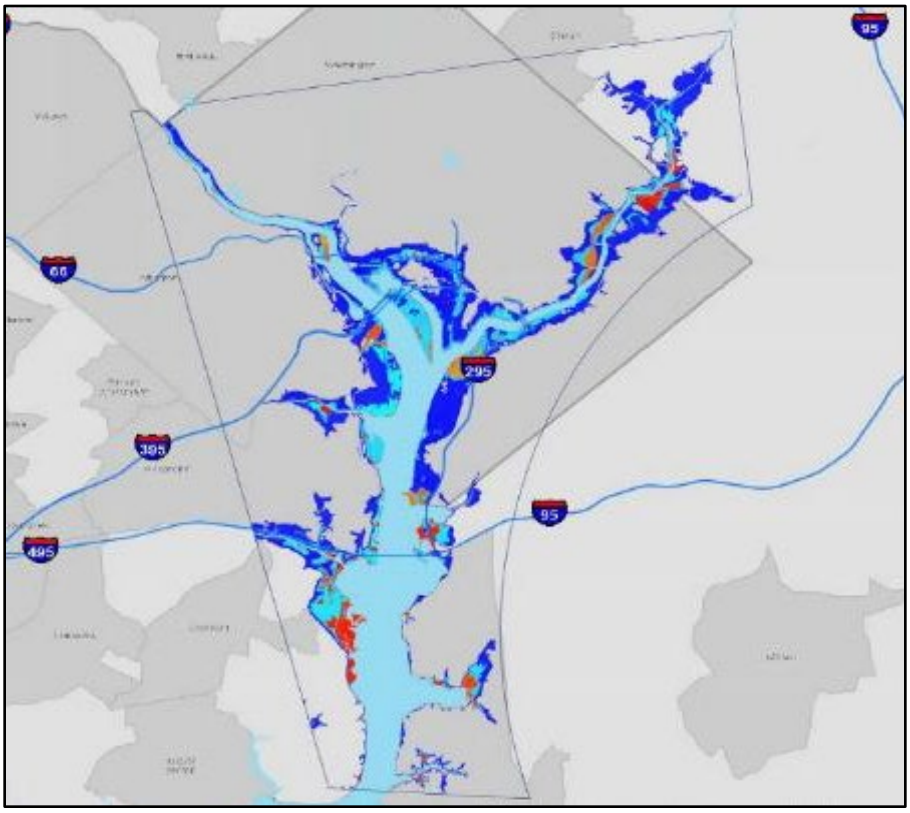
Metropolitan Washington District of Columbia Coastal Storm Risk Management Feasibility Study

Appendix C: Cost Engineering and Risk Analysis



Northern Virginia

May 2022

US Army Corps of Engineers
Baltimore District

Metropolitan Washington Council of Governments

METROPOLITAN WASHINGTON DISTRICT OF COLUMBIA COASTAL STORM RISK MANAGEMENT FEASIBILITY STUDY

Discussion of Alternative Arrays:

The Metropolitan Washington District of Columbia Coastal Storm Risk Management Feasibility Study includes multiple structural alternatives initially. The following Table 1 shows the Rough Order of Magnitude (ROM) costs for the initial arrays of structural alternatives.

Table 1. Rough Order of Magnitude Costs for the Initial Array of Structural Alternatives

Alternative Number	Description	Total Cost
2	**Comprehensive Coastal Storm Surge Barrier**	**$9,000,000,000**
3	**Upper Coastal Storm Surge Barrier**	**$600,000,000**
4	**Critical Infrastructure Plan (GWMP, Reagan, Arlington WPCP)**	**$82,863,000**
4a	GWMP Floodwall	$55,349,000
4b	Reagan National Airport Levee and Floodwall	$19,547,000
4c	Arlington WPCP Floodwall	$7,968,000
5	**Floodwall/Levee Plan (Four Mile Run, Alexandria, Belle Haven)**	**$63,476,000**
5a	Four Mile Run Floodwall	$14,368,000
5b	Alexandria Floodwall	$24,045,000
5c	Belle Haven Levee & Floodwall	$25,063,000

Except for Alternatives 2 and 3 which were based on ROM costs by the consultant (CH2MHill, 2015), Alternatives 4a, 4b, 4c, 5a, 5b, and 5c were estimated based on lengths and heights of proposed structures from preliminary data and based on the North Atlantic Comprehensive Coastal Study which includes unit costs for floodwalls, levees, and deployable floodwall. For floodwalls, the unit cost was deduced from the assumption in the study which is a 10 ft high floodwall for 1 mile long with 13 drainage outlets in between. The 10 ft high was assumed because a 10 ft floodwall was assumed to provide protection for a 7 ft above grade plus 3 ft of freeboard which was based on one of the FEMA criteria for levee and floodwall certification. Likewise for levees, the unit cost was based on a 10 ft high levee for 1 mile long with 13 drainage outlets in between. For deployable floodwall, the unit cost was also based on NACCS ROM cost but with a slightly different assumption, 6 ft high with 0.5 mile long. The deployable structure was assumed to be a stoplog structure. The 6 ft height was assumed to be 3 ft above grade with 3 ft freeboard based on FEMA criteria. The floodwall cost, levee cost, and

deployable floodwall cost are based on weighted average of costs estimated for good and poor foundation condition. The derived ROM unit costs for Alternatives 4a, 4b, 4c, 5a, 5b, and 5c were escalated from quarter 3 of 2014 to quarter 1 of 2019 using Mar 2019 CWCCIS indices for accounts 11 and 15 because the NACCS costs were in May 2014 price level. NACCS recommends 25% contingency for all accounts, but a 30% contingency was included in the ROM cost as shown in Table 1, since the project area is in congested areas in D.C. and Virginia.

See the following pages for the TPCS for ROM costs of Initial Array of Structural Alternatives that was completed in November 2019.

Total Project Cost Summary
for Initial Array of Structural Alternatives

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

PROJECT: **NoVA DC Coastal Storm Risk Management - Initial Array of Structural Alternatives**
PROJECT NO: P2 497631
LOCATION: DC and VA

DISTRICT: **NAB District** **PREPARED:** **11/1/2019**
POC: **CHIEF, Estimating and Specs Section, Parris J. McGhee-Bey**

This Estimate reflects the scope and schedule in report; METRO WASHINGTON, DC COASTAL STORM RISK MANAGEMENT FEASIBILITY STUDY

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)						TOTAL PROJECT COST (FULLY FUNDED)			
	Initial Array					Program Year (Budget EC): 2020 Effective Price Level Date: 1 OCT 19									
WBS NUMBER *A*	Civil Works Feature & Sub-Feature Description *B*	COST ($K) *C*	CNTG ($K) *D*	CNTG (%) *E*	TOTAL ($K) *F*	ESC (%) *G*	COST ($K) *H*	CNTG ($K) *I*	**TOTAL ($K)** *J*	Spent Thru: **1-Oct-19** ($K)	**TOTAL FIRST COST** ($K) *K*	INFLATED (%) *L*	COST ($K) *M*	CNTG ($K) *N*	FULL ($K) *O*
11	LEVEES & FLOODWALLS	$78,421	$23,526	30.0%	$101,947	0.0%	$78,421	$23,526	$101,947	$0	$101,947	0.0%	$78,421	$23,526	$101,947
15	FLOODWAY CONTROL & DIVERSION STRU	$3,269	$981	30.0%	$4,250	0.0%	$3,269	$981	$4,250	$0	$4,250	0.0%	$3,269	$981	$4,250
	CONSTRUCTION ESTIMATE TOTALS:	$81,690	$24,507		$106,197	0.0%	$81,690	$24,507	$106,197	$0	$106,197	0.0%	$81,690	$24,507	$106,197
01	LANDS AND DAMAGES	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN	$22,710	$6,813	30.0%	$29,523	0.0%	$22,710	$6,813	$29,523	$0	$29,523	0.0%	$22,710	$6,813	$29,523
31	CONSTRUCTION MANAGEMENT	$8,169	$2,451	30.0%	$10,620	0.0%	$8,169	$2,451	$10,620	$0	$10,620	0.0%	$8,169	$2,451	$10,620
	PROJECT COST TOTALS:	$112,569	$33,771	30.0%	$146,339		$112,569	$33,771	**$146,339**	$0	**$146,339**	0.0%	$112,569	$33,771	$146,339

ESTIMATED TOTAL PROJECT COST: **$146,339**

CHIEF, Estimating and Specs Section, Parris J. McGhee-Bey

PROJECT MANAGER, Katherine Perkins

CHIEF, REAL ESTATE, Benjamin Ro

CHIEF, PLANNING, Amy M. Guise

CHIEF, ENGINEERING, Mary P. Foutz

CHIEF, OPERATIONS, Patrick G. Findlay

CHIEF, CONSTRUCTION, Jeff J. Werner

CHIEF, CONTRACTING, Paula M. Beck

CHIEF, PP-C, Justin Callahan

CHIEF, DPM, David B. Morrow

Filename: DC Coastal Initial Array TPCS-Nov2019
TPCS

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

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

PROJECT: NoVA DC Coastal Storm Risk Management Structural Plan
DISTRICT: NAB District
PREPARED: 11/1/2019
LOCATION: DC and VA
POC: CHIEF, Estimating and Specs Section, Parris J. McGhee-Bey
This Estimate reflects the scope and schedule in report; METRO WASHINGTON, DC COASTAL STORM RISK MANAGEMENT FEASIBILITY STUDY

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: 1-Nov-19 Effective Price Level: 1-Oct-19				Program Year (Budget EC): 2020 Effective Price Level Date: 1 OCT 19								
				RISK BASED										
WBS NUMBER *A*	Civil Works Feature & Sub-Feature Description *B*	COST ($K) *C*	CNTG ($K) *D*	CNTG (%) *E*	TOTAL ($K) *F*	ESC (%) *G*	COST ($K) *H*	CNTG ($K) *I*	TOTAL ($K) *J*	Mid-Point Date *P*	INFLATED (%) *L*	COST ($K) *M*	CNTG ($K) *N*	FULL ($K) *O*
	Alt 4a GWMP Floodwalls													
11	LEVEES & FLOODWALLS	$30,897	$9,269	30.0%	$40,166	0.0%	$30,897	$9,269	$40,166	2020Q1	0.0%	$30,897	$9,269	$40,166
	CONSTRUCTION ESTIMATE TOTALS:	$30,897	$9,269	30.0%	**$40,166**		$30,897	$9,269	$40,166			$30,897	$9,269	$40,166
01	LANDS AND DAMAGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
2.5%	Project Management	$772	$232	30.0%	$1,004	0.0%	$772	$232	$1,004	2020Q1	0.0%	$772	$232	$1,004
2.0%	Planning & Environmental Compliance	$618	$185	30.0%	$803	0.0%	$618	$185	$803	2020Q1	0.0%	$618	$185	$803
15.5%	Engineering & Design	$4,789	$1,437	30.0%	$6,226	0.0%	$4,789	$1,437	$6,226	2020Q1	0.0%	$4,789	$1,437	$6,226
1.3%	Reviews, ATRs, IEPRs, VE	$386	$116	30.0%	$502	0.0%	$386	$116	$502	2020Q1	0.0%	$386	$116	$502
1.3%	Life Cycle Updates (cost, schedule, risks)	$402	$120	30.0%	$522	0.0%	$402	$120	$522	2020Q1	0.0%	$402	$120	$522
0.8%	Contracting & Reprographics	$232	$70	30.0%	$301	0.0%	$232	$70	$301	2020Q1	0.0%	$232	$70	$301
3.0%	Engineering During Construction	$927	$278	30.0%	$1,205	0.0%	$927	$278	$1,205	2020Q1	0.0%	$927	$278	$1,205
0.5%	Planning During Construction	$154	$46	30.0%	$201	0.0%	$154	$46	$201	2020Q1	0.0%	$154	$46	$201
1.0%	Adaptive Management & Monitoring	$309	$93	30.0%	$402	0.0%	$309	$93	$402	2020Q1	0.0%	$309	$93	$402
0.0%	Project Operations	$0	$0	30.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
7.5%	Construction Management	$2,317	$695	30.0%	$3,012	0.0%	$2,317	$695	$3,012	2020Q1	0.0%	$2,317	$695	$3,012
0.0%	Project Operation:	$0	$0	30.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
2.5%	Project Management	$772	$232	30.0%	$1,004	0.0%	$772	$232	$1,004	2020Q1	0.0%	$772	$232	$1,004
	CONTRACT COST TOTALS:	$42,576	$12,773		**$55,349**		$42,576	$12,773	**$55,349**			$42,576	$12,773	**$55,349**

Filename: DC Coastal Initial Array TPCS-Nov2019
TPCS

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

**** CONTRACT COST SUMMARY ****

PROJECT: NoVA DC Coastal Storm Risk Management Structural Plan
DISTRICT: NAB District
PREPARED: 11/1/2019
LOCATION: DC and VA
POC: CHIEF, Estimating and Specs Section, Parris J. McGhee-Bey
This Estimate reflects the scope and schedule in report; METRO WASHINGTON, DC COASTAL STORM RISK MANAGEMENT FEASIBILITY STUDY

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared:			1-Nov-19	Program Year (Budget EC):			2020					
		Effective Price Level:			1-Oct-19	Effective Price Level Date:			1 OCT 19					
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	Alt 4b Reagan National Airport Levee and Floodwall													
11	LEVEES & FLOODWALLS	$10,912	$3,273	30.0%	$14,185	0.0%	$10,912	$3,273	$14,185	2020Q1	0.0%	$10,912	$3,273	$14,185
	CONSTRUCTION ESTIMATE TOTALS:	$10,912	$3,273	30.0%	**$14,185**		$10,912	$3,273	$14,185			$10,912	$3,273	$14,185
01	LANDS AND DAMAGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
2.5%	Project Management	$273	$82	30.0%	$355	0.0%	$273	$82	$355	2020Q1	0.0%	$273	$82	$355
2.0%	Planning & Environmental Compliance	$218	$65	30.0%	$284	0.0%	$218	$65	$284	2020Q1	0.0%	$218	$65	$284
15.5%	Engineering & Design	$1,691	$507	30.0%	$2,199	0.0%	$1,691	$507	$2,199	2020Q1	0.0%	$1,691	$507	$2,199
1.3%	Reviews, ATRs, IEPRs, VE	$136	$41	30.0%	$177	0.0%	$136	$41	$177	2020Q1	0.0%	$136	$41	$177
1.3%	Life Cycle Updates (cost, schedule, risks)	$142	$43	30.0%	$184	0.0%	$142	$43	$184	2020Q1	0.0%	$142	$43	$184
0.8%	Contracting & Reprographics	$82	$25	30.0%	$106	0.0%	$82	$25	$106	2020Q1	0.0%	$82	$25	$106
3.0%	Engineering During Construction	$327	$98	30.0%	$426	0.0%	$327	$98	$426	2020Q1	0.0%	$327	$98	$426
0.5%	Planning During Construction	$55	$16	30.0%	$71	0.0%	$55	$16	$71	2020Q1	0.0%	$55	$16	$71
1.0%	Adaptive Management & Monitoring	$109	$33	30.0%	$142	0.0%	$109	$33	$142	2020Q1	0.0%	$109	$33	$142
0.0%	Project Operations	$0	$0	30.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
7.5%	Construction Management	$818	$246	30.0%	$1,064	0.0%	$818	$246	$1,064	2020Q1	0.0%	$818	$246	$1,064
0.0%	Project Operation:	$0	$0	30.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
2.5%	Project Management	$273	$82	30.0%	$355	0.0%	$273	$82	$355	2020Q1	0.0%	$273	$82	$355
	CONTRACT COST TOTALS:	$15,036	$4,511		**$19,547**		$15,036	$4,511	**$19,547**			$15,036	$4,511	**$19,547**

Filename: DC Coastal Initial Array TPCS-Nov2019
TPCS

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

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

PROJECT: NoVA DC Coastal Storm Risk Management Structural Plan
DISTRICT: NAB District
PREPARED: 11/1/2019
LOCATION: DC and VA
POC: CHIEF, Estimating and Specs Section, Parris J. McGhee-Bey
This Estimate reflects the scope and schedule in report; METRO WASHINGTON, DC COASTAL STORM RISK MANAGEMENT FEASIBILITY STUDY

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared:			1-Nov-19	Program Year (Budget EC):			2020					
		Effective Price Level:			1-Oct-19	Effective Price Level Date:			1 OCT 19					
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	Alt 4c Arlington WPCP Floodwall													
11	LEVEES & FLOODWALLS	$4,389	$1,317	30.0%	$5,706	0.0%	$4,389	$1,317	$5,706	2020Q1	0.0%	$4,389	$1,317	$5,706
15	FLOODWAY CONTROL & DIVERSION STRU	$58	$18	30.0%	$76	0.0%	$58	$18	$76	2020Q1	0.0%	$58	$18	$76
	CONSTRUCTION ESTIMATE TOTALS:	$4,448	$1,334	30.0%	**$5,782**		$4,448	$1,334	$5,782			$4,448	$1,334	$5,782
01	LANDS AND DAMAGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
2.5%	Project Management	$111	$33	30.0%	$145	0.0%	$111	$33	$145	2020Q1	0.0%	$111	$33	$145
2.0%	Planning & Environmental Compliance	$89	$27	30.0%	$116	0.0%	$89	$27	$116	2020Q1	0.0%	$89	$27	$116
15.5%	Engineering & Design	$689	$207	30.0%	$896	0.0%	$689	$207	$896	2020Q1	0.0%	$689	$207	$896
1.3%	Reviews, ATRs, IEPRs, VE	$56	$17	30.0%	$72	0.0%	$56	$17	$72	2020Q1	0.0%	$56	$17	$72
1.3%	Life Cycle Updates (cost, schedule, risks)	$58	$17	30.0%	$75	0.0%	$58	$17	$75	2020Q1	0.0%	$58	$17	$75
0.8%	Contracting & Reprographics	$33	$10	30.0%	$43	0.0%	$33	$10	$43	2020Q1	0.0%	$33	$10	$43
3.0%	Engineering During Construction	$133	$40	30.0%	$173	0.0%	$133	$40	$173	2020Q1	0.0%	$133	$40	$173
0.5%	Planning During Construction	$22	$7	30.0%	$29	0.0%	$22	$7	$29	2020Q1	0.0%	$22	$7	$29
1.0%	Adaptive Management & Monitoring	$44	$13	30.0%	$58	0.0%	$44	$13	$58	2020Q1	0.0%	$44	$13	$58
0.0%	Project Operations	$0	$0	30.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
7.5%	Construction Management	$334	$100	30.0%	$434	0.0%	$334	$100	$434	2020Q1	0.0%	$334	$100	$434
0.0%	Project Operation:	$0	$0	30.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
2.5%	Project Management	$111	$33	30.0%	$145	0.0%	$111	$33	$145	2020Q1	0.0%	$111	$33	$145
	CONTRACT COST TOTALS:	$6,129	$1,839		**$7,968**		$6,129	$1,839	**$7,968**			$6,129	$1,839	**$7,968**

Filename: DC Coastal Initial Array TPCS-Nov2019
TPCS

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

**** CONTRACT COST SUMMARY ****

PROJECT: NoVA DC Coastal Storm Risk Management Structural Plan
DISTRICT: NAB District
PREPARED: 11/1/2019
LOCATION: DC and VA
POC: CHIEF, Estimating and Specs Section, Parris J. McGhee-Bey
This Estimate reflects the scope and schedule in report; METRO WASHINGTON, DC COASTAL STORM RISK MANAGEMENT FEASIBILITY STUDY

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared:			1-Nov-19	Program Year (Budget EC):			2020					
		Effective Price Level:			1-Oct-19	Effective Price Level Date:			1 OCT 19	FULLY FUNDED PROJECT ESTIMATE				
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	Alt 5a Four Mile Run Floodwall													
11	LEVEES & FLOODWALLS	$7,967	$2,390	30.0%	$10,357	0.0%	$7,967	$2,390	$10,357	2020Q1	0.0%	$7,967	$2,390	$10,357
15	FLOODWAY CONTROL & DIVERSION STRU	$54	$16	30.0%	$70	0.0%	$54	$16	$70	2020Q1	0.0%	$54	$16	$70
	CONSTRUCTION ESTIMATE TOTALS:	$8,021	$2,406	30.0%	**$10,427**		$8,021	$2,406	$10,427			$8,021	$2,406	$10,427
01	LANDS AND DAMAGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
2.5%	Project Management	$201	$60	30.0%	$261	0.0%	$201	$60	$261	2020Q1	0.0%	$201	$60	$261
2.0%	Planning & Environmental Compliance	$160	$48	30.0%	$209	0.0%	$160	$48	$209	2020Q1	0.0%	$160	$48	$209
15.5%	Engineering & Design	$1,243	$373	30.0%	$1,616	0.0%	$1,243	$373	$1,616	2020Q1	0.0%	$1,243	$373	$1,616
1.3%	Reviews, ATRs, IEPRs, VE	$100	$30	30.0%	$130	0.0%	$100	$30	$130	2020Q1	0.0%	$100	$30	$130
1.3%	Life Cycle Updates (cost, schedule, risks)	$104	$31	30.0%	$136	0.0%	$104	$31	$136	2020Q1	0.0%	$104	$31	$136
0.8%	Contracting & Reprographics	$60	$18	30.0%	$78	0.0%	$60	$18	$78	2020Q1	0.0%	$60	$18	$78
3.0%	Engineering During Construction	$241	$72	30.0%	$313	0.0%	$241	$72	$313	2020Q1	0.0%	$241	$72	$313
0.5%	Planning During Construction	$40	$12	30.0%	$52	0.0%	$40	$12	$52	2020Q1	0.0%	$40	$12	$52
1.0%	Adaptive Management & Monitoring	$80	$24	30.0%	$104	0.0%	$80	$24	$104	2020Q1	0.0%	$80	$24	$104
0.0%	Project Operations	$0	$0	30.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
7.5%	Construction Management	$602	$180	30.0%	$782	0.0%	$602	$180	$782	2020Q1	0.0%	$602	$180	$782
0.0%	Project Operation:	$0	$0	30.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
2.5%	Project Management	$201	$60	30.0%	$261	0.0%	$201	$60	$261	2020Q1	0.0%	$201	$60	$261
	CONTRACT COST TOTALS:	$11,053	$3,316		**$14,368**		$11,053	$3,316	**$14,368**			$11,053	$3,316	**$14,368**

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

**** CONTRACT COST SUMMARY ****

PROJECT: NoVA DC Coastal Storm Risk Management Structural Plan
DISTRICT: NAB District
PREPARED: 11/1/2019
LOCATION: DC and VA
POC: CHIEF, Estimating and Specs Section, Parris J. McGhee-Bey
This Estimate reflects the scope and schedule in report; METRO WASHINGTON, DC COASTAL STORM RISK MANAGEMENT FEASIBILITY STUDY

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared:			1-Nov-19	Program Year (Budget EC):			2020					
		Effective Price Level:			1-Oct-19	Effective Price Level Date:			1 OCT 19	FULLY FUNDED PROJECT ESTIMATE				
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	Alt 5b Alexandria Floodwall													
11	LEVEES & FLOODWALLS	$11,375	$3,412	30.0%	$14,787	0.0%	$11,375	$3,412	$14,787	2020Q1	0.0%	$11,375	$3,412	$14,787
15	FLOODWAY CONTROL & DIVERSION STRU	$2,048	$614	30.0%	$2,662	0.0%	$2,048	$614	$2,662	2020Q1	0.0%	$2,048	$614	$2,662
	CONSTRUCTION ESTIMATE TOTALS:	$13,422	$4,027	30.0%	**$17,449**		$13,422	$4,027	$17,449			$13,422	$4,027	$17,449
01	LANDS AND DAMAGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
2.5%	Project Management	$336	$101	30.0%	$436	0.0%	$336	$101	$436	2020Q1	0.0%	$336	$101	$436
2.0%	Planning & Environmental Compliance	$268	$81	30.0%	$349	0.0%	$268	$81	$349	2020Q1	0.0%	$268	$81	$349
15.5%	Engineering & Design	$2,080	$624	30.0%	$2,705	0.0%	$2,080	$624	$2,705	2020Q1	0.0%	$2,080	$624	$2,705
1.3%	Reviews, ATRs, IEPRs, VE	$168	$50	30.0%	$218	0.0%	$168	$50	$218	2020Q1	0.0%	$168	$50	$218
1.3%	Life Cycle Updates (cost, schedule, risks)	$174	$52	30.0%	$227	0.0%	$174	$52	$227	2020Q1	0.0%	$174	$52	$227
0.8%	Contracting & Reprographics	$101	$30	30.0%	$131	0.0%	$101	$30	$131	2020Q1	0.0%	$101	$30	$131
3.0%	Engineering During Construction	$403	$121	30.0%	$523	0.0%	$403	$121	$523	2020Q1	0.0%	$403	$121	$523
0.5%	Planning During Construction	$67	$20	30.0%	$87	0.0%	$67	$20	$87	2020Q1	0.0%	$67	$20	$87
1.0%	Adaptive Management & Monitoring	$134	$40	30.0%	$174	0.0%	$134	$40	$174	2020Q1	0.0%	$134	$40	$174
0.0%	Project Operations	$0	$0	30.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
7.5%	Construction Management	$1,007	$302	30.0%	$1,309	0.0%	$1,007	$302	$1,309	2020Q1	0.0%	$1,007	$302	$1,309
0.0%	Project Operation:	$0	$0	30.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
2.5%	Project Management	$336	$101	30.0%	$436	0.0%	$336	$101	$436	2020Q1	0.0%	$336	$101	$436
	CONTRACT COST TOTALS:	$18,496	$5,549		**$24,045**		$18,496	$5,549	**$24,045**			$18,496	$5,549	**$24,045**

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

**** CONTRACT COST SUMMARY ****

PROJECT: NoVA DC Coastal Storm Risk Management Structural Plan
DISTRICT: NAB District
PREPARED: 11/1/2019
LOCATION: DC and VA
POC: CHIEF, Estimating and Specs Section, Parris J. McGhee-Bey
This Estimate reflects the scope and schedule in report; METRO WASHINGTON, DC COASTAL STORM RISK MANAGEMENT FEASIBILITY STUDY

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared:			1-Nov-19	Program Year (Budget EC):			2020					
		Effective Price Level:			1-Oct-19	Effective Price Level Date:			1 OCT 19	FULLY FUNDED PROJECT ESTIMATE				
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	Alt 5c Belle Haven Levee & Floodwall													
11	LEVEES & FLOODWALLS	$12,882	$3,864	30.0%	$16,746	0.0%	$12,882	$3,864	$16,746	2020Q1	0.0%	$12,882	$3,864	$16,746
15	FLOODWAY CONTROL & DIVERSION STRU	$1,109	$333	30.0%	$1,442	0.0%	$1,109	$333	$1,442	2020Q1	0.0%	$1,109	$333	$1,442
	CONSTRUCTION ESTIMATE TOTALS:	$13,991	$4,197	30.0%	**$18,188**		$13,991	$4,197	$18,188			$13,991	$4,197	$18,188
01	LANDS AND DAMAGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
2.5%	Project Management	$350	$105	30.0%	$455	0.0%	$350	$105	$455	2020Q1	0.0%	$350	$105	$455
2.0%	Planning & Environmental Compliance	$280	$84	30.0%	$364	0.0%	$280	$84	$364	2020Q1	0.0%	$280	$84	$364
15.5%	Engineering & Design	$2,169	$651	30.0%	$2,819	0.0%	$2,169	$651	$2,819	2020Q1	0.0%	$2,169	$651	$2,819
1.3%	Reviews, ATRs, IEPRs, VE	$175	$52	30.0%	$227	0.0%	$175	$52	$227	2020Q1	0.0%	$175	$52	$227
1.3%	Life Cycle Updates (cost, schedule, risks)	$182	$55	30.0%	$236	0.0%	$182	$55	$236	2020Q1	0.0%	$182	$55	$236
0.8%	Contracting & Reprographics	$105	$31	30.0%	$136	0.0%	$105	$31	$136	2020Q1	0.0%	$105	$31	$136
3.0%	Engineering During Construction	$420	$126	30.0%	$546	0.0%	$420	$126	$546	2020Q1	0.0%	$420	$126	$546
0.5%	Planning During Construction	$70	$21	30.0%	$91	0.0%	$70	$21	$91	2020Q1	0.0%	$70	$21	$91
1.0%	Adaptive Management & Monitoring	$140	$42	30.0%	$182	0.0%	$140	$42	$182	2020Q1	0.0%	$140	$42	$182
0.0%	Project Operations	$0	$0	30.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
7.5%	Construction Management	$1,049	$315	30.0%	$1,364	0.0%	$1,049	$315	$1,364	2020Q1	0.0%	$1,049	$315	$1,364
0.0%	Project Operation:	$0	$0	30.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
2.5%	Project Management	$350	$105	30.0%	$455	0.0%	$350	$105	$455	2020Q1	0.0%	$350	$105	$455
	CONTRACT COST TOTALS:	$19,279	$5,784		**$25,063**		$19,279	$5,784	**$25,063**			$19,279	$5,784	**$25,063**

Filename: DC Coastal Initial Array TPCS-Nov2019
TPCS

The final array for the Metropolitan DC Coastal Feasibility Study includes 8 Alternatives, but only five (5) study areas with structural plan and a nonstructural plan for entire study area at different level of protection (20 years, 50 years, and 100 years) were further developed and evaluated with cost estimating and economic values. The structural alternatives include the following areas or planning units: Ronald Reagan Washington National Airport, Arlington Water Pollution Control Plant, Four Mile Run, Belle Haven, and Old Town Alexandria. Selected structures were elevated roads, earthen levees, floodwalls, and aluminum stop log closures as a flood protection line. The following Table 2 shows final array of alternatives.

Table 2. Final Array of Alternatives

Alt.	Description	Screen/Retain
1	**No Action**	Retain
2	**Comprehensive Coastal Surge Barrier**	Screened Out
3	**Upper Coastal Surge Barrier**	Screened Out
4	**Critical Infrastructure Plan (GWMP, Reagan, Arlington WPCP)**	
4a	GWMP Floodwall	Screened Out
4b	Reagan National Airport Levee and Floodwall	Retain
4c	Arlington WPCP Floodwall	Retain
5	**Floodwall/Levee Plan (Four Mile Run, Alexandria, Belle Haven)**	
5a	Four Mile Run Floodwall	Retain
5b1	Alexandria Floodwall	Screened Out
5c	Belle Haven Levee & Floodwall	Retain
6	**Non-Structural Plan (entire study area or components)**	Retain
7	Alts 3 and 6 (Upper Coastal Barrier + Nonstructural downstream)	Screened Out
8	Combinations of 4, 5, and 6	Retain

Screened-Out Alternatives:

The cost for the Comprehensive Coastal Barrier (Alternative 2) was estimated by the consultant (CH2MHill, 2015) for rising sector gates (16) spanning a 4,000 feet wide channel, with a 4,400 feet earth/rock levee barrier. The capital costs in rough order of magnitude cost at the alternative selection for the barriers and gates were $7.4 billion. Given the magnitude of the total estimated cost for this alternative, it was immediately screened out from consideration.

The Upper Coastal Storm Surge Barrier (Alternative 3) was estimated by the same consultant for radial gates with a 1,000 feet wide channel, and 2,800 feet of an earth/rock levee barrier. The capital cost in rough order magnitude for the Upper Coastal Storm Surge Barrier was estimated to be $600 million for the barriers and gates. Following the alternative milestone meeting, the

PDT coordinated removal of storm surge barriers from further consideration in the study with USACE higher authorities. Consideration of barriers would have resulted in a substantial increase in the project scope (budget), by expanding the study area to include Maryland and Washington D.C., in addition to Northern Virginia. Additionally, the following preliminary considerations indicate that the barrier would not be acceptable to resource agencies or local jurisdictions including:

- Hydraulic constraints - riverine discharge, induced flooding impacts on either side of the barrier
- Cultural resource constraints - impacts to the George Washington Memorial Parkway and other cultural resources
- Environmental - water quality impacts, impacts to endangered species (e.g., Atlantic Sturgeon) and other anadromous fish

The study was descoped to include just the Northern Virginia area and based on this change in scope and the preliminary considerations listed, USACE removed surge barriers from further consideration.

Alternative 7 was also eliminated because it was a combination of the cost prohibitive Alternative 3 and a nonstructural plan for a downstream area. The combination of the two planning units makes it even more cost prohibitive.

As far as Alternative 4a, coordination with the National Park Service led to the elimination of the floodwall/levee measures along the GWMP dropping this alternative from consideration. During agency coordination meetings, NPS has voiced that they are very concerned with any impact to the parkway, which includes anything that detracts from the character or viewshed of the road and its' historic integrity. This includes changes to views of the river, disconnection from the natural landscape, alterations of other views, impact to the historical character of the road itself, impacts from induced flooding to trails or other NPS resources, and other cultural resource impacts. NPS has been negotiating with the Federal Highway Administration (FHWA) over a 7-inch raising of the wall along the parkway, and therefore there is little viability for a floodwall that would be significantly higher than what is currently under negotiation.

Alternative 5b, Alexandria Deployable Floodwall, is further evaluated but is also eliminated due to low benefit cost ratio and also due to the fact that most benefits cannot be claimed if and when the City of Alexandria is implementing their own Waterfront Mitigation Plan to address nuisance flooding, including building a six foot bulkhead along their "core" waterfront area, from Duke Street to Queen Street. In 2021, $120 million in funding was approved for this project with planned implementation expected by 2025-2026. The City of Alexandria conducted extensive public outreach as part of their Waterfront Mitigation Plan development and following public feedback, it was determined that six feet was the maximum height that is acceptable by the community. Additionally, new construction along the waterfront has elevation requirements above the base flood elevation and a majority of new development sits well above the planned six feet bulkhead along the waterfront. If USACE will not be implementing flood protection along the waterfront, the project could not justify this feature through NED benefits, as no storm

damage reduction would occur. Cost estimate for Alternative 5b is included in CSRA and TPCS for references only.

As a result, Alternatives 4b, 4c, 5a, 5c, and 6 requires further evaluation.

The following discussion is for the civil works feature accounts for selected structures and associated work for the structural and nonstructural plans for study areas that require further evaluation:

- Account 01. Land and Damages. For both structural and nonstructural features of work, real estate costs due to construction impacts are assessed by and provided by Real Estate Division. Real estate cost for structural plan includes real estate administrative cost to provide easement and access to study areas. Real estate cost for nonstructural plan includes estimated cost to temporary relocate local residents while nonstructural measures such as flood proofing or structural elevation is applied. Both real estate costs are accounted in for in separate Total Project Cost Summaries, one for structural plan, and one for nonstructural plan.

- Account 02. Relocation. Relocation is likely but because of lack of utility survey, allowance costs based on experience of similar past studies were used. For structural plan, a budgetary allowance applied using ten (10) percent of construction accounts, accounts 11, 13, and 15, except for Arlington Water Pollution Control Plant. This study area includes $200,000 allowance to cover potential minor relocation costs such as disconnect or reconnect or repair of local communication lines. There are large light poles where a 4 ft I-wall can conceivably be built around to avoid relocation and potentially tremendous opposition from utility companies and local sponsors.

- Account 11. Levees and Floodwalls. The proposed project alignment shows elements of Measures that include walls and levee constructions for multiple areas. As far as flood wall construction goes, I-walls and T-walls are used. Elevated roads or levees with asphalt pavement are also included. Length of wall and levees and assumed typical cross section dimensions are provided by Baltimore District civil engineer. Preliminary quantity take-offs for the walls and levees based on averaged wall heights and typical cross section dimensions were conservatively estimated. Each segment of proposed lengths for walls or levees are assumed to have the same averaged elevation with the same as the constant desired structure height. The project alignment is crossing many areas that may need traffic control, which is estimated by assuming that new traffic signals, vehicle barriers, and flagmen may be needed. All costs in connection with construction work for floodwalls and levees were estimated in MII using MII software, Cost Book Library 2016 as starting point, updated with 2021 National Labor Library, and latest fuel prices for 2020 Equipment Region 02, and escalated to 2022 price level using CWCCIS Escalation Calculation dated 30 Sep 2021 for account 11.

- Account 13. Pumping Plant. The NAO preliminary estimate for a pump station in Freemanson, Norfolk VA at price level in 3rd quarter, 2014 price level was used as a cost model to parametrically estimate pump stations for some of the areas in the project alignment. The MII estimate portion is repriced with 2016 Cost Book, updated latest

wage rates and escalated to current price using CWCCIS Escalation Calculation dated 30 Sep 2021 for account 13 from Q3 2014 to Q1 2022. The size of concrete sump chamber, sluice gates, pipes, electrical, and other appropriate items are also adjusted to accommodate the number of pumps. Pumps are assumed as vertical axial pumps. Pump stations are proposed only in Four Mile Run and Belle Haven study areas.

- Account 15. Floodway Control - Diversion Structures. Stop log structure cost is parametrically estimated using historical $580/sf stop log cost in a DC project in quarter 1 of 2016 which is escalated to quarter 1 in 2022 for account 15. The square foot area is basically length times height of structure. It is not exact cost but should provide a close estimated cost of a stop log closure structure. The parametrical cost is assigned to subcontractor since the historical cost was done by a Prime contractor. Stop log closure structures are assumed in all four (4) study areas because they are cheapest solution while providing a temporary sturdy structure, but they may require a lot of time to set up and install. Some sponsors such as the Reagan Airport may desire to have a quicker and more expensive temporary structure such as automatic pop-up structure that can be controlled afar with a push button. A final decision has not been made from the sponsors but a market survey for a compatible structure is done and has shown that an auto push-button pop-up structure could cost as much as 62% higher than a stop log structure. Risk analysis for this item includes estimated magnitude of cost impact.

- Account 18. Cultural Resource Preservation. The proposed project alignment has potential impacts on cultural resources that may require extensive archaeological mitigations. Since no surveys were done, areas that are currently considered as significant sites may potentially have extensive impacts or none at all. A conservative approach was taken to count as if most sites are high probability sites and will have substantial archaeological mitigations. The cost for archaeological mitigation was conservatively estimated and provided by NAB archeologist, considering the most likely areas in Four Mile Run and Belle Haven. For nonstructural plan, the cultural preservation cost is also provided by NAB archeologist and is captured in separate TPCSs for 100 years, 50 years, and 20 years level of protection.

- Account 19. Buildings, Grounds, and Utilities. This account is for nonstructural costs for properties available in study areas. There are two (2) types of nonstructural methods being considered, flood proofing and structural raising or elevation. The nonstructural cost is based on MII cost models done for the 2020 Denville study in New Jersey. It is upgraded to 2022 price level using escalation and latest cost libraries such as 2021 Labor Library and 2020 Equipment Library for Region 2 with updated fuel and Cost of Money rates. The average cost of flood proofing and the average cost for structural elevation for different types of properties are computed. These two (2) average costs are applied to each property according to whether it is selected to be either flood proofing or structural elevation. The total nonstructural cost for all properties for each level of protection is included in separate TPCSs. For example, for the 100 years protection, there is a TPCS, and likewise for 50 years and 20 years of protection.

- Account 30. Planning, Engineering, and Design. For structural plan, the team decided to use 27.8% of construction cost. For nonstructural plan, it is decided that 15.3% of construction cost is adequate since less paperwork would be involved. It is also noted that the Baltimore District does not have any history of actual involvement in contract acquisition for nonstructural plan. We only may only have some small and partial involvement with local authorities such as cost sharing and administrative oversight.
- Account 31. Construction Management. For structural plan, the team decided to use 10% of construction cost. For nonstructural plan, it is decided that 9.5% of construction cost would be adequate. Again, because lack of history of District's involvement, it is hard to tell. However, considering contract management for construction work at residential areas, it would not be expected to be extensive as regular construction work such as those for levees or floodwalls. Plus, there is an expectation that most contract management would be done by local authorities.

Construction Cost Estimate:

The following methodology is used in the preparation of the cost estimate for Northern Virginia DC Coastal Storm Risk Management Project:

a. The estimate is in accordance with the guidance contained in ER 1110-2-1302, Civil Works Cost Engineering.

b. The estimate is presented in Civilworks Work Breakdown Structure.

c. The price level for the estimate is in 1st Quarter of FY2022.

d. Construction costs developed by Estimating and Specifications Section, Engineering Division, Baltimore District are based on a concept design developed by NAB Engineering team. Unit costs are developed using the M-CACES Second Generation (MII) software containing the 2016 English Cost Book Library which was used as a starting point. Historical cost data from similar projects are used for parametric estimate and updated with latest RSMeans material cost. The estimate is documented with notes to explain the assumed construction methods, crews, productivity, and other specific information. The intent is to provide or convey a "fair and reasonable" estimate that which depicts the local market conditions.

e. Labor costs are based on the 2021 National Labor Library.

f. Bid competition: No contracting plan is done at this point. Bidding competition is assumed to be unrestricted in the baseline estimate since the overall work is typical to the area and the massive size of the project will likely draw multiple national level large size contractors to bid on the project. However, unfavorable bidding environment such as low competition due to saturated work in the area could cause increase in bid costs. This assessment is reflected in the Cost and Schedule Risk Analysis.

g. Contract Acquisition Strategy: Acquisition strategy is not yet determined at this point. However, to reflect the historical market condition for this type of work, Prime Contractor is assumed to perform minimal work and will sub-contract out all remaining work.

h. Labor Shortages: It is assumed that there will be a normal labor market since large project such as this would likely be delayed that by the time funding is authorized, the expectation is that a normal labor market will return. In addition, even though current labor shortage is happening almost everywhere, the cost impact due to labor shortage in construction cost for civil work projects appears to be minimal.

i. Materials: Most material costs are from the Cost Book Library. Vendor quotes were used for non-Cost Book items such as quotes for vertical axial pumps for the pump stations. Assumptions include:

1. Government furnished materials are assumed. Quoted delivery charge is included in the vendor's material cost.
2. Materials will be available from local nearest available sources.
3. Hauling: most hauling will be done by trucks. For trucking, it is assumed that the average speed is 30 mph factoring traffic hours in often congested major routes.

j. Equipment: Rates used are based on the latest USACE EP-1110-1-8, Region II. Adjustments are made for fuel and facility capital cost of money (FCCM). Judicious use of owned verses rental rates was considered based on typical contractor usage and local equipment availability. Full FCCM/Cost of Money rate is latest available; MII program takes EP recommended discount, no other adjustments have been made to the FCCM.

k. Fuels (gasoline, on and off-road diesel) were based on local market averages for on-road and off-road fuels in Mid Atlantic areas. Since fuels fluctuate irrationally, an average was used.

l. Major crew and productivity rates were developed and studied by senior USACE estimators familiar with the type of work. All the work is typical to the Baltimore District. The crews and productivities were checked by local NAB estimators, discussions with contractors and comparisons with historical cost data. Major crews include hauling, stonework, and planting.

m. Most crew work hours are assumed to be 8 hrs 5 days/week which is typical to the area. It is anticipated that no overtime is required for reasons such as time of year restriction because it is anticipated that there is none. At the Reagan Airport area, there will likely be off hour or nightly differential hours which may take place to avoid the interruption to the normal operations of the airport. Therefore, the construction estimate for levees and floodwalls at the airport includes ten (10) percent labor cost increase for nightly differential.

n. Mobilization and demobilization: Contractor mobilization and demobilization are based on the assumption that most of the contractors will take about one 8 hrs day to mobilize and one 8 hrs day to demobilize.

o. Field Office Overhead: Typically civil works project has field office overhead ranging from 9% to 11%. Since this project is a larger than the norm, 13% was used for Job Office Overhead. Overhead assumptions may include: Superintendent, office manager, pickups, periodic travel, costs, communications, temporary offices (contractor and government), office furniture, office supplies, computers and software, as-built drawings and minor designs, tool trailers, staging setup, camp and kitchen maintenance and utilities, utility service, toilets, safety equipment, security and fencing, small hand and power tools, project signs, traffic control, surveys, temp fuel tank station, generators, compressors, lighting, and minor miscellaneous. Field office overhead for Pump Station work is kept at 15% as the original pump station MII estimate. It is reasonable since the pump station may likely be awarded in a separate contract or bundled in a phased contract which is typically seen with high field overhead.

p. Home Office Overhead: Due to large size of project a little less than typical percentage was used (4%) for HOOH. Subcontractor's HOOH is at 5%. The rates are based upon estimating and negotiating experience, and consultation with local construction representatives. However, the HOOH rate could be higher if market and bidding condition is limited in competition or there is a labor shortage which forces construction companies to increase overhead to provide incentives to hire skill workers or professionals field management teams. This risk is captured as part of market risk and rated as high risk in the CSRA.

q. Profit: Since the Construction Cost Estimate is currently in a budgetary phase, profit is typically included at 10% for Prime Contractor. However, due to the size of project and general expectation that there will be some competition, 8% profit was used for Prime and Prime's Profit on Sub's work. Sub-contractors' profit is mostly 8%. Profit in pump station is kept at 9% for Prime and 10% for subs to maintain the integrity of the original estimate and to also assume that pump station may be in a separate contract.

r. Sales Tax: Only State sales tax was applied. No local sales tax was included in the estimate.

s. Bond: Bond is calculated at 0.66% using Bond Table in MII for the Prime contractor. For pump station estimate under a separate Pump Station Prime, it is at 0.7% which is also from Bond Table calculation.

t. Contingency: Contingency is based the outcome of the Cost and Schedule Risk Analysis for TSP milestone which was done on 27 January 2022.

u. Escalation: No escalation to midpoint of construction according to tentative construction start dates is included in the estimate but will be included in the Total Project Cost Summary (TPCS) to avoid duplicates.

v. HTRW: The estimate includes no costs for Hazardous, Toxic, and Radioactive Waste (HTRW) since there is no potential concern for HTRW where the levees, floodwalls, closure structures, and pump stations are proposed.

The Tentative Selected Plan:

The Tentative Selected Plan is Alternative 8 which includes Alternative 4c, Arlington WPCP and Alternative 5c, Belle Haven Levee and Floodwall. These combined alternatives were selected because they provide highest benefit cost ratio of 1.3.

Cost and Schedule Risk Analysis

Cost and Schedule Risk Analysis (CSRA) was used in developing the cost and schedule contingencies for both structural and nonstructural alternatives. The CSRA was vigorous process which includes all key team members of the PDT to meet, discuss, provide evaluation of probability, and impacts from various risks that could increase costs or delay the project from the baseline estimate and schedule. A CSRA report is generated and included as follows to provide evaluation of data and elaborate the entire process.

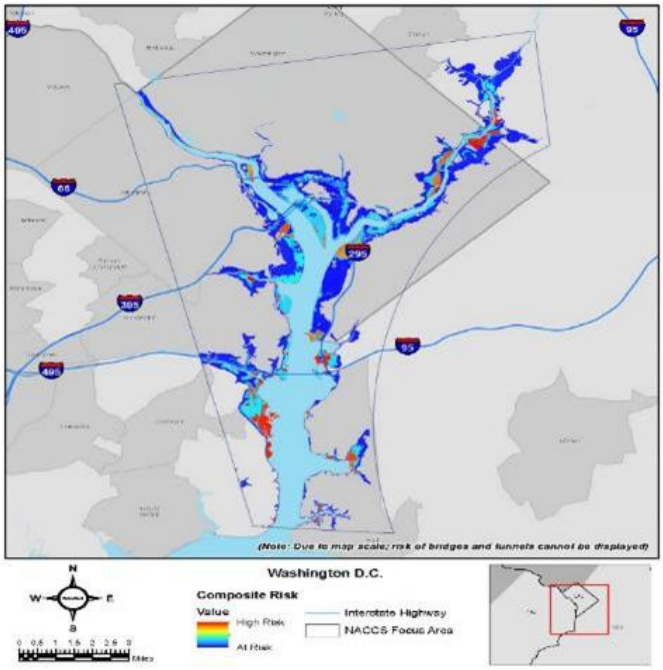
US Army Corps of Engineers

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

Metropolitan Washington District of Columbia Coast Storm Risk Management Feasibility Study

DC, VA

Project Cost & Schedule Risk Analysis Report



Prepared by:
U.S. Army Corps of Engineers
Cost Engineering Baltimore District

February 2022

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Table of Contents

Figures

Tables

Appendixes

Executive Summary

The US Army Corps of Engineers (USACE), Baltimore District, presents this cost and schedule risk analysis (CSRA) report regarding the risk findings and recommended contingencies for the Metropolitan Washington District of Columbia Coastal Storm Risk Management project. In compliance with Engineer Regulation (ER) 1110-2-1302 CIVIL WORKS COST ENGINEERING, dated June 30, 2016, a *Monte-Carlo* based risk analysis was conducted by the Project Development Team (PDT) on remaining costs. The purpose of this risk analysis study is to present the cost and schedule risks considered, those determined and respective project contingencies at a recommended 80% confidence level of successful execution to project completion.

The Metropolitan Washington District of Columbia Coastal Storm Risk Management is proposed to include construction of levees or road raising, floodwalls, flood closure structures, and pump stations for four (4) area of consideration: Ronald Reagan Washington National Airport, Arlington Water Pollution Control Plant, Four Mile Run, and Belle Haven. For nonstructural plan, it is proposed that flood proofing and structural elevation would be the appropriate nonstructural methods for the areas of concerns which include Old Town Alexandria, Belle Haven, and Occoquan Bay.

The current project base cost for the structural plan is approximately $159 M for all structural alternatives excluding contingency and expressed in FY 2022 dollars. This CSRA study included all estimated construction costs, Planning, Engineering, Design and Construction Management costs. Based on the results of the analysis, the Estimating and Specifications Section in Baltimore District recommends a contingency value of $71.5 M or approximately 45% of base project cost at an 80% confidence level of successful execution.

Cost estimates fluctuate over time. During this period of study, minor cost fluctuations can and have occurred. For this reason, contingency reporting is based in cost and per cent values. Should cost vary to a slight degree with similar scope and risks, contingency percent values will be reported, cost values rounded.

Table 1. Cost Contingency Results for Structural Alternatives

Base Estimate		**$83,076,000**	
Confidence Level	**Cost w/ Contingencies ($)**	**Contingency (%)**	**Contingency ($)**
50%	$214,624,000	35%	$55,643,000
80%	**$230,522,000**	**45%**	**$71,541,000**
90%	$240,061,000	51%	$81,080,000

Table 2. Schedule Duration Contingency Results for Structural Alternatives

Base Schedule		**125 Months**	
Confidence Level	**Duration w/ Contingencies (Months)**	**Contingency (%)**	**Contingency (Months)**
50%	169.0 Months	35%	44.0 Months
80%	**180.0 Months**	**44%**	**55.0 Months**
90%	186.0 Months	49%	61.0 Months

Table 3. Cost Contingency Results for Nonstructural Alternatives 100 Years Protection

Base Estimate		$117,154,000	
Confidence Level	**Cost w/ Contingencies ($)**	**Contingency (%)**	**Contingency ($)**
50%	$149,957,000	28%	$32,803,000
80%	**$156,986,280**	**34%**	**$39,832,000**
90%	$160,501,000	37%	$43,347,000

Table 4. Schedule Duration Contingency Results for Nonstructural Alternatives 100 Years Protection

Base Schedule		90 Months	
Confidence Level	**Duration w/ Contingencies (Months)**	**Contingency (%)**	**Contingency (Months)**
50%	122.0 Months	36%	32.0 Months
80%	**130.0 Months**	**44%**	**40.0 Months**
90%	133.0 Months	48%	43.0 Months

Table 5. Cost Contingency Results for Nonstructural Alternatives 50 Years Protection

Base Estimate		$105,141,000	
Confidence Level	**Cost w/ Contingencies ($)**	**Contingency (%)**	**Contingency ($)**
50%	$134,580,000	28%	$29,439,480
80%	**$140,889,000**	**34%**	**$35,747,940**
90%	$144,043,000	37%	$38,902,170

Table 6. Schedule Duration Contingency Results for Nonstructural Alternatives 50 Years Protection

Base Schedule		85 Months	
Confidence Level	**Duration w/ Contingencies (Months)**	**Contingency (%)**	**Contingency (Months)**
50%	117.0 Months	37%	32.0 Months
80%	**124.0 Months**	**45%**	**38.0 Months**
90%	127.0 Months	49%	42.0 Months

Table 7. Cost Contingency Results for Nonstructural Alternatives 20 Years Protection

Base Estimate		$73,030,000	
Confidence Level	**Cost w/ Contingencies ($)**	**Contingency (%)**	**Contingency ($)**
50%	$93,479,000	28%	$20,448,000
80%	**$97,860,000**	**34%**	**$24,830,000**
90%	$100,051,000	37%	$27,021,000

Table 8. Schedule Duration Contingency Results for Nonstructural Alternatives 20 Years Protection

Base Schedule		72 Months	
Confidence Level	**Duration w/ Contingencies (Months)**	**Contingency (%)**	**Contingency (Months)**
50%	100.0 Months	40%	29.0 Months
80%	**107.0 Months**	**49%**	**35.0 Months**
90%	109.0 Months	53%	38.0 Months

KEY FINDINGS/OBSERVATIONS/ASSUMPTIONS & RECOMMENDATIONS

The PDT worked through the risk register in February 2022. For the structural plan, the key risk drivers identified through sensitivity analysis suggest a cost contingency of $37.4M and schedule risks adding a potential 45 months; all at an 80% confidence level.

Cost Risks: From the CSRA, the key or greater Cost Risk items of include:

- CV2 – Scope Change – The alignments, wall heights, pump flow rates, closure sizes may change later. Interior drainage is not done (until PED). Current assumption of the alignments seems conservative and less likely to be changed to larger measures. However, the deployable closure type may not be stoplogs but a more high tech expensive type. Weak and saturated soil in some areas at the airport can cause foundation problems. Schedule will not be much of concerns because most sponsors seem to be responsive so far.
- SD1 – Foundation Design - Current Geotech info is not available and current assumption could be questionable. Deep foundation may be required.
- EX1 – Market/Bidding Conditions - Generally the project is straightforward and there should be multiple firms in the area capable of performing the work. However, projects of this size in the area depends for available workforce and resources.
- EX4 - Escalation of key materials – Concrete and steel are major cost items, and the price could vary based on world market conditions. Other projects in the nearby areas may cause more limitation in availability of resources.

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

- PM1 – Overall project funding – Cost share may be too high. What is the actual ability/annual funding level that could be undertaken and put in the project schedule/cost estimate flow. Funding concerns lie mostly with the Regan airport because of the large $ amounts and desire of using new technology (auto deployable closures, not yet researched) that could be expensive. The airport may prolong the process by breaking the alignments into multiple phases. This risk can impact both cost and schedule
- PM1B – Agreement from sponsors on design – Some sponsor such as Belle Haven may not agree to design because it has high cost and the structures can block the view. This risk can impact both cost and schedule.
- PM4B– Wetland impact– It is likely that there would be wetland impact in the footprint of culverts, flap gates, and pump stations.
- CA2 – Acquisition Plan – Project includes 5 study areas which could likely be broken into 8 or more smaller contracts which would impact cost and schedule.
- TR1- Geotech modeling deferred – . Existing Geotech data is being used. Geotech modeling is deferred till PED phase. There is a possibility of sediment issues. Belle Haven has more concerns in Geotech.

- TR2 - ERDC Model done for existing condition and FWOP condition but not done for "with project condition." Upstream and downstream impact needs to be considered. These areas can show up later on in the study which can impact both cost and schedule.
- SD6 – Number of pump stations – We may need to add additional pump stations as we progress forward with the design to account for the additional drainage.
- L03 – Acquisitions and Easements – Easement may be delayed for Non-Standard Estates which will require HQUSACE approval.
- ES1 - Utility Relocation. This cost is estimated at 10% of total of other construction cost which seems conservative since it appears that not all areas will have all utilities issues (communication, gas, storm drain, sewer, and water) at the same time, but if they did, it would be a moderate impact.
- EX3 - Storm events during construction – Projects typically include weather delays but in large storms, there may be a need for restrictions on the amount of teardown of exiting floodwall. In a severe storm event, additional costs can come from standby time, EDC, cleanup effort, and Corps S&A. This risk can affect both cost and schedule.

Schedule Risks: From the CSRA, the key or greater Schedule Risk items include:

- LD2 – Delay in discussion with some sponsors – Time to coordinate with the airport in discussion with real estate issues such as the trail could take longer than necessary.
- EX2 – Time of Funding - Experience on large civil projects shows that authorization of funding to initiate the start of the design of the project is likely not the time the PDT anticipated. This risk concerns mostly the project schedule.

Medium schedule risks include:

- PM1 – Overall project funding – Cost share may be too high. What is the actual ability/annual funding level that could be undertaken and put in the project schedule/cost estimate flow. Funding concerns lie mostly with the Regan airport because of the large $ amounts and desire of using new technology (auto deployable closures, not yet researched) that could be expensive. The airport may prolong the process by breaking the alignments into multiple phases. This risk can impact both cost and schedule
- PM1B – Agreement from sponsors on design – Some sponsor such as Belle Haven may not agree to design because it has high cost and the structures can block the view. This risk can impact both cost and schedule.
- CA1 – Schedule of acquisition - Project needs to be grouped and considered in terms of contracts etc. and realistic schedule for each segment to get proper escalation. Estimate is currently laid out with areas not necessarily contracts and the zones that the order the work needs to be constructed in which may not match with actual contracts in future.
- CA2 – Acquisition Plan – Project includes 4 study areas which could likely be broken into 8 or more smaller contracts which would impact cost and schedule.
- TR2 - ERDC Model done for existing condition and FWOP condition but not done for "with project condition." Upstream and downstream impact needs to be considered. These areas can show up later on in the study which can impact both cost and schedule.
- ES3 – Design duration - Design duration is estimated to be 2 years but it may take longer if there are challenges in design or site condition issues.
- EX3 - Storm events during construction – Projects typically include weather delays but in large storms, there may be a need for restrictions on the amount of teardown of exiting floodwall. In a severe storm event, additional costs can come from standby time, EDC, cleanup effort, and Corps S&A. This risk can affect both cost and schedule.

-

For Nonstructural plans for 100 years, 50 years, and 20 years protection, the key or high cost risk items are similar for those level of protections:

- CV2 – Scope Change - More complicated types of nonstrutrual methods may present cost and schedule risks. Number of properties should be conservative as 100% participation is assumed which is rare and unlikely. This can also affect schedule.
- SD7 – Types of Structures - Foundation of each property is still a guess. Actual surveys of properties may show higher level of difficulty to implement which can affect both cost and schedule.
- ES4 – Estimating Assumptions - Historical construction material costs are escalated. Prime and subcontractor markups/assignments is unknown, and the estimate includes most work as prime's work which seems in line with local contractor's quotes. However, government contract acquisition may show that the Prime subs out almost all works.
- EX3 - Storm events or harsh weather during construction - Typical risk of storms for the area - There may be a need for restrictions on the amount of teardown of exiting floodwall. Project schedule should include typical weather productivity effects. However in a severe storm event, additional costs can come from standby time, EDC, cleanup effort, and Corps S&A. In addition, ADA requirement may be a possible claim. This can also result in medium schedule risk.
- EX4 - Escalation of key materials - Concrete, steel are major cost items, and the price could vary based on world market conditions. Other projects in the nearby areas may cause more limitation in availability of resources.

There are other risks at medium level that can contribute to cost impacts:

- CA2 - Acquisition plan – There is the risk that the project could be split into smaller contracts and incur higher costs. Current estimate is already including individual mob/demob costs for each property. There's a chance that those large areas may be broken up into more smaller contracts. Schedule may also be impacted.
- TR1 – Design may be more complicated - Corps never got involved in implementation phase of nonstructural projects. Current assumption is based on conventional knowledge but can vary at implementation phase
- A1B - Project goes through a national historic district for nonstructural measures - There are some historic areas the nonstructural measures are on those areas (old town Alexandria).
- NS1 – Basement Fill - Basement fill estimate is based on historical cost from another studies. Based on the typical basements encountered in the area the estimate is probably conservative (mainly small wet basements). Cost assumption may not be accurate since there is no design for nonstructural measures. This can also result in medium schedule risk.
- NS2 - Raising Structures - Raising structures is conservative and may not have significant cost impact but may present marginal schedule impact. Cost assumption may not be accurate since there is no design for nonstructural measures.
- NS3 – Floodproofing - Dry flood proofing is being considered and is more conservative because it is more expensive than wet flood proofing. Schedule impact is more of concern in later stage of design. Cost assumption may not be accurate since there is no design for nonstructural measures.
- LD1 - Acquisitions and Easements - Estimated budget for real estate relocation for each household while nonstructural measures are being implemented is conservative but may not be accurate since number of people in a household is unknown and the time it requires for completing each measure may be off. But on average, it may marginally off.
- EX1 - Market/Bidding conditions - Limited competition may increase construction cost.

For schedule risk, the Nonstructural plan for 100 years, 50 years, and 20 years protection levels have similar key or high schedule risks:

- EX2 – Timing of Funding - Past experience on large civil projects shows that authorization of funding to initiate the start of the design of the project is likely not the time the PDT anticipated. This risk concerns mostly the project schedule.

Nonstructural plan for 100 years, 50 years, and 20 years level of protection also share similar medium risks as stated above along with other key and medium cost risks.

1. Purpose

Within the authority of the US Army Corps of Engineers (USACE), Baltimore District, this report presents the efforts and results of the cost and schedule risk analysis for the Metropolitan Washington District of Columbia Coastal Storm Risk Management Feasibility Study. The report includes risk methodology, discussions, findings and recommendations regarding the identified risks and the necessary contingencies to confidently administer the project, presenting a cost and schedule contingency value with an 80% confidence level of successful execution.

2. Background

The Middle Potomac River watershed encompasses approximately 11,500 square miles, including a diverse landscape, with urban, rural, and natural areas in six different eco-regions and four states and the District of Columbia. The study area for the DC Coastal Feasibility Study encompasses approximately 76 square miles and includes the Northern Virginia jurisdictions within the Middle Potomac watershed boundary, from Arlington County south to include a portion of Prince William County Within the study area, the Virginia side of the Potomac River contains approximately 135 miles of Potomac River shoreline. The population within the study area is approximately 155,000). The study area was further reduced to 4 main sections: Ronald Reagan Washington National Airport, Arlington Water Pollution Control Plant, Four Mile Run, and Belle Haven. Many flood risk management structures were evaluated and through the project matrix elimination process. Selected structures were elevated roads, earthen levees, floodwalls, and aluminum stop log closures as a flood protection line.

3. Report Scope

The scope of the risk analysis report is to identify cost and schedule risks with a resulting recommendation for contingencies at the 80 percent confidence level using the risk analysis processes, as mandated by U.S. Army Corps of Engineers (USACE) Engineer Regulation (ER) 1110-2-1150, Engineering and Design for Civil Works, ER 1110-2-1302, Civil Works Cost Engineering, and Engineer Technical Letter 1110-2-573, Construction Cost Estimating Guide for Civil Works. The report presents the contingency results for cost risks for construction features. The CSRA does not include consideration for life cycle costs.

3.1. Project Scope

The formal process included extensive involvement of the PDT for risk identification and the development of the risk register. The analysis process evaluated the Micro Computer Aided Cost Estimating System (MCACES) cost estimate, project schedule, and funding profiles using Crystal Ball software to conduct a *Monte Carlo* simulation and statistical sensitivity analysis, per the guidance in Engineer Technical Letter (ETL) CONSTRUCTION COST ESTIMATING GUIDE FOR CIVIL WORKS, dated September 30, 2008.

The project technical scope, estimates and schedules were developed and presented by the District. Consequently, these documents serve as the basis for the risk analysis.

The scope of this study addresses the identification of concerns, needs, opportunities and potential solutions that are viable from an economic, environmental, and engineering viewpoint.

3.2. Risk Analysis Process

The risk analysis process for this study follows the USACE Headquarters requirements as well as the guidance provided by the Cost Engineering MCX. The risk analysis process reflected within this report uses probabilistic cost and schedule risk analysis methods within the framework of the Crystal Ball software. Furthermore, the scope of the report includes the identification and communication of important steps, logic,

key assumptions, limitations, and decisions to help ensure that risk analysis results can be appropriately interpreted.

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

In addition to broadly defined risk analysis standards and recommended practices, this risk analysis was performed to meet the requirements and recommendations of the following documents and sources:

- Cost and Schedule Risk Analysis Process guidance prepared by the USACE Cost Engineering MCX.
- Engineer Regulation (ER) 1110-2-1302 CIVIL WORKS COST ENGINEERING, dated June 30, 2016.
- Engineer Technical Letter (ETL) CONSTRUCTION COST ESTIMATING GUIDE FOR CIVIL WORKS, dated September 30, 2008.

4. Methodology/Process

The Cost Engineering MCX performed the Cost and Schedule Risk Analysis, relying on local District staff to provide expertise and information gathering. The District PDT conducted initial risk identification via meetings with the Walla Walla Cost Engineering MCX facilitator in January 2021. The initial risk identification meeting also included qualitative analysis to produce a risk register that served as the draft framework for the risk analysis.

Participants in the risk identification meeting in December 8, 2016 are included in Table 3 below.

Table 3. Risk Identification Meeting Participants

Name	Office	Representing
Andrew Roach	USACE	Plan Formulator
Komla Jackatey	USACE	Lead Economist
Daniel Lovette	USACE	Civil Engineer
Amber Metallo	USACE	Study Manager
Kristina May	USACE	Environmental
Mike Fritzges	USACE	Geotechnical
CJ Ditsious	USACE	HTRW
Dennis Powers	USACE	HTRW
Ethan Bean	USACE	Archaeologist
Katherine Perkins	USACE	PM
Jack Steketee	USACE	Support Economist
Robert Klara	USACE	Real Estate
La-Wanda Carter	USACE	Real Estate
Syed Qayum	USACE	H&H
Daniel Risley	USACE	Chief H&H

Name	Office	Representing
Andrew Orlovsky	USACE	Chief Civil
Alissa Albrecht	USACE	DA Intern H&H
Geoffrey Tapalu	USACE	Geographer
Luis Santiago	USACE	Geographer
Luan Ngo	USACE	Cost

The risk analysis process for this study is intended to determine the probability of various cost outcomes and quantify the required contingency needed in the cost estimate to achieve the desired level of cost confidence. Per regulation and guidance, the P80 confidence level (80% confidence level) is the normal and accepted cost confidence level. District Management has the prerogative to select different confidence levels, pending approval from Headquarters, USACE.

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

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

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

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

4.1. Identify and Assess Risk Factors

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

A formal PDT meeting was held with the District office and project owners for the purposes of identifying and assessing risk factors. The meeting included capable and qualified representatives from multiple project team disciplines and functions, including project management, cost engineering, design, environmental compliance, real estate, construction, contracting and representatives of the sponsoring agencies.

The initial formal meetings focused primarily on risk factor identification using brainstorming techniques, but also included some facilitated discussions based on risk factors common to projects of similar scope and geographic location. Additionally, numerous conference calls and informal meetings were conducted

throughout the risk analysis process on an as-needed basis to further facilitate risk factor identification, market analysis, and risk assessment.

4.2. Quantify Risk Factor Impacts

The quantitative impacts (putting it to numbers of cost and time) of risk factors on project plans were analyzed using a combination of professional judgment, empirical data, and analytical techniques. Risk factor impacts were quantified using probability distributions (density functions) because risk factors are entered into the Crystal Ball software in the form of probability density functions.

Similar to the identification and assessment process, risk factor quantification involved multiple project team disciplines and functions. However, the quantification process relied more extensively on collaboration between cost engineering and risk analysis team members with lesser inputs from other functions and disciplines. This process used an iterative approach to estimate the following elements of each risk factor:

- Maximum possible value for the risk factor,
- Minimum possible value for the risk factor,
- Most likely value (the statistical mode), if applicable,
- Nature of the probability density function used to approximate risk factor uncertainty,
- Mathematical correlations between risk factors, and
- Affected cost estimate and schedule elements.

The resulting product from the PDT discussions is captured within a risk register as presented in Section 6 for both cost and schedule risk concerns. Note that the risk register records the PDT's risk concerns, discussions related to those concerns, and potential impacts to the current cost and schedule estimates. The concerns and discussions support the team's decisions related to event likelihood, impact, and the resulting risk levels for each risk event.

4.3. Analyze Cost and Schedule Contingency

Contingency is analyzed using the Crystal Ball software, an add-in to the Microsoft Excel format of the cost estimate and schedule. Monte Carlo simulations are performed by applying the risk factors (quantified as probability density functions) to the appropriate estimated cost and schedule elements identified by the PDT. Contingencies are calculated by applying only the moderate and high-level risks identified for each option (i.e., low-level risks are typically not considered, but remain within the risk register to serve historical purposes as well as support follow-on risk studies as the project and risks evolve).

For the cost estimate, the contingency is calculated as the difference between the P80 cost forecast and the baseline cost estimate. Each option-specific contingency is then allocated on a civil works feature level based on the dollar-weighted relative risk of each feature as quantified by Monte Carlo simulation. Standard deviation is used as the feature-specific measure of risk for contingency allocation purposes. This approach results in a relatively larger portion of all the project feature cost contingency being allocated to features with relatively higher estimated cost uncertainty.

5. Project Assumptions

The following data sources and assumptions were used in quantifying the costs associated with the project.

a. The District provided estimate files electronically. The files transmitted and resulting independent review, served as the basis for the final cost and schedule risk analyses.

b. The cost comparisons and risk analyses performed and reflected within this report are based on design scope and estimates that are at the feasibility level of design.

c. Schedules are analyzed for impact to the project cost in terms of delayed funding, uncaptured escalation (variance from OMB factors and the local market) and unavoidable fixed contract costs and/or languishing federal administration costs incurred throughout delay.

d. The Cost Engineering MCX guidance generally focuses on the eighty-percent level of confidence (P80) for cost contingency calculation. For this risk analysis, the eighty-percent level of confidence (P80) was used. It should be noted that the use of P80 as a decision criteria is a moderately risk averse approach, generally resulting in higher cost contingencies. However, the P80 level of confidence also assumes a small degree of risk that the recommended contingencies may be inadequate to capture actual project costs.

e. Only high and moderate risk level impacts, as identified in the risk register, were considered for the purposes of calculating cost contingency. Low level risk impacts should be maintained in project management documentation and reviewed at each project milestone to determine if they should be placed on the risk "watch list".

6. Results

The cost and schedule risk analysis results are provided in the following sections. In addition to contingency calculation results, sensitivity analyses are presented to provide decision makers with an understanding of variability and the key contributors to the cause of this variability.

6.1. Risk Register

A risk register is a tool commonly used in project planning and risk analysis. The actual risk register is provided in 0. The complete risk register includes low level risks, as well as additional information regarding the nature and impacts of each risk.

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

- Documenting risk mitigation strategies being pursued in response to the identified risks and their assessment in terms of probability and impact.
- Providing project sponsors, stakeholders, and leadership/management with a documented framework from which risk status can be reported in the context of project controls.
- Communicating risk management issues.
- Providing a mechanism for eliciting feedback and project control input.
- Identifying risk transfer, elimination, or mitigation actions required for implementation of risk management plans.

6.2. Cost Contingency and Sensitivity Analysis

The result of risk or uncertainty analysis is quantification of the cumulative impact of all analyzed risks or uncertainties as compared to probability of occurrence. These results, as applied to the analysis herein, depict the overall project cost at intervals of confidence (probability).

6.2.1. Sensitivity Analysis

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

approximates the impact of each risk/opportunity contributing to variability of cost outcomes during Monte Carlo simulation.

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

6.2.2. Sensitivity Analysis Results

The risks/opportunities considered as key or primary cost drivers and the respective value variance are ranked in order of importance in contribution to variance bar charts. Opportunities that have a potential to reduce project cost and are shown with a negative sign; risks are shown with a positive sign to reflect the potential to increase project cost. A longer bar in the sensitivity analysis chart represents a greater potential impact to project cost.

Figure 1 presents a sensitivity analysis for cost growth risks of Structural Alternatives from the high-level cost risks identified in the risk register. Likewise, Figure 2 presents a sensitivity analysis for schedule growth risk from the high-level schedule risks identified in the risk register.

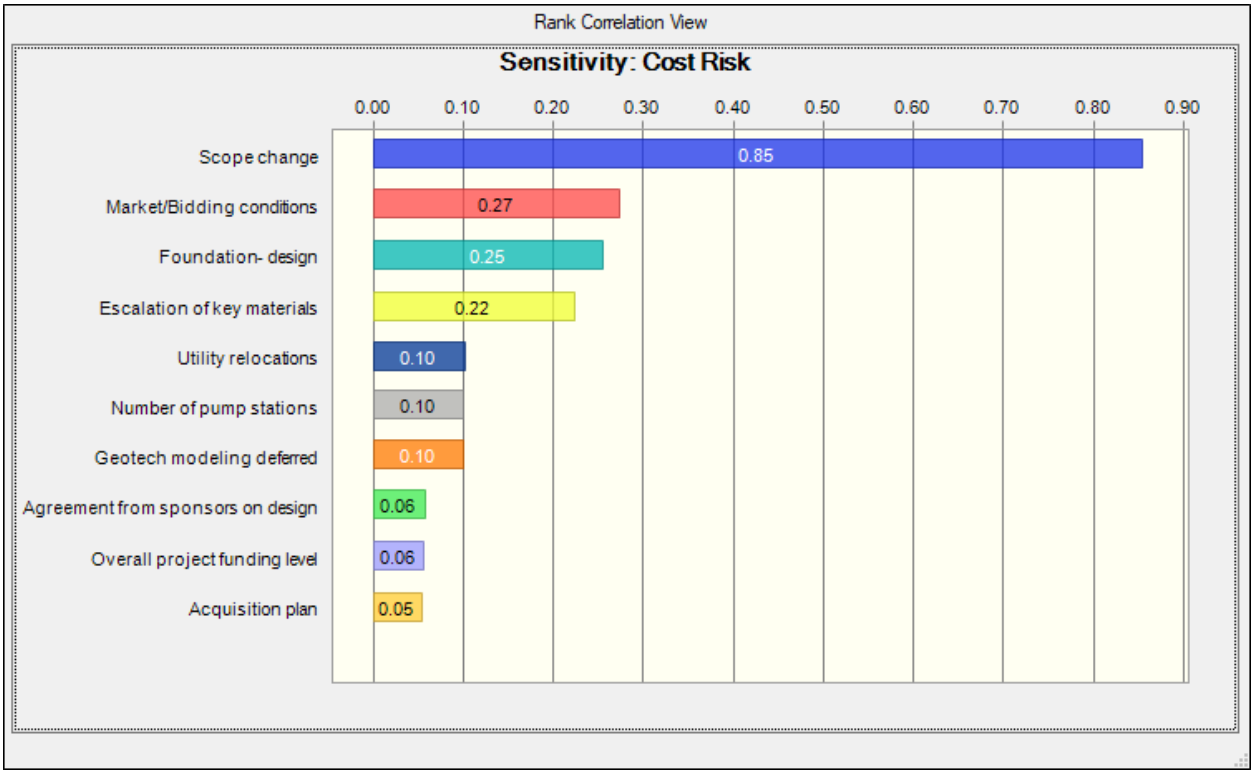


Figure 1. Cost Sensitivity Analysis

6.3. Schedule Contingency and Sensitivity Analysis

The result of risk or uncertainty analysis is quantification of the cumulative impact of all analyzed risks or uncertainties as compared to probability of occurrence. These results, as applied to the analysis herein, depict the overall project duration at intervals of confidence (probability).

The schedule contingencies were calculated by applying the high-level schedule risks identified in the risk register for each option to the durations of critical path and near critical path tasks.

The schedule was not resource loaded and contained open-ended tasks and non-zero lags (gaps in the logic between tasks) that limit the overall utility of the schedule risk analysis. These issues should be considered as limitations in the utility of the schedule contingency data presented. Schedule contingency impacts presented in this analysis are based solely on projected residual fixed costs. Figure 1 presents a sensitivity analysis for cost growth risks of Structural Alternatives from the high-level schedule risks identified in the risk register.

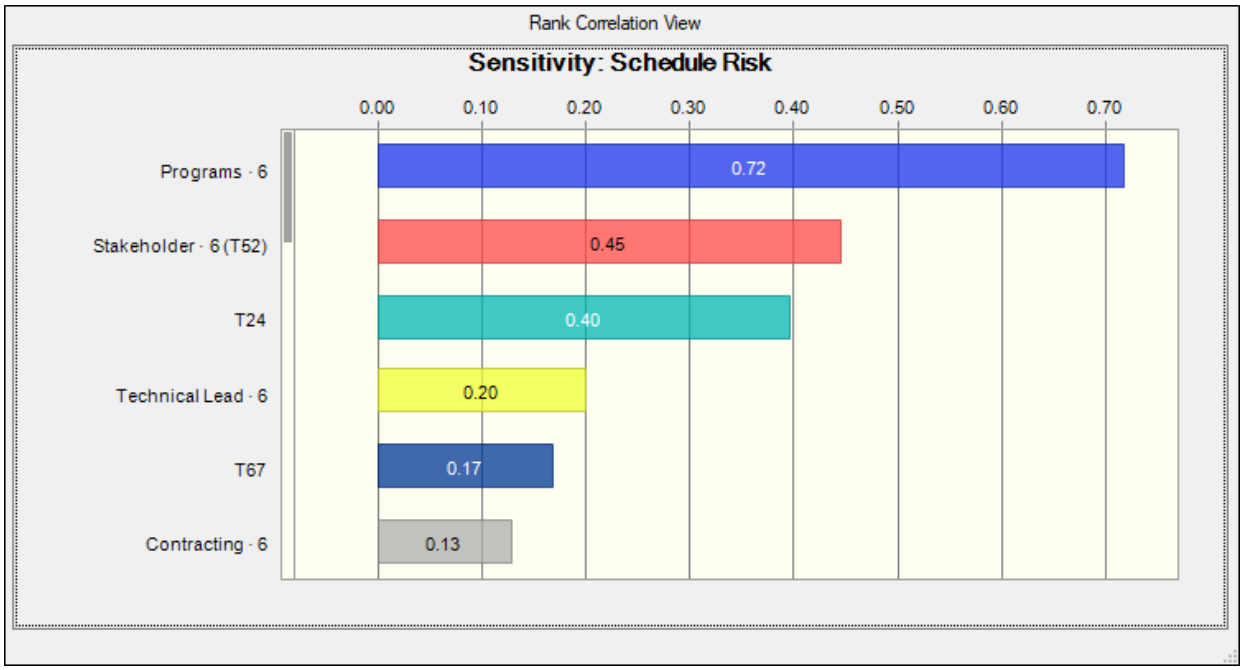


Figure 2. Schedule Sensitivity Analysis

Similarly, both cost and schedule sensitivity charts for nonstructural alternatives were created. See sub Appendix B for details.

6.4. 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)*, *6th edition*, states that "project risk management includes the processes concerned with conducting risk management planning, identification, analysis, responses, and monitoring and control on a project." Risk identification and analysis are processes within the knowledge area of risk management. Its outputs pertinent to this effort include the risk register, risk quantification (risk analysis model), contingency report, and the sensitivity analysis.

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

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

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

6.4.1. 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.

6.4.2. Risk Analysis Updates

Project leadership should review risk items identified in the original risk register and add others, as required, throughout the project life cycle. Risks should be reviewed for status and 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).

Sub Appendix A

Cost and Schedule Contingency Tables Supporting the CSRA

NoVA CSRM CSRA Structural Alternatives Contingency Tables

Contingency on Base Estimate	80% Confidence Project Cost	
Base Construction Estimate	$158,981,000	
Baseline Estimate Cost Contingency Amount ->	$71,541,450	45%
Baseline Estimate Construction Cost (80% Confidence) ->	$230,522,450	

Contingency on Schedule	80% Confidence Project Schedule	
Project Base Schedule Duration ->	125.0 Months	
Schedule Contingency Duration ->	55.0 Months	44%
Project Schedule Duration (80% Confidence) ->	180.0 Months	

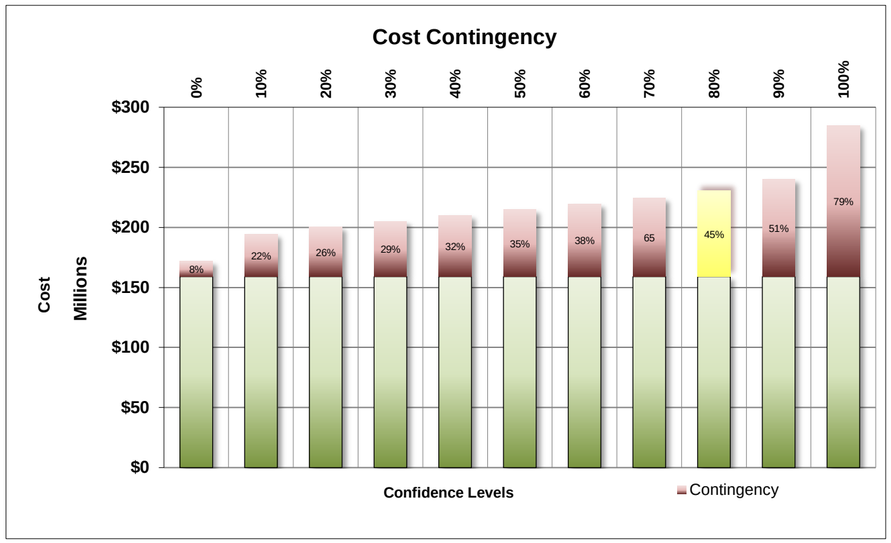
Northern Virginia Coastal Storm Risk Management Feasability Study
19-Jan-22

- PROJECT CONTINGENCY DEVELOPMENT -

INITIAL CONSTRUCTION

Contingency Analysis

Base Case Estimate (Excluding 01)	$158,981,000	
Confidence Level	**Contingency Value**	**Contingency**
0%	12,718,480	8%
10%	34,975,820	22%
20%	41,335,060	26%
30%	46,104,490	29%
40%	50,873,920	32%
50%	55,643,350	35%
60%	60,412,780	38%
70%	65,182,210	41%
80%	**71,541,450**	**45%**
90%	81,080,310	51%
100%	125,594,990	79%

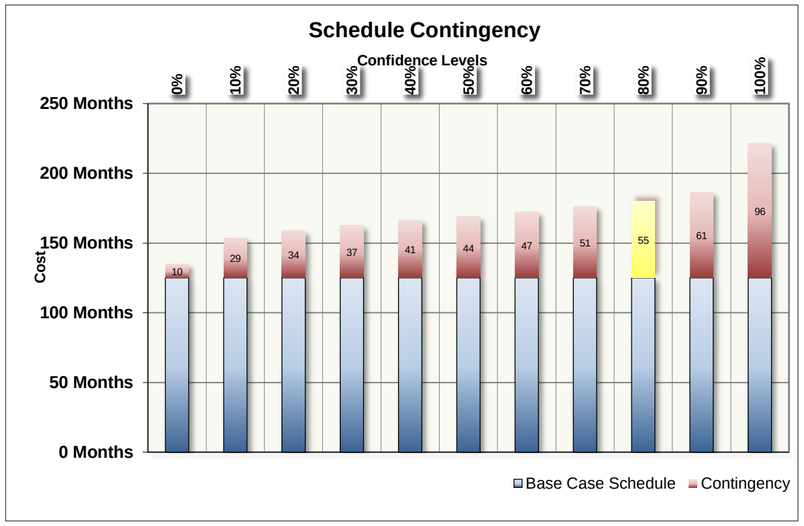


Northern Virginia Coastal Storm Risk Management Feasability Study
19-Jan-22

- SCHEDULE CONTINGENCY (DURATION) DEVELOPMENT -

Contingency Analysis

Base Case Schedule	125.0 Months	
Confidence Level	**Contingency Value**	**Contingency**
0%	10 Months	8%
10%	29 Months	23%
20%	34 Months	27%
30%	37 Months	30%
40%	41 Months	33%
50%	44 Months	35%
60%	47 Months	38%
70%	51 Months	41%
80%	**55 Months**	**44%**
90%	61 Months	49%
100%	96 Months	77%



NoVA CSRM CSRA-Nonstructural-100 Yrs-Contingency Tables

Contingency on Base Estimate	80% Confidence Project Cost	
Base Construction Estimate	$117,153,940	
Baseline Estimate Cost Contingency Amount ->	$39,832,340	34%
Baseline Estimate Construction Cost (80% Confidence) ->	$156,986,280	

Contingency on Schedule	80% Confidence Project Schedule	
Project Base Schedule Duration ->	90.0 Months	
Schedule Contingency Duration ->	39.6 Months	44%
Project Schedule Duration (80% Confidence) ->	129.6 Months	

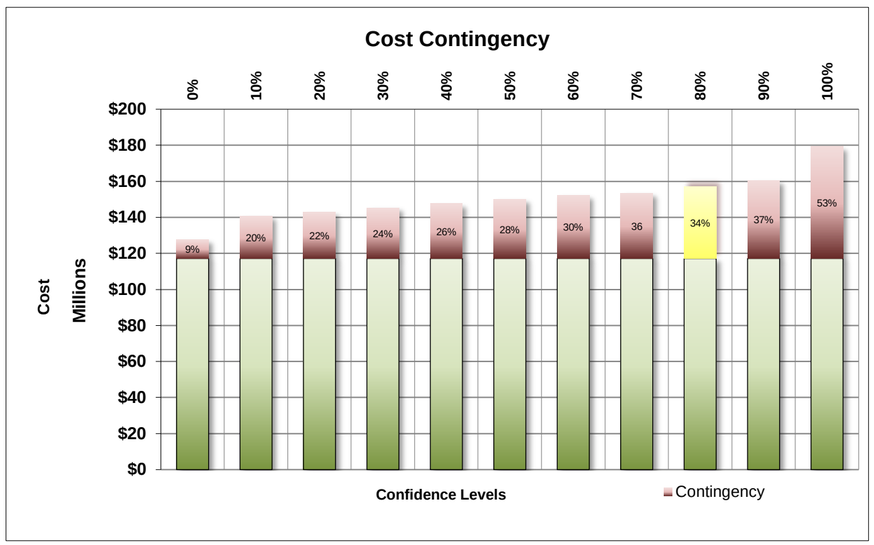
Northern Virginia Coastal Storm Risk Management Feasability Study
19-Jan-22

- PROJECT CONTINGENCY DEVELOPMENT -

INITIAL CONSTRUCTION

Contingency Analysis

Base Case Estimate (Excluding 01)	$117,153,940	
Confidence Level	**Contingency Value**	**Contingency**
0%	10,543,855	9%
10%	23,430,788	20%
20%	25,773,867	22%
30%	28,116,946	24%
40%	30,460,024	26%
50%	32,803,103	28%
60%	35,146,182	30%
70%	36,317,721	31%
80%	**39,832,340**	**34%**
90%	43,346,958	37%
100%	62,091,588	53%

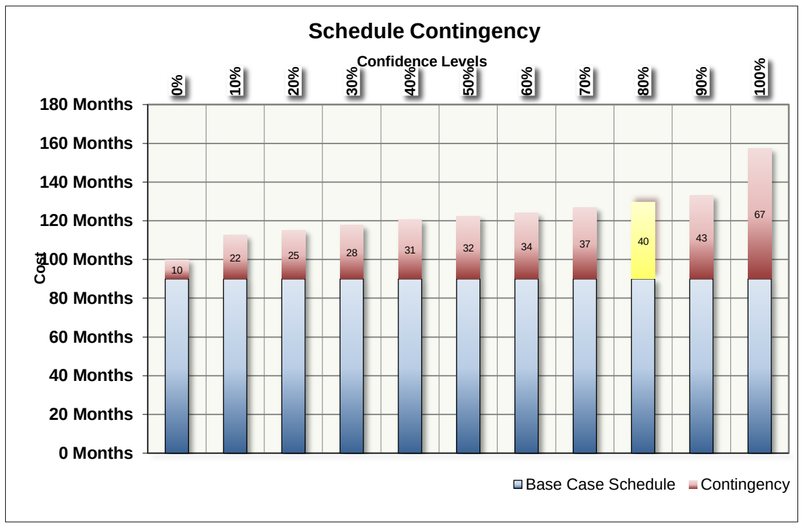


Northern Virginia Coastal Storm Risk Management Feasability Study
19-Jan-22

- SCHEDULE CONTINGENCY (DURATION) DEVELOPMENT -

Contingency Analysis

Base Case Schedule	90.0 Months	
Confidence Level	**Contingency Value**	**Contingency**
0%	10 Months	11%
10%	22 Months	25%
20%	25 Months	28%
30%	28 Months	31%
40%	31 Months	34%
50%	32 Months	36%
60%	34 Months	38%
70%	37 Months	41%
80%	**40 Months**	**44%**
90%	43 Months	48%
100%	67 Months	75%



NoVA CSRM CSRA-Nonstructural-50 Yrs Contingency Tables

Contingency on Base Estimate	80% Confidence Project Cost	
Base Construction Estimate	$105,141,000	
Baseline Estimate Cost Contingency Amount ->	$35,747,940	34%
Baseline Estimate Construction Cost (80% Confidence) ->	$140,888,940	

Contingency on Schedule	80% Confidence Project Schedule	
Project Base Schedule Duration ->	85.1 Months	
Schedule Contingency Duration ->	38.3 Months	45%
Project Schedule Duration (80% Confidence) ->	123.5 Months	

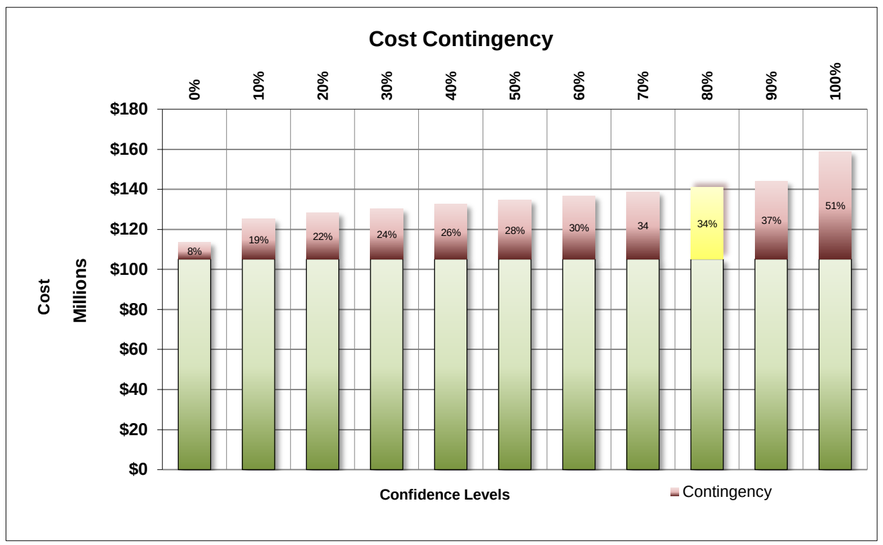
Northern Virginia Coastal Storm Risk Management Feasability Study
19-Jan-22

- PROJECT CONTINGENCY DEVELOPMENT -

INITIAL CONSTRUCTION

Contingency Analysis

Base Case Estimate (Excluding 01)	$105,141,000	
Confidence Level	**Contingency Value**	**Contingency**
0%	8,411,280	8%
10%	19,976,790	19%
20%	23,131,020	22%
30%	25,233,840	24%
40%	27,336,660	26%
50%	29,439,480	28%
60%	31,542,300	30%
70%	33,645,120	32%
80%	**35,747,940**	**34%**
90%	38,902,170	37%
100%	53,621,910	51%

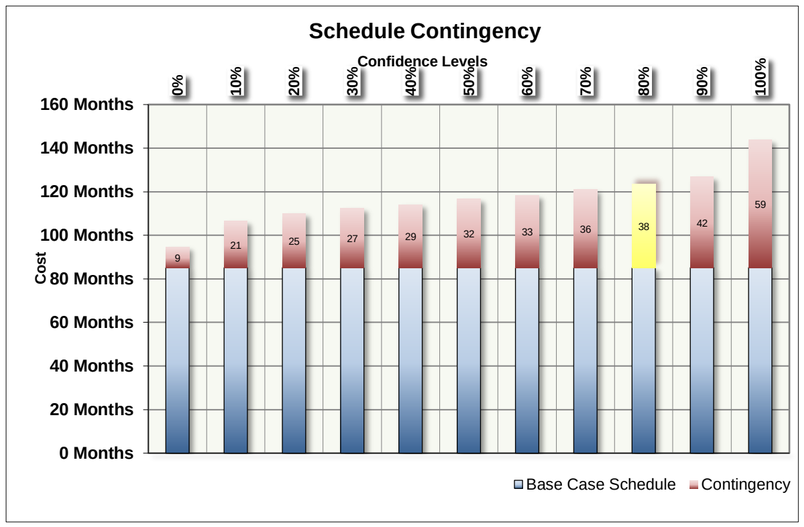


Northern Virginia Coastal Storm Risk Management Feasability Study
19-Jan-22

- SCHEDULE CONTINGENCY (DURATION) DEVELOPMENT -

Contingency Analysis

Base Case Schedule	85.1 Months	
Confidence Level	**Contingency Value**	**Contingency**
0%	9 Months	11%
10%	21 Months	25%
20%	25 Months	29%
30%	27 Months	32%
40%	29 Months	34%
50%	32 Months	37%
60%	33 Months	39%
70%	36 Months	42%
80%	**38 Months**	**45%**
90%	42 Months	49%
100%	59 Months	69%



NoVA CSRM CSRA-Nonstructural-20 Yrs Contingency Tables

Contingency on Base Estimate	80% Confidence Project Cost	
Base Construction Estimate	$73,030,070	
Baseline Estimate Cost Contingency Amount ->	$24,830,224	34%
Baseline Estimate Construction Cost (80% Confidence) ->	$97,860,294	

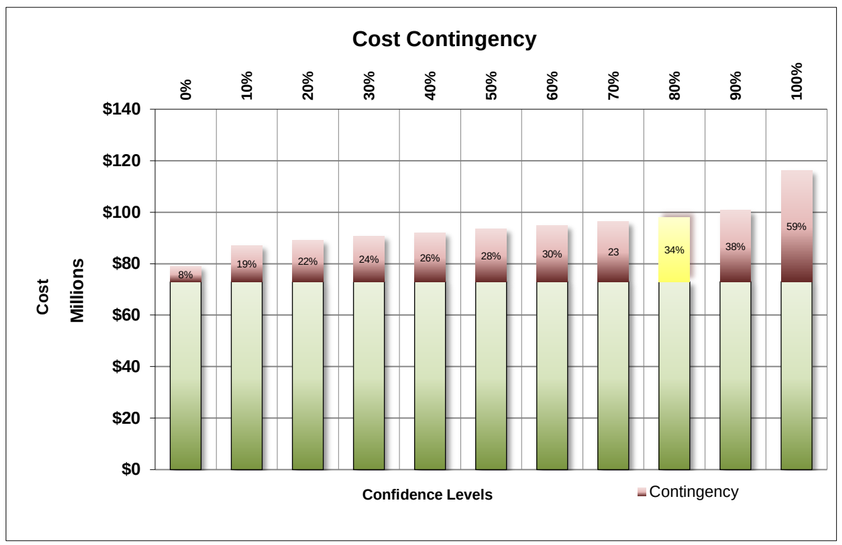
Contingency on Schedule	80% Confidence Project Schedule	
Project Base Schedule Duration ->	71.5 Months	
Schedule Contingency Duration ->	35.0 Months	49%
Project Schedule Duration (80% Confidence) ->	106.6 Months	

Northern Virginia Coastal Storm Risk Management Feasability Study
19-Jan-22

- PROJECT CONTINGENCY DEVELOPMENT -

INITIAL CONSTRUCTION
Contingency Analysis

Base Case Estimate (Excluding 01)	$73,030,070	
Confidence Level	**Contingency Value**	**Contingency**
0%	5,842,406	8%
10%	13,875,713	19%
20%	16,066,615	22%
30%	17,527,217	24%
40%	18,987,818	26%
50%	20,448,420	28%
60%	21,909,021	30%
70%	23,369,622	32%
80%	**24,830,224**	**34%**
90%	27,751,427	38%
100%	43,087,741	59%

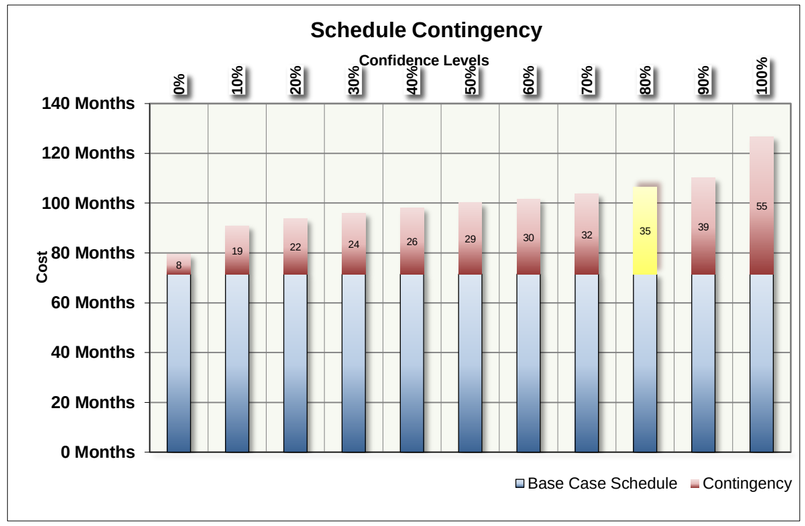


Northern Virginia Coastal Storm Risk Management Feasability Study
19-Jan-22

- SCHEDULE CONTINGENCY (DURATION) DEVELOPMENT -

Contingency Analysis

Base Case Schedule	71.5 Months	
Confidence Level	**Contingency Value**	**Contingency**
0%	8 Months	11%
10%	19 Months	27%
20%	22 Months	31%
30%	24 Months	34%
40%	26 Months	37%
50%	29 Months	40%
60%	30 Months	42%
70%	32 Months	45%
80%	**35 Months**	**49%**
90%	39 Months	54%
100%	55 Months	77%



Sub Appendix B

Cost and Schedule Sensitivity Charts Supporting the CSRA

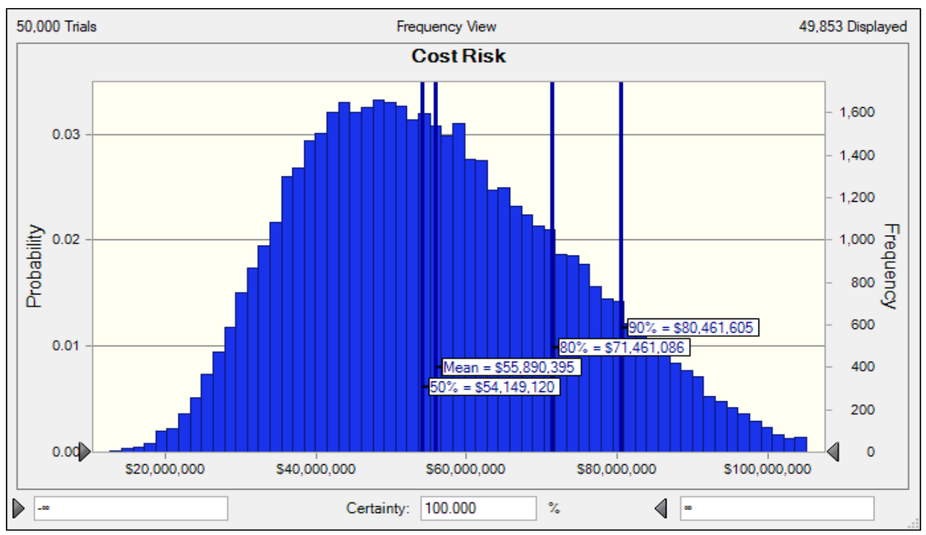
NoVA CSRM CSRA Sensitivity Charts for Structural Alternatives

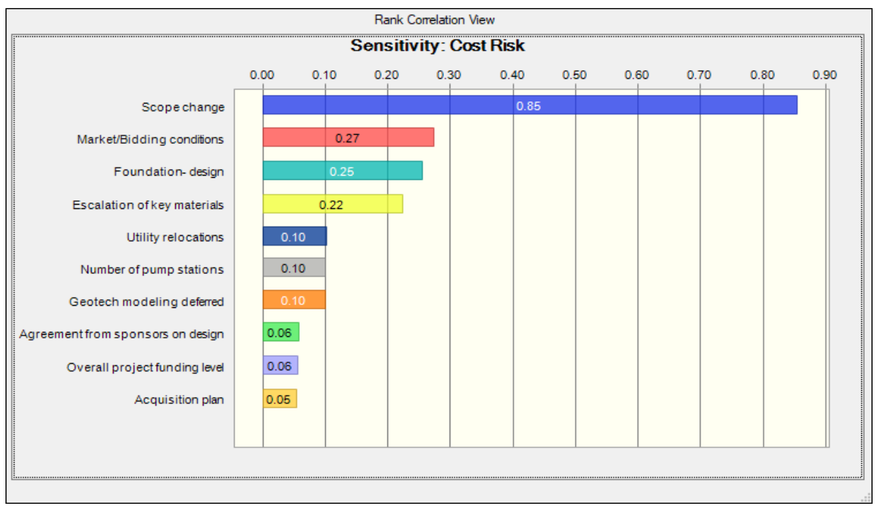
Contingency on Base Estimate		
Base Construction Estimate	**$158,981,000**	
Baseline Estimate Cost Contingency Amount ->	$71,541,450	**45%**
Baseline Estimate Construction Cost (80% Confidence) ->	**$230,522,450**	

Contingency on Schedule		
Project Base Schedule Duration ->	**125.0 Months**	
Schedule Contingency Duration ->	55.0 Months	44%
Project Schedule Duration (80% Confidence) ->	**180.0 Months**	

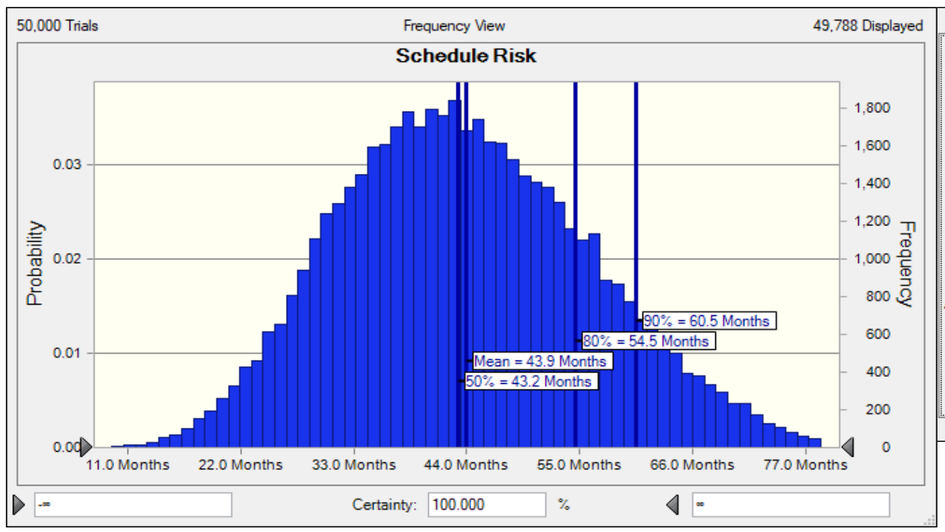
Northern Virginia Coastal Storm Risk Management Feasability Study
19-Jan-22

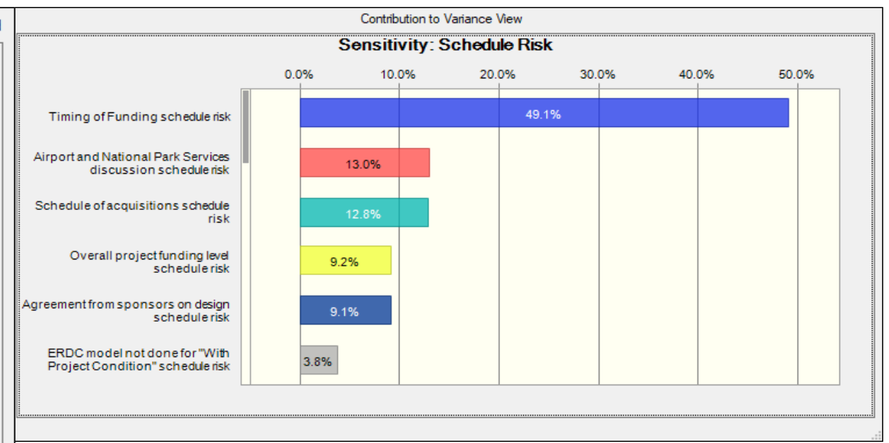
- Cost Outputs Distribution and Sensitivity -





- Schedule Outputs Distribution and Sensitivity -





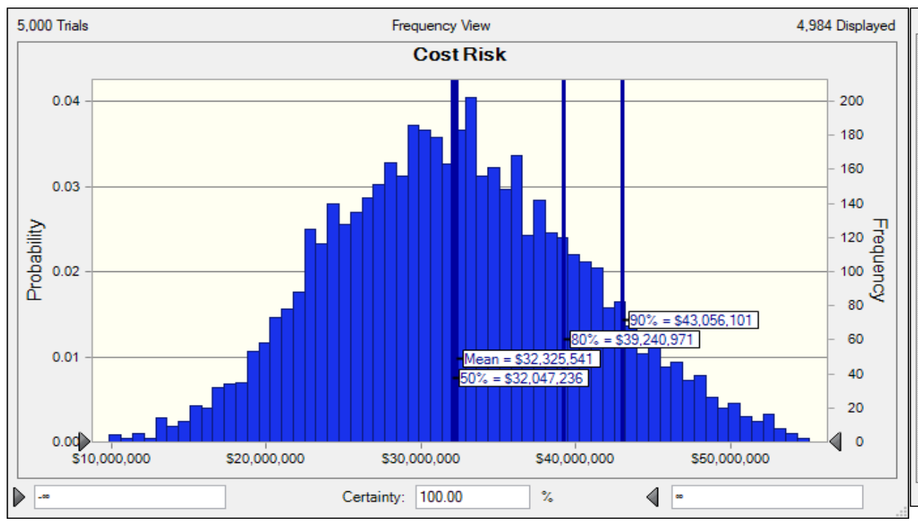
NoVA CSRM CSRA-Nonstructural-100 Yrs Sensitivity Charts

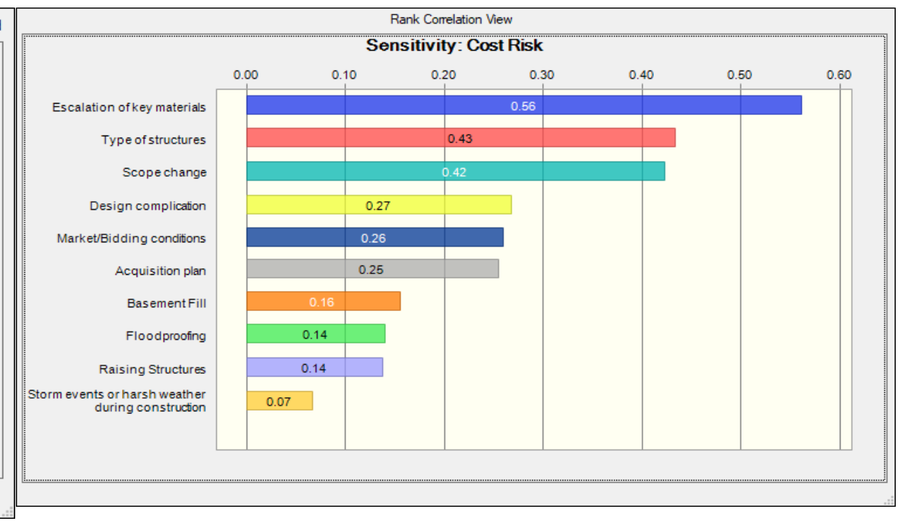
Contingency on Base Estimate		
Base Construction Estimate	**$117,153,940**	
Baseline Estimate Cost Contingency Amount ->	$39,832,340	**34%**
Baseline Estimate Construction Cost (80% Confidence) ->	**$156,986,280**	

Contingency on Schedule		
Project Base Schedule Duration ->	**90.0 Months**	
Schedule Contingency Duration ->	39.6 Months	44%
Project Schedule Duration (80% Confidence) ->	**129.6 Months**	

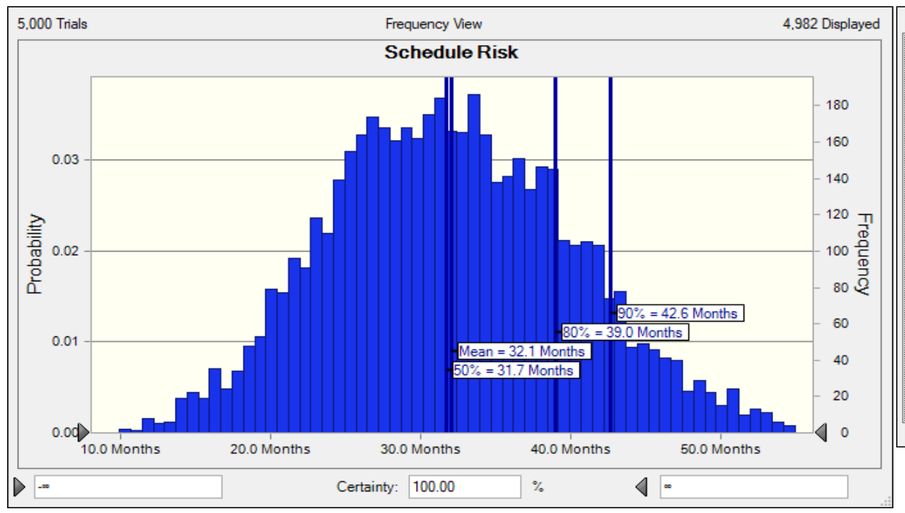
Northern Virginia Coastal Storm Risk Management Feasability Study
19-Jan-22

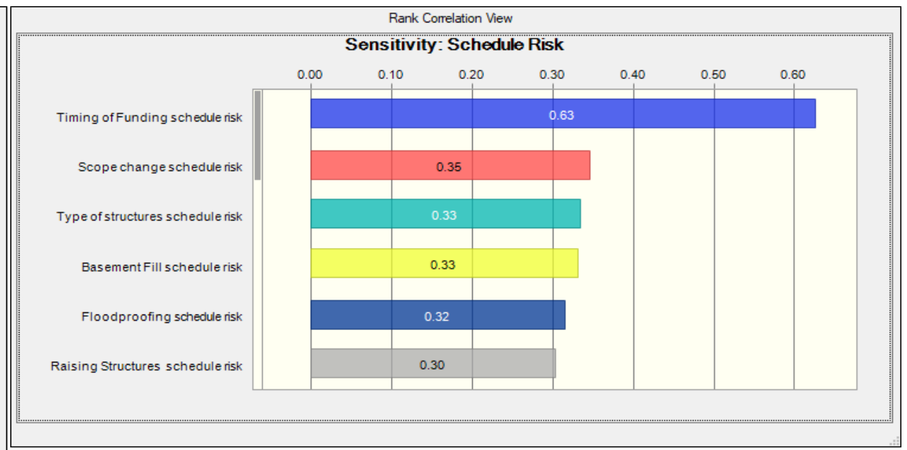
- Cost Outputs Distribution and Sensitivity -





- Schedule Outputs Distribution and Sensitivity -





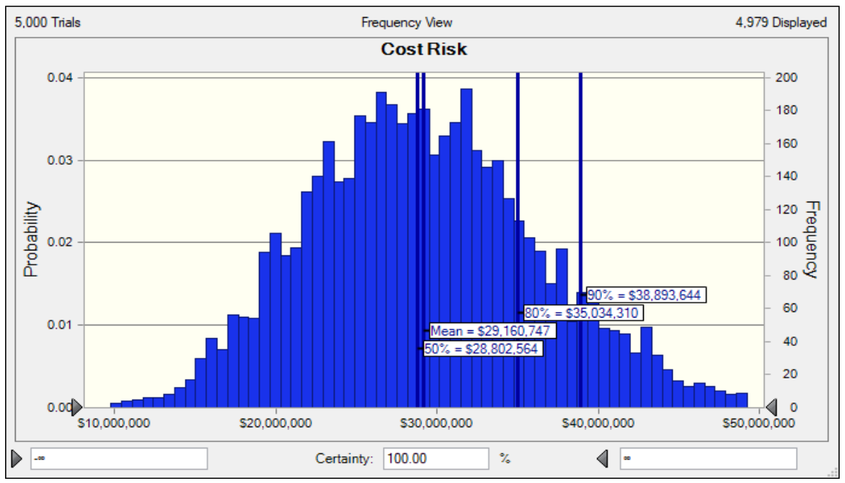
NoVA CSRM CSRA-Nonstructural-50 Yrs Sensitivity Charts

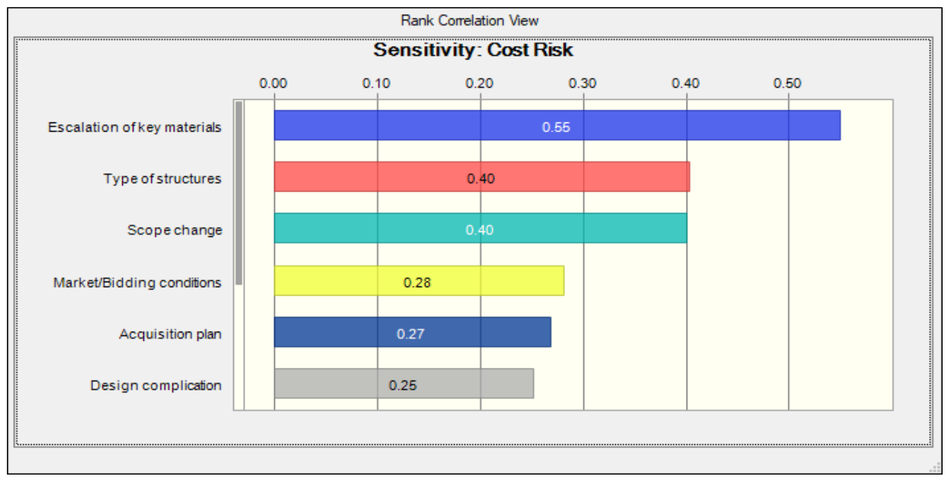
Contingency on Base Estimate		
Base Construction Estimate	**$105,141,000**	
Baseline Estimate Cost Contingency Amount ->	$35,747,940	**34%**
Baseline Estimate Construction Cost (80% Confidence) ->	**$140,888,940**	

Contingency on Schedule		
Project Base Schedule Duration ->	**85.1 Months**	
Schedule Contingency Duration ->	38.3 Months	45%
Project Schedule Duration (80% Confidence) ->	**123.5 Months**	

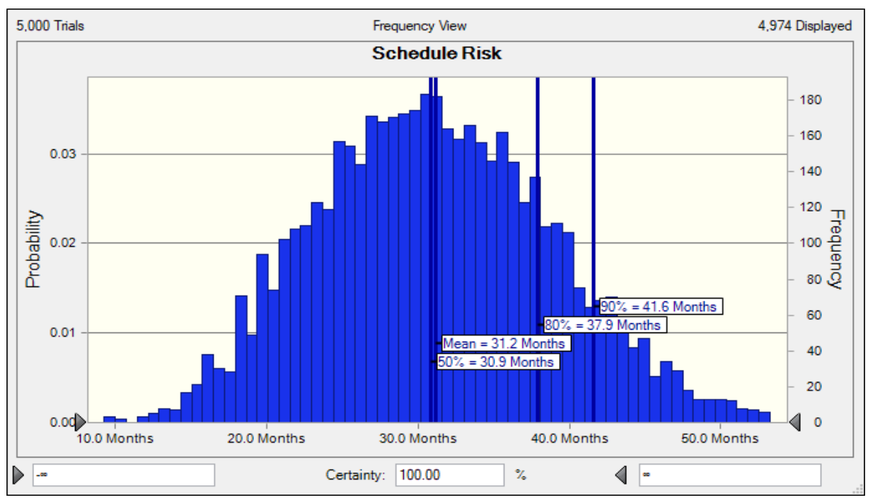
Northern Virginia Coastal Storm Risk Management Feasability Study
19-Jan-22

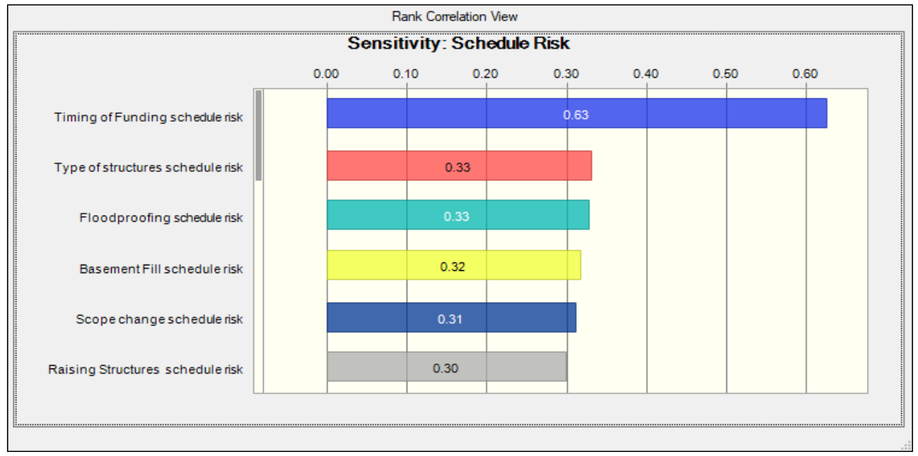
- Cost Outputs Distribution and Sensitivity -





- Schedule Outputs Distribution and Sensitivity -





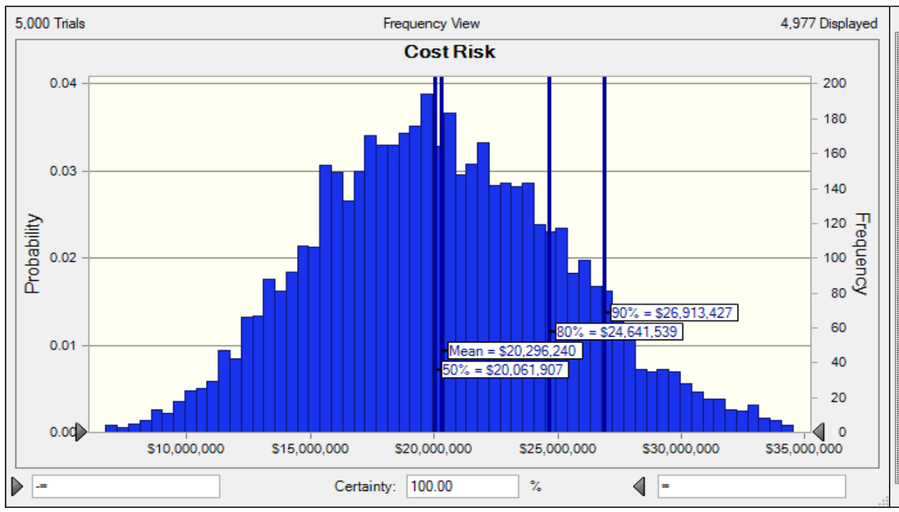
NoVA CSRM CSRA-Nonstructural-20 Yrs Sensitivity Charts

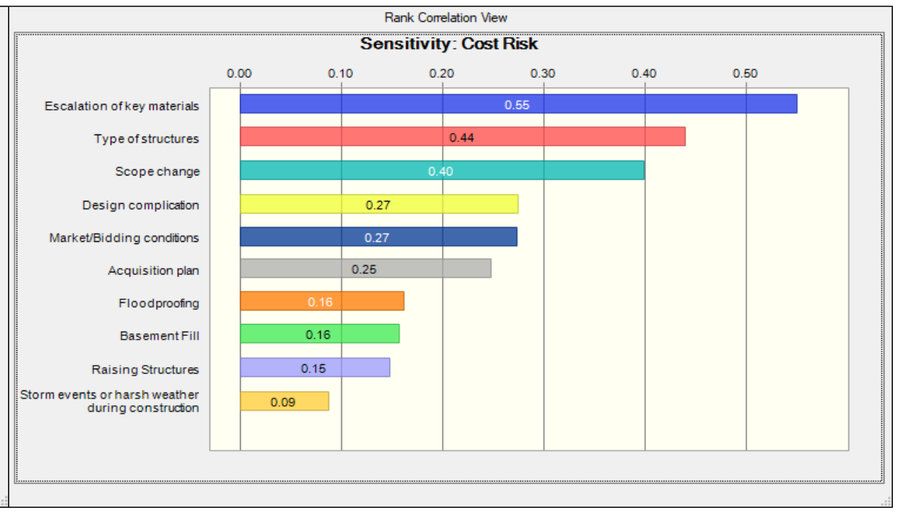
Contingency on Base Estimate		
Base Construction Estimate	**$73,030,070**	
Baseline Estimate Cost Contingency Amount ->	$24,830,224	**34%**
Baseline Estimate Construction Cost (80% Confidence) ->	**$97,860,294**	

Contingency on Schedule		
Project Base Schedule Duration ->	**71.5 Months**	
Schedule Contingency Duration ->	35.0 Months	49%
Project Schedule Duration (80% Confidence) ->	**106.6 Months**	

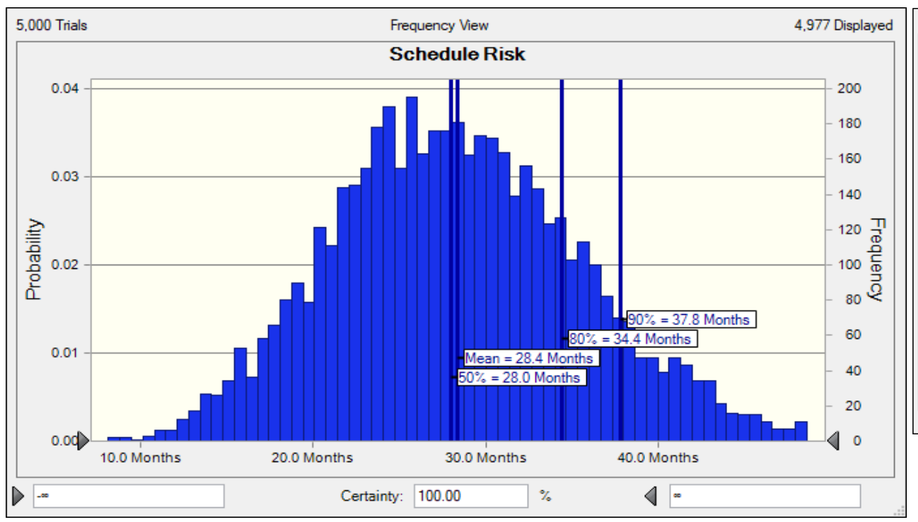
Northern Virginia Coastal Storm Risk Management Feasability Study
19-Jan-22

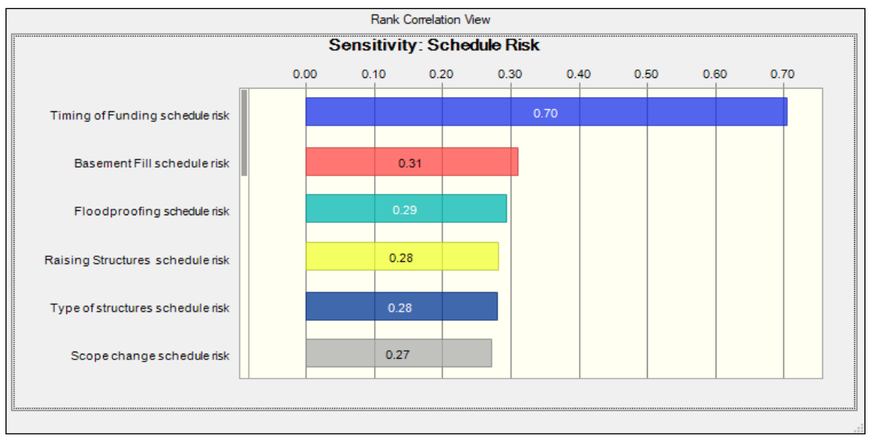
- Cost Outputs Distribution and Sensitivity -





- Schedule Outputs Distribution and Sensitivity -





Sub Appendix C

Cost & Schedule Risk Analysis Details

NoVA CSRM CSRA Risk Model for Structural Alternatives

				Project Cost			Project Schedule			Other Informatio					
CREF	Risk/Opportunity Event	Risk Event Description	PDT Discussions on Impact and Likelihood	Likelihood	Impact	Risk Level	Likelihood (S)	Impact (S)	Risk Level (S)	Cost Variance Distribution	Schedule Variance Distribution	Correlation to Other(s)	Responsibility/ POC	Affected Project Component	Suggested Risk Reduction Measures
Organizational and Project Management Risks (PM)															
PM1	Overall project funding level	Cost share funding share from sponsor.	Cost share may be too high. What is the actual ability/annual funding level that could be undertaken and put in the project schedule/cost estimate flow. Funding concerns lie mostly with the Regan airport because of the large $ amounts and desire of using new technology (auto deployable closures, not yet researched) that could be really expensive. The airport may prolong the process by breaking the alignments into multiple phases.	Likely	Moderate	Medium	Likely	Moderate	Medium	N/A -Not Modeled	N/A -Not Modeled		Stakeholder	Project Cost & Schedule	Consider a lower level of protection and increase it as time and money allow.
PM1B	Agreement from sponsors on design	Sponsors may not agree because the structures may present other issues such esthetics	Belle Haven may have also high price tag and other challenges such as not willing to give up the views.	Possible	Moderate	Medium	Likely	Moderate	Medium				Stakeholder	Project Cost & Schedule	Consider a lower level of protection and increase it as time and money allow. Consider a different approach such as using more pump stations.
PM2	Design team management	Design approach could vary based on complexity and district workload	It's likely that not all alignments will be approved at the same time. Most of them can be designed in-house. Some of the design may be AE and or cooperative with other districts. Generally the design can be complex (e.g., auto deployable closures)	Likely	Negligible	Low	Very Likely	Negligible	Low	N/A -Not Modeled	N/A -Not Modeled		Technical Lead	N/A -Not Modeled	
PM3	Multiple agency coordination	This is a large project involving multiple agencies	Cooperation is generally good and agencies generally work well together. National Park Service has raised concerns about the impact to historic properties. Working with National Park Service may be challenging, but the schedule delay may be minimal.	Likely	Negligible	Low	Likely	Negligible	Low	N/A -Not Modeled	N/A -Not Modeled		Environmental Compliance	N/A -Not Modeled	Continue coordination with the National Park Services as much as we can prior to review periods.
PM4	Endangered Species	Limited endangered species are in the area.	Determination that project most likely will not affect any endangered species.	Possible	Marginal	Low	Possible	Marginal	Low	N/A -Not Modeled	N/A -Not Modeled		Environmental Compliance	N/A -Not Modeled	
PM4B	Wetland impact	Minor impact likely in the footprint of culverts, flap gates, and pump stations.	It is likely that there would be wetland impact. But the impact seems to be marginal.	Likely	Marginal	Medium	Possible	Marginal	Low	Triangular	N/A -Not Modeled		Environmental Compliance	Project Cost	
PM4C	Air quality impact	Region is in non-attainment for ozone	Not likely that mitigation will be required. Air quality conformity analysis still needs to be completed.	Unlikely	Marginal	Low	Unlikely	Marginal	Low	N/A -Not Modeled	N/A -Not Modeled		Environmental Compliance	N/A -Not Modeled	If air quality is not in conformity with standards, may need to work on the construction schedule to avoid mitigation. Also coordinate with USEPA.
PM5	Project Turnover plan	Each section will get turned over at completion	Project will be turned over asap and sponsor will assume operating costs as soon as possible. Some items are not defined such as spare parts, consumables on hand etc. Team indicates that this will not be a concern on both cost and schedule.	Unlikely	Marginal	Low	Possible	Negligible	Low	N/A -Not Modeled	N/A -Not Modeled		Project Management	N/A -Not Modeled	
PM7	PED budget amount	PED effort may different at start of design	PED is estimated at 27.8% of construction cost which appears to be conservative. It may be less if everything happens smoothly at start of design.	Possible	Marginal	Low	Possible	Marginal	Low	N/A -Not Modeled	N/A -Not Modeled		Stakeholder	N/A -Not Modeled	
PM7	Sponsor performed construction	Work by sponsor	There may be unlikely that some work that the sponsor may want to do themselves - generally small items that may make sense for them to do. This is an opportunity to reduce schedule primarily.	Unlikely	Negligible	Low	Unlikely	Negligible	Low	N/A -Not Modeled	N/A -Not Modeled		Stakeholder	N/A -Not Modeled	
PM7	Sponsor performed construction	Work by sponsor	There may be unlikely that some work that the sponsor may want to do themselves - generally small items that may make sense for them to do. This is an opportunity to reduce schedule primarily.	Unlikely	Negligible	Low	Unlikely	Negligible	Low	N/A -Not Modeled	N/A -Not Modeled		Stakeholder	N/A -Not Modeled	
Contract Acquisition Risks (CA)															
CA1	Schedule of acquisitions	Estimate needs to be scheduled out	Project needs to be grouped and considered in terms of contracts etc. and realistic schedule for each segment to get proper escalation. Estimate is currently laid out with areas not necessarily contracts and the zones that the order the work needs to be constructed in which may not match with actual contracts in future.	Possible	Marginal	Low	Likely	Moderate	Medium	N/A -Not Modeled	Triangular		Project Management	Project Schedule	Grouping zones/segments now so that proper escalation rates can be applied to.
CA2	Acquisition plan	Based on the current plan with approximately 4 areas most likely there will be at least 8 separate contracting actions to complete all reaches.	Estimate assumes substantial subcontracting and is generally conservative however there is the risk that the project could be split into smaller contracts and incur higher costs. Current estimate is already including 3 mob/demob costs for large areas such as Airport and Bell Haven. There's a chance that those large areas may be broken up into more smaller contracts. Schedule may also be impacted.	Likely	Marginal	Medium	Likely	Marginal	Medium	Triangular	N/A -Not Modeled		Contracting	Contract Cost	Early involvement with Contracting may provide better planning to group projects into larger scopes of work to avoid or minimize using small negotiated contracts.
General Technical Risks (TR)															
TR1	Geotech modeling deferred	Belle Haven areas that can have geotech modeling deferred.	Geotech modeling deferred until PED. There is a possibility of sediment settlment issues. Existing geotech data is being used. Belle Haven is more concerns in geotech.	Likely	Moderate	Medium	Possible	Negligible	Low	Triangular	N/A -Not Modeled		Technical Lead	Project Cost	Geotech modeling will clarify and mitigate the issue at PED.
TR2	ERDC model not done for "With Project Condition"	With Project Condition Modeling Was not completed to show impact of proposed alternatives.	Upstream and downstream impact needs to be considered. These areas can show up later on in the study.	Likely	Moderate	Medium	Likely	Marginal	Medium	Triangular	Triangular		Technical Lead	Project Cost & Schedule	HH modeling in PED will clearly be defined and reduce risks.
Architectural and Interior (AI)															
A1	Project goes through a national historic district	Historical zone requirements	There are some historic areas but the project alignments are not on those areas. There might be a possility of having an archaelogical survey in some areas. But the impact is thought be negligible.	Possible	Negligible	Low	Possible	Negligible	Low	N/A -Not Modeled	N/A -Not Modeled		Project Management	N/A -Not Modeled	
AI2	Gates and crossings	Not necessarily all gates need to be included in current plan.	Gates and crossings are included but may not be an issue such as blocking traffic.	Unlikely	Negligible	Low	Unlikely	Negligible	Low	N/A -Not Modeled	N/A -Not Modeled		Technical Lead	N/A -Not Modeled	
Civil/Site Design (CV)															
CV1	Survey data	Generally the LIDAR data is plus or minus 6 in	GIS data and LIDAR have a lot of data info that are not necessary and may be challenging in converting into design.	Possible	Marginal	Low	Possible	Negligible	Low	N/A -Not Modeled	N/A -Not Modeled		Geotechnical/Civil Design	N/A -Not Modeled	
CV2	Scope change	Alignments are changed, height of walls, pump flow rate change, closure gate size change now till 100% design	What is the likelihood of changing of the alignments, wall heights, pump flow rates, closure sizes. Interior drainage is not done (not until PED). Current assumption seems to be conservative and less likely to be changed to larger measures. The deployable closure type may not be stop logs but a more high tech expensive type. Weak and saturated soil in some areas at the airport can cause foundation problems. Schedule will not be much of concerns because the sponsors (airport) seem to be responsive so far.	Likely	Critical	High	Possible	Marginal	Low	Triangular	Triangular		Geotechnical/Civil Design	Project Cost	Early engagement with sponsors to find out the design options. Market survey may be lead to less inexpensive options.

				Project Cost			Project Schedule			Other Informatio					
CREF	Risk/Opportunity Event	Risk Event Description	PDT Discussions on Impact and Likelihood	Likelihood	Impact	Risk Level	Likelihood (S)	Impact (S)	Risk Level (S)	Cost Variance Distribution	Schedule Variance Distribution	Correlation to Other(s)	Responsibility/ POC	Affected Project Component	Suggested Risk Reduction Measures
Structural (SD)															
SD1	Foundation- design	Generally consistent Geotech data	Current geotech info is available to some degree and current assumption could be questionable. Deep foundation may be required.	Likely	Significant	High	Possible	Negligible	Low	Triangular	N/A -Not Modeled		Geotechnical/Civil Design	Project Cost	PED will clearly define the need of deep foundation or not.
SD2	Floodwalls	Design of Wall and criteria	I wall and T walls are being used. Assumption on these wall types are conservative. Changes in between these wall types may be unlikely for many walls. There may be one wall that may need to be revised from I wall to T wall.	Possible	Negligible	Low	Possible	Negligible	Low	N/A -Not Modeled	N/A -Not Modeled		Geotechnical/Civil Design	N/A -Not Modeled	
SD3	Modeling requirements	what modeling will be required (ERDC)	Modeling issue is already discussed in risk TR2. In addition, higher water level in wetland does not seem to put risks to wetland but rather bring more benefits to the plants.	Unlikely	Negligible	Low	Unlikely	Negligible	Low	N/A -Not Modeled	N/A -Not Modeled		Hydrology/Hydraulic Design	N/A -Not Modeled	
SD4	Pump stations	Storm water discharge permits	New pump stations will discharge into rivers and may not require new discharge permits because there would be no new discharge points.	Possible	Marginal	Low	Possible	Marginal	Low	N/A -Not Modeled	N/A -Not Modeled		Regulatory	N/A -Not Modeled	
SD5	Existing interior drainage	pump stations may need configuration changes	Existing storm water system may need some operational changes to work with the newer floodwall-- the interior drainage area isn't changing but should the pump station need some marginal changes or modifications (at near airport area).	Possible	Marginal	Low	Possible	Negligible	Low	Triangular	N/A -Not Modeled		Technical lead	N/A -Not Modeled	
SD6	Number of pump stations	Is the plan for interior drainage adequate	Will we need to add additional pump stations as we progress forward with the design to account for the additional drainage.	Possible	Moderate	Medium	Possible	Negligible	Low	Triangular	N/A -Not Modeled		Technical lead	Project Cost	Number of pumps will be known in PED.
SD7	Height of wall	Wall height may be conservative and be able to be reduced.	Wall height seems conservative and may be unlikely to change or not be reduced. Several areas could have the height lowered due to the wave action. Especially in the railroad area.	Unlikely	Negligible	Low	Unlikely	Negligible	Low	Triangular	N/A -Not Modeled		Geotechnical/Civil Design	N/A -Not Modeled	
SD8	Proximity of buildings to floodwall	In many areas the wall is close to existing buildings	There may not be a need to revise significant part of the wall design approach. There may be a issue with an apartment complex having a closure structure nearby.	Possible	Negligible	Low	Possible	Negligible	Low	N/A -Not Modeled	N/A -Not Modeled		Geotechnical/Civil Design	N/A -Not Modeled	
Electrical EE															
EE1	Pump stations electrical needs	Pump stations may need some revisions to the power grid.	Additional transformers other large electrical equipment because of availability of existing power and the pump stations are on generators. The generator cost is included in the estimate but size will need to be revised.	Possible	Marginal	Low	Possible	Negligible	Low	N/A -Not Modeled	N/A -Not Modeled		Mechanical Design	N/A -Not Modeled	
Equipment (EQ)															
EQ1	Annunciation and controls	Pump stations, gauge stations and Scads systems will need to be integrated together.	A placeholder cost based on a conversation from USGS is added to tie everything into the City operations center. The cost may change later.	Possible	Marginal	Low	Possible	Negligible	Low	N/A -Not Modeled	N/A -Not Modeled		Technical Lead	N/A -Not Modeled	
Commissioning/Certification (CC)															
CC1	Commissioning	Commissioning costs in estimate may be minimal	There is 100k to 200K in commissioning costs for each pump station, depending on the pump size. This is considered conservative.	Possible	Marginal	Low	Possible	Negligible	Low	N/A -Not Modeled	Triangular		Technical Lead	N/A -Not Modeled	
Lands and Damages (LD)															
LD1	Draft Wetland Mitigation Plan	Mitigation requirements.	Overall mitigation costs are generally low. Due to the interest of several of the environmental groups there may be a need for additional mitigation efforts.	Possible	Marginal	Low	Possible	Negligible	Low	N/A -Not Modeled	N/A -Not Modeled		Project Management	N/A -Not Modeled	
LD2	Airport and National Park Services discussion	Difficulty of engaging the Airport and National Park Services to discuss a trail	Time to coordinate with the airport could take longer than necessary.	Possible	Marginal	Low	Likely	Significant	High	N/A -Not Modeled	Triangular		Stakeholder	Project Schedule	
LD3	Acquisitions and Easements	Easements follow existing right of way for most part and try to avoid private property.	The acquisitions need to be completed prior to construction so that the project can move forward. There may not be many issues of getting easements. Early involvment is usually applied and will minimize schedule risk, with exception to Non-Standard Estates which will require HQUSACE approval.	Likely	Marginal	Medium	Possible	Marginal	Low	Triangular	N/A -Not Modeled		Stakeholder	Project Cost	
LD4	Recreational trails	Are costs included to rebuild recreational trails	The project has trails and there may be some issues with recreation use. The trail impacted is at Four Miles Run and is potentially about 4,000 ft. Estimate already includes pavement for the trails.	Possible	Marginal	Low	Possible	Marginal	Low	N/A -Not Modeled	N/A -Not Modeled		Stakeholder	N/A -Not Modeled	
LD5	Sidewalks and new wall	Is the alignment along roads and sidewalls	Are cost currently included to restore roads, sidewalks, etc. along alignment	Possible	Marginal	Low	Unlikely	Negligible	Low	N/A -Not Modeled	N/A -Not Modeled		Cost Engineering	N/A -Not Modeled	
Regulatory Environmental Risks (RG)															
RG2	Work windows	TOY restrictions generally low risk	Possible TOY restrictions imposed based on T&E species presence in the Action Area. Biological assessment is being worked on but not completed. This is primarily a schedule risk and is considered low. Not many trees will be cleared.	Unlikely	Moderate	Low	Possible	Marginal	Low	N/A -Not Modeled	N/A -Not Modeled		Environmental Compliance	N/A -Not Modeled	Work with agencies to determine if any TOY restrictions will be needed.
RG3	Contaminated soils	There is some potential to encounter contaminated soils	The airport may have some issues with contaminated soils. But the airport may mitigate this risk themselves. Contamination is mostly inside buildings.	Possible	Marginal	Low	Possible	Marginal	Low	N/A -Not Modeled	Triangular		Stakeholder	N/A -Not Modeled	
RG5	Abandoned heating oil tanks	Most likely the older homes being bought out may have old heating oil tanks	No data indicates abandoned tanks in residential areas.	Unlikely	Negligible	Low	Unlikely	Negligible	Low	N/A -Not Modeled	N/A -Not Modeled		Stakeholder	N/A -Not Modeled	

				Project Cost			Project Schedule			Other Informatio					
CREF	Risk/Opportunity Event	Risk Event Description	PDT Discussions on Impact and Likelihood	Likelihood	Impact	Risk Level	Likelihood (S)	Impact (S)	Risk Level (S)	Cost Variance Distribution	Schedule Variance Distribution	Correlation to Other(s)	Responsibility/ POC	Affected Project Component	Suggested Risk Reduction Measures
Construction Risks (CO)															
CO1	Laydown Areas	Adequate lay down/staging areas may be difficult to find	Only Belle Haven may have some challenge finding a location for staging areas. Since this is the only location that have this concern, it may have marginal impact. Real estate does not have any concerns with easement.	Possible	Marginal	Low	Possible	Negligible	Low	Triangular	N/A -Not Modeled		Construction	N/A -Not Modeled	
CO2	Vibration/seismic/noise monitoring	Only the floodwalls in Belle Haven is near existing buildings/properties.	No pile driving is included in design. Therefore, no vibration monitoring is needed. There may be some concern of construction noise complaints in Belle Haven only. Alternate shift may need to be considered in Belle Haven estimate but it may have marginal cost impact. Construction schedule impact should also be marginal.	Possible	Marginal	Low	Possible	Negligible	Low	N/A -Not Modeled	N/A -Not Modeled		Technical Lead	N/A -Not Modeled	
CO3	Traffic Control	Traffic control may be an issue in Belle Haven only.	Especially in urban/downtown areas traffic controls could cause issues with construction. Traffic control cost is in the estimate and considered to be conservative.	Likely	Negligible	Low	Likely	Negligible	Low	N/A -Not Modeled	N/A -Not Modeled		Cost Engineering	N/A -Not Modeled	
Estimate and Schedule Risks (ES)															
ES1	Utility relocations	Utility relocations not 100% known current estimate does include a placeholder cost.	No utility data is available but there is a great chance that utility relocation (communication, gas, and water) is necessary. However, there is a placeholder cost included in the estimate.	Likely	Moderate	Medium	Likely	Negligible	Low	Triangular	N/A -Not Modeled		Cost Engineering	Project Cost	
ES2	Road relocations	Is road relocations necessary	There should not be any permanent road relocation.	Unlikely	Negligible	Low	Unlikely	Negligible	Low	N/A -Not Modeled	N/A -Not Modeled		Geotechnical/Civil Design	N/A -Not Modeled	
ES3	Design duration	Design duration may be longer if there are design and/or site condition issues	Design duration is estimated to be 2 years but it may take longer if there are design or site condition issues.	Possible	Marginal	Low	Likely	Marginal	Medium	N/A -Not Modeled	N/A -Not Modeled		Technical Lead	N/A -Not Modeled	
ES4	Site Restoration	Site restoration costs in estimate can vary due to the range of areas covered and urban area.	There could be variations in the cost of the site restoration after construction is complete.	Possible	Marginal	Low	Possible	Negligible	Low	N/A -Not Modeled	N/A -Not Modeled		Technical Lead	N/A -Not Modeled	
External Risks (EX)															
EX1	Market/Bidding conditions	Typical various due to local market and bidding conditions	Generally the project is straightforward and there are multiple firms in the area capable of performing the work. Projects of this size in the area depends for available workforce and resources.	Likely	Significant	High	Unlikely	Negligible	Low	Triangular	N/A -Not Modeled		Project Manager	Project cost	Perform market surveys.
EX2	Timing of Funding	Project may be delayed due to funding delay.	Past experience on large civil projects shows that authorization of funding to initiate the start of the design of the project is likely not the time the PDT anticipated. This risk concerns mostly the project schedule.	Possible	Marginal	Low	Very Likely	Critical	High	N/A -Not Modeled	Triangular		Programs	Project Schedule	Regular communication with vertical team regarding the status of project may provide insight into accurate planning and scheduling.
EX3	Storm events during construction	Significant storm during Construction.	Typical risk of storms for the area - There may be a need for restrictions on the amount of teardown of exiting floodwall. Project schedule should include typical weather productivity effects. However in a severe storm event, additional costs can come from standby time, EDC, cleanup effort, and Corps S&A	Likely	Moderate	Medium	Likely	Marginal	Medium	Triangular	Single Event (2 Step)		Cost Engineering	Project Cost	Perform market surveys.
EX4	Escalation of key materials	Key materials could increase price	Concrete, steel are major cost items and the price could vary based on world market conditions. Other projects in the nearby areas may cause more limitation in availability of resources.	Likely	Moderate	Medium	Possible	Marginal	Low	Triangular	N/A -Not Modeled		Cost Engineering	Project cost	Perform market surveys.

NoVA CSRM CSRA Risk Model for Nonstructural Alternatives

				Project Cost			Project Schedule			Other Informatio					
CREF	Risk/Opportunity Event	Risk Event Description	PDT Discussions on Impact and Likelihood	Likelihood	Impact	Risk Level	Likelihood (S)	Impact (S)	Risk Level (S)	Cost Variance Distribution	Schedule Variance Distribution	Correlation to Other(s)	Responsibility/ POC	Affected Project Component	Suggested Risk Reduction Measures
Organizational and Project Management Risks (PM)															
PM1	Multiple agency coordination	This is a large project involving multiple agencies	Cooperation is generally good and agencies generally work well together. National Park Service has raised concerns about the impact to historic properties. Working with National Park Service may be challenging, but the schedule delay may be minimal.	Likely	Negligible	Low	Likely	Negligible	Low	N/A -Not Modeled	N/A -Not Modeled		Environmental Compliance	N/A -Not Modeled	Continue coordination with the National Park Services as much as we can prior to review periods.
PM3	PED budget amount	PED effort may different at start of design	PED is estimated at 15.25% of construction cost which appears to be conservative. It may be less if everything happens smoothly at start of design.	Possible	Marginal	Low	Possible	Marginal	Low	N/A -Not Modeled	N/A -Not Modeled		Stakeholder	N/A -Not Modeled	
PM4	Construction Management amount	Account 31 may be different	PED is estimated at 9.5% of construction cost which appears to be conservative. It may be less if there is less amount of paperwork required.	Unlikely	Negligible	Low	Unlikely	Negligible	Low	N/A -Not Modeled	N/A -Not Modeled		Stakeholder	N/A -Not Modeled	
PM5	Sponsor performed construction	Work by sponsor	There may be unlikely that some work that the sponsor may want to do themselves - generally small items that may make sense for them to do. This is an opportunity to reduce schedule primarily.	Unlikely	Negligible	Low	Unlikely	Negligible	Low	N/A -Not Modeled	N/A -Not Modeled		Stakeholder	N/A -Not Modeled	
Contract Acquisition Risks (CA)															
CA1	Schedule of acquisitions	Estimate needs to be scheduled out	Nonstructural schedule is based on 3 months per property which appears to be conservative as in reality multiple properties will be grouped and done together at about the same time.	Possible	Marginal	Low	Likely	Negligible	Low	N/A -Not Modeled	Triangular		Project Management	Project Schedule	Grouping zones/segments now so that proper escalation rates can be applied to.
CA2	Acquisition plan	Based on the current plan with approximately 4 areas most likely there will be at least 10 separate contracting actions to complete all reaches.	There is the risk that the project could be split into smaller contracts and incur higher costs. Current estimate is already including individual mob/demob costs for each property. There's a chance that those large areas may be broken up into more smaller contracts. Schedule may also be impacted.	Likely	Moderate	Medium	Likely	Marginal	Medium	Triangular	N/A -Not Modeled		Contracting	Contract Cost	Early involvement with Contracting may provide better planning to group projects into larger scopes of work to avoid or minimize using small negotiated contracts.
General Technical Risks (TR)															
TR1	Design may be more complicated	Design may be more complicated than current assumptions	Corps never got involved in implementation phase of nonstructural projects. Current assumption is based on conventional knowledge but can vary at implementation phase	Likely	Moderate	Medium	Possible	Negligible	Low	Triangular	N/A -Not Modeled		Technical Lead	Project Cost	Geotech modeling will clarify and mitigate the issue at PED.
Architectural and Interior (AI)															
A1	Project goes through a national historic district	Historical zone requirements	There are some historic areas but the project alignments are not on those areas. There might be a possility of having an archaelogical survey in some areas. But the impact is thought be negligible.	Possible	Negligible	Low	Possible	Negligible	Low	N/A -Not Modeled	N/A -Not Modeled		Project Management	N/A -Not Modeled	
A1B	Project goes through a national historic district for nonstructural measures	Historical zone requirements	There are some historic areas the nonstructural measures are on those areas (old town Alexandria).	Likely	Marginal	Medium	Possible	Negligible	Low	Triangular	N/A -Not Modeled		Project Management	Project Cost	Recommend internal nonstructural measure such as flood proofing to avoid or minimize impacts on the building facades.
Civil/Site Design (CV)															
CV2	Scope change	Number of properties and type of nonstructural methods may change	More complicated types of nonstrutrual methods may present cost and schedule risks. Number of properties should be conservative as 100% participation is assumed which is rare and unlikely.	Likely	Significant	High	Likely	Moderate	Medium	Triangular	Triangular		Geotechnical/Civil Design	Project Cost	Early engagement with sponsors to find out the design options. Market survey may be lead to inexpensive options.
Structural (SD)															
SD7	Type of structures	Type of structures of each home is still a guess	Foundation of each property is still a guess. Actual surveys of properties may show higher level of difficulty to implement which can affect both cost and schedule.	Likely	Significant	High	Likely	Moderate	Medium	Triangular	N/A -Not Modeled		Geotechnical/Civil Design	N/A -Not Modeled	Site survey and site visits to collect more data as far as structures and structural types. Well laid plans and coordination with local sponsors will reduce risks of schedule delays.
Non Structural Measures															
NS-1	Basement Fill	Basement fill estimate used	Basement fill estimate is based on historical cost from another studies. Based on the typical basements encountered in the area the estimate is probably conservative (mainly small wet basements). Cost assumption may not be accurate since there is no design for nonstructural measures.	Likely	Moderate	Medium	Likely	Moderate	Medium	N/A -Not Modeled	Triangular		Local Sponsor	Project Schedule	More coordination and well development of nonstructural plans.
NS-2	Raising Structures	Raising a few single family houses	Raising structures is conservative and may not have significant cost impact but may present marginal schedule impact. Cost assumption may not be accurate since there is no design for nonstructural measures.	Likely	Moderate	Medium	Likely	Moderate	Medium	N/A -Not Modeled	Triangular		Local Sponsor	Project Schedule	More coordination and well development of nonstructural plans.
NS-3	Floodproofing	Majority of nonstructural measure is dry and wet flood proofing	Dry flood proofing is being considered and is more conservative because it is more expensive than wet flood proofing. Schedule impact is more of concern in later stage of design.. Cost assumption may not be accurate since there is no design for nonstructural measures.	Likely	Moderate	Medium	Likely	Moderate	Medium	N/A -Not Modeled	Triangular		Local Sponsor	Project Schedule	More coordination and well development of nonstructural plans.
Lands and Damages (LD)															
LD1	Acquisitions and Easements	Estimated budget for real estate relocation for each household may not be accurate	Estimated budget for real estate relocation for each household while nonstructural measures are being implemented is conservative but may not be accurate since number of people in a household is unknown and the time it requires for completing each measure may be off. But on average, it may marginally off	Likely	Marginal	Medium	Possible	Marginal	Low	Triangular	N/A -Not Modeled		Stakeholder	Project Cost	More coordination and well development of nonstructural plans.
Regulatory Environmental Risks (RG)															
RG2	Work windows	TOY restrictions generally low risk	Possible TOY restrictions imposed based on T&E species presence in the Action Area. Biological assessment is being worked on but not completed. This is primarily a schedule risk and is considered low. Not many trees will be cleared.	Unlikely	Moderate	Low	Possible	Marginal	Low	N/A -Not Modeled	N/A -Not Modeled		Environmental Compliance	N/A -Not Modeled	Work with agencies to determine if any TOY restrictions will be needed.
RG3	Contaminated soils	There is some potential to encounter contaminated soils	The airport may have some issues with contaminated soils. But the airport may mitigate this risk themselves. Contamination is mostly inside buildings.	Possible	Marginal	Low	Possible	Marginal	Low	N/A -Not Modeled	Triangular		Stakeholder	N/A -Not Modeled	
RG5	Abandoned heating oil tanks	Most likely the older homes being bought out may have old heating oil tanks	No data indicates abandoned tanks in residential areas.	Unlikely	Negligible	Low	Unlikely	Negligible	Low	N/A -Not Modeled	N/A -Not Modeled		Stakeholder	N/A -Not Modeled	
Construction Risks (CO)															
CO1	Laydown Areas	Adequate lay down/staging areas may be difficult to find	Only Belle Haven may have some challenge finding a location for staging areas. Since this is the only location that have this concern, it may have marginal impact. Real estate does not have any concerns with easement.	Possible	Marginal	Low	Possible	Negligible	Low	Triangular	N/A -Not Modeled		Construction	N/A -Not Modeled	

				Project Cost			Project Schedule			Other Informatio					
CREF	Risk/Opportunity Event	Risk Event Description	PDT Discussions on Impact and Likelihood	Likelihood	Impact	Risk Level	Likelihood (S)	Impact (S)	Risk Level (S)	Cost Variance Distribution	Schedule Variance Distribution	Correlation to Other(s)	Responsibility/ POC	Affected Project Component	Suggested Risk Reduction Measures
CO2	Vibration/seismic/noise monitoring	Only the floodwalls in Belle Haven is near existing buildings/properties.	No pile driving is included in design. Therefore, no vibration monitoring is needed. There may be some concern of construction noise complaints in Belle Haven only. Alternate shift may need to be considered in Belle Haven estimate but it may have marginal cost impact. Construction schedule impact should also be marginal.	Possible	Marginal	Low	Possible	Negligible	Low	N/A -Not Modeled	N/A -Not Modeled		Technical Lead	N/A -Not Modeled	
CO3	Traffic Control	Traffic control may be an issue in Belle Haven only.	Especially in urban/downtown areas traffic controls could cause issues with construction. Traffic control cost is in the estimate and considered to be conservative.	Likely	Negligible	Low	Likely	Negligible	Low	N/A -Not Modeled	N/A -Not Modeled		Cost Engineering	N/A -Not Modeled	
Estimate and Schedule Risks (ES)															
ES4	Estimating assumptions	Reliability and number of key quotes and assumptions related to prime and subcontractor markups/assignments	• Historical construction material costs are escalated. • Prime and subcontractor markups/assignments is unknown and the estimate includes most work as prime's work which seems in line with local contractor's quotes. However, government contract acquisition later on may make the Prime to sub out all works.	Likely	Significant	High	Possible	Negligible	Low	N/A -Not Modeled	N/A -Not Modeled		Technical Lead	N/A -Not Modeled	Research on more recent costs even if it was done by local sponsors. Get better understanding of contract actions by local sponsors to adjust historical costs in the estimate if contract is to be with the Corps.
ES4	Estimated cost for Cultural Resource Preservation	Assumption of 1% of construction cost may not be enough for cultural preservation	No historical cost or data is available to base on. However judging by the dollar amount, it seems adequate for residential areas	Possible	Marginal	Low	Possible	Negligible	Low	N/A -Not Modeled	N/A -Not Modeled		Technical Lead	N/A -Not Modeled	
ES4	Site Restoration	Site restoration costs in estimate can vary due to the range of areas covered and urban area.	There could be variations in the cost of the site restoration after construction is complete.	Possible	Marginal	Low	Possible	Negligible	Low	N/A -Not Modeled	N/A -Not Modeled		Technical Lead	N/A -Not Modeled	
External Risks (EX)															
EX1	Market/Bidding conditions	Typical various due to local market and bidding conditions	Limited competition may increase construction cost.	Likely	Moderate	Medium	Unlikely	Negligible	Low	Triangular	N/A -Not Modeled		Project Manager	Project cost	Perform market surveys.
EX2	Timing of Funding	Project may be delayed due to funding delay.	Past experience on large civil projects shows that authorization of funding to initiate the start of the design of the project is likely not the time the PDT anticipated. This risk concerns mostly the project schedule.	Possible	Marginal	Low	Very Likely	Critical	High	N/A -Not Modeled	Triangular		Programs	Project Schedule	Regular communication with vertical team regarding the status of project may provide insight into accurate planning and scheduling.
EX3	Storm events or harsh weather during construction	Significant storm or harsh weather during construction can cause delays and mods and claims	Typical risk of storms for the area - There may be a need for restrictions on the amount of teardown of exiting floodwall. Project schedule should include typical weather productivity effects. However in a severe storm event, additional costs can come from standby time, EDC, cleanup effort, and Corps S&A. In addition, ADA requirement may be a possible claim.	Likely	Significant	High	Likely	Marginal	Medium	Triangular	Single Event (2 Step)		Cost Engineering	Project Cost	Perform market surveys.
EX4	Escalation of key materials	Key materials could increase price	Concrete, steel are major cost items and the price could vary based on world market conditions. Other projects in the nearby areas may cause more limitation in availability of resources.	Likely	Significant	High	Possible	Marginal	Low	Triangular	N/A -Not Modeled		Cost Engineering	Project cost	Perform market surveys.

Total Project Cost Summary
for Final Array of Structural Alternatives

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

PROJECT: **NoVA DC Coastal Storm Risk Management Structural Plan for Final Array**
PROJECT NO: P2 497631
LOCATION: DC and VA

DISTRICT: **NAB District** **PREPARED:** **3/15/2022**
POC: **CHIEF, Estimating and Specs Section, Parris J. McGhee-Bey**

This Estimate reflects the scope and schedule in report; METRO WASHINGTON, DC COASTAL STORM RISK MANAGEMENT FEASIBILITY STUDY

Program Year (Budget EC): 2023
Effective Price Level Date: 1 OCT 22

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)						TOTAL PROJECT COST (FULLY FUNDED)			
WBS NUMBER *A*	Civil Works Feature & Sub-Feature Description *B*	COST ($K) *C*	CNTG ($K) *D*	CNTG (%) *E*	TOTAL ($K) *F*	ESC (%) *G*	COST ($K) *H*	CNTG ($K) *I*	**TOTAL ($K)** *J*	Spent Thru: **1-Oct-21** ($K)	**TOTAL FIRST COST** ($K) *K*	INFLATED (%) *L*	COST ($K) *M*	CNTG ($K) *N*	FULL ($K) *O*
02	RELOCATIONS	$14,412	$6,485	45.0%	$20,898	3.2%	$14,869	$6,691	$21,560	$0	$21,560	8.8%	$16,185	$7,283	$23,468
11	LEVEES & FLOODWALLS	$15,488	$6,970	45.0%	$22,458	3.2%	$15,980	$7,191	$23,171	$0	$23,171	30.9%	$20,912	$9,411	$30,323
13	PUMPING PLANT	$23,719	$10,673	45.0%	$34,392	3.2%	$24,471	$11,012	$35,483	$1	$35,484	26.5%	$30,956	$13,930	$44,888
15	FLOODWAY CONTROL & DIVERSION STRU	$103,180	$46,431	45.0%	$149,611	3.2%	$106,453	$47,904	$154,357	$2	$154,359	1.4%	$107,951	$48,578	$156,531
18	CULTURAL RESOURCE PRESERVATION	$2,182	$982	45.0%	$3,164	3.2%	$2,251	$1,013	$3,264	$3	$3,267	9.6%	$2,466	$1,110	$3,579
	CONSTRUCTION ESTIMATE TOTALS:	$158,981	$71,542		$230,523	3.2%	$164,024	$73,811	$237,835	$6	$237,841	8.8%	$178,471	$80,312	$258,789
01	LANDS AND DAMAGES	$4,691	$1,407	30.0%	$6,099	3.2%	$4,840	$1,452	$6,292	$0	$6,292	5.0%	$5,083	$1,525	$6,607
30	PLANNING, ENGINEERING & DESIGN	$44,197	$19,889	45.0%	$64,085	2.5%	$45,302	$20,386	$65,688	$0	$65,688	2.6%	$46,472	$20,912	$67,384
31	CONSTRUCTION MANAGEMENT	$15,898	$7,154	45.0%	$23,052	2.5%	$16,296	$7,333	$23,629	$0	$23,629	9.9%	$17,904	$8,057	$25,961
	PROJECT COST TOTALS:	$223,768	$99,992	44.7%	$323,759		$230,462	$102,982	**$333,443**	$6	**$333,449**	7.6%	$247,929	$110,806	$358,741

ESTIMATED TOTAL PROJECT COST: **$358,741**

CHIEF, Estimating and Specs Section, Parris J. McGhee-Bey

PROJECT MANAGER, Katherine Perkins

CHIEF, REAL ESTATE, Benjamin Rooney

CHIEF, PLANNING, Amy M. Guise

CHIEF, ENGINEERING, Mary P. Foutz

CHIEF, OPERATIONS, Patrick G. Findlay

CHIEF, CONSTRUCTION, Jeff J. Werner

CHIEF, CONTRACTING, Paula M. Beck

CHIEF, PP-C, Justin Callahan

CHIEF, DPM, David B. Morrow

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

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

PROJECT: NoVA DC Coastal Storm Risk Management Structural Plan
LOCATION: DC and VA
This Estimate reflects the scope and schedule in report; METRO WASHINGTON, DC COASTAL STORM RISK MANAGEMENT FEASIBILITY STUDY

DISTRICT: NAB District
POC: CHIEF, Estimating and Specs Section, Parris J. McGhee-Bey
PREPARED: 3/15/2022

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: 15-Mar-22 Effective Price Level: 1-Oct-21				Program Year (Budget EC): 2023 Effective Price Level Date: 1 OCT 22								
				RISK BASED										
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	Alt 4b Reagan Airport													
02	RELOCATIONS	$3,940	$1,773	45.0%	$5,713	3.2%	$4,065	$1,829	$5,894	2032Q3	33.7%	$5,434	$2,445	$7,880
11	LEVEES & FLOODWALLS	$7,630	$3,433	45.0%	$11,063	3.2%	$7,872	$3,542	$11,414	2032Q3	33.7%	$10,523	$4,736	$15,259
15	FLOODWAY CONTROL & DIVERSION STRU	$31,739	$14,283	45.0%	$46,021	3.2%	$32,746	$14,736	$47,481	2032Q3	33.7%	$43,776	$19,699	$63,476
18	CULTURAL RESOURCE PRESERVATION		$0	45.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:	$43,309	$19,489	45.0%	**$62,798**		$44,682	$20,107	$64,790			$59,734	$26,880	$86,615
01	LANDS AND DAMAGES		$0	30.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
2.5%	Project Management	$1,083	$487	45.0%	$1,570	2.5%	$1,110	$499	$1,609	2026Q1	7.7%	$1,195	$538	$1,733
2.0%	Planning & Environmental Compliance	$866	$390	45.0%	$1,256	2.5%	$888	$400	$1,287	2026Q1	7.7%	$956	$430	$1,386
15.5%	Engineering & Design	$6,713	$3,021	45.0%	$9,734	2.5%	$6,881	$3,096	$9,977	2026Q1	7.7%	$7,410	$3,334	$10,744
1.3%	Reviews, ATRs, IEPRs, VE	$541	$244	45.0%	$785	2.5%	$555	$250	$805	2026Q1	7.7%	$598	$269	$866
1.3%	Life Cycle Updates (cost, schedule, risks)	$563	$253	45.0%	$816	2.5%	$577	$260	$837	2026Q1	7.7%	$621	$280	$901
0.8%	Contracting & Reprographics	$325	$146	45.0%	$471	2.5%	$333	$150	$483	2026Q1	7.7%	$359	$161	$520
3.0%	Engineering During Construction	$1,299	$585	45.0%	$1,884	2.5%	$1,332	$599	$1,931	2032Q3	27.1%	$1,693	$762	$2,455
0.5%	Planning During Construction	$217	$97	45.0%	$314	2.5%	$222	$100	$322	2032Q3	27.1%	$282	$127	$409
1.0%	Adaptive Management & Monitoring	$433	$195	45.0%	$628	2.5%	$444	$200	$644	2032Q3	27.1%	$564	$254	$818
0.0%	Project Operations	$0	$0	45.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
7.5%	Construction Management	$3,248	$1,462	45.0%	$4,710	2.5%	$3,329	$1,498	$4,828	2032Q3	27.1%	$4,232	$1,905	$6,137
0.0%	Project Operation:	$0	$0	45.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
2.5%	Project Management	$1,083	$487	45.0%	$1,570	2.5%	$1,110	$499	$1,609	2032Q3	27.1%	$1,411	$635	$2,046
	CONTRACT COST TOTALS:	$59,679	$26,856		$86,535		$61,462	$27,658	**89,120**			$79,055	$35,575	**$114,630**

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

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

PROJECT: NoVA DC Coastal Storm Risk Management Structural Plan
LOCATION: DC and VA
This Estimate reflects the scope and schedule in report; METRO WASHINGTON, DC COASTAL STORM RISK MANAGEMENT FEASIBILITY STUDY

DISTRICT: NAB District
POC: CHIEF, Estimating and Specs Section, Parris J. McGhee-Bey
PREPARED: 3/15/2022

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared:			15-Mar-22	Program Year (Budget EC):			2023					
		Effective Price Level:			1-Oct-21	Effective Price Level Date:			1 OCT 22					
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	Alt 4c Four Mile Run WPCP													
02	RELOCATIONS	$200	$90	45.0%	$290	3.2%	$206	$93	$299	2027Q3	14.8%	$237	$107	$343
11	LEVEES & FLOODWALLS	$469	$211	45.0%	$681	3.2%	$484	$218	$702	2027Q3	14.8%	$556	$250	$806
15	FLOODWAY CONTROL & DIVERSION STRU	$245	$110	45.0%	$355	3.2%	$253	$114	$367	2027Q3	14.8%	$290	$131	$421
18	CULTURAL RESOURCE PRESERVATION		$0	45.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:	$914	$411	45.0%	**$1,326**		$943	$425	$1,368			$1,083	$487	$1,570
01	LANDS AND DAMAGES	$615	$184	30.0%	$799	3.2%	$634	$190	$825	2026Q1	9.6%	$695	$209	$904
30	PLANNING, ENGINEERING & DESIGN													
2.5%	Project Management	$23	$10	45.0%	$33	2.5%	$23	$11	$34	2026Q1	7.7%	$25	$11	$37
2.0%	Planning & Environmental Compliance	$18	$8	45.0%	$27	2.5%	$19	$8	$27	2026Q1	7.7%	$20	$9	$29
15.5%	Engineering & Design	$142	$64	45.0%	$206	2.5%	$145	$65	$211	2026Q1	7.7%	$156	$70	$227
1.3%	Reviews, ATRs, IEPRs, VE	$11	$5	45.0%	$17	2.5%	$12	$5	$17	2026Q1	7.7%	$13	$6	$18
1.3%	Life Cycle Updates (cost, schedule, risks)	$12	$5	45.0%	$17	2.5%	$12	$5	$18	2026Q1	7.7%	$13	$6	$19
0.8%	Contracting & Reprographics	$7	$3	45.0%	$10	2.5%	$7	$3	$10	2026Q1	7.7%	$8	$3	$11
3.0%	Engineering During Construction	$27	$12	45.0%	$40	2.5%	$28	$13	$41	2027Q3	11.8%	$31	$14	$46
0.5%	Planning During Construction	$5	$2	45.0%	$7	2.5%	$5	$2	$7	2027Q3	11.8%	$5	$2	$8
1.0%	Adaptive Management & Monitoring	$9	$4	45.0%	$13	2.5%	$9	$4	$14	2027Q3	11.8%	$10	$5	$15
0.0%	Project Operations	$0	$0	45.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
7.5%	Construction Management	$69	$31	45.0%	$99	2.5%	$70	$32	$102	2027Q3	11.8%	$79	$35	$114
0.0%	Project Operation:	$0	$0	45.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
2.5%	Project Management	$23	$10	45.0%	$33	2.5%	$23	$11	$34	2027Q3	11.8%	$26	$12	$38
	CONTRACT COST TOTALS:	$1,875	$751		$2,626		$1,932	$774	**$2,706**			$2,165	$870	**$3,035**

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

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

PROJECT: NoVA DC Coastal Storm Risk Management Structural Plan
LOCATION: DC and VA
This Estimate reflects the scope and schedule in report; METRO WASHINGTON, DC COASTAL STORM RISK MANAGEMENT FEASIBILITY STUDY

DISTRICT: NAB District
POC: CHIEF, Estimating and Specs Section, Parris J. McGhee-Bey
PREPARED: 3/15/2022

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared:			15-Mar-22	Program Year (Budget EC):			2023					
		Effective Price Level:			1-Oct-21	Effective Price Level Date:			1 OCT 22					
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	Alt 5a Four Mile Run Alexandria													
02	RELOCATIONS	$1,300	$585	45.0%	$1,885	3.2%	$1,341	$604	$1,945	2029Q3	22.0%	$1,636	$736	$2,372
11	LEVEES & FLOODWALLS	$1,434	$645	45.0%	$2,079	3.2%	$1,480	$666	$2,145	2029Q3	22.0%	$1,805	$812	$2,617
13	PUMPING PLANT	$11,383	$5,122	45.0%	$16,506	3.2%	$11,744	$5,285	$17,029	2029Q3	22.0%	$14,326	$6,447	$20,773
15	FLOODWAY CONTROL & DIVERSION STRU	$186	$84	45.0%	$270	3.2%	$192	$86	$279	2029Q3	22.0%	$234	$106	$340
18	CULTURAL RESOURCE PRESERVATION	$1,030	$464	45.0%	$1,494	3.2%	$1,063	$478	$1,541	2029Q3	22.0%	$1,297	$584	$1,880
	CONSTRUCTION ESTIMATE TOTALS:	$15,334	$6,900	45.0%	**$22,234**		$15,820	$7,119	$22,940			$19,299	$8,684	$27,983
01	LANDS AND DAMAGES	$2,420	$726	30.0%	$3,146	3.2%	$2,496	$749	$3,245	2026Q1	9.6%	$2,736	$821	$3,557
30	PLANNING, ENGINEERING & DESIGN													
2.5%	Project Management	$383	$173	45.0%	$556	2.5%	$393	$177	$570	2026Q1	7.7%	$423	$190	$614
2.0%	Planning & Environmental Compliance	$307	$138	45.0%	$445	2.5%	$314	$141	$456	2026Q1	7.7%	$339	$152	$491
15.5%	Engineering & Design	$2,377	$1,070	45.0%	$3,446	2.5%	$2,436	$1,096	$3,532	2026Q1	7.7%	$2,624	$1,181	$3,804
1.3%	Reviews, ATRs, IEPRs, VE	$192	$86	45.0%	$278	2.5%	$196	$88	$285	2026Q1	7.7%	$212	$95	$307
1.3%	Life Cycle Updates (cost, schedule, risks)	$199	$90	45.0%	$289	2.5%	$204	$92	$296	2026Q1	7.7%	$220	$99	$319
0.8%	Contracting & Reprographics	$115	$52	45.0%	$167	2.5%	$118	$53	$171	2026Q1	7.7%	$127	$57	$184
3.0%	Engineering During Construction	$460	$207	45.0%	$667	2.5%	$472	$212	$684	2029Q3	17.6%	$554	$249	$804
0.5%	Planning During Construction	$77	$35	45.0%	$111	2.5%	$79	$35	$114	2029Q3	17.6%	$92	$42	$134
1.0%	Adaptive Management & Monitoring	$153	$69	45.0%	$222	2.5%	$157	$71	$228	2029Q3	17.6%	$185	$83	$268
0.0%	Project Operations	$0	$0	45.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
7.5%	Construction Management	$1,150	$518	45.0%	$1,668	2.5%	$1,179	$530	$1,709	2029Q3	17.6%	$1,386	$624	$2,009
0.0%	Project Operation:	$0	$0	45.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
2.5%	Project Management	$383	$173	45.0%	$556	2.5%	$393	$177	$570	2029Q3	17.6%	$462	$208	$670
	CONTRACT COST TOTALS:	$23,550	$10,234		**$33,784**		$24,258	$10,542	**$34,799**			$28,657	$12,485	**$41,143**

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

**** CONTRACT COST SUMMARY ****

PROJECT: NoVA DC Coastal Storm Risk Management Structural Plan
LOCATION: DC and VA
DISTRICT: NAB District
POC: CHIEF, Estimating and Specs Section, Parris J. McGhee-Bey
PREPARED: 3/15/2022
This Estimate reflects the scope and schedule in report; METRO WASHINGTON, DC COASTAL STORM RISK MANAGEMENT FEASIBILITY STUDY

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared:			15-Mar-22	Program Year (Budget EC):			2023					
		Effective Price Level:			1-Oct-21	Effective Price Level Date:			1 OCT 22	FULLY FUNDED PROJECT ESTIMATE				
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	Alt 5c Belle Haven													
02	RELOCATIONS	$2,140	$963	45.0%	$3,103	3.2%	$2,208	$994	$3,201	2031Q4	30.7%	$2,885	$1,298	$4,183
11	LEVEES & FLOODWALLS	$5,955	$2,680	45.0%	$8,635	3.2%	$6,144	$2,765	$8,909	2031Q4	30.7%	$8,028	$3,613	$11,641
13	PUMPING PLANT	$12,336	$5,551	45.0%	$17,887	3.2%	$12,727	$5,727	$18,454	2031Q4	30.7%	$16,630	$7,483	$24,113
15	FLOODWAY CONTROL & DIVERSION STRU	$2,689	$1,210	45.0%	$3,899	3.2%	$2,774	$1,248	$4,023	2031Q4	30.7%	$3,625	$1,631	$5,257
18	CULTURAL RESOURCE PRESERVATION	$400	$180	45.0%	$580	3.2%	$413	$186	$598	2031Q4	30.7%	$539	$243	$782
	CONSTRUCTION ESTIMATE TOTALS:	$23,520	$10,584	45.0%	**$34,104**		$24,266	$10,920	$35,186			$31,708	$14,268	$45,976
01	LANDS AND DAMAGES	$898	$269	30.0%	$1,167	3.2%	$926	$278	$1,204	2026Q1	9.6%	$1,015	$304	$1,319
30	PLANNING, ENGINEERING & DESIGN													
2.5%	Project Management	$588	$265	45.0%	$853	2.5%	$603	$271	$874	2026Q1	7.7%	$649	$292	$941
2.0%	Planning & Environmental Compliance	$470	$212	45.0%	$682	2.5%	$482	$217	$699	2026Q1	7.7%	$519	$234	$753
15.5%	Engineering & Design	$3,646	$1,641	45.0%	$5,286	2.5%	$3,737	$1,682	$5,418	2026Q1	7.7%	$4,024	$1,811	$5,835
1.3%	Reviews, ATRs, IEPRs, VE	$294	$132	45.0%	$426	2.5%	$301	$136	$437	2026Q1	7.7%	$325	$146	$471
1.3%	Life Cycle Updates (cost, schedule, risks)	$306	$138	45.0%	$443	2.5%	$313	$141	$454	2026Q1	7.7%	$338	$152	$489
0.8%	Contracting & Reprographics	$176	$79	45.0%	$256	2.5%	$181	$81	$262	2026Q1	7.7%	$195	$88	$282
3.0%	Engineering During Construction	$706	$318	45.0%	$1,023	2.5%	$723	$325	$1,049	2031Q4	24.6%	$901	$406	$1,307
0.5%	Planning During Construction	$118	$53	45.0%	$171	2.5%	$121	$54	$175	2031Q4	24.6%	$150	$68	$218
1.0%	Adaptive Management & Monitoring	$235	$106	45.0%	$341	2.5%	$241	$108	$350	2031Q4	24.6%	$300	$135	$436
0.0%	Project Operations	$0	$0	45.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
7.5%	Construction Management	$1,764	$794	45.0%	$2,558	2.5%	$1,808	$814	$2,622	2031Q4	24.6%	$2,253	$1,014	$3,267
0.0%	Project Operation:	$0	$0	45.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
2.5%	Project Management	$588	$265	45.0%	$853	2.5%	$603	$271	$874	2031Q4	24.6%	$751	$338	$1,089
	CONTRACT COST TOTALS:	$33,308	$14,854		**$48,162**		$34,305	$15,298	**$49,603**			$43,128	$19,255	**$62,383**

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

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

PROJECT: NoVA DC Coastal Storm Risk Management Structural Plan
LOCATION: DC and VA
This Estimate reflects the scope and schedule in report; METRO WASHINGTON, DC COASTAL STORM RISK MANAGEMENT FEASIBILITY STUDY

DISTRICT: NAB District
POC: CHIEF, Estimating and Specs Section, Parris J. McGhee-Bey

PREPARED: 3/15/2022

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared:			15-Mar-22	Program Year (Budget EC):			2023					
		Effective Price Level:			1-Oct-21	Effective Price Level Date:			1 OCT 22	FULLY FUNDED PROJECT ESTIMATE				
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	Alt 5b1 Old Town Alexandria - Hydraulically Operated Flood Barriers													
02	RELOCATIONS	$6,832	$3,074	45.0%	$9,907	3.2%	$7,049	$3,172	$10,221	2020Q2	-15.0%	$5,993	$2,697	$8,689
15	FLOODWAY CONTROL & DIVERSION STRU	$68,321	$30,744	45.0%	$99,065	3.2%	$70,488	$31,720	$102,208	2020Q2	-14.8%	$60,025	$27,011	$87,036
18	CULTURAL RESOURCE PRESERVATION	$752	$338	45.0%	$1,090	3.2%	$775	$349	$1,124	2020Q2	-18.7%	$630	$284	$914
	CONSTRUCTION ESTIMATE TOTALS:	$75,904	$34,157	45.0%	**$110,061**		$78,312	$35,240	$113,553			$66,648	$29,991	$96,639
01	LANDS AND DAMAGES	$759	$228	30.0%	$987	3.2%	$783	$235	$1,018	2018Q1	-18.7%	$637	$191	$828
30	PLANNING, ENGINEERING & DESIGN													
2.5%	Project Management	$1,898	$854	45.0%	$2,752	2.5%	$1,945	$875	$2,820	2018Q2	-6.1%	$1,826	$822	$2,648
2.0%	Planning & Environmental Compliance	$1,518	$683	45.0%	$2,201	2.5%	$1,556	$700	$2,256	2018Q2	-6.1%	$1,461	$657	$2,118
15.5%	Engineering & Design	$11,765	$5,294	45.0%	$17,060	2.5%	$12,059	$5,427	$17,486	2018Q2	-6.1%	$11,322	$5,095	$16,417
1.3%	Reviews, ATRs, IEPRs, VE	$949	$427	45.0%	$1,376	2.5%	$973	$438	$1,410	2018Q2	-6.1%	$913	$411	$1,324
1.3%	Life Cycle Updates (cost, schedule, risks)	$987	$444	45.0%	$1,431	2.5%	$1,011	$455	$1,467	2018Q2	-6.1%	$950	$427	$1,377
0.8%	Contracting & Reprographics	$569	$256	45.0%	$825	2.5%	$584	$263	$846	2018Q2	-6.1%	$548	$247	$794
3.0%	Engineering During Construction	$2,277	$1,025	45.0%	$3,302	2.5%	$2,334	$1,050	$3,384	2020Q2	-6.1%	$2,191	$986	$3,178
0.5%	Planning During Construction	$380	$171	45.0%	$550	2.5%	$389	$175	$564	2020Q2	-6.1%	$365	$164	$530
1.0%	Adaptive Management & Monitoring	$759	$342	45.0%	$1,101	2.5%	$778	$350	$1,128	2022Q1	-2.4%	$759	$342	$1,101
0.0%	Project Operations	$0	$0	45.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
7.5%	Construction Management	$5,693	$2,562	45.0%	$8,255	2.5%	$5,835	$2,626	$8,461	2020Q2	-6.1%	$5,478	$2,465	$7,944
0.0%	Project Operation:	$0	$0	45.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
2.5%	Project Management	$1,898	$854	45.0%	$2,752	2.5%	$1,945	$875	$2,820	2020Q2	-6.1%	$1,826	$822	$2,648
	CONTRACT COST TOTALS:	$105,355	$47,296		**$152,651**		$108,504	$48,710	**$157,214**			$94,925	$42,621	**$137,545**

Total Project Cost Summary
for Final Array of Nonstructural Alternatives

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

PROJECT: **NoVA DC Coastal Storm Risk Management Nonstructural 100 Years**
PROJECT NO: P2 497631
LOCATION: DC and VA

DISTRICT: **NAB District** **PREPARED:** **2/6/2022**
POC: **CHIEF, Estimating and Specs Section, Parris J. McGhee-Bey**

This Estimate reflects the scope and schedule in report; FS Report (underway)

Program Year (Budget EC): 2023
Effective Price Level Date: 1 OCT 22

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)						TOTAL PROJECT COST (FULLY FUNDED)			
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-21** ($K)	**TOTAL FIRST COST** ($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	$115,994	$39,438	34.0%	$155,432	3.2%	$119,673	$40,689	$160,362	$0	$160,362	18.3%	$141,595	$48,142	$189,738
18	CULTURAL RESOURCE PRESERVATION	$1,160	$394	34.0%	$1,554	3.2%	$1,197	$407	$1,604	$0	$1,604	18.3%	$1,416	$481	$1,897
	CONSTRUCTION ESTIMATE TOTALS:	$117,154	$39,832		$156,986	3.2%	$120,870	$41,096	$161,966	$0	$161,966	18.3%	$143,011	$48,624	$191,635
01	LANDS AND DAMAGES	$1,160	$348	30.0%	$1,508	3.2%	$1,197	$359	$1,556	$0	$1,556	10.5%	$1,322	$397	$1,718
30	PLANNING, ENGINEERING & DESIGN	$17,866	$6,074	34.0%	$23,940	2.5%	$18,313	$6,226	$24,539	$0	$24,539	9.0%	$19,954	$6,784	$26,738
31	CONSTRUCTION MANAGEMENT	$11,130	$3,784	34.0%	$14,914	2.5%	$11,408	$3,879	$15,287	$0	$15,287	14.6%	$13,071	$4,444	$17,515
	PROJECT COST TOTALS:	$147,309	$50,039	34.0%	$197,348		$151,787	$51,560	**$203,347**	$0	**$203,347**	16.8%	$177,357	$60,249	$237,606

ESTIMATED TOTAL PROJECT COST: **$237,606**

_____ **CHIEF, Estimating and Specs Section, Parris J. McGhee-Bey**

_____ **PROJECT MANAGER, Katherine Perkins**

_____ **CHIEF, REAL ESTATE, Benjamin Rooney**

_____ **CHIEF, PLANNING, Amy M. Guise**

_____ **CHIEF, ENGINEERING, Mary P. Foutz**

_____ **CHIEF, OPERATIONS, Patrick G. Findlay**

_____ **CHIEF, CONSTRUCTION, Jeff J. Werner**

_____ **CHIEF, CONTRACTING, Paula M. Beck**

_____ **CHIEF, PP-C, Justin Callahan**

_____ **CHIEF, DPM, David B. Morrow**

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

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

PROJECT: NoVA DC Coastal Storm Risk Management Nonstructural 100 Years
LOCATION: DC and VA
This Estimate reflects the scope and schedule in report; FS Report (underway)

DISTRICT: NAB District PREPARED: 2/6/2022
POC: CHIEF, Estimating and Specs Section, Parris J. McGhee-Bey

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: 6-Feb-22 Effective Price Level: 1-Oct-21				Program Year (Budget EC): 2023 Effective Price Level Date: 1 OCT 22								
				RISK BASED										
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	100 Years Protection													
19	BUILDINGS, GROUNDS & UTILITIES	$115,994	$39,438	34.0%	$155,432	3.2%	$119,673	$40,689	$160,362	2028Q3	18.3%	$141,595	$48,142	$189,738
18	CULTURAL RESOURCE PRESERVATION	$1,160	$394	34.0%	$1,554	3.2%	$1,197	$407	$1,604	2028Q3	18.3%	$1,416	$481	$1,897
	CONSTRUCTION ESTIMATE TOTALS:	$117,154	$39,832	34.0%	**$156,986**		$120,870	$41,096	$161,966			$143,011	$48,624	$191,635
01	LANDS AND DAMAGES	$1,160	$348	30.0%	$1,508	3.2%	$1,197	$359	$1,556	2026Q2	10.5%	$1,322	$397	$1,718
30	PLANNING, ENGINEERING & DESIGN													
2.5%	Project Management	$2,929	$996	34.0%	$3,925	2.5%	$3,002	$1,021	$4,023	2026Q2	8.3%	$3,253	$1,106	$4,359
1.0%	Planning & Environmental Compliance	$1,172	$398	34.0%	$1,570	2.5%	$1,201	$408	$1,609	2026Q2	8.3%	$1,301	$442	$1,743
8.0%	Engineering & Design	$9,372	$3,187	34.0%	$12,559	2.5%	$9,607	$3,266	$12,873	2026Q2	8.3%	$10,409	$3,539	$13,948
1.3%	Reviews, ATRs, IEPRs, VE	$1,464	$498	34.0%	$1,962	2.5%	$1,501	$510	$2,011	2026Q2	8.3%	$1,626	$553	$2,179
1.0%	Life Cycle Updates (cost, schedule, risks)	$1,172	$398	34.0%	$1,570	2.5%	$1,201	$408	$1,609	2026Q2	8.3%	$1,301	$442	$1,743
0.0%	Contracting & Reprographics	$0	$0	34.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
1.0%	Engineering During Construction	$1,172	$398	34.0%	$1,570	2.5%	$1,201	$408	$1,609	2028Q3	14.6%	$1,376	$468	$1,844
0.5%	Planning During Construction	$586	$199	34.0%	$785	2.5%	$600	$204	$805	2028Q3	14.6%	$688	$234	$922
0.0%	Adaptive Management & Monitoring	$0	$0	34.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
0.0%	Project Operations	$0	$0	34.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
7.5%	Construction Management	$8,787	$2,987	34.0%	$11,774	2.5%	$9,006	$3,062	$12,068	2028Q3	14.6%	$10,319	$3,508	$13,827
0.0%	Project Operation:	$0	$0	34.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
2.0%	Project Management	$2,343	$797	34.0%	$3,140	2.5%	$2,402	$817	$3,218	2028Q3	14.6%	$2,752	$936	$3,687
	CONTRACT COST TOTALS:	$147,309	$50,039		$197,348		$151,787	$51,560	**203,347**			$177,357	$60,249	**$237,606**

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

PROJECT: **NoVA DC Coastal Storm Risk Management Nonstructural 50 Years**
PROJECT NO: P2 497631
LOCATION: DC and VA

DISTRICT: **NAB District** **PREPARED:** **2/6/2022**
POC: **CHIEF, Estimating and Specs Section, Parris J. McGhee-Bey**

This Estimate reflects the scope and schedule in report; FS Report (underway)

Program Year (Budget EC): 2023
Effective Price Level Date: 1 OCT 22

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)						TOTAL PROJECT COST (FULLY FUNDED)			
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-21** ($K)	**TOTAL FIRST COST** ($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	$104,100	$35,394	34.0%	$139,494	3.2%	$107,402	$36,517	$143,919	$0	$143,919	17.4%	$126,095	$42,872	$168,967
18	CULTURAL RESOURCE PRESERVATION	$1,041	$354	34.0%	$1,395	3.2%	$1,074	$365	$1,439	$0	$1,439	17.4%	$1,261	$429	$1,690
	CONSTRUCTION ESTIMATE TOTALS:	$105,141	$35,748		$140,889	3.2%	$108,476	$36,882	$145,358	$0	$145,358	17.4%	$127,356	$43,301	$170,657
01	LANDS AND DAMAGES	$1,041	$312	30.0%	$1,353	3.2%	$1,074	$322	$1,396	$0	$1,396	10.5%	$1,186	$356	$1,542
30	PLANNING, ENGINEERING & DESIGN	$16,034	$5,452	34.0%	$21,486	2.5%	$16,435	$5,588	$22,023	$0	$22,023	8.9%	$17,896	$6,085	$23,980
31	CONSTRUCTION MANAGEMENT	$9,988	$3,396	34.0%	$13,384	2.5%	$10,238	$3,481	$13,719	$0	$13,719	13.8%	$11,655	$3,963	$15,617
	PROJECT COST TOTALS:	$132,204	$44,908	34.0%	$177,112		$136,223	$46,273	**$182,496**	$0	**$182,496**	16.1%	$158,093	$53,704	$211,797

ESTIMATED TOTAL PROJECT COST: **$211,797**

_____ **CHIEF, Estimating and Specs Section, Parris J. McGhee-Bey**

_____ **PROJECT MANAGER, Katherine Perkins**

_____ **CHIEF, REAL ESTATE, Susan K. Lev**

_____ **CHIEF, PLANNING, Amy M. Guise**

_____ **CHIEF, ENGINEERING, Mary P. Foutz**

_____ **CHIEF, OPERATIONS, Patrick G. Findlay**

_____ **CHIEF, CONSTRUCTION, Jeff J. Werner**

_____ **CHIEF, CONTRACTING, Paula M. Beck**

_____ **CHIEF, PP-C, Justin Callahan**

_____ **CHIEF, DPM, David B. Morrow**

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

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

PROJECT: NoVA DC Coastal Storm Risk Management Nonstructural 50 Years
LOCATION: DC and VA
This Estimate reflects the scope and schedule in report; FS Report (underway)

DISTRICT: NAB District PREPARED: 2/6/2022
POC: CHIEF, Estimating and Specs Section, Parris J. McGhee-Bey

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: 6-Feb-22 Effective Price Level: 1-Oct-21				Program Year (Budget EC): 2023 Effective Price Level Date: 1 OCT 22								
				RISK BASED										
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	50 Years Protection													
19	BUILDINGS, GROUNDS & UTILITIES	$104,100	$35,394	34.0%	$139,494	3.2%	$107,402	$36,517	$143,919	2028Q2	17.4%	$126,095	$42,872	$168,967
18	CULTURAL RESOURCE PRESERVATION	$1,041	$354	34.0%	$1,395	3.2%	$1,074	$365	$1,439	2028Q2	17.4%	$1,261	$429	$1,690
	CONSTRUCTION ESTIMATE TOTALS:	$105,141	$35,748	34.0%	**$140,889**		$108,476	$36,882	$145,358			$127,356	$43,301	$170,657
01	LANDS AND DAMAGES	$1,041	$312	30.0%	$1,353	3.2%	$1,074	$322	$1,396	2026Q2	10.5%	$1,186	$356	$1,542
30	PLANNING, ENGINEERING & DESIGN													
2.5%	Project Management	$2,629	$894	34.0%	$3,522	2.5%	$2,694	$916	$3,610	2026Q2	8.3%	$2,919	$993	$3,912
1.0%	Planning & Environmental Compliance	$1,051	$357	34.0%	$1,409	2.5%	$1,078	$366	$1,444	2026Q2	8.3%	$1,168	$397	$1,565
8.0%	Engineering & Design	$8,411	$2,860	34.0%	$11,271	2.5%	$8,622	$2,931	$11,553	2026Q2	8.3%	$9,341	$3,176	$12,518
1.3%	Reviews, ATRs, IEPRs, VE	$1,314	$447	34.0%	$1,761	2.5%	$1,347	$458	$1,805	2026Q2	8.3%	$1,460	$496	$1,956
1.0%	Life Cycle Updates (cost, schedule, risks)	$1,051	$357	34.0%	$1,409	2.5%	$1,078	$366	$1,444	2026Q2	8.3%	$1,168	$397	$1,565
0.0%	Contracting & Reprographics	$0	$0	34.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
1.0%	Engineering During Construction	$1,051	$357	34.0%	$1,409	2.5%	$1,078	$366	$1,444	2028Q2	13.8%	$1,227	$417	$1,644
0.5%	Planning During Construction	$526	$179	34.0%	$704	2.5%	$539	$183	$722	2028Q2	13.8%	$613	$209	$822
0.0%	Adaptive Management & Monitoring	$0	$0	34.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
0.0%	Project Operations	$0	$0	34.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
7.5%	Construction Management	$7,886	$2,681	34.0%	$10,567	2.5%	$8,083	$2,748	$10,831	2028Q2	13.8%	$9,201	$3,128	$12,329
0.0%	Project Operation:	$0	$0	34.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
2.0%	Project Management	$2,103	$715	34.0%	$2,818	2.5%	$2,155	$733	$2,888	2028Q2	13.8%	$2,454	$834	$3,288
	CONTRACT COST TOTALS:	$132,204	$44,908		$177,112		$136,223	$46,273	**182,496**			$158,093	$53,704	**$211,797**

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

PROJECT: **NoVA DC Coastal Storm Risk Management Nonstructural 20 Years**
PROJECT NO: P2 497631
LOCATION: DC and VA

DISTRICT: **NAB District** **PREPARED:** **2/6/2022**
POC: **CHIEF, Estimating and Specs Section, Parris J. McGhee-Bey**

This Estimate reflects the scope and schedule in report; FS Report (underway)

Program Year (Budget EC): 2023
Effective Price Level Date: 1 OCT 22

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)						TOTAL PROJECT COST (FULLY FUNDED)			
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-21** ($K)	**TOTAL FIRST COST** ($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	$72,307	$24,584	34.0%	$96,891	3.2%	$74,601	$25,364	$99,965	$0	$99,965	16.5%	$86,903	$29,547	$116,450
18	CULTURAL RESOURCE PRESERVATION	$723	$246	34.0%	$969	3.2%	$746	$254	$1,000	$0	$1,000	16.5%	$869	$295	$1,165
	CONSTRUCTION ESTIMATE TOTALS:	$73,030	$24,830		$97,860	3.2%	$75,347	$25,618	$100,964	$0	$100,964	16.5%	$87,772	$29,843	$117,615
01	LANDS AND DAMAGES	$723	$217	30.0%	$940	3.2%	$746	$224	$970	$0	$970	10.5%	$824	$247	$1,071
30	PLANNING, ENGINEERING & DESIGN	$11,137	$3,787	34.0%	$14,924	2.5%	$11,416	$3,881	$15,297	$0	$15,297	8.8%	$12,422	$4,224	$16,646
31	CONSTRUCTION MANAGEMENT	$6,938	$2,359	34.0%	$9,297	2.5%	$7,111	$2,418	$9,529	$0	$9,529	13.1%	$8,046	$2,736	$10,781
	PROJECT COST TOTALS:	$91,828	$31,193	34.0%	$123,021		$94,619	$32,141	**$126,760**	$0	**$126,760**	15.3%	$109,064	$37,049	$146,113

ESTIMATED TOTAL PROJECT COST: **$146,113**

CHIEF, Estimating and Specs Section, Parris J. McGhee-Bey

PROJECT MANAGER, Katherine Perkins

CHIEF, REAL ESTATE, Susan K. Lev

CHIEF, PLANNING, Amy M. Guise

CHIEF, ENGINEERING, Mary P. Foutz

CHIEF, OPERATIONS, Patrick G. Findlay

CHIEF, CONSTRUCTION, Jeff J. Werner

CHIEF, CONTRACTING, Paula M. Beck

CHIEF, PP-C, Justin Callahan

CHIEF, DPM, David B. Morrow

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

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

PROJECT: NoVA DC Coastal Storm Risk Management Nonstructural 20 Years
LOCATION: DC and VA
This Estimate reflects the scope and schedule in report; FS Report (underway)

DISTRICT: NAB District PREPARED: 2/6/2022
POC: CHIEF, Estimating and Specs Section, Parris J. McGhee-Bey

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: 6-Feb-22 Effective Price Level: 1-Oct-21				Program Year (Budget EC): 2023 Effective Price Level Date: 1 OCT 22								
				RISK BASED										
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	20 Years Protection													
19	BUILDINGS, GROUNDS & UTILITIES	$72,307	$24,584	34.0%	$96,891	3.2%	$74,601	$25,364	$99,965	2028Q1	16.5%	$86,903	$29,547	$116,450
18	CULTURAL RESOURCE PRESERVATION	$723	$246	34.0%	$969	3.2%	$746	$254	$1,000	2028Q1	16.5%	$869	$295	$1,165
	CONSTRUCTION ESTIMATE TOTALS:	$73,030	$24,830	34.0%	**$97,860**		$75,347	$25,618	$100,964			$87,772	$29,843	$117,615
01	LANDS AND DAMAGES	$723	$217	30.0%	$940	3.2%	$746	$224	$970	2026Q2	10.5%	$824	$247	$1,071
30	PLANNING, ENGINEERING & DESIGN													
2.5%	Project Management	$1,826	$621	34.0%	$2,447	2.5%	$1,871	$636	$2,508	2026Q2	8.3%	$2,028	$689	$2,717
1.0%	Planning & Environmental Compliance	$730	$248	34.0%	$979	2.5%	$749	$255	$1,003	2026Q2	8.3%	$811	$276	$1,087
8.0%	Engineering & Design	$5,842	$1,986	34.0%	$7,829	2.5%	$5,988	$2,036	$8,025	2026Q2	8.3%	$6,488	$2,206	$8,695
1.3%	Reviews, ATRs, IEPRs, VE	$913	$310	34.0%	$1,223	2.5%	$936	$318	$1,254	2026Q2	8.3%	$1,014	$345	$1,359
1.0%	Life Cycle Updates (cost, schedule, risks)	$730	$248	34.0%	$979	2.5%	$749	$255	$1,003	2026Q2	8.3%	$811	$276	$1,087
0.0%	Contracting & Reprographics	$0	$0	34.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
1.0%	Engineering During Construction	$730	$248	34.0%	$979	2.5%	$749	$255	$1,003	2028Q1	13.1%	$847	$288	$1,135
0.5%	Planning During Construction	$365	$124	34.0%	$489	2.5%	$374	$127	$502	2028Q1	13.1%	$423	$144	$567
0.0%	Adaptive Management & Monitoring	$0	$0	34.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
0.0%	Project Operations	$0	$0	34.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
7.5%	Construction Management	$5,477	$1,862	34.0%	$7,340	2.5%	$5,614	$1,909	$7,523	2028Q1	13.1%	$6,352	$2,160	$8,512
0.0%	Project Operation:	$0	$0	34.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
2.0%	Project Management	$1,461	$497	34.0%	$1,957	2.5%	$1,497	$509	$2,006	2028Q1	13.1%	$1,694	$576	$2,270
	CONTRACT COST TOTALS:	$91,828	$31,193		$123,021		$94,619	$32,141	**126,760**			$109,064	$37,049	**$146,113**

Backup MII Cost Report for Final Array of Structural Alternatives

Cost Report

Title Page

This version of the estimate includes an alternative for a push button flood barrier type for Old Town Alexandria, VA. Associated site work for push button flood barriers is based on assumptions from the look of the site. There was no design for associated site work.

No Planning Engineering Design (PED) account 30 and Construction Management (CM) are included b/c they are estimated by % of construction cost and are included in the TPCS.
No Design Contingency from CSRA is included because it will be included in the TPCS.

Note: The estimated costs prior to contingency in this cost report has very minor differences from the costs used risk analysis due to the fact that 100 years and 50 years structural plans for stoplog structures at Old Town Alexandria were added and later on removed, causing very small % change in Bond Table B calculation.

Estimated by CENAB-EN-DT
Designed by CENAB-EN
Prepared by Luan Ngo
Preparation Date 3/15/2022
Effective Date of Pricing 3/15/2022
Estimated Construction Time Days

Description	Quantity	UOM	ContractCost
Cost Summary			**158,983,717.10**
1 Reagan Airport	**1.0000**	**EA**	**43,302,393.54**
1.1 Relocation	**1.0000**	**EA**	**3,940,000.00**
1.1.1 Utility Relocation	**1.0000**	**EA**	**3,940,000.00**
1.2 Levees, Floodwalls, and Floodway Control	**1.0000**	**EA**	**39,362,393.54**
1.2.1 Levees and Floodwalls - Phase 1 and 2	**11,297.0000**	**LF**	**7,628,521.37**
1.2.1.1 Levees - Phase 1	**1,919.0000**	**LF**	**5,108,066.76**
1.2.1.2 Floodwalls - Phase 2	**2,533.0000**	**LF**	**2,520,454.61**
1.2.2 Floodway Control - Diversion Structures - Phase 3 Year 5-6	**1.0000**	**EA**	**31,733,872.17**
1.2.2.1 Mob and Demob	**1.0000**	**EA**	**59,625.97**
1.2.2.2 New Stop Logs Closure at 31+20 Phase 3 Year 6	**5,600.0000**	**SF**	**6,576,536.97**
1.2.2.3 New Stop Logs Closure at 45+00 Phase 3 Year 6	**13,545.0000**	**SF**	**15,906,998.80**
1.2.2.4 New Stop Logs Closure at 88+35 Phase 3 Year 6	**1,928.0000**	**SF**	**2,264,207.73**
1.2.2.5 New Stop Logs Closure at 106+50 Phase 3 Year 5	**1,170.0000**	**SF**	**1,374,026.47**
1.2.2.6 New Stop Logs Closure at 134+42 Phase 3 Year 5	**2,616.0000**	**SF**	**3,072,182.27**
1.2.2.7 New Stop Logs Closure at 155+50 Phase 3 Year 5	**2,112.0000**	**SF**	**2,480,293.94**
2 Four Mile Run Arlington WPCP - 1 Contract	**1.0000**	**EA**	**914,252.19**
2.1 Relocation	**1.0000**	**EA**	**200,000.00**
2.1.1 Utility Relocation	**1.0000**	**EA**	**200,000.00**
2.2 Floodwalls, and Floodway Control	**1.0000**	**EA**	**714,252.19**
2.2.1 Floodwalls	**1.0000**	**EA**	**469,264.00**
2.2.1.1 Mob and Demob	**1.0000**	**EA**	**27,777.98**
2.2.1.2 1 ft Elevated Concrete Curb	**1,300.0000**	**LF**	**26,531.66**
2.2.1.3 4 ft I-Wall	**1,160.0000**	**LF**	**346,073.88**
2.2.1.4 Site Restoration - Asphalt Repair Replacement	**10,000.0000**	**SF**	**68,880.47**
2.2.2 Floodway Control - Diversion Structures	**1.0000**	**EA**	**244,988.19**
2.2.2.1 Mob and Demob	**1.0000**	**EA**	**21,855.69**
2.2.2.2 New Stop Logs Closure at 24+60	**190.0000**	**SF**	**223,132.50**
3 Four Mile Run Alexandria	**1.0000**	**EA**	**15,333,338.44**
3.1 Relocation	**1.0000**	**EA**	**1,300,000.00**
3.1.1 Utility Relocation	**1.0000**	**EA**	**1,300,000.00**
3.2 Levees, Floodwalls, and Floodway Control	**1.0000**	**EA**	**13,003,338.44**
3.2.1 Levees and Floodwalls	**1.0000**	**EA**	**1,433,798.79**
3.2.1.1 Levee	**4,996.0000**	**LF**	**1,148,977.40**
3.2.1.2 Floodwalls	**1.0000**	**EA**	**284,821.39**
3.2.2 Floodway Control - Diversion Structures	**1.0000**	**EA**	**186,269.11**
3.2.2.1 Storm Gate Structures	**1.0000**	**EA**	**186,269.11**
3.2.3 Pump Stations Phase 2 Year 1	**1.0000**	**EA**	**11,383,270.54**
3.2.3.1 Pump Station 1 at 14+90	**1.0000**	**EA**	**5,676,333.23**
3.2.3.2 Pump Station 1 at 32+00	**1.0000**	**EA**	**5,706,937.31**
3.3 Cultural Resource Preservation	**1.0000**	**EA**	**1,030,000.00**
4 Belle Haven	**1.0000**	**EA**	**23,518,569.81**
4.1 Relocation	**1.0000**	**EA**	**2,140,000.00**
4.1.1 Utility Relocation	**1.0000**	**EA**	**2,140,000.00**
4.2 Levees, Floodwalls, Floodway Control, and Pump Stations	**1.0000**	**EA**	**20,978,569.81**
4.2.1 Levees and Floodwalls	**1.0000**	**EA**	**5,954,354.83**
4.2.1.1 Levees	**1.0000**	**EA**	**496,513.19**
4.2.1.2 Floodwalls	**4,996.0000**	**LF**	**5,457,841.64**
4.2.2 Floodway Control - Diversion Structures - Phase 2 Year 4	**1.0000**	**EA**	**2,688,669.04**

Currency in US dollars

Description	Quantity	UOM	ContractCost
4.2.2.1 Site Work	1.0000	EA	210,723.86
4.2.2.2 New Stop Logs Closure at 2+85	300.0000	SF	352,314.48
4.2.2.3 New Stop Logs Closure at 12+00	840.0000	SF	986,480.55
4.2.2.4 New Stop Logs Closure at 33+25	490.0000	SF	575,446.99
4.2.2.5 New Stop Logs Closure at 52+00	280.0000	SF	328,826.85
4.2.2.6 New Stop Logs Closure at 53+50	200.0000	SF	234,876.32
4.2.3 Pump Stations Phase 2 Year 1	1.0000	EA	12,335,545.94
4.2.3.1 Pump Station 1 at 49+00 Belle Haven	1.0000	EA	7,409,975.58
4.2.3.2 Pump Station 2 at 61+60 Belle Haven	1.0000	EA	4,925,570.36
4.3 Cultural Resource Preservation	1.0000	EA	400,000.00
6 Old Town Alexandria	1.0000	EA	75,915,163.13
6.3 Relocation	1.0000	EA	6,832,000.00
6.3.1 Utility Relocation	1.0000	EA	6,832,000.00
6.4 50 years Protection Floodway Control - Diversion Structures-Flood Barriers	39,900.0000	SF	68,324,163.13
6.4.1 Site Preparation	1.0000	EA	214,668.12
6.4.1.1 Traffic Controls at closure gates	5.0000	EA	159,112.15
6.4.1.2 Mob and Demob	1.0000	EA	55,555.97
6.4.2 Hydraulic Operated Flood Barriers at 0+00 to 3+35	39,900.0000	SF	59,442,238.97
6.4.3 Concrete Base	16,800.0000	SF	3,082,493.02
6.4.4 Excavation	7,156.0000	CY	306,368.41
6.4.5 Dewatering System	30.0000	DAY	1,881,758.49
6.4.6 Shoring	39,900.0000	SF	2,147,179.51
6.4.7 Site Restoration	16,800.0000	SF	1,194,376.64
6.4.8 Fencing	4,200.0000	LF	55,079.98
6.5 Cultural Resource Preservation	1.0000	EA	759,000.00

Currency in US dollars

Backup MII Cost Report Used as Basis for Final Array of Nonstructural Alternatives

Cost Report

Title Page

This cost estimate develops the program unit costs for different Floodproofing measures. Unit costs transferred to an Excel summary sheet for TOTAL cost to include on TPCS.

For purpose of calculating FOOH, 35 representative properties with different types and elevation done in an assumed group of 4 with 45 days per group, it's about 12 months construction duration.

Estimated by	USACE - LRH
Designed by	
Prepared by	Bryan R. Adkins - Updated by Luan Ngo (NAB)
Preparation Date	2/5/2022
Effective Date of Pricing	2/5/2022
Estimated Construction Time	365 Days

Description	Quantity	UOM	ContractCost
Cost Summary			**7,310,459.27**
1 NoVA Nonstructural Cost Estimates	**1.0000**	**LS**	**7,310,459.27**
1.1 Multi-Floor Split Level Structures (50% Slab on Grade, 50% Basement)	**1.0000**	**LS**	**1,494,400.45**
1.1.1 6 Foot Elevation	**1,200.0000**	**SF**	**188,003.83**
1.1.1.2 Structure Elevation Contract	**1,200.0000**	**SF**	**188,003.83**
1.1.2 5 Foot Elevation	**1,000.0000**	**SF**	**172,143.29**
1.1.2.2 Structure Elevation Contract	**1,000.0000**	**SF**	**172,143.29**
1.1.3 4 Foot Elevation	**2,200.0000**	**SF**	**225,003.25**
1.1.3.2 Structure Elevation Contract	**2,200.0000**	**SF**	**225,003.25**
1.1.4 4 Foot Elevation	**1,200.0000**	**SF**	**167,218.28**
1.1.4.2 Structure Elevation Contract	**1,200.0000**	**SF**	**167,218.28**
1.1.5 3 Foot Elevation	**1,800.0000**	**SF**	**192,244.58**
1.1.5.2 Structure Elevation Contract	**1,800.0000**	**SF**	**192,244.58**
1.1.6 3 Foot Elevation	**1,200.0000**	**SF**	**157,579.13**
1.1.6.2 Structure Elevation Contract	**1,200.0000**	**SF**	**157,579.13**
1.1.7 2 Foot Elevation	**2,600.0000**	**SF**	**236,021.49**
1.1.7.2 Structure Elevation Contract	**2,600.0000**	**SF**	**236,021.49**
1.1.8 2 Foot Elevation	**1,400.0000**	**SF**	**156,186.59**
1.1.8.2 Structure Elevation Contract	**1,400.0000**	**SF**	**156,186.59**
1.2 Single Floor Slab on Grade	**1.0000**	**LS**	**353,294.39**
1.2.1 6 Foot Elevation	**1,100.0000**	**SF**	**177,681.18**
1.2.1.2 Structure Elevation Contract	**1,100.0000**	**SF**	**177,681.18**
1.2.2 2 Foot Elevation	**1,900.0000**	**SF**	**175,613.21**
1.2.2.2 Structure Elevation Contract	**1,900.0000**	**SF**	**175,613.21**
1.3 Dry FloodProofing	**1.0000**	**LS**	**1,582,197.36**
1.3.1 Slab on Grade 1000 Square Feet	**1.0000**	**LS**	**263,699.56**
1.3.2 Slab on Grade 2000 Square Feet	**1.0000**	**LS**	**263,699.56**
1.3.3 Slab on Grade 3000 Square Feet	**1.0000**	**LS**	**263,699.56**
1.3.4 Slab on Grade 4000 Square Feet	**1.0000**	**LS**	**263,699.56**
1.3.5 Slab on Grade 5000 Square Feet	**1.0000**	**LS**	**263,699.56**
1.3.6 Slab on Grade 6000 Square Feet	**1.0000**	**LS**	**263,699.56**
1.4 Multi-Floor Slab on Grade	**1.0000**	**LS**	**1,011,622.66**
1.4.1 6 Foot Elevation	**1,200.0000**	**SF**	**173,363.48**
1.4.1.2 Structure Elevation Contract	**1,200.0000**	**SF**	**173,363.48**
1.4.2 4 Foot Elevation	**2,700.0000**	**SF**	**300,229.03**
1.4.2.2 Structure Elevation Contract	**2,700.0000**	**SF**	**300,229.03**
1.4.3 4 Foot Elevation	**1,600.0000**	**SF**	**185,527.96**
1.4.3.2 Structure Elevation Contract	**1,600.0000**	**SF**	**185,527.96**
1.4.4 3 Foot Elevation	**1,900.0000**	**SF**	**189,644.98**
1.4.4.2 Structure Elevation Contract	**1,900.0000**	**SF**	**189,644.98**
1.4.5 2 Foot Elevation	**1,600.0000**	**SF**	**162,857.22**
1.4.5.2 Structure Elevation Contract	**1,600.0000**	**SF**	**162,857.22**
1.5 Single Floor Basement Foundation	**1.0000**	**LS**	**962,769.19**
1.5.1 6 Foot Lift	**1,400.0000**	**SF**	**210,098.49**
1.5.1.2 Structure Elevation Contract	**1,400.0000**	**SF**	**210,098.49**
1.5.2 5 Foot Lift	**1,200.0000**	**SF**	**189,534.67**
1.5.2.2 Structure Elevation Contract	**1,200.0000**	**SF**	**189,534.67**
1.5.3 4 Foot Lift	**1,300.0000**	**SF**	**185,203.03**
1.5.3.2 Structure Elevation Contract	**1,300.0000**	**SF**	**185,203.03**

Currency in US dollars

Description	Quantity	UOM	ContractCost
1.5.4 2 Foot Lift	2,200.0000	SF	216,587.02
1.5.4.2 Structure Elevation Contract	2,200.0000	SF	216,587.02
1.5.5 2 Foot Lift	1,200.0000	SF	161,345.99
1.5.5.2 Structure Elevation Contract	1,200.0000	SF	161,345.99
1.6 Fill Basement & Add Utility Room	1.0000	LS	244,894.63
1.6.1 2600 Square Foot Structure	2,600.0000	SF	144,768.29
1.6.1.1 General Requirements	1,200.0000	SF	12,423.83
1.6.1.2 Fill Basement (w/dirt)	2,600.0000	SF	83,029.73
1.6.1.3 Utility Room	150.0000	SF	22,749.95
1.6.1.4 Utility Allowances	150.0000	SF	26,564.79
1.6.2 1200 Square Foot Structure	1,200.0000	SF	100,126.34
1.6.2.1 General Requirements	1,200.0000	SF	12,423.83
1.6.2.2 Fill Basement (w/dirt)	1,200.0000	SF	38,387.77
1.6.2.3 Utility Room	150.0000	SF	22,749.95
1.6.2.4 Utility Allowances	150.0000	SF	26,564.79
1.7 Multi-Floor Basement Foundation	1.0000	LS	1,661,280.58
1.7.1 5 Foot Lift	1,900.0000	SF	240,025.92
1.7.1.2 Structure Elevation Contract	1,900.0000	SF	240,025.92
1.7.2 4 Foot Lift	2,300.0000	SF	248,007.84
1.7.2.2 Structure Elevation Contract	2,300.0000	SF	248,007.84
1.7.3 4 Foot Lift	1,400.0000	SF	190,392.22
1.7.3.2 Structure Elevation Contract	1,400.0000	SF	190,392.22
1.7.4 3 Foot Lift	4,300.0000	SF	361,764.45
1.7.4.2 Structure Elevation Contract	4,300.0000	SF	361,764.45
1.7.5 3 Foot Lift	1,700.0000	SF	199,762.17
1.7.5.2 Structure Elevation Contract	1,700.0000	SF	199,762.17
1.7.6 2 Foot Lift	2,600.0000	SF	259,982.00
1.7.6.2 Structure Elevation Contract	2,600.0000	SF	259,982.00
1.7.7 2 Foot Lift	1,200.0000	SF	161,345.99
1.7.7.2 Structure Elevation Contract	1,200.0000	SF	161,345.99

Currency in US dollars