performance is November 2029 - May 2037.

4. Cost & Schedule Risk Analysis Process

Refer to the ‘Civil Works Cost Engineering’ - ER 1110-2-1302, which details out the overview, responsibilities, documentation, process, review, market analysis, risk register, modeling, and deliverables required in developing the CSRA.

5. Base Estimate

See Appendix A for a summary of the base cost estimate from which this CSRA was conducted.

6. Base Schedule

See Appendix B for a summary of the base schedule from which this CSRA was conducted.

7. Cost & Schedule Risk Analysis

The CSRA results are provided in the following sections. In addition to contingency calculation results, the top cost and schedule risks were identified, and sensitivity analyses are presented to provide decision makers with:

- An understanding of variability and the key contributors,
- Contingency information for scheduling, budgeting, and project control purposes, and
- Provide tools to support decision making and risk management as projects progress through planning and implementation.

Additional information and details can be found in various Appendix C subsections which are described below.

- **Appendix C-1: Risk Dashboard.** Summary of the top cost & schedule risk items, confidence levels, and suggested risk reduction measures.
- **Appendix C-2: Risk Register.** Summary of the risk register documenting risk type, risk details, likelihood, impact ratings, responsibility, suggested risk reduction measures, etc.
- **Appendix C-3: CSRA Assumptions.** Summary of the risk matrix, likelihood of occurrence definition, impact or consequence definitions for cost / schedule, and cost / schedule impact ranges as they relate to this project.
- **Appendix C-4: Risk Register Attendance.** Summary of the participants of the risk register meeting which was conducted on 2/28/2024.
- **Appendix C-5: Risk Details (if applicable).** Some projects and their risk items could require more complex calculations to determine their risk impact ranges. This is not a mandatory requirement, but risk detail sheets are sometimes developed to help document these assumptions and calculations. These risk detail sheets are typically not included by default but can be available upon request.

7.1. Summary of Results

The current remaining construction cost with escalation is approximately $65.2M excluding contingency and expressed in FY2024 dollars. Based on the results of the analysis, the CSRA recommends a contingency value of $28M, or approximately 43% of base project cost at an 80% confidence level of successful execution. The current project base construction schedule is approximately 109 months excluding contingency. Based on the results of the analysis, the CSRA recommends a contingency value of nearly 39 months, or approximately 36% of base project schedule at an 80% confidence level of successful execution. See Table 1 below for a more detailed summary and Appendix C for additional details regarding risk-based contingency development.

Table 1. Summary of CSRA Results

Contingency on Base Estimate	80% Confidence Project Cost	
Base Estimate	$65,179,218	
Estimate Contingency	$28,027,064	43%
Base Estimate w/ Contingency (80% Confidence)	$93,206,281	

Contingency on Base Schedule	80% Confidence Project Schedule	
Base Schedule Start Date	May 3, 2029	
Base Schedule Finish Date	June 8, 2038	
Base Schedule Duration	109.2 Months	
Schedule Contingency Duration	39.3 Months	36%
Base Schedule w/ Contingency (80% Confidence)	148.5 Months	
Base Finish Date w/ Contingency (80% Confidence)	September 18, 2041	

7.2. Cost Risk Analysis

7.2.1. Cost Confidence Levels

The result of risk or uncertainty analysis is quantification of the cumulative impact of all analyzed risks or uncertainties as compared to probability of occurrence. These results, as applied to the analysis herein, depict the overall project cost at intervals of confidence (probability). Table 2 provides the cost contingencies calculated for the various confidence levels with the 80% confidence level highlighted. Contingencies are rounded up to the nearest whole percentage.

Table 2. Cost Confidence Levels

Base Estimate		$65,179,218	
Confidence Level	Contingency Value	Contingency	Cost with Contingency
0%	$5,214,337	8%	$70,393,555
10%	$14,339,428	22%	$79,518,646
20%	$16,946,597	26%	$82,125,814
30%	$18,901,973	29%	$84,081,191
40%	$20,205,557	31%	$85,384,775
50%	$22,160,934	34%	$87,340,152
60%	$24,116,311	37%	$89,295,528
70%	$26,071,687	40%	$91,250,905
80%	**$28,027,064**	**43%**	**$93,206,281**
90%	$31,286,025	48%	$96,465,242
100%	$46,929,037	72%	$112,108,255

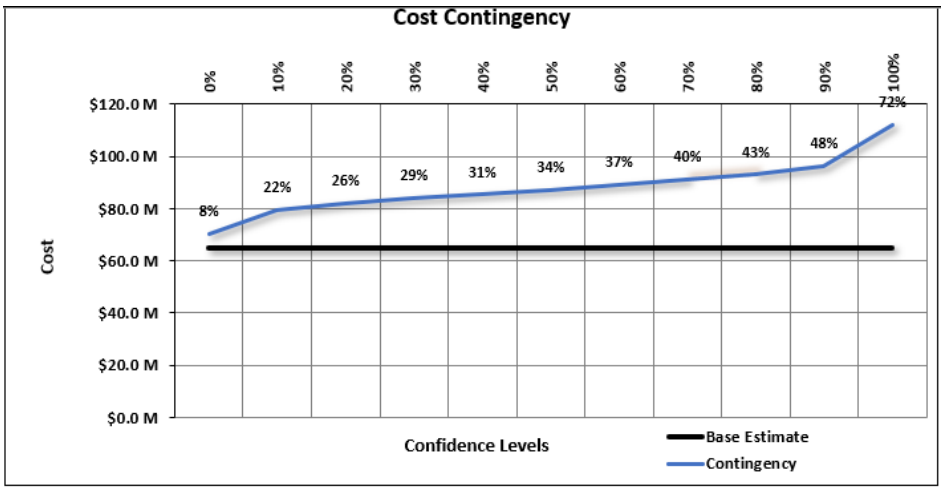


Figure 1. Cost Contingency Levels

7.2.2. Top Cost Risks

The risks/opportunities considered as key or primary cost drivers are ranked in order of potential impact (positive or negative) in Figure 2 at various confidence levels (50%, 80%, and 90%). Opportunities that have a potential to reduce project cost and are shown with a negative sign to reflect the potential to decrease project cost; risks are shown with a positive sign to reflect the potential to increase project cost. These key cost drivers 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, these results can also be used to support development of strategies to eliminate, mitigate, accept, or transfer key risks. See Appendix C for additional details for these risks and further information regarding CSRA development.

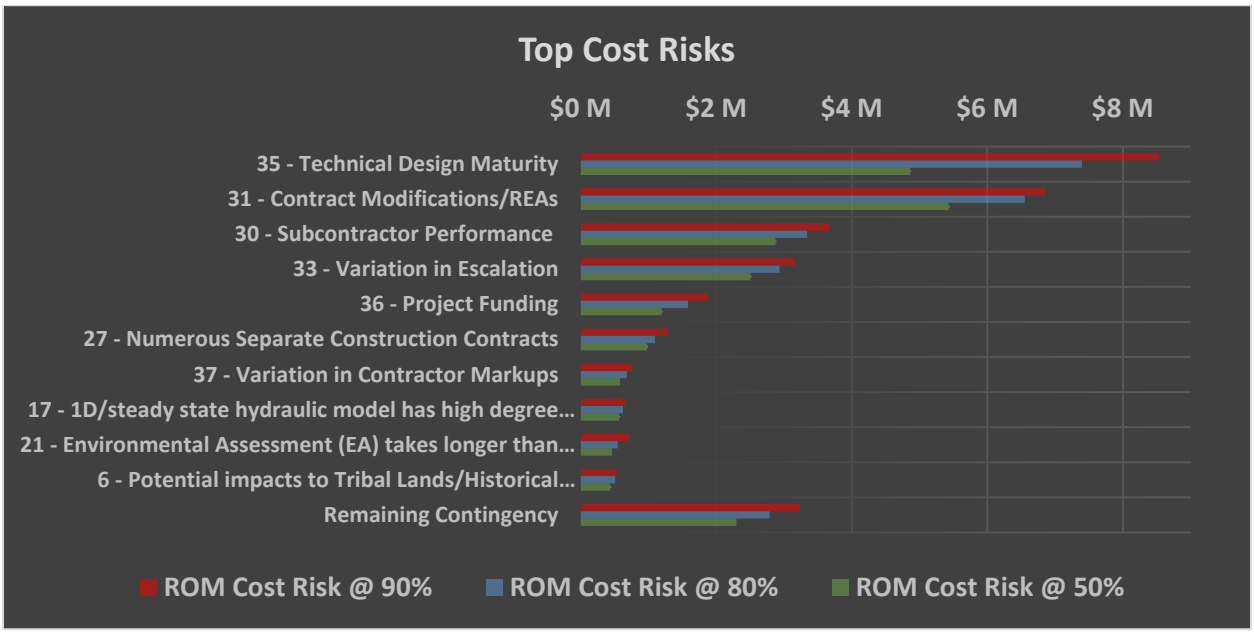


Figure 2. Top Cost Risks

- **Risk 35: Technical Design Maturity.** Current level of technical/design maturity could result in future changes or modifications to the approach as the design matures.
- **Risk 31: Contract Modifications/REAs.** Potential for contract modifications. Particularly with the number of structures and locations, there is potential for numerous contract modifications.
- **Risk 30: Subcontractor Performance.** Poor/inefficient subcontractor performance could lead to extend project schedule and cost associated to schedule extension.
- **Risk 33: Variation in Escalation.** Given the length of the project's construction duration, the currently forecasted escalation rates could vary.
- **Risk 36: Project Funding.** Adequacy of project funding (incremental funding vs. fully funding).
- **Risk 27: Numerous Separate Construction Contracts.** The number of structures to be raised and the estimated construction schedule likely prohibits one, single contract.
- **Risk 37: Variation in Contractor Markups.** Common risk related to Subcontractor markups or indirect rates such as JOOH, HOOH, profit, bond, etc.
- **Risk 17: 1-D/Steady State Hydraulic Model Uncertainty.** Overestimation of flood risk and associated damages could result in development of tentatively selected plan that does not reflect the optimal plan and requires significant revision during feasibility level design or PED.
- **Risk 21: Environmental Assessment (EA) Exceeds One (1) Year.** Current planning process and schedule will maintain more than a year between TSP and the signed Chief's Report. If the EA process takes longer than a year, or is forced due to project scheduling, than an EA waiver may be required.
- **Risk 6: Potential Impacts to Tribal Lands/Historical Structures.** Work limits contained to previously developed areas/property. Possibility of encountering structures identified on the

historical registry. This would include additional coordination with the State Historic Preservation Office (SHPO) and additional measures for floodproofing (i.e., aesthetic accommodations which differ from the standard materials). Number of possible structures has not been identified.

7.3. Schedule Risk Analysis

7.3.1. Schedule Confidence Levels

The result of risk or uncertainty analysis is quantification of the cumulative impact of all analyzed risks or uncertainties as compared to probability of occurrence. These results, as applied to the analysis herein, depict the overall project duration at intervals of confidence (probability). Table 3 provides the schedule duration contingencies calculated for the various confidence levels with the 80% confidence level highlighted. Contingencies are rounded up to the nearest whole percentage.

Table 3. Schedule Confidence Levels

Base Schedule Duration		109.2 Months	
Confidence Level	Contingency Value	Contingency	Duration with Contingency
0%	-14.2 Months	-13%	95.0 Months
10%	8.7 Months	8%	117.9 Months
20%	14.2 Months	13%	123.4 Months
30%	18.6 Months	17%	127.8 Months
40%	21.8 Months	20%	131.0 Months
50%	26.2 Months	24%	135.4 Months
60%	29.5 Months	27%	138.7 Months
70%	33.8 Months	31%	143.0 Months
80%	**39.3 Months**	**36%**	**148.5 Months**
90%	45.9 Months	42%	155.0 Months
100%	93.9 Months	86%	203.1 Months

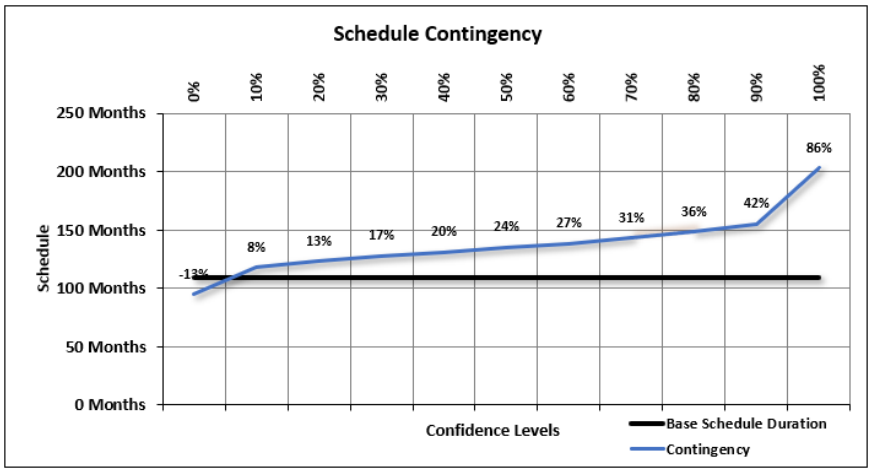


Figure 3. Schedule Contingency Levels

These contingencies were also used to calculate the projected residual fixed cost impact of project delays that are included in the Table 2 presentation of total cost contingency. The schedule contingencies were calculated by applying the high-level schedule risks identified in the risk register for each option to the durations of critical path and near critical path tasks.

The schedule was not resource loaded and was limited to only summary level type durations that limit the overall utility of the schedule risk analysis. These issues should be considered as limitations in the utility

of the schedule contingency data presented. Schedule contingency impacts presented in this analysis are based solely on projected residual fixed costs.

7.3.2. Top Schedule Risks

The risks/opportunities considered as key or primary schedule drivers are ranked in order of potential impact (positive or negative) in Figure 4 at various confidence levels (50%, 80%, and 90%). Opportunities that have a potential to reduce project schedule and are shown with a negative sign to reflect the potential to decrease project duration; risks are shown with a positive sign to reflect the potential to increase project duration. These key schedule drivers 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. See Appendix C for additional details for these risks and further information regarding CSRA development.

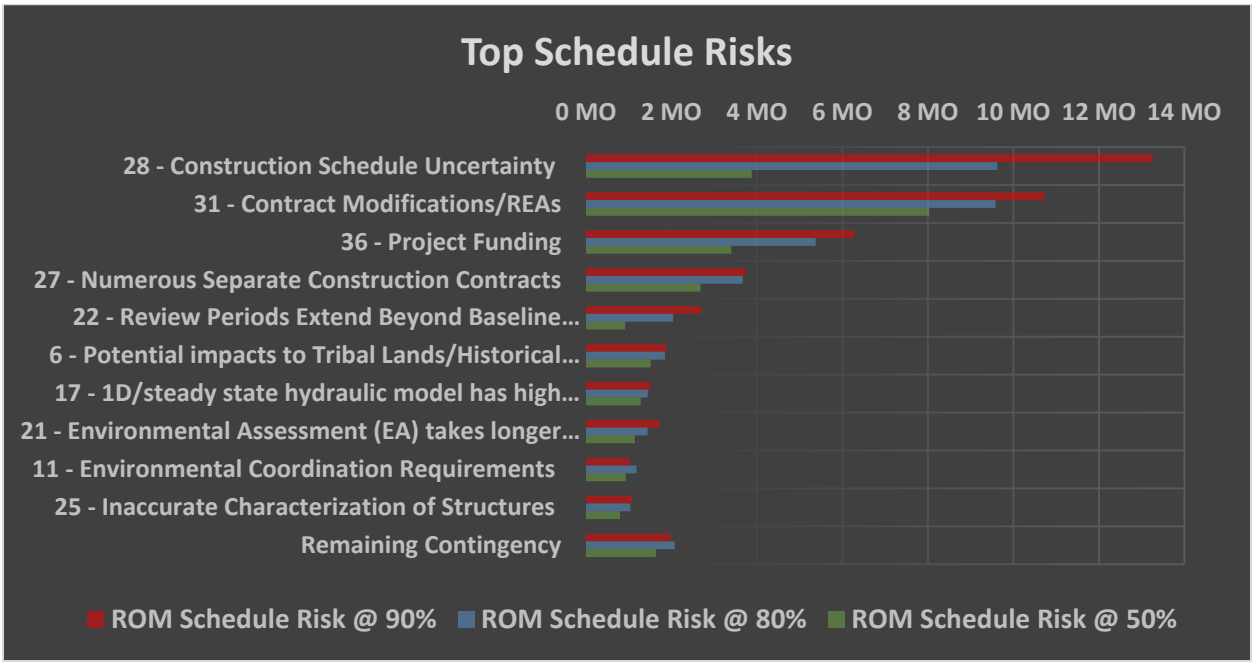


Figure 4. Top Schedule Risks

- **Risk 28: Construction Schedule Uncertainty.** The existing construction schedule is at a Class 5 level. Changes in construction sequencing or phasing could impact the scheduled duration.
- **Risk 31: Construction Modifications/REAs.** Potential for contract modifications. Particularly with the number of structures and locations, there is potential for numerous modifications.
- **Risk 36: Project Funding.** Adequacy of project funding (incremental funding vs. fully funded). The schedule is currently technically driven, thus a shift to a funding constrained schedule could impact the overall duration of the project.
- **Risk 27: Numerous Separate Construction Contracts.** The number of structures to be raised and the estimated construction schedule likely prohibits one, single contract.
- **Risk 22: Review Periods Extend Beyond Baseline Schedule.** The study timeline has extended past the original planned timeline. Delays in District Quality Control (DQC) and Agency Technical Review (ATR) could impact the incorporation into the 2024 WRDA.
- **Risk 6: Potential Impacts to Tribal Lands/Historical Structures.** Possibility of encountering structures identified on the historical registry. This would include additional coordination with the State Historic Preservation Office (SHPO) and additional measures for floodproofing, thus extending the project schedule for the affected structures. The number of structures potential affected are not yet determined.

- **Risk 17: 1-D/Steady State Hydraulic Model Uncertainty.** Overestimation of flood risk and associated damages could result in development of tentatively selected plan that does not reflect the optimal plan and requires significant revision during feasibility level design or PED.
- **Risk 21: Environmental Assessment (EA) Exceeds One (1) Year.** Current planning process and schedule will maintain more than a year between TSP and the signed Chief's Report. If the EA process takes longer than a year, or is forced due to project scheduling, than an EA waiver may be required.
- **Risk 11: Environmental Coordination Requirements.** Unique permitting and environmental regulations could potentially pose schedule delays.
- **Risk 25: Inaccurate Characterization of Structures.** The use of publicly available data (i.e. Google Earth) could pose inaccurate assumptions or characteristics needed for nonstructural measures. Inaccurate assumptions could affect the number and location of structures within the TSP.

See Appendix C for additional details for these risks and further information regarding CSRA development.

8. Recommendations, Risk Management, & Updates

8.1. 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)*, *Sixth Edition*, states that "project risk management includes the processes of conducting risk management planning, identification, analysis, response planning, response implementation, and monitoring risk 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 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.

8.2. Risk Management

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

8.3. 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).

Tar-Pamlico River Basin - Feasibility (TSP) - For Milestone #2

February 2024

							Project Cost		Project Schedule		Other Information					Cost Impacts			Schedule Impacts			Cost from Schedule Impacts			Event Risk Info		Cost Risk Modeling					Schedule Risk Modeling		Additional Documentation	
REF	**Risk Type**	**Risk/Opportunity Event**	**Risk Event Description**	**Team Discussions on Impact and Likelihood**	**Likelihood**	**Impact (C)**	**Risk Level (C)**	**Impact (S)**	**Risk Level (S)**	**Cost Variance Distribution**	**Schedule Variance Distribution**	**Correlation to Other(s)**	**Responsibility/ POC**	**Affected Project Component**	**Low Variance (C)**	**Likely (C)**	**High Variance (C)**	**Low Variance (S)**	**Likely (S)**	**High Variance (S)**	**Low Variance (CS)**	**Likely (CS)**	**High Variance (CS)**	**TWO STEP (Cost & Schedule)**	**Event Prob (PCS)**	**Low Variance (TC)**	**Likely (TC)**	**High Variance (TC)**	**Cost Risk**	**Simulated Cost Cost Risk x PCS**	**Schedule Risk**	**Simulated Schedule Schedule Risk x PCS**	**Risk Quantification Discussions**	**Suggested Risk Reduction Measures (Avoid, Escalate, Exploit, Transfer/Share, Mitigate/Enhance, or Accept)**
1	1 - Project & Program Management (PM)	Performing USACE District LRP outside of USACE SAW AOR	Unfamiliarity with local conditions could delay analyses and engineering, or result in designs that don't appropriately account for local conditions.	Study team is working closely with SAW--who is conducting a study on the neighboring Neuse River. The PDT has also been regionalized, leveraging appropriate expertise within LRD. **MAR 2024 update:** Identified as a study level risk. Construction will be implemented by USACE SAW. No impact on the current stage of the project or moving forward into implementation.	Unlikely	Moderate	Low	Moderate	Low	N/A -Not Modeled	N/A -Not Modeled		Project Management	N/A -Not Modeled	$0	$0	$0	0.00 MO	0.00 MO	0.00 MO	$0	$0	$0	100%	1	$0	$0	$0	$0	$0	0.00 MO	0.00 MO	N/A - Not modeled	1. Regionalize PDT to include technical members familiar with NC. 2. Coordinate with local agency offices and subject area experts (e.g., universities) as appropriate. 3. Conduct site visits to verify existing data and assumptions.
2	1 - Project & Program Management (PM)	Future travel restrictions due to COVID-19	Study could require considerable travel to conduct necessary surveys (e.g., HTRW, wetland, etc.) and collect information (e.g., real estate information). Travel Restrictions could cause study delays or reliance on imperfect existing data.	Decreased public involvement and/or support for the study and/or study delays due to travel restrictions. Travel restrictions removed with development of vaccines and decline of COVID-19 pandemic. **MAR 2024 Update:** Possible. Lessons learned from the COVID-19 pandemic can be used to mitigate potential impacts. Public/homeowner meetings could be switched to virtual. Schedule impacts could delay PED schedule.	Possible	Significant	Medium	Marginal	Low	Single Event (2 Step)	Single Event (2 Step)		Project Management	Project Schedule	$0	$0	$0	0.00 MO	0.25 MO	1.00 MO	$0	$415,730	$1,247,191	30%	1	$0	$415,730	$1,247,191	$0	$0	0.00 MO	0.00 MO	The base schedule assumes 1 year outreach and application period. (Outreach and education to homeowners: door-to-door discussions, meetings, Letter campaign, applications / assistance with applications) LV (Best Case): No impact to the base schedule ML (Most Likely): 1 month delay to schedule. Extension of PED costs. HV (Worst Case): 3 month delay to schedule. Extension of PED costs.	1. Identify potential travel requirements early and make contingency plans. 2. include contingency plans and discussions related to COVID-19 when conducting environmental coordination.
3	1 - Project & Program Management (PM)	Study area designation and plan formulation process requires additional waiver	Complex H&H engineering necessitated obtaining a 3x3x3 framework waiver for the project, with additional time and resources requested.	Large study area will require substantial analysis to be completed within the 3x3x3 framework. For example, development of FDA models to include >20,000 structures; potential real estate surveys/appraisals on a large number of structures). New hydraulic model was required, significantly delaying schedule (included in base schedule). Coincidental probability analysis also dramatically increased flood extents, increasing structure inventory and required economic and engineering work. **MAR 2024 Update:** Realized risk. The impacts have been included in the base cost estimate ($200k) and schedule (11 months). Unlikely to exceed current waiver limit or incur additional schedule/cost.	Unlikely	Marginal	Low	Marginal	Low	N/A -Not Modeled	N/A -Not Modeled		Project Management	N/A -Not Modeled	$0	$0	$0	0.00 MO	0.00 MO	0.00 MO	$0	$0	$0	100%	1	$0	$0	$0	$0	$0	0.00 MO	0.00 MO	N/A - Not modeled	1. Work with the PDT to develop a realistic budget estimate early with contingency that covers all likely resource need scenarios. 2. Coordinate with the state of NC to identify and obtain all existing models, data, and information.
4	6 - Planning-Site (PS)	Alternative Formulation and Evaluation - Relocation Program	The extent and location of ongoing relocation programs will affect the costs, benefits, and viability of various alternatives.	Significant historic buyout programs have reduced risk in many key population centers. These previous efforts could reduce benefits and potential justification for projects that reduce remaining risks. Discussions with state agencies in charge of buyout programs. **MAR 2024 Update:** PDT engages in on-going communication with the State and Counties regarding house raising/buy-outs. Particularly area of NC is historically active in engaging non structural actions.	Unlikely	Negligible	Low	Negligible	Low	N/A -Not Modeled	N/A -Not Modeled		Planning	N/A -Not Modeled	$0	$0	$0	0.00 MO	0.00 MO	0.00 MO	$0	$0	$0	100%	1	$0	$0	$0	$0	$0	0.00 MO	0.00 MO	N/A - Not modeled	The study team will work with the appropriate stakeholders to obtain and incorporate these data into analyses as early as possible.
5	6 - Planning-Site (PS)	Plan formulation strategy limited to Tar River and major tributaries only	Size of watershed and extensive analytical requirements required limiting the plan formulation process to the Tar River and its major tributaries in order to be completed within the 3x3x3 framework. Study scope and plan formulation leaves residual risk in upper portion of the watershed.	Potential for unhappy local sponsor and/or general public. Not meeting the local sponsor's and/or communities needs could jeopardize project implementation. Ongoing status updates with the State of NC have indicated that the study is meeting their needs. No pushback to plan formulation strategy and assessed measures during public meetings. **MAR 2024 Update:** Resolved. Did not receive comments from the public during the formal comment period. TSP will not change based on an additional public comment period.	Unlikely	Negligible	Low	Negligible	Low	N/A -Not Modeled	N/A -Not Modeled		Planning	N/A -Not Modeled	$0	$0	$0	0.00 MO	0.00 MO	0.00 MO	$0	$0	$0	100%	1	$0	$0	$0	$0	$0	0.00 MO	0.00 MO	N/A - Not modeled	1. Communicate risks associated with not assessing structural measures for all communities to local sponsor. 2. Consider non-structural risk reduction opportunities across rural areas.
6	6 - Planning-Site (PS)	Potential impacts to Tribal Lands/Historical Structures	Alternatives were formulated that intersect tribal lands and potentially affect historical structures. Selection of one of these alternatives could require significant coordination.	Significant coordination could delay schedule and increase study cost. Dry dams that intersect tribal lands represent a potentially viable solution due to the diffuse nature of development/damages throughout much of the watershed. Dry dams have been screened. **MAR 2024 Update:** Work limits contained to previously developed areas/property. Possibility of encountering structures identified on the historical registry. This would include additional coordination with the State Historic Preservation Office (SHPO) and additional measures for floodproofing (i.e. aesthetic accommodations which differ from the standard materials). Number of possible structures has not been identified.	Likely	Moderate	Medium	Moderate	Medium	Triangular (LV, ML, 80%)	Triangular (LV, ML, 80%)		Planning	Project Cost & Schedule	$0	$0	$244,292	0.00 MO	0.00 MO	2.50 MO	$0	$0	$484,939	100%	1	$0	$0	$729,231	$0	$0	0.00 MO	0.00 MO	The base cost estimate and schedule does not include considerations for historical structure which would require coordination with SHPO. LV: Base estimate. No structures require SHPO considerations. ML: Base estimate. No structures require SHPO considerations. HV: Assume five (5) structures at an additional 20% each and 2 week schedule extension. See Risk Backup Sheet	1. Conduct early outreach with all tribal entities; 2. Focus siting for management measures to not intersect tribal lands.
7	18 - Hydraulics / Hydrology (HH)	Alternative formulation and evaluation - Transferred Risk	Incorporation of certain measures (e.g., levees, channel modifications) may transfer risk to surrounding or downstream areas. Could affect overall project viability (i.e., increased project and study costs due to chasing water and requiring additional measures downstream) and/or public support.	Several large-scale solutions that could transfer risk are being considered. Structural measures have been screened from further consideration. Risk largely reduced/eliminated. **MAR 2024 Update:** Unlikely for the structures identified.	Unlikely	Negligible	Low	Negligible	Low	N/A -Not Modeled	N/A -Not Modeled		Hydrology/Hydraulic Design	N/A -Not Modeled	$0	$0	$0	0.00 MO	0.00 MO	0.00 MO	$0	$0	$0	100%	1	$0	$0	$0	$0	$0	0.00 MO	0.00 MO	N/A - Not modeled	Conduct extensive hydraulic modeling with all proposed structures and determine a final levee height required and what impacts are possible in surrounding areas.
8	1 - Project & Program Management (PM)	Triggering Independent External Peer Review (IEPR) and/or Risk Assessment	Inclusion of large-scale structural measures and/or extensive and complex recommendations could trigger IEPR and/or risk assessment. Triggering an IEPR risk assessment could further increase the study cost and delay the study schedule.	Costs and time required for IEPR and risk assessment could likely be covered by existing contingency. All structural measures have screened, so the risk if triggering an IEPR and risk assessment is much lower. **MAR 2024 Update:** No triggers for an IEPR are met or forecasted to be met at this time. Trigger being project cost >$200M. Changes due to subsequent policy reviews (DQC/ATR) unlikely to result in cost/schedule impacts. However, climate policy data changes, resulting in potentially higher structure elevation is possible.	Possible	Significant	Medium	Moderate	Medium	Single Event (2 Step)	Single Event (2 Step)		Project Management	Project Cost & Schedule	$0	$250,000	$600,000	0.00 MO	1.00 MO	3.00 MO	$0	$415,730	$1,247,191	30%	1	$0	$665,730	$1,847,191	$0	$0	0.00 MO	0.00 MO	The base estimate and schedule reflects the current design and execution strategy. Changes in guidance/policy is not included. LV: Base Estimate & Schedule ML: $250k cost impacts related to implementation changes. Assume 1 month PED schedule delay HV: $600k cost impacts related to implementation changes. Assume 3 month PED schedule delay	1. Set aside contingency to cover IEPR between TSP and ADM.
9	21 - Environmental & Cultural/Historical Resources (EC)	Alternative Formulation - Discovery of HTRW	Encountering contaminated soil or sediment within the area of the selected alternative due to agricultural or other industrial activities. Encountering contaminated soils/HTRW within the area of recommended plan could increase project cost and affect overall viability and implementability.	Significant historic industrial and agricultural industry activities within the watershed increase likelihood of encountering contaminated soils/HTRW. All structural measures have screened, decreasing the likelihood of contaminated soils/HTRW affecting implementation. Potential impacts to nonstructural measures are low. **MAR 2024 Update:** Complete survey of all properties has not performed. Currently only 1-2 properties identified as possible concern for HTRW near airport/industrial area. The Contractor would have to put the structure in a safe/structural sound position until further investigation is performed.	Possible	Negligible	Low	Negligible	Low	Triangular (LV, ML, 80%)	Triangular (LV, ML, 80%)		Environmental Compliance	Project Cost & Schedule	$0	$10,000	$97,717	0.00	0.25	0.50	$0	$55,773	$55,773	30%	1	$0	$65,773	$153,490	$0	$0	0.00 MO	0.00 MO	The base cost estimate and schedule does not include considerations for the discovery of HTRW. LV: Base estimate. No HTRW is discovered. ML: HTRW is discovered during a pre-implementation survey. Results in an additional $10k plus 1 week schedule extension. HV: Assume HTRW discovered at multiple structures during implementation resulting in a Contractor work stoppage and placing the structure in a sound/structural safe position. Assume two (2) structures at an additional 20% each and 2 week schedule extension. See Risk Backup Sheet	1. Conduct a Phase 1 ESA. 2. Coordinate with NCDEQ to gather information on their state cleanup response programs and ongoing sites. 3. Coordinate with EPA Region 4 regarding Superfund site in Washington.
10	21 - Environmental & Cultural/Historical Resources (EC)	EA/Mitigated EA identified as the NEPA compliance path	Inclusion of structural measures could trigger the need for an EIS due to extensive environmental resources, including numerous threatened and endangered species and associated critical habitats. Presence of cultural resources could also trigger EIS.	Presence of extensive environmental resources, including T&E species and associated critical habitats, would likely necessitate result in significant impacts should structural measure be implemented. All structural measures have been screened. Low risk of converting to EIS due to environmental or cultural impacts. **MAR 2024 Update:** Environmental impact of Non-Structural project less significant than other alternatives (i.e. levees, dams, etc.). Unlikely to trigger any environmental coordination at this stage of the project and beyond.	Unlikely	Negligible	Low	Moderate	Low	N/A -Not Modeled	N/A -Not Modeled		Environmental Compliance	N/A -Not Modeled	$0	$0	$0	0.00 MO	0.00 MO	0.00 MO	$0	$0	$0	100%	1	$0	$0	$0	$0	$0	0.00 MO	0.00 MO	N/A - Not modeled	1. Coordinate early and often with USFWS and other environmental/cultural resource (SHPO) agencies. 2. Choose to mitigate impacts. 3. Conduct field/site visits early to identify potentially vulnerable resources. 4. Seek out available data and information on HTRW issues.
11	21 - Environmental & Cultural/Historical Resources (EC)	Environmental Coordination Requirements	Permitting and Environmental regulations are different than the team is used to increasing the potential to miss some unique requirement to NC.	Delays to schedule would likely be minimal due to similar environmental requirements among NC and other states within LRD's AOR. **MAR 2024 Update:** Coordination is required with the state of NC during implementation. No environmental permits are anticipated to be needed. The current baseline schedule includes anticipated coordination efforts with NC during PED & Construction phases. However, it is possible additional coordination could be required.	Possible	Moderate	Medium	Moderate	Medium	Single Event (2 Step)	Single Event (2 Step)		Environmental Compliance	Project Schedule	$0	$0	$0	0.00 MO	0.00 MO	3.00 MO	$0	$0	$849,555	30%	1	$0	$0	$849,555	$0	$0	0.00 MO	0.00 MO	The base schedule assumes acquisition of all required state environmental coordination. However, it is possible additional coordination will be required during PED and/or Construction which could lead to delays. LV: No schedule delay. ML: No schedule delay. HV: Three (3) month schedule delay. Assume 50% PED & 50% Construction cost of schedule delay.	1. Identify all required permits early in the process. 2.Coordinate with local agencies via NEPA scoping outreach and ongoing coordination.
12	18 - Hydraulics / Hydrology (HH)	Uncertainty in tidal data that underpin the coincidental probability analysis (i.e., South Atlantic Coastal Study and Coastal Hazard Study data)	Uncertainty within the SACS/CHS inundation depths and extents may result in a recommendation that is not reflective of true risk within tidally-influenced areas, including the City of Washington.	Original measures identified to reduce risk in these areas are no longer viable, requiring reformulation for tidally-influenced areas. Reformulation will require additional engineering and economic work and re-work, delaying schedule and increasing cost to TSP. Reformulation will require a delay in the TSP. However, additional analyses can likely be executed within existing funding stream. Initial analyses indicate the originally-developed measures and alternatives are no longer effective at reducing risk giving updated coincidental probability analysis. Vertically-aligned decision to remove tidally-influenced areas from the current study. SAW coordinating with the state on potential for incorporation of these areas in separate study. **MAR 2024 Update:** The PDT has removed areas from the study that would be included in tidally influenced areas (i.e. storm surge flooding). No potential for this to be reincorporated into the study. Resolved risk.	Unlikely	Marginal	Low	Moderate	Low	N/A -Not Modeled	N/A -Not Modeled		Hydrology/Hydraulic Design	N/A -Not Modeled	$0	$0	$0	0.00 MO	0.00 MO	0.00 MO	$0	$0	$0	100%	1	$0	$0	$0	$0	$0	0.00 MO	0.00 MO	N/A - Not modeled	1. Coordinate with the vertical team regarding whether tidally-influenced areas should be included in current study. 2. Coordinate with the SACS/CHS teams to better understand underlying uncertainties in existing data.
13	6 - Planning-Site (PS)	Coastal Storm Tidal and Surge Interaction with Riverine Flooding (coincidental frequency analysis)	Original measures identified to reduce risk in these areas are no longer viable, requiring reformulation for tidally-influenced areas. Reformulation will require additional engineering and economic work and re-work, delaying schedule and increasing cost to TSP.	Reformulation will require a delay in the TSP. However, additional analyses can likely be executed within existing funding stream. Realized Risk. Initial analyses indicate the originally-developed measures and alternatives are no longer effective at reducing risk giving updated coincidental probability analysis. Vertically-aligned decision to remove tidally-influenced areas from the current study. SAW coordinating with the state on potential for incorporation of these areas in separate study. **MAR 2024 Update:** Based on the number of sensitivity analyses performed, unlikely any changes to the plan would be made due to tidal and surge interaction with riverine flooding. Affected areas have been removed from the study.	Unlikely	Marginal	Low	Moderate	Low	N/A -Not Modeled	N/A -Not Modeled		Planning	N/A -Not Modeled	$0	$0	$0	0.00 MO	0.00 MO	0.00 MO	$0	$0	$0	100%	1	$0	$0	$0	$0	$0	0.00 MO	0.00 MO	N/A - Not modeled	1. Develop coincidental frequency model to understand water elevation changes and extent of the changes on flood-impacted areas 2. Utilize technical experts, who understand local coastal and riverine systems, to review and provide oversight on analysis.
14	6 - Planning-Site (PS)	Current study area may be insufficient to adequately account for complex and tidally-dominated coincidental flood risk.	Extent of updated flood risk following coincidental probability analysis could necessitate expansion of the study area to effectively reduce risk and ensure identified measures function as intended.	Expanding scope to include additional tidally-influenced areas would have significant impacts on study schedule and budget due to additional H&H modeling, plan formulation, and associated engineering required. Study will already require a 3x3x3 waiver to extend beyond 3 year study period. Vertical team concurred that incorporating tidal areas would be a massive increase in scope, requiring extensive resources. Measures identified to reduce risk in Washington, NC, including a large-scale floodwall, will affect flood risk downstream--an area not currently incorporated into the current study area or existing model. Vertically-aligned decision to remove tidally-influenced areas from the current study. SAW coordinating with the state on potential for incorporation of these areas in separate study. **MAR 2024 Update:** Unlikely, as affected areas have been removed from the study.	Unlikely	Marginal	Low	Marginal	Low	N/A -Not Modeled	N/A -Not Modeled		Planning	Project Cost & Schedule	$0	$0	$0	0.00 MO	0.00 MO	0.00 MO	$0	$0	$0	100%	1	$0	$0	$0	$0	$0	0.00 MO	0.00 MO	N/A - Not modeled	1. Coordinate with the vertical team regarding whether tidally-influenced areas should be included in current study. 2. Coordinate with SAW to ensure consistency between the Tar Pamlico and Neuse River studies, with respect to incorporation of tidally-influenced areas 3. Coordinate with the State of NC regarding potential interest in separate study for tidally-influenced areas.
15	1 - Project & Program Management (PM)	Inclusion of tidal areas within the study scope may not be within study authority.	Moving forward with tidal areas in the study scope could result in a significant waste of resources if it is determined that these areas are not within the study authority and must be removed from the final report and recommended plan.	Cannot recommend a feature or alternative that is not within the study/project authorization. If study is expanded or continues to include tidal areas, significant resources could be wasted. Initial OC analysis of the authorization indicates that substantial effort would be needed to determine if tidal areas are covered by the study authorization. Thus, there is some uncertainty in whether these areas could be included. **MAR 2024 Update:** Unlikely, as affected areas have been removed from the study.	Unlikely	Marginal	Low	Moderate	Low	N/A -Not Modeled	N/A -Not Modeled		Project Management	N/A -Not Modeled	$0	$0	$0	0.00 MO	0.00 MO	0.00 MO	$0	$0	$0	100%	1	$0	$0	$0	$0	$0	0.00 MO	0.00 MO	N/A - Not modeled	1. Coordinate with district, division, and HQ OC and planning and policy groups. 2. Coordinate with SAW and state of NC on potential for including these areas in a subsequent study. 3. Consider this risk within the context of other risks related to inclusion of tidally-influenced areas to inform path forward.
16	18 - Hydraulics / Hydrology (HH)	Tributary Flooding	Tributaries do not have discharge or depth gage data to use to calibrate H&H models. Lack of calibration/validation data could impact model accuracy in areas without gauges. This could affect the appropriateness of measure/alternative formulation.	Could affect overall viability and effectiveness of recommended plan. Sound engineering techniques exist to address lack of gauge data. Therefore, the likelihood of the lack of gauge data affecting the recommended plan is low. **MAR 2024 Update:** The PDT utilized industry best practices where lack of gauge data was of concern. Based on the sample data used and the frequency of floods defined by the record length study, it is unlikely the lack of gauge date in certain areas will impact the recommended plan.	Unlikely	Negligible	Low	Marginal	Low	N/A -Not Modeled	N/A -Not Modeled		Hydrology/Hydraulic Design	N/A -Not Modeled	$0	$0	$0	0.00 MO	0.00 MO	0.00 MO	$0	$0	$0	50%	1	$0	$0	$0	$0	$0	0.00 MO	0.00 MO	N/A - Not modeled	1. Utilize rainfall runoff relationship to model un-gaged tributaries.
17	18 - Hydraulics / Hydrology (HH)	1D/steady state hydraulic model has high degree of uncertainty in certain areas.	Overestimation of flood risk and associated damages could result in development of a tentatively selected plan that does not reflect the optimal plan and requires significant revision during feasibility level design or PED.	Initial nonstructural analysis indicates that approximately 65% of potentially viable nonstructural measures occur in areas with a high-degree of uncertainty. Therefore, this uncertainty stands to have a large impact on the final recommendation. **MAR 2024 Update:** Likely to impact structures in the study area; upwards of 4-5 structures.	Likely	Moderate	Medium	Marginal	Medium	Triangular (LV, ML, 80%)	Triangular (LV, ML, 80%)		Hydrology/Hydraulic Design	Project Cost & Schedule	$0	$0	$610,730	0.00 MO	0.00 MO	2.00 MO	$0	$0	$301,280	100%	1	$0	$0	$912,009	$0	$0	0.00 MO	0.00 MO	The base cost estimate and schedule do not currently account for design changes to structures based on uncertainties founded upon 1D modeling. LV: No change to the structures as currently scheduled/estimated. ML: No change to the structures as currently scheduled/estimated. HV: Five (5) structure are affected resulting in 50% cost increase and additional 8 weeks of schedule. See risk backup for additional detail.	1. Coordinate with regional and national H&H experts on potential solutions to model uncertainty, including revisions to the 1D model and development of a 2D model. 2. Coordinate recommended path forward with the VT.
18	18 - Hydraulics / Hydrology (HH)	Delays in 2D modeling	Delays in 2D modeling could impact the revised schedule and cost estimate	Additional time and funding requests would be needed. Additional model development was conducted to address this uncertainty in Rocky Mount. Study will require a 3x3x3 waiver. Need to execute the study within the revised schedule and funding stream. **MAR 2024 Update:** No additional 2D modeling is anticipated. Cost & Schedule impacts associated with that lack of 2D modeling in areas is captured in Risk 17.	Unlikely	Marginal	Low	Marginal	Low	N/A -Not Modeled	N/A -Not Modeled	17	Hydrology/Hydraulic Design	N/A -Not Modeled	$0	$0	$0	0.00 MO	0.00 MO	0.00 MO	$0	$0	$0	100%	1	$0	$0	$0	$0	$0	0.00 MO	0.00 MO	N/A - Not modeled	1. Coordinate with regional and national H&H experts early and often. 2. Set aside additional month of time contingency to address any remaining H&H issues. 3. Pull additional contingency up from ADM and CR milestones to the TSP milestone.
19	1 - Project & Program Management (PM)	Potentially large-scale nonstructural recommendation	National Nonstructural Committee could require a large-scale gross appraisal that could take significant resources. Uncertainty in nonstructural RE requirements.	Delayed study schedule depending on resource availability and extent of effort. Study will require a 3x3x3 waiver. Need to execute the study within the revised schedule/funding stream. **MAR 2024 Update:** The project has progressed past the study execution phase where a large-scale gross appraisal could be implemented.	Unlikely	Marginal	Low	Moderate	Low	N/A -Not Modeled	N/A -Not Modeled		Project Management	N/A -Not Modeled	$0	$0	$0	0.00 MO	0.00 MO	0.00 MO	$0	$0	$0	100%	1	$0	$0	$0	$0	$0	0.00 MO	0.00 MO	N/A - Not modeled	1. Start coordinating with RE experts early. 2. Set aside additional schedule contingency between ADM and CR to accommodate effort, as needed.
20	1 - Project & Program Management (PM)	Potential to recommend plan other than NED plan based on comprehensive benefits.	Presence of socially-vulnerable and EJ communities throughout the watershed could result in recommendation of a plan other than the NED plan that maximizes comprehensive benefits.	Recommending a plan other than the NED plan would require an NED waiver. The waiver approval process can take time, increasing overall study schedule. **MAR 2024 Update:** NED waiver granted, PDT will move forward with the Comprehensive Benefits plan. Implementing a non-NED plan resulting in the current plan.	Unlikely	Marginal	Low	Marginal	Low	N/A -Not Modeled	N/A -Not Modeled		Project Management	N/A -Not Modeled	$0	$0	$0	0.00 MO	0.00 MO	0.00 MO	$0	$0	$0	100%	1	$0	$0	$0	$0	$0	0.00 MO	0.00 MO	N/A - Not modeled	1. Set aside additional schedule contingency between to accommodate the waiver approval process.

Tar-Pamlico River Basin - Feasibility (TSP) - For Milestone #2

February 2024						Project Cost		Project Schedule		Other Information					Cost Impacts			Schedule Impacts			Cost from Schedule Impacts			Event Risk Info		Cost Risk Modeling					Schedule Risk Modeling		Additional Documentation	
REF	Risk Type	Risk/Opportunity Event	Risk Event Description	Team Discussions on Impact and Likelihood	Likelihood	Impact (C)	Risk Level (C)	Impact (S)	Risk Level (S)	Cost Variance Distribution	Schedule Variance Distribution	Correlation to Other(s)	Responsibility/ POC	Affected Project Component	Low Variance (C)	Likely (C)	High Variance (C)	Low Variance (S)	Likely (S)	High Variance (S)	Low Variance (CS)	Likely (CS)	High Variance (CS)	TWO STEP (Cost & Schedule)	Event Prob (PCS)	Low Variance (TC)	Likely (TC)	High Variance (TC)	Cost Risk	Simulated Cost Cost Risk x PCS	Schedule Risk	Simulated Schedule Schedule Risk x PCS	Risk Quantification Discussions	Suggested Risk Reduction Measures (Avoid, Escalate, Exploit, Transfer/Share, Mitigate/Enhance, or Accept)
21	21 - Environmental & Cultural/Historical Resources (EC)	Environmental Assessment (EA) takes longer than one (1) year to complete	Current planning process and schedule will maintain more than a year between TSP and the signed Chief's Report. If the EA process takes longer than a year, or is forced to due to project scheduling , then an EA waiver may be required.	Study schedule is slipped currently and study will require a 3x3x3 waiver. Uncertainties surrounding the current schedule and likelihood of the recommendations that will develop from an EA. **MAR 2024 Update:** The EA has currently taken over 1 year. Currently does not pose any impact on execution/implementation. However, additional extension could impact the project.	Possible	Significant	Medium	Moderate	Medium	Single Event (2 Step)	Single Event (2 Step)		Environmental Compliance	Project Cost & Schedule	$0	$0	$0	0.00 MO	0.00 MO	4.00 MO	$0	$0	$1,662,922	30%	1	$0	$0	$1,662,922	$0	$0	0.00 MO	0.00 MO	Current status of the EA does not impact the base estimate or schedule. However, further delay could cause schedule delay and associated PED costs due to schedule extension. LV: No cost or schedule impact. ML: No cost or schedule impact. HV: Assume 4 month schedule impact with associated PED extension.	1. Monitor project progress and timeline. 2. If necessary, request an EA extension waiver.
22	1 - Project & Program Management (PM)	Review Periods Extend Beyond Baseline Schedule	The study timeline has extended past the original planned timeline. The PDT recommends shortening review timelines between these milestones. Shortening the review time from TSP to ADM and ADM to Final Report Submittal	NED waiver granted, the PDT will move forward with the Comprehensive Benefits Plan. **MAR 2024 Update:** The project is seeking incorporation into the 2024 WRDA Authorization Act. Historically May 31 deadline for inclusion. Delays in DQC & ATR reviews could cause the project to miss the May 31st deadline.	Unlikely	Critical	Medium	Critical	Medium	Single Event (2 Step)	Single Event (2 Step)		Project Management	Project Cost & Schedule	$0	$0	$6,284,639	0.00 MO	0.00 MO	24.00 MO	$0	$0	$0	5%	1	$0	$0	$6,284,639	$0	$0	0.00 MO	0.00 MO	The base cost estimate and schedule assume project inclusion in the 2024 WRDA Authorization Act. The following assumptions are based on a delay in meeting the deadline date: LV: Base schedule, no delay. ML: Base schedule, no delay. HV: 2 Year delay for inclusion in 2026 WRDA Authorization Act. Assume project mid-point pushes 2 years.	1. Incorporate two months of contingency prior to submittal of the final report to address RE uncertainties. 2. Monitor project progress and timeline
23	6 - Planning-Site (PS)	NED Waiver does not get approved	Select the comprehensive benefits plan as the TSP and seek an NED waiver. NED waiver request does not get approved by the Assistant Secretary of the Army (Civil Works).	Considerable changes in the plan could necessitate re-review by the public, impacting study schedule and project viability. If the NED waiver does not get approved, the plan that ultimately gets recommended in the final report will be different than the plan included in the draft report. **MAR 2024 Update:** The NED waiver has been approved. Risk is retired.	Unrated	Negligible	Unrated	Negligible	Unrated	N/A -Not Modeled	N/A -Not Modeled		Planning	N/A -Not Modeled	$0	$0	$0	0.00 MO	0.00 MO	0.00 MO	$0	$0	$0	100%	1	$0	$0	$0	$0	$0	0.00 MO	0.00 MO	N/A - Not modeled	Submit draft NED waiver request at the TSP and coordinate early with the vertical team.
24	6 - Planning-Site (PS)	Selection of the TSP without conducting a sensitivity analysis on nonstructural participation rates.	The PDT has not yet conducted a sensitivity analysis to determine if the BCR of the TSP would be affected by landowners who decline to participate in the TSP	Lack of participation in the TSP, particularly by larger commercial facilities, could result in negative net economic benefits and a benefit cost ratio below unity for the TSP. **MAR 2024 Update:** Initial study performed. The NED waiver has been approved thus no impacts related to the lack of participation affects the sensitivity analysis. Risk is retired.	Unrated	Negligible	Unrated	Negligible	Unrated	N/A -Not Modeled	N/A -Not Modeled		Planning	N/A -Not Modeled	$0	$0	$0	0.00 MO	0.00 MO	0.00 MO	$0	$0	$0	100%	1	$0	$0	$0	$0	$0	0.00 MO	0.00 MO	N/A - Not modeled	Complete sensitivity analysis as soon as possible to clearly document the extent to which participation rates could affect net economic benefits. Document risk within the NED waiver request.
25	7 - General Technical Risk (TR)	Inaccurate Characterization of Structures	For this feasibility study, the PDT utilized online publicly available street view maps in order to determine the flood-proof level of structures. Use of Google Earth ID and existing data to characterize need for nonstructural measures. Inaccurate assumptions/characterization of current risk could affect the number and location of structures within the TSP/recommended plan, affecting the benefits calculation for one or more reaches.	Could result in changes to the recommended plan between the draft and final reports. **MAR 2024 Update:** Commercially available software used (i.e. Google Earth). Commercial structures harder to determine based on Google Earth imagery based on imagery definition and potential improved due to an outdated timestamp. Potential for unnecessarily including previously floodproofed structures. Potential to decrease number of structures based on actual surveys (assessor database) vs Google Earth.	Likely	Moderate	Medium	Marginal	Medium	Triangular (LV, ML, 80%)	Triangular (LV, ML, 80%)		Planning	Project Cost & Schedule	-$733,159	$0	$763,518	-0.50 MO	0.00 MO	1.50 MO	-$75,320	$0	$225,960	100%	1	-$808,479	$0	$989,478	$0	$0	0.00 MO	0.00 MO	The base estimate and schedule includes a total of 61 residential and 94 commercial structures. LV: Upon on-ground assessments, assume discovery of two (2) commercial structures having flood proofing measures meeting USACE standards previously performed. Resulting in the reduction of 2 commercial structures and a 2 week reduction in schedule. ML: No change in base estimate or schedule. HV: Upon on-ground assessments, assume discovery of three (3) commercial structures needing additional flood proof measures and the addition of two (2) residential structures and an increase of 1.5 months of schedule.	Work with the State of NC to ensure the study team is utilizing the most up-to-date mitigation database. Collect additional data/survey information during feasibility-level design.
26	9 - Lands and Damages Risk (RE)	Updated/changing USACE guidance for nonstructural recommendations.	The National Nonstructural Committee (NNC) and HQUSACE are currently working to update implementation guidance for non-structural flood risk management plans. An ER will be released in ~Oct / Nov. The new guidance may affect the implementation of the Tar Pamlico plan, particularly with regards to potential real estate acquisitions.	Changing guidance for nonstructural recommendations, including requirement for a detailed implementation plan and non-federal sponsor acquisition responsibilities, could affect study schedule and budget. **MAR 2024 Update:** Incorporating guidance with the NNC. Easement would not be required but still being discussed, correlates with Risk #19. If Easement required - during PED phase - easement granted to Non-Federal sponsor.	Unlikely	Marginal	Low	Marginal	Low	N/A -Not Modeled	N/A -Not Modeled		Civil/Site Design	N/A -Not Modeled	$0	$0	$0	0.00 MO	0.00 MO	0.00 MO	$0	$0	$0	100%	1	$0	$0	$0	$0	$0	0.00 MO	0.00 MO	N/A - Not modeled	Coordinate with the vertical team regarding interim and updated guidance. Bring questions and challenges the study team faces to the vertical team as soon as they arise.
27	5 - Contract Acquisition Risks (CA)	Numerous Separate Construction Contracts	The number of structure to be raised and the estimated construction schedule likely prohibits one, single contract.	**MAR 2024 Update:** The acquisition strategy is currently unknown at this time. Likely multiple contracts grouped by specific structure type or geographic location or utilizing a phased approached.	Likely	Significant	High	Significant	High	Triangular (LV, ML, 80%)	Triangular (LV, ML, 80%)		Planning	Project Cost & Schedule	$0	$0	$500,000	-4.00 MO	0.00 MO	6.00 MO	-$892,372	$0	$1,338,558	100%	1	-$892,372	$0	$1,838,558	$0	$0	0.00 MO	0.00 MO	The base estimate and schedule assume one (1) Prime contractor with multiple subcontractors performing under a single contract award. Additional contracts could reduce the overall schedule if awards and execution is done concurrently. If awarded to the same contractor and performed sequentially the schedule could extend. LV: Base estimate and assume awards to different contractors resulting in a 4 month schedule reduction. ML: Base estimate and schedule. HV: Total of three (3) contracts will be awarded (Two (2) additional contract from the current base assumption). Results in additional mobilization/demobilization and procurement costs at $225k/EA. Assume awards to the same contractor resulting in an 6 month schedule extension.	1) A sources sought and more market research will help to identify and substantiate the assumptions made by the PDT and the cost engineer.
28	13 - Construction (CO)	Construction Schedule Uncertainty	The existing construction schedule is at a Class S level. Changes in construction sequencing or phasing could impact the scheduled duration.	**MAR 2024 Update:** The base schedule for implementation is currently based on a 7.5 year execution schedule. 155 structures / 9 working months/year / ~2.3 structures/month = 7.5 years	Likely	Significant	High	Critical	High	Triangular (LV, ML, 80%)	Triangular (LV, ML, 80%)		Construction	Project Cost & Schedule	$0	$0	$0	-21.00 MO	0.00 MO	13.20 MO	-$1,521,515	$0	$956,381	100%	1	-$1,521,515	$0	$956,381	$0	$0	0.00 MO	0.00 MO	The base schedule for implementation is currently based on a 7.5 year execution schedule. 155 structures / 9 working months/year / ~2.3 structures/month = 7.5 years LV: 155 structures / 9 working months/year / 3 structures/month = 5.7 years or a reduction of 1.75 years off the base schedule HV: 155 structures / 9 working months/year / 2 structures/month = 8.6 years or an increase of 1.1 years to the base schedule Assume cost of 31 Account only as one contractor is assumed. Risk #27 accounts for the cost of contractor extension.	1) Developing a more detailed schedule will help to mitigate this risk. Additionally, knowing the number of contracts/contractors will help to build a more accurate and useful schedule.
29	13 - Construction (CO)	Subcontractor Availability	General Contractor relying heavily on specialty subcontractors for the lifting and utility work for the structure raisings.	**MAR 2024 Update:** Based on estimator research, potential for 1 or 2 subcontractors identified in the area that is specializes in the subject scope. Possible outside subcontractors could be needed resulting in per diem for craft labor.	Possible	Significant	Medium	Negligible	Low	Single Event (2 Step)	N/A -Not Modeled		Construction	Project Cost	$0	$678,424	$1,356,856	0.00 MO	0.00 MO	0.00 MO	$0	$0	$0	30%	1	$0	$716,724	$1,433,448	$0	$0	0.00 MO	0.00 MO	The base estimate includes per diem allowance for the Prime Contractor field support oversight staff/ field non-manual labor, across a total of 229,354 hours. The Subcontractor hours total 179,181 labor hours for field/craft labor. LV: No change to base estimate. Assume local subcontractors with no per diem allowance. ML: Assume 50% craft labor is out of the working region thus requiring per diem. 179,181 hrs * 0.5 = 89,590 hrs * $8.00/hr = $716,724 HV: Assume 100% craft labor is out of the working region thus requiring per diem. 179,181 hrs * $8.00/hr = $1,433,448	1) Utilize a sources sought and market research can help to flush out this issue.
30	13 - Construction (CO)	Subcontractor Performance	Poor/inefficient subcontractor performance could lead to extended project schedule & cost associated to schedule delay.	**MAR 2024 Update:** Estimated Contractor productivity rates could vary which impact cost and schedule. The base estimate assumes a productivity of 90%. Schedule consideration are accounted for in Risk #28.	Likely	Critical	High	Negligible	Low	Triangular (LV, ML, 80%)	N/A -Not Modeled		Construction	Project Cost	$0	$0	$4,679,696	0.00 MO	0.00 MO	0.00 MO	$0	$0	$0	100%	1	$0	$0	$4,679,696	$0	$0	0.00 MO	0.00 MO	The base estimate assumes a productivity factor of 95% across all workfronts. LV: No change to base estimate. Assume 90% productivity across all workfronts. ML: No change to base estimate. Assume 90% productivity across all workfronts. HV: Assume reduction in productivity from the base estimate to 80% across all workfronts. See Risk Backup sheet for additional detail.	1) Develop detailed construction schedule and execution strategy to help mitigate standby time. Front-end planning to get homeowner location prepared for efficient contractor performance.
31	13 - Construction (CO)	Contract Modifications/REAs	Potential for contract modifications. Particularly with the number of structures and locations, there is a potential for numerous contract modifications.	**MAR 2024 Update:** Construction modifications are likely given the number of structures and locations.	Likely	Critical	High	Significant	High	Triangular (LV, ML, 80%)	Triangular (LV, ML, 80%)		Construction	Project Cost & Schedule	$1,348,537	$2,247,561	$6,742,683	3.28 MO	5.46 MO	10.92 MO	$237,333	$395,556	$791,111	100%	1	$1,585,870	$2,643,117	$7,533,794	$0	$0	0.00 MO	0.00 MO	Given the number of structures, contract modifications are likely. Assume to following variances for both cost & schedule: LV: 3% cost & schedule impact. ML: 5% cost and schedule impact HV: 15% cost and schedule impact Assume only 31-Account cost of schedule extension as Contractor costs are covered as part of the REA.	1) A thorough design and review process can help to mitigate the risk of contract modifications. There are some issues, such as unforeseen site conditions, that may be unavoidable as this work progresses.
32	13 - Construction (CO)	Inadequate Staging/Lay-Down Areas	Adequate staging area for the subcontractors is required.	**MAR 2024 Update:** The current strategy is to utilize the landowner's property for staging and material/equipment lay-down. Based on previous execution of USACE scope by other districts. Negligible cost or schedule impacts.	Unlikely	Negligible	Low	Negligible	Low	N/A -Not Modeled	N/A -Not Modeled		Construction	N/A -Not Modeled	$0	$0	$0	0.00 MO	0.00 MO	0.00 MO	$0	$0	$0	100%	1	$0	$0	$0	$0	$0	0.00 MO	0.00 MO	N/A - Not modeled	
33	14 - Estimate and Schedule Risks (ES)	Variation in Escalation	Given the project's construction duration, the currently forecasted escalation rates could vary.	**MAR 2024 Update:** Due to the project's ~90 month schedule duration, escalation rates used in the out-years of the project will likely vary.	Likely	Critical	High	Negligible	Low	Triangular (LV, ML, 80%)	N/A -Not Modeled		Cost Engineering	Project Cost	$0	$0	$4,045,495	0.00 MO	0.00 MO	0.00 MO	$0	$0	$0	100%	1	$0	$0	$4,045,495	$0	$0	0.00 MO	0.00 MO	Assume the following inflationary rates: LV: Base estimate, no change. ML: Base estimate, no change. HV: Annual 4.75% for the out-years. See Risk backup sheet for additional detail.	1) Continual updating of the TPCS with the latest edition of CWCCIS can help to mitigate this risk. Confirming that escalation factor with outside sources can help corroborate the CWCCIS.
34	13 - Construction (CO)	Delay in Permitting	The contractor(s) will be required to obtain building permits prior to work on the structures.	**MAR 2024 Update:** Based on the number of structures, the project has the potential to experience delays due to delays in local/state permitting. Ideally, permits will be obtained prior to construction. However, there is potential for delay which could impact construction execution.	Possible	Moderate	Medium	Moderate	Medium	Single Event (2 Step)	Single Event (2 Step)		Construction	Project Cost	$0	$0	$0	0.00 MO	1.00 MO	4.00 MO	$0	$150,640	$602,560	30%	1	$0	$150,640	$602,560	$0	$0	0.00 MO	0.00 MO	Based on the number of structures that require raising, it is likely the contractor(s) will have options as to which structures to raise and when. If one structure is held up by a building permit, it is likely they will other nearby options. Assume the following variances: LV: Base estimate. No delays in structure permitting. ML: 1 month schedule delay. HV: 4 month schedule delay.	1) This risk can be mitigated by ensuring the contractor(s) know of this requirement and encourage them to apply for the permits as soon as possible to avoid any potential delays.
35	7 - General Technical Risk (TR)	Technical Design Maturity	Current level of technical/design maturity could result in future changes or modifications to the approach as the design matures.	**MAR 2024 Update:** The cost estimate is based on the current design elevation. Design elevation unlikely to change based on the modeling performed. However, there is potential for the individual cost of each structure to vary rather than a standard unit rate for each.	Likely	Critical	High	Negligible	Low	Triangular (LV, ML, 80%)	N/A -Not Modeled		Cost Engineering	Project Cost	-$2,247,561	$0	$8,990,244	0.00 MO	0.00 MO	0.00 MO	$0	$0	$0	100%	1	-$2,247,561	$0	$8,990,244	$0	$0	0.00 MO	0.00 MO	The cost estimate is based on a standard design per structure and modification type. Assume the following variances: LV: -5% cost reduction based on structures costing less than the standard estimated. ML: Base estimate, no variance. HV: +20% cost increase based on structures costing more than the standard estimated.	1) Progress design and conduct field studies to verify assumptions used in the model.
36	4 - External Risks (EX)	Project Funding	Adequacy of project funding (incremental funding vs. fully funded)	**MAR 2024 Update:** The current project funding is unknown at this time. There is potential for incremental funding; however, the project will likely be fully funded. Non-Federal funding is 35%. There is potential for delay in Non-Federal funds	Possible	Critical	High	Critical	High	Single Event (2 Step)	Single Event (2 Step)		Customer	Project Cost & Schedule	$0	$0	$4,097,038	0.00 MO	0.00 MO	12.00 MO	$0	$0	$0	30%	1	$0	$0	$4,097,038	$0	$0	0.00 MO	0.00 MO	A delay in funding could result in schedule extension. LV: Assume base schedule (fully funded) ML: Assume base schedule (fully funded) HV: Assume one (1) year schedule delay due to inadequate funding/delayed funding w/ associated cost of schedule extension.	Accept
37	14 - Estimate and Schedule Risks (ES)	Variation in Contractor Markups	Common risk related to Subcontractor markups or indirect rates such as JOOH, HOOH,profit, bond, etc.	**MAR 2024 Update:** The base estimate includes the following Subcontractor markups: JOOH: 5% , HOOH: 10%, and Profit: 10%. It is likely the Subcontractor rates will vary from the base estimate.	Likely	Critical	High	Negligible	Low	Triangular (LV, ML, 80%)	N/A -Not Modeled		Cost Engineering	Contract Cost	$0	$0	$1,797,630	0.00 MO	0.00 MO	0.00 MO	$0	$0	$0	100%	1	$0	$0	$1,797,630	$0	$0	0.00 MO	0.00 MO	Variation in Subcontractor Markups: LV: No change from base estimate (5% JOOH, 10% HOOH, 10% Profit). ML: No change from base estimate (5% JOOH, 10% HOOH, 10% Profit). HV: 7% JOOH, 10% HOOH, 2% Bond, 10% Profit	Accept. Base estimate assumes likely contractor markups.

TPCS

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

PROJECT: **Tar Pamlico Basin FRM Feasibility Study**
PROJECT NO: P2 487786
LOCATION: Pitt County North Carolina

DISTRICT: SAW District
POC: CHIEF, COST ENGINEERING, xxx

PREPARED: 5/30/2024

This Estimate reflects the scope and schedule in report; FRM Feasibility Study

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)						TOTAL PROJECT COST (FULLY FUNDED)			
						Program Year (Budget EC): 2026 Effective Price Level Date: 1 OCT 25									
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	**TOTAL ($K)**	Spent Thru: **1-Oct-23** ($K)	**TOTAL FIRST COST** ($K)	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*K*	*L*	*M*	*N*	*O*
19	BUILDINGS, GROUNDS & UTILITIES	$10,493	$4,512	43.0%	$15,005	5.3%	$11,050	$4,751	$15,801	$0	$15,801	21.3%	$13,398	$5,761	$19,159
19	BUILDINGS, GROUNDS & UTILITIES	$34,458	$14,817	43.0%	$49,276	5.3%	$36,287	$15,604	$51,891	$0	$51,891	21.3%	$44,000	$18,920	$62,920
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:	$44,951	$19,329		$64,280	5.3%	$47,337	$20,355	$67,692	$0	$67,692	21.3%	$57,398	$24,681	$82,079
01	LANDS AND DAMAGES	$4,396	$1,099	25.0%	$5,495	5.3%	$4,629	$1,157	$5,787	$0	$5,787	4.6%	$4,843	$1,211	$6,054
30	PLANNING, ENGINEERING & DESIGN	$13,710	$5,895	43.0%	$19,605	6.8%	$14,641	$6,296	$20,937	$0	$20,937	11.0%	$16,257	$6,990	$23,247
31	CONSTRUCTION MANAGEMENT	$6,518	$2,803	43.0%	$9,321	6.8%	$6,961	$2,993	$9,954	$0	$9,954	27.3%	$8,863	$3,811	$12,673
	PROJECT COST TOTALS:	$69,575	$29,126	41.9%	$98,701		$73,568	$30,801	**$104,369**	$0	**$104,369**	18.9%	$87,361	$36,693	$124,054

ESTIMATED TOTAL PROJECT COST: $124,054

_____ **CHIEF, COST ENGINEERING, xxx**

_____ **PROJECT MANAGER, xxx**

_____ **CHIEF, REAL ESTATE, xxx**

_____ **CHIEF, PLANNING, xxx**

_____ **CHIEF, ENGINEERING, xxx**

_____ **CHIEF, OPERATIONS, xxx**

_____ **CHIEF, CONSTRUCTION, xxx**

_____ **CHIEF, CONTRACTING,xxx**

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

_____ **CHIEF, DPM, xxx**

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

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

PROJECT: Tar Pamlico Basin FRM Feasibility Study
LOCATION: Pitt County North Carolina
This Estimate reflects the scope and schedule in report; FRM Feasibility Study

DISTRICT: SAW District
POC: CHIEF, COST ENGINEERING, xxx

PREPARED: 5/30/2024

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: 1-Oct-23; Effective Price Level: 1-Oct-23				Program Year (Budget EC): 2026; Effective Price Level Date: 1 OCT 25								
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	RISK BASED CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	PHASE 1 or CONTRACT 1													
19	BUILDINGS, GROUNDS & UTILITIES ELEVATIONS	$10,493	$4,512	43.0%	$15,005	5.3%	$11,050	$4,751	$15,801	2033Q3	21.3%	$13,398	$5,761	$19,159
19	BUILDINGS, GROUNDS & UTILITIES DRY FLOODPROOFING	$34,458	$14,817	43.0%	$49,276	5.3%	$36,287	$15,604	$51,891	2033Q3	21.3%	$44,000	$18,920	$62,920
	#N/A	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	#N/A	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	#N/A	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	#N/A	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	#N/A	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	#N/A	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:	$44,951	$19,329	43.0%	**$64,280**		$47,337	$20,355	$67,692			$57,398	$24,681	$82,079
01	LANDS AND DAMAGES	$4,396	$1,099	25.0%	$5,495	5.3%	$4,629	$1,157	$5,787	2027Q4	4.6%	$4,843	$1,211	$6,054
30	PLANNING, ENGINEERING & DESIGN													
2.5%	Project Management	$1,124	$483	43.0%	$1,607	6.8%	$1,200	$516	$1,716	2027Q4	5.5%	$1,266	$544	$1,810
1.0%	Planning & Environmental Compliance	$450	$193	43.0%	$643	6.8%	$480	$206	$686	2027Q4	5.5%	$506	$218	$724
15.0%	Engineering & Design	$6,743	$2,899	43.0%	$9,642	6.8%	$7,201	$3,096	$10,297	2027Q4	5.5%	$7,596	$3,266	$10,862
1.0%	Reviews, ATRs, IEPRs, VE	$450	$193	43.0%	$643	6.8%	$480	$206	$686	2027Q4	5.5%	$506	$218	$724
1.0%	Life Cycle Updates (cost, schedule, risks)	$450	$193	43.0%	$643	6.8%	$480	$206	$686	2027Q4	5.5%	$506	$218	$724
1.0%	Contracting & Reprographics	$450	$193	43.0%	$643	6.8%	$480	$206	$686	2027Q4	5.5%	$506	$218	$724
3.0%	Engineering During Construction	$1,349	$580	43.0%	$1,928	6.8%	$1,440	$619	$2,059	2034Q1	27.3%	$1,834	$788	$2,622
2.0%	Planning During Construction	$899	$387	43.0%	$1,286	6.8%	$960	$413	$1,373	2034Q1	27.3%	$1,222	$526	$1,748
3.0%	Adaptive Management & Monitoring	$1,349	$580	43.0%	$1,928	6.8%	$1,440	$619	$2,059	2033Q3	25.5%	$1,807	$777	$2,584
1.0%	Project Operations	$450	$193	43.0%	$643	6.8%	$480	$206	$686	2027Q4	5.5%	$506	$218	$724
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	$4,495	$1,933	43.0%	$6,428	6.8%	$4,800	$2,064	$6,865	2034Q1	27.3%	$6,112	$2,628	$8,740
2.0%	Project Operation:	$899	$387	43.0%	$1,286	6.8%	$960	$413	$1,373	2034Q1	27.3%	$1,222	$526	$1,748
2.5%	Project Management	$1,124	$483	43.0%	$1,607	6.8%	$1,200	$516	$1,716	2034Q1	27.3%	$1,528	$657	$2,185
	CONTRACT COST TOTALS:	$69,575	$29,126		$98,701		$73,568	$30,801	**$104,369**			$87,361	$36,693	**$124,054**

Design Maturity Memo

Design Maturity Determination for Cost Certification

Date: 5/3/24
P2 Designation/Project Name: 487786- Tar Pamlico Basin FRM Feasibility Study

The Chief of Engineering is responsible for the technical content and engineering sufficiency for all engineering products produced by the command. As such, I have performed the Management Control Evaluation per Engineer Regulation (ER) 1110-2-1150, Engineering and Design for Civil Works Projects, Appendix H, Internal Management Control Review Checklist.

The current design DOES NOT require HQ approval (i.e., engineering waivers), requiring a deviation from mandatory requirements and mandatory standards, as defined in ERs, Engineering Manuals, Engineering Technical letters, and Engineering Circulars.

The current hydrology and hydraulics modeling is at 90 % design maturity, per reference (h) below.

The current geotechnical data and subsurface investigations are at 5 % design maturity, per reference (h) below. Subsurface investigations shall also include investigations of potential borrow and spoil areas.

The current survey data is at 10 % design maturity, per reference (h) below.

Other major technical and/or scope assumptions and risks include the following, which will be refined as the design progresses.

Please see the attached sheet.

The aggregate for all features is 20 % design maturity. Therefore, per the CECW-EC memorandum dated 05-June-2023, I certify that the design deliverables used to generate the cost products for this project and the estimate meet the requirements for a CLASS 3 estimate, as per reference (a) below. Design risks, impacts and remaining efforts are summarized on page 2.

Considering risks and assumptions noted above, along with all other concerns documented in the Risk Register, the Cost and Schedule Risk Analysis has developed a contingency of 43 % at the 80 % confidence level for the defined project scope.

Chief of Engineering & Construction

Mohammed Ibrahim

Printed Name

Mohammed Ibrahim

Digitally signed by Mohammed Ibrahim
Date: 2024.05.03 12:33:28 -04'00'

Signature

Design Maturity Determination for Cost Certification, Remaining Work

If an engineering waiver is required, list the risks and remaining design work needed to mitigate this issue in the current design. Identify remaining effort to complete the design required for 100% design.

No engineering waiver is required.

Identify remaining effort to complete geotechnical design effort required for 100% design. List the risks and cost and schedule impacts needed to mitigate this issue in the current design.

Please see attached sheet.

Identify remaining effort required to complete H&H required for 100% design. List the risks and cost and schedule impacts needed to mitigate this issue in the current design.

Please see attached sheet.

Identify remaining effort needed to complete survey data required for 100% design. List the risks and cost and schedule impacts needed to mitigate this issue in the current design.

Please see attached sheet.

If the project is anticipated to be executed in parts, provide a design assessment (percent complete) of each part/phase below.

Structures will be prioritized for implementation of nonstructural measures by one or more contractors over a broad geographic area and long duration. This lends itself to potential risks associated with contract modifications, subcontractor performance, and managing and executing multiple contracts. Decisions regarding the number of contracts and prioritization of structures will be made during PED. Uncertainties regarding execution by one or more contractors were among the top cost risks identified during the CSRA accounting for greater than $10M in cost contingency.

References:

a. ER 1110-2-1302 – Civil Works Cost Engineering
b. CECW-EC memorandum dated 05-June-2023MFR, Guidance on Cost Engineering Products update for Civil Works Projects in accordance with Engineer Regulation 1110-2-1302 – Civil Works Cost Engineering
c. ER 1165-2-217 – Civil Works Review Policy
d. ER 1110-2-1150 – Engineering and Design for Civil Works Projects
e. ER 1110-3-12 – Quality Management
f. ER 1110-345-700 – Design Analysis, Drawings and Specifications
g. EM 5-1-11 – Project Delivery Business Process (PDBP)
h. Engineering and Construction Bulletin (ECB) 2023-9 – Civil Works Design Milestone Checklists

Design Maturity Determination for Cost Certification

Additional Information

Other major technical and/or scope assumptions and risks include the following, which will be refined as the design progresses.
The plan consists of implementing nonstructural flood risk reduction measures to 155 residential and commercial structures. The National Structure Inventory and the North Carolina Flood Risk Information System structure inventory were cross-checked against each other and used to develop a singular, project-specific structural inventory. This project specific structural inventory was compared to and updated via examination of the properties in Google Earth / Street View and the County Assessor's online database to determine condition, current footprint, construction materials, foundation, first floor elevation, and presence or absence of existing nonstructural features. Recommended actions and associated designs/costs were developed by considering whether the subject properties were commercial or residential, and then considering the visual survey information and the perimeter and height of the structure from the structural inventory. Material assumptions were made that were appropriate for the area and elevation or floodproofing requirements. Costs were developed through the use of MCACES (MII) Templates created by Steven Goodpaster from the National Nonstructural Center that priced the major features of work for the floodproofing method chosen and the data provided by the Economists on the individual structures identified. For each method of elevation work given, the total square footage of foundation wall was calculated and used to develop a weighted average of elevation height and length. Using the MII template, the cost to disconnect and reconnect utilities was priced along with a material allowance to perform the work. Sewer backflow preventers, including earthwork and materials and the costs to elevate the outdoor mechanical equipment on an outside deck were also priced. Indoor mechanical equipment was considered elevated with the structure, however, reconnection and material needed for reconnection is included.
Identify remaining effort to complete geotechnical design effort required for 100% design. List the risks and cost and schedule impacts needed to mitigate this issue in the current design.
Office investigations are recommended to review available soil maps, as-built drawings, and any other available site-specific subsurface information. This information will be used to evaluate existing foundation depths and types, as well as the soil bearing strata condition and material properties. A site-specific subsurface investigation consisting of test pits and/or borings is also recommended to supplement the information gathered during the office investigation and fill any data gaps. Data gathered from the office and subsurface investigations will be utilized to assess new foundation types and bearing stratum properties for the structures to be elevated. Foundation designs will be performed based on the site-specific data collected during the office and subsurface investigations. These surveys will occur during PED and are accounted for in the Engineering & Design component of the TCPS. Design maturity risk is the largest cost risk identified in the CSRA, accounting for over $6M in contingency costs.

Identify remaining effort required to complete H&H required for 100% design. List the risks and cost and schedule impacts needed to mitigate this issue in the current design.
The H&H modeling meets the objectives of a feasibility level analysis. Input data consisted of river gage observation data i.e. stage and flow, terrain models based on high resolution lidar provided by the State of North Carolina and USGS National Map Digital Elevation Model downloader, as-built drawings associated with existing facilities such the Tar River Reservoir operated by Rocky Mount NC, and rainfall frequency data retrieved from National Oceanic and Atmospheric Administration. High Water Marks were limited in the basin, however an exhaustive effort was pursued to identify locations that could be verified through comparison of hydraulic model resultant depths. The study area was evaluated with a 1D Steady RAS model due to limitations of size and scope as well as the guidance provided under current best practices. Some special areas of interest required 2D Hydraulic modeling to best predict the distribution of flow in highly complex floodplains. This resultant 2D Hydraulic model covers an area spanning the tailwater of the Tar River Reservoir down to the confluence of Swift Creek and also includes the confluence with Stony Creek. Remaining effort may be a limited 2D hydraulic model in targeted regions of Greenville, NC, that would be used to verify water surface elevations produced by the HEC RAS 1D model. Design maturity risk is the largest cost risk identified in the CSRA, accounting for over $6M in contingency costs. Risks associated with use of 1-dimenstional modeling account for an additional $580K in contingency.
Identify remaining effort needed to complete survey data required for 100% design. List the risks and cost and schedule impacts needed to mitigate this issue in the current design.
The current design relies on existing LiDAR. Additional typographic and Structure-specific surveys will be needed to verify design and cost assumptions including, but not limited to, the need for and type of nonstructural measures applied and design height for specific features. These surveys will occur during PED and are accounted for in the Engineering & Design component of the TCPS. Design maturity risk is the largest cost risk identified in the CSRA, accounting for over $6M in contingency costs. In addition, in accurate characterization of structures was identified as a cost risk contributing approximately $500K to the overall 43% in cost contingency.