

APPENDIX A
COST ESTIMATE
COMPREHENSIVE ECONOMIC REANALYSIS
DELAWARE RIVER MAIN CHANNEL DEEPENING
TABLE OF CONTENTS

1. INTRODUCTION	1
2. INITIAL CONSTRUCTION COSTS	1
2.1. Federal Project	1
2.1.1. Contingencies.....	12
2.1.2. Planning Engineering and Design.....	13
2.1.3. Construction Management	13
2.2. Environmental Monitoring Costs	13
2.2.1. Introduction.....	13
2.2.2. Kelly Island	14
2.2.3. Broadkill Beach.....	14
2.2.4. Egg Island Point	14
2.2.5. Other Studies.....	14
2.3. Navigation Aid Costs	14
2.4. Non-Federal Associated Costs	16
3. OPERATION AND MAINTENANCE COSTS	25
3.1. Federal Project	25
3.1.1. Maintenance Dredging Analysis	25
3.1.2. Revised Maintenance Dredging Analysis	26
4.0 SENSITIVITY ANALYSES	32
4.1. Federal Dredging Costs	32
4.2. Contingency Estimates	33
4.2.1. Pipeline Dredge Estimate.....	34
4.2.2. Hopper Dredge Estimate	34
4.2.3. Summary.....	34

LIST OF TABLES

Table A-1 Initial Construction Cost	3
Table A-2 Construction Contract No. 1	4
Table A-3 Construction Contract No. 2	5
Table A-4 Construction Contract No. 3	6
Table A-5 Construction Contract No. 4	7
Table A-6 Construction Contract No. 5	8
Table A-7 Construction Contract No. 6	9
Table A-8 Construction Contract No. 7	10
Table A-9 Construction Contract No. 8	11
Table A-10 Construction Contract No. 9	12
Table A-11 Initial Dredging Costs - Beckett Street Terminal.....	17
Table A-12 Initial Dredging Costs – Packer Avenue Terminal.....	18
Table A-13 Initial Dredging Costs – Valero	19
Table A-14 Initial Rock Dredging Costs – Sunoco Marcus Hook	20
Table A-15 Initial Silt Dredging Costs – Sunoco Marcus Hook.....	21
Table A-16 Initial Dredging Costs – Sunoco Fort Mifflin.....	22
Table A-17 Initial Dredging Costs – Phillips 66 - Tosco.....	23
Table A-18 Initial Dredging Costs – Coastal Eagle Point	24
Table A-19 Initial Associated Costs For Benefiting Facilities	25
Table A-20 Average Annual Gross Maintenance Dredging Quantities.....	26
Table A-21 Average Annual Maintenance Dredging Quantities (Pay) 45-Foot Channel	29
Table A-22 Summary of Operation and Maintenance Costs 40-Foot Project	30
Table A-23 Summary of Operation and Maintenance Costs 45-Foot Project	31
Table A-24 Associated Maintenance Dredging Volumes and Cost	32
Table A-25 Sensitivity Analyses on Project Costs.....	33

List of Figures

Figure A-1 Philadelphia to Sea, O&M Dredging Data, Annual Series and Cumulative Data	27
Figure A-2 Philadelphia to Sea, Gross Pay Ratio, Contract Dredging	28

1. INTRODUCTION

Project implementation costs at May 2002 Price Levels are comprised of:

- 1) Initial construction costs for the Federal project;
- 2) Non-Federal associated costs for facility upgrades necessary to achieve the benefits of the 45-foot project;
- 3) Future operation and maintenance costs of the Federal channel, navigation aids; and,
- 4) Incremental associated operation and maintenance costs (i.e., the difference between the non-Federal cost for modifying current facilities to include dredging berthing areas of the benefiting facilities for the 45-foot project compared to the 40-foot project).

Cost estimates were developed assuming that dredging of the Federal and non-Federal associated portions of the project will be done independently.

As part of the reanalysis, cost estimates were thoroughly reviewed and revised to reflect current conditions. Below is a summary of changes that were incorporated from the previous District estimate.

1. In Reaches AA, A, B, C, and D, cost estimates were revised to incorporate the cost of water quality monitoring.
2. The size of the hopper dredges was increased from a 4,000 cubic yard hopper dredge to a generic large size dredge. The rationale behind the change was due to the increase availability of the large size dredges. Letters indicating the availability of such dredges were obtained and are on file in the Philadelphia District. In addition, this change reflects the needs of dredging in the bay portion of the project, as most of the dredging will be done in open water and is more suitable for the large size dredge. Although the size of the dredge used in the estimate was increased, a conservative approach was used in loading only to 25 percent of the hopper capacity and using an average large size dredge to streamline and optimize the costs.
3. The price of fuel was adjusted from \$1.00 to \$0.80 per gallon. This adjustment was based on contacting brokers and obtaining quotes for diesel #2 fuel.

The unit price for rock excavation was recomputed using information from recent rock blasting contracts for the New York/New Jersey Harbor Deepening Project. Based on the information provided several changes were made to the cost estimate, which significantly reduced the cost per cubic yard for drilling and blasting. The major change involved the reduction of the sub drilling channel depth from 12 to 8 feet. The type and hardness of the rock on the Delaware River project is very similar to the rock in the New York Harbor Project.

2. INITIAL CONSTRUCTION COSTS

2.1. *Federal Project*

Dredging quantities and cost estimates were prepared for the initial dredging of the Federal portions of the project. For the initial deepening, 26,012,000 cubic yards of material would be

dredged and placed by pipeline, clamshell and hopper dredges in confined upland disposal areas and for beneficial uses in Delaware Bay.

The estimate for the Federal portion of the project assumes using pipeline, clamshell and hopper dredges. Due to the long pumping distances, Reaches AA/A and Reach D will use large size hopper dredges. Dredged material would be pumped into confined upland disposal facilities. For Reaches B and C, 30-inch hydraulic pipeline dredges were used with dredged material being pumped into confined upland disposal facilities. Rock excavation in Reach B will be dredged using a clamshell dredge after drilling and blasting operations are completed. Excavated material will be placed in a confined upland disposal facility. For Reach E, large size hopper dredges were used with the dredged material being pumped to wetland restoration/protection areas (Kelly Island and Egg Island Point) and sand being placed for beach nourishment at Broadkill Beach. Cost estimates developed for Reach E take into account environmental windows that may be encountered during dredging or placement of dredged material.

Cost estimates for development of disposal areas include site clearing, raising dikes and constructing sluices. Construction schedules, disposal areas use schedule and all quantities for initial and maintenance dredging cost estimates, including disposal area development were developed in estimating the cost of the project. The dredged material disposal plan was established using the most recent Delaware River hydrographic survey channel examinations. Detailed dredging cost estimates were prepared using the Corps of Engineers' Dredge Estimating Programs (CEDEP). Non-dredging costs were prepared using the Corps of Engineers' Micro Computer-Aided Cost Engineering System (MCACES).

Due to the amount of material to be dredged (26 million cubic yards), disposal area capacity considerations and locations, it is planned to construct the project over five years. Work has been divided into nine construction contracts as shown in Table A-1. The total initial construction cost is estimated at \$208,422,000 (May 2002 Price Level).

Table A-1
Initial Construction Cost (1)
May 2002 Price Level

Project Year	Contract Number	Description	Initial Construction Cost
1	1	Dredging Reach C	\$11,227,130
1	2	Kelly Island Wetland/Restoration Project	\$37,327,144
1	3	Disposal areas (Raccoon Island, 15G and 15D)	\$8,767,487
2	4	Dredging Reach D	\$27,228,325
2	5	Rock Excavation Reach B	\$15,194,952
3	6	Broadkill Beach	\$27,016,432
4	7	Dredging Reach B	\$18,373,595
4	8	Egg Island Wetland/ Restoration/Protection Project	\$32,973,658
5	9	Dredging Reach AA/A	\$30,313,007
Total			\$208,421,731

(1) Cost includes Contingencies, Engineering and Design (E&D) and Supervision and Administration (S&A) during construction.

Summary level CEDEP and MCACES estimates for each of the nine (9) construction contracts are presented in Tables A-2 to A-10. Due to the voluminous nature of the detailed cost estimates, the full CEDEP and MCACES estimates have been retained in the Philadelphia District files.

Table A-2
Construction Contract No. 1
May 2002 Price Level

Reach C D/A: Killcohook	DEPTH	45			FY - 04	Contract No.1	
ACCOUNT CODE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	CONTINGENCY (In acct. 12.0.Z-)	TOTAL PROJECT COST
12.0.0	DREDGING						
12.0.A-	Mobilization, Demobilization and Preparatory Work	--	Job	LS	\$666,320	\$33,316	\$699,636
12.0.2-	Pipeline Dredging						
12.0.2.B	Site Work						
	Excavation and Disposal	3,409,000	CY	\$2.26	\$7,704,340	\$539,304	\$8,243,644
12.0.2.C	Water Quality Monitoring	6.70	MO	\$75,000.00	\$502,500	\$35,175	\$537,675
	Subtotal, Construction Costs:				\$8,673,160		
12.0.Z-	Contingencies					\$607,795	
12.0.0-	Total Construction Costs:						\$9,480,955
30.0.0-	Planning, Engineering & Design				\$1,175,000	\$58,750	\$1,233,750
31.0.0-	Construction Management				\$488,024	\$24,401	\$512,425
					\$10,536,184	\$690,946	\$11,227,130
	Total Project Costs					ROUNDED.....	\$11,227,000

Table A-3
Construction Contract No. 2
May 2002 Price Level

D/A Kelly Island	DEPTH	45			FY- 04	Contract No. 2	
						CONTINGENCY	TOTAL
ACCOUNT CODE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	(In acct. 12.0.Z-)	PROJECT COST
12 ---	DREDGING						
12.0.A-	Mobilization, Demobilization and Preparatory Work	--	Job	LS	\$100,000	\$5,000	\$105,000
12.0.1 - 12.0.1B	Disposal Areas Site Work						
	Dike Construction-Kelly Is						
	Embankment-sand	2,484,000	CY	\$1.50	\$3,726,000	\$372,600	\$4,098,600
	Riprap	1,300	TON	\$60.00	\$78,000	\$7,800	\$85,800
	Sluice	3	EA	\$29,500.00	\$88,500	\$8,850	\$97,350
	Geotubes	6000	LF	\$125.00	\$750,000	\$75,000	\$825,000
	Terminal Groin, 2 - 500 ft	1000	LF	\$1,600.00	\$1,600,000	\$160,000	\$1,760,000
	Interior Groins, 5 - 290 ft	1450	LF	\$1,600.00	\$2,320,000	\$232,000	\$2,552,000
12.0.A-	Mobilization, Demobilization and Preparatory Work	--	Job	LS	\$758,417	\$37,921	\$796,338
12.0.2 - 12.0.2B	Hopper Dredging Site Work						
	Excavation and Disposal	2,484,000	CY	\$8.21	\$20,393,640	\$1,427,555	\$21,821,195
	Subtotal, Construction Costs:				\$29,814,557		
12.0.Z-	Contingencies					\$2,326,726	
12.0.-	Total Construction Costs:						\$32,141,283
30 ---	Planning, Engineering & Design				\$2,284,000	\$114,200	\$2,398,200
31 ---	Construction Management				\$2,534,237	\$253,424	\$2,787,661
	Total Project Costs:				\$34,632,794	\$2,694,350	\$37,327,144
						ROUNDED	\$37,327,000

Table A-5
Construction Contract No. 4
May 2002 Price Level

Reach D D/A Reedy S.; Art. 15	DEPTH	45			FY - 05	Contract No. 4	
						CONTINGENCY (In acct. 12.0.Z-)	TOTAL PROJECT COST
ACCOUNT CODE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT		
12.---	DREDGING						
12.0.A.-	Mobilization, Demobilization and Preparatory Work	--	Job	LS	\$1,263,820	\$63,191	\$1,327,011
12.0.2.- 12.0.2.B	Pipeline Dredging Site Work Excavation and Disposal	0	CY	\$0.00	\$0	\$0	\$0
12.0.3.- 12.0.3.B	Hopper Dredging Site Work Excavation and Disposal	844,000	CY	\$5.62	\$4,743,280	\$332,030	\$5,075,310
	Excavation and Disposal	3,075,700	CY	\$5.43	\$16,701,051	\$1,169,074	\$17,870,125
12.0.3.C	Water Quality Monitoring	2.20	MO	\$75,000.00	\$165,000	\$11,550	\$176,550
12.0.3.C	Water Quality Monitoring	7.87	MO	\$75,000.00	\$590,250	\$41,318	\$631,568
12.0.4.- 12.0.4.B	Mechanical Dredging Site Work Excavation and Disposal	0	CY	\$0.00	\$0	\$0	\$0
12.0.5.- 12.0.5.A	Rock Excavation Mobilization, Demobilization	--	Job	LS	\$0	\$0	\$0
12.0.5.B	Excavation and Disposal	0	CY	\$0.00	\$0	\$0	\$0
	Subtotal, Dredging Cost				\$23,463,401	\$1,617,163	\$25,080,564
	Subtotal, Construction Costs:				\$23,463,401		
12.0.Z.-	Contingencies					\$1,617,163	
12.0.--	Total Construction Costs:						\$25,080,564
30.---	Planning/Engineering & Design				\$755,000	\$37,750	\$792,750
31.---	Construction Management Dredging				\$1,290,487	\$64,524	\$1,355,011
	Total Project Costs:				\$25,508,888	\$1,719,437	\$27,228,325
						ROUNDED	\$27,228,000

Table A-6
Construction Contract No.5
May 2002 Price Level

Rock @ B	DEPTH	45			FY 05	Contract No. 5	
ACCOUNT CODE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	CONTINGENCY (In acct. 12.0 Z-)	TOTAL PROJECT COST
12.000	DREDGING						
12.0 A-	Mobilization, Demobilization and Preparatory Work	--	Job	LS	\$531,110	\$53,111	\$584,221
12.0.2 - 12.0.2 B	Pipeline Dredging Site Work Excavation and Disposal	0	CY	\$0.00	\$0	\$0	\$0
12.0.3 - 12.0.3 B	Hopper Dredging Site Work Excavation and Disposal	0	CY	\$0.00	\$0	\$0	\$0
12.0.4 - 12.0.4 B	Mechanical Dredging Site Work Excavation and Disposal	77,000	CY	\$17.56	\$1,352,120	\$94,648	\$1,446,768
12.0.5 - 12.0.5 A 12.0.5 B	Rock Excavation Mobilization, Demobilization Drilling and Blasting	-- 77,000	Job CY	LS \$120.01	\$552,857 \$9,240,770	\$55,266 \$2,310,193	\$607,923 \$11,550,963
	Subtotal, Construction Costs:				\$11,876,657		
12.0.Z-	Contingencies					\$2,513,218	
12.0.-	Total Construction Costs:						\$14,189,875
30.000	Planning/Engineering & Design				\$315,000	\$15,750	\$330,750
31.000	Construction Management				\$642,216	\$32,111	\$674,327
	Total Project Costs:				\$12,833,873	\$2,561,079	\$15,194,952
						ROUNDED	\$15,195,000

Table A-7
Construction Contract No. 6
May 2002 Price Level

Broadkill Beach	DEPTH	45			FY 06	Contract No. 6	
ACCOUNT CODE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	CONTINGENCY (In acct. 12.0 Z-)	TOTAL PROJECT COST
12 ---	DREDGING						
12.0 A -	Mobilization, Demobilization and Preparatory Work	--	Job	LS	\$758,417	\$37,921	\$796,338
12.0.2 -	Pipeline Dredging						
12.0.2 B	Site Work						
	Excavation and Disposal	0	CY	\$0.00	\$0	\$0	\$0
12.0.3 -	Hopper Dredging						
12.0.3 B	Broadkill						
	Excavation and Disposal	2,244,200	CY	\$8.25	\$18,514,650	\$1,296,026	\$19,810,676
	Embankment work on beach	2,244,200	CY	\$1.50	\$3,366,300	\$336,630	\$3,702,930
	Sabellaria Habitat	711	TON	\$60.00	\$42,660	\$4,266	\$46,926
	Dewey						
	Excavation and Disposal	0	CY	\$0.00	\$0	\$0	\$0
	Embankment work on beach	0	CY	\$0.00	\$0	\$0	\$0
12.0.5 -	Rock Excavation						
12.0.5 A	Mobilization, Demobilization	--	Job	LS	\$0	\$0	\$0
12.0.5 B	Excavation and Disposal	0	CY	\$0.00	\$0	\$0	\$0
	Subtotal, Construction Costs:				\$22,682,027		
12.0.Z -	Contingencies					\$1,674,843	
12.0 --	Total Construction Costs:						\$24,356,870
30 ---	Planning, Engineering & Design				\$1,226,000	\$61,300	\$1,287,300
31 ---	Construction Management				\$1,247,511	\$124,751	\$1,372,262
					\$25,155,538	\$1,800,894	\$27,016,432
	Total Project Costs:					ROUNDED	\$27,016,000

Table A-8
Construction Contract No. 7
May 2002 Price Level

Reach B D/A: 15-D,15-G, Pedricktown N&S	DEPTH	45			FY- 07	Contract No. 7	
ACCOUNT CODE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	CONTINGENCY (in acct. 12.0.Z-)	TOTAL PROJECT COST
12.---	DREDGING						
12.0.A.-	Mobilization, Demobilization and Preparatory Work	--	Job	LS	\$1,385,664	\$69,283	\$1,454,947
12.0.2.- 12.0.2.B	Pipeline Dredging Site Work						
	Excavation and Disposal	2,112,943	CY	\$3.19	\$6,740,268	\$471,820	\$7,212,108
	Excavation and Disposal	1,626,123	CY	\$0.63	\$1,024,457	\$71,712	\$1,096,169
	Excavation and Disposal	1,626,123	CY	\$0.98	\$1,593,601	\$111,552	\$1,705,153
	Excavation and Disposal	1,482,692	CY	\$2.89	\$4,284,960	\$299,949	\$4,584,929
12.0.2.C	Water Quality Monitoring	4.23	MO	\$75,000.00	\$317,250	\$22,208	\$339,458
12.0.2.C	Water Quality Monitoring	1.24	MO	\$75,000.00	\$93,000	\$6,510	\$99,510
12.0.2.C	Water Quality Monitoring	0.83	MO	\$75,000.00	\$62,250	\$4,358	\$66,608
12.0.2.C	Water Quality Monitoring	2.74	MO	\$75,000.00	\$205,500	\$14,385	\$219,885
12.0.3.- 12.0.3.B	Hopper Dredging Site Work						
	Excavation and Disposal	0	CY	\$0.00	\$0	\$0	\$0
12.0.4.- 12.0.4.B	Mechanical Dredging Site Work						
	Excavation and Disposal	0	CY	\$0.00	\$0	\$0	\$0
12.0.5.- 12.0.5.A	Rock Excavation Mobilization, Demobilization	--	Job	LS	\$0	\$0	\$0
12.0.5.B	Excavation and Disposal	0	CY	\$0.00	\$0	\$0	\$0
	Subtotal, Construction Costs:				\$15,706,990		
12.0.Z.-	Contingencies					\$1,071,777	
12.0.-	Total Construction Costs:						\$16,778,767
30.---	Planning, Engineering & Design				\$855,000	\$32,750	\$887,750
31.---	Construction Management				\$863,884	\$43,194	\$907,078
					\$17,225,874	\$1,147,721	\$18,373,595
	Total Project Costs:					ROUNDED	\$18,374,000

Table A-9
Construction Contract No.8
May 2002 Price Level

D/A: Egg Island	DEPTH	45			FY - 07	Contract No. 8	
ACCOUNT CODE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	CONTINGENCY (in acct. 12.0.Z-)	TOTAL PROJECT COST
12- - -	DREDGING						
12.0.A- -	Mobilization, Demobilization and Preparatory Work	--	Job	LS	\$100,000	\$5,000	\$105,000
12.0.1- 12.0.1B	Disposal Areas Site Work						
	Dike Construction- Egg Is. Embankment-sand	2,600,000	CY	\$1.50	\$3,900,000	\$390,000	\$4,290,000
	Sluice	0	EA	\$29,500.00	\$0	\$0	\$0
	Gectubes	22800	L F	\$125.00	\$2,850,000	\$285,000	\$3,135,000
	Subtotal, Disposal Area Cost				\$6,850,000	\$680,000	\$7,530,000
12.0.A- -	Mobilization, Demobilization and Preparatory Work	--	Job	LS	\$758,417	\$37,921	\$796,338
12.0.2- 12.0.2B	Hopper Dredging Site Work						
	Excavation and Disposal	2,600,000	CY	\$7.32	\$19,032,000	\$1,332,240	\$20,364,240
	Subtotal, Construction Costs:				\$19,790,417	\$1,370,161	\$21,160,578
	Total Construction Cost				\$26,640,417		\$26,690,578
12.0.Z- -	Contingencies					\$2,050,161	
12.0- - -	Total Construction Costs:						\$28,690,578
30- - -	Planning, Engineering & Design				\$2,428,000	\$121,300	\$2,547,300
31- - -	Construction Management				\$1,577,982	\$157,796	\$1,735,780
	Total Project Costs:				\$30,644,399	\$2,329,259	\$32,973,658
						ROUNDED	\$32,974,000

Table A-10
Construction Contract No.9
May 2002 Price Level

Reach AA/A D/A Nat. Park, Racoon	DEPTH	45			FY- 08	Contract No. 9	
ACCOUNT CODE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	CONTINGENCY (In acct. 12.0.Z.-)	TOTAL PROJECT COST
12 ---	DREDGING						
12.0.A.-	Mobilization, Demobilization and Preparatory Work	--	Job	LS	\$1,407,247	\$70,362	\$1,477,609
12.0.2.- 12.0.2.B	Pipeline Dredging Site Work Excavation and Disposal	0	CY	\$0.00	\$0	\$0	\$0
12.0.3.- 12.0.3.B	Hopper Dredging Site Work Excavation and Disposal	1,293,522	CY	\$4.57	\$5,911,396	\$413,798	\$6,325,194
	Excavation and Disposal	3,213,661	CY	\$5.63	\$18,092,911	\$1,266,504	\$19,359,415
12.0.3.C	Water Quality Monitoring	3.21	MO	\$75,000.00	\$240,750	\$16,853	\$257,603
12.0.3.C	Water Quality Monitoring	8.56	MO	\$75,000.00	\$642,000	\$44,940	\$686,940
12.0.4.- 12.0.4.B	Mechanical Dredging Site Work Excavation and Disposal	0	CY	\$0.00	\$0	\$0	\$0
12.0.5.- 12.0.5.A	Rock Excavation Mobilization, Demobilization	--	Job	LS	\$0	\$0	\$0
12.0.5.B	Excavation and Disposal	0	CY	\$0.00	\$0	\$0	\$0
	Subtotal, Construction Costs:				\$26,294,304		
12.0.Z.-	Contingencies					\$1,812,457	
12.0.-	Total Construction Costs:						\$28,106,761
30 ---	Planning, Engineering & Design				\$655,000	\$32,750	\$687,750
31 ---	Construction Management				\$1,446,187	\$72,309	\$1,518,496
	Total Project Costs:				\$28,395,491	\$1,917,516	\$30,313,007
						ROUNDED	\$30,313,000

2.1.1. Contingencies

The estimated cost for each major subdivision or feature includes an item for “contingencies”. By definition, a “contingency” is an allowance against some adverse or unanticipated condition not susceptible to exact evaluation from the data at hand, but which must be expressed or represented in the cost estimate. The contingency allowances used in the cost estimates reflect the following uncertainties and concerns:

Mobilization, Demobilization and Preparatory Work. The contingency reflects uncertainty regarding the availability of dredges and locations of available dredges. A contingency factor of 5% was used for this item. For the rock excavation, a contingency factor of 10% was used to reflect an increased concern due to the specialized nature of this type of work.

Pipeline Dredging. The contingency reflects uncertainties associated with pumping distances and production rates when dredging new/undisturbed materials. In addition, contingencies include possible fluctuation of fuel prices, additional survey requirements, and increases in labor rates. A contingency of 7% was used for the initial dredging.

Hopper Dredging. The contingency reflects uncertainties associated with pumping distances and production rates when dredging new/undisturbed materials. A contingency allowance was also included for unanticipated difficulties interfacing with environmental windows that may be encountered during the bottom-dumping portion of the project. A contingency of 7% was used for initial dredging.

Rock Excavation. Contingency was included for unavailability of equipment and type of material. A contingency of 25 % was used for the rock drilling and blasting operation and in the extent of rock formations. For the clamshell dredging operation, a contingency 7 % was applied to the initial dredging.

Disposal Areas. Contingency reflects the uncertainty associated with unanticipated difficulties in developing disposal areas. A contingency factor of 10 % was used for initial dredging.

2.1.2. Planning Engineering and Design

Planning, Engineering and Design (PED) related costs during the initial dredging were estimated as a lump sum based on similar Corps of Engineers projects. Engineering and Design (E&D) during construction was estimated at \$11,629,800 including contingencies. Costs include preparation of the Project Cooperation Agreement, environmental studies and regulatory activities, design related engineering, plans and specifications, engineering during construction, cost engineering, construction and contract award activities and project management.

2.1.3. Construction Management

Supervision and Administration (S&A) of project construction was estimated as a lump sum in the amount of \$11,420,338 including contingencies. S&A was based on similar Corps of Engineers projects. S&A costs include contract administration, review of shop drawings, inspection and quality assurance, project office operation, contractor initiated claims and litigations and government initiated claims and litigations, and project management.

2.2. *Environmental Monitoring Costs*

2.2.1. Introduction

The Corps' Final Supplemental Environmental Impact Statement (July 1997) indicated that there would be no significant adverse impacts from construction of the 45-foot Delaware River Main Channel Deepening Project based on existing data and modeling studies. However, due to the sensitivity of some of the resources, the Corps has agreed to gather pre-construction information for those resources and to monitor them both during and after construction to insure that no

significant adverse impacts occur. If any are detected, corrective strategies will be implemented. All monitoring studies were designed in coordination with Federal and State resource agencies, as well as other resource experts. The cost of monitoring that is done before and during project construction is included as part of the initial project construction cost (Engineering and Design); subsequent costs (post construction) are reflected in the 45-foot channel operation and maintenance costs. The monitoring studies are discussed below.

2.2.2. Kelly Island

Monitoring activities at the Kelly Island Wetland Restoration Site include: water quality monitoring, sediment profiling, oyster bed and spat set surveying, fisheries surveying, fall benthic sampling, surveying of juvenile horseshoe crabs, a hydrographic acoustic survey of oyster bed conditions using the Acoustic Seabed Classification System, and benthic sled camera evaluation of near shore habitat. In addition, surveys will be done of spawning horseshoe crabs, migratory shorebirds, and sand builder worms. Development of wetland vegetation and physical characteristics of the wetland restoration will also be monitored.

2.2.3. Broadkill Beach

The resources that will be monitored at the Broadkill Beach sand placement site include migratory shorebirds, spawning horseshoe crabs, and sand builder worms.

2.2.4. Egg Island Point

Monitoring activities at the Egg Island Point Wetland Restoration Site include water quality monitoring, sediment profiling, oyster bed and spat set surveying, fisheries surveying, fall benthic sampling, juvenile horseshoe crab surveying, a hydro acoustic survey of oyster bed conditions using the Acoustic Seabed Classification System, and benthic sled camera evaluation of near shore habitat. In addition, surveys will be done of spawning horseshoe crabs and migratory shorebirds. Development of wetland vegetation and physical characteristics of the wetland restoration will also be monitored.

2.2.5. Other Studies

Oysters in the States of New Jersey and Delaware will be monitored to examine the health and productivity of oyster populations on the natural seed beds in the Delaware Bay to attempt to determine if the project is significantly impacting oyster resources. Studies to determine the number and proportion of blue crabs wintering in the navigation channel will be conducted. During rock blasting, monitoring will be ongoing to determine any adverse impacts on the endangered shortnose sturgeon.

2.3. *Navigation Aid Costs*

In a letter dated July 23, 2002, the U.S. Coast Guard provided costs to relocate, install and maintain aids to navigation for the 45-foot project. A copy of this letter is attached.

U.S. Department
of Transportation

United States
Coast Guard



Commander
Coast Guard Atlantic Area

431 Crawford St.
Portsmouth VA 23704-5004
Staff Symbol: (Aow)
Phone: (757) 398-6230
FAX: (757) 398-6334

16500
July 23, 2002

Lieutenant Colonel Timothy Brown
Philadelphia District, Corps of Engineers
District Engineer
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107-3390

Dear Colonel Brown:

This is a revised set of estimates in response to your letter of May 30, 2002 requesting updated information concerning the Delaware River Main Channel Deepening Project. After discussions between our mutual staffs, we determined that we had misread your initial request. We have also taken another look at our original 1997 estimates and revised those in 1 and 2 below using current FY02 cost data.

- | | |
|---|---------|
| 1. First cost of aids to navigation to improve the current 40 foot project: | \$ 905K |
| 2. Annual maintenance costs for item 1 above: | \$ 241K |
| 3. First cost of aids to navigation for new and relocated aids to navigation at twelve bends that will be widened as part of the 45 foot project: | \$ 322K |
| 4. Annual maintenance costs for item 3 above: | \$ 93K |

Sincerely,

A handwritten signature in dark ink, appearing to read "D. Ouellette".

DONALD OUELLETTE
Commander, U. S. Coast Guard
Chief, Aids to Navigation and
Waterways Management Branch
By direction of the Commander
U.S. Coast Guard Atlantic Area

2.4. Non-Federal Associated Costs

Associated costs are any required initial construction (e.g., berth deepening, dock modifications) or operations and maintenance costs incurred by non-Federal interests that would be necessary to achieve benefits from a deepened 45-foot Delaware River Federal channel. Initial associated costs are discussed in this section. Associated operations and maintenance costs are discussed in Section 3.

Interviews were conducted with potentially benefiting facilities (users of the Delaware River Main Channel) to determine what type of incremental modifications, if any, would be necessary for them to accrue benefits from a deepened 45-foot Delaware River Main Channel. Interviews were documented and sent to the interviewees to ensure that the information collected was accurately recorded. Estimates were prepared for both dredging of berthing areas and any required berth modifications from data collected during the interviews, the latest hydrographic survey data, and existing facility drawings. Associated cost written reports were prepared documenting information gathered regarding vessel berthing areas that would need to be modified to take advantage of the 45-foot Delaware River Main Channel Deepening. These reports include facility site map/aerial photographs, summary of findings, and estimated costs.

The berth modifications costs for the various facilities represent the incremental cost to modify, if needed, the existing berth facilities to increase their design dredge depth to 45 feet below mean low water. Existing engineering drawings and available engineering reports were used to rate each facility and prepare preliminary design modification sketches as needed to make cost estimates. The condition of all existing facilities for determination of needed modifications was assumed to be free of any structural deterioration, including missing or damaged berth components. This assumption was used so only the incremental costs attributed to the 45-foot project would be determined. The need for routine maintenance and repair of the existing structures are the same for both the existing 40-foot project and the proposed 45-foot project.

The dredging estimate assumed that any non-Federal dredging of the berthing areas will be done by a local dredging contractor who would continue to haul the dredged material to a private disposal site, consistent with the long term history of such work and their current permit requirements. The initial dredging cost is based on the removal of a volume of dredge material to obtain a dredge depth of 45 feet below mean low water plus one foot over dredge depth. The incremental maintenance dredging cost is based on the additional amount of maintenance dredging needed to maintain the berth at 45 feet below mean low water, versus 40 feet below mean low water.

For each of the benefiting facilities the following is a summary of the berth or storage modification and initial dredging.

SJPC (Beckett Street Terminal)

Berth Modification. Berthing Areas No. 3 and 4 would be considered for deepening to 45 feet. Berth No. 3 would require modification of fenders and structure. The structure must be modified to provide support for the soils under the pier to maintain the existing pile support of the pier. The modification of Berth No. 3 consists of providing a steel sheet pile bulkhead at the present river bottom at the face of the pier to provide a retaining wall for the sloped soils under the pier. In addition, a dead man wall and tie rod support will be added to provide additional lateral

support for the pier. The dead man wall will consist of steel sheet piling. The existing rubber fenders and reinforced plastic fender piles must be moved out shore by building out the existing concrete with steel beams or concrete. Berth No. 4 was reviewed for actual installed conditions (i.e., depth of cellular sheet pile). It was found that the cell structure and pier are considered satisfactory for dredging to 45 feet. The fender system would require modification at the juncture of Berth No. 3 and Berth No. 4 to accommodate relocation of the fender line at Berth No.3. The modifications to Berth No. 3 are estimated to be \$2,000,000. The modifications to Berth No.4 are estimated to be \$50,000.

Berth Dredging (Beckett Street Terminal). Initial dredging costs to bring the berth from 40 feet below MLW to 45 feet below MLW are displayed in Table A-11 below.

Table A-11
Initial Dredging Costs - Beckett Street Terminal

S. Jersey Port @ Beckett	DEPTH	45					
ACCOUNT CODE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	CONTINGENCY (in acct. 12.0 Z-)	TOTAL PROJECT COST
12---	DREDGING						
12.0 A.-	Mobilization, Demobilization and Preparatory Work	--	Job	LS	\$88,097	\$8,810	\$96,907
12.0.2.-	Pipeline Dredging						
12.0.2.B	Site Work						
	Excavation and Disposal	0	CY	\$0.00	\$0	\$0	\$0
12.0.3.-	Hopper Dredging						
12.0.3.B	Site Work						
	Excavation and Disposal	0	CY	\$0.00	\$0	\$0	\$0
12.0.4.-	Mechanical Dredging						
12.0.4.B	Site Work						
	Excavation and Disposal	59,164	CY	\$8.20	\$485,145	\$33,960	\$519,105
12.0.5.-	Rock Excavation						
12.0.5.A	Mobilization, Demobilization	--	Job	LS	\$0	\$0	\$0
12.0.5.B	Drilling and Blasting	0	CY	\$0.00	\$0	\$0	\$0
	Subtotal, Construction Costs:				\$573,242		
12.0.Z.-	Contingencies					\$42,770	
12.0.-.-	Total Construction Costs:						\$616,012
30---	Planning, Engineering & Design				\$50,000	\$2,500	\$52,500
31---	Construction Management				\$31,528	\$1,576	\$33,104
					\$81,528	\$4,076	\$85,604
	Total Project Costs:				\$654,770	\$46,846	\$701,616
						ROUNDED	\$702,000

PRPA (Packer Avenue Terminal)

Berth Modification. PRPA does plan to increase the water depth to 45 feet below mean low water at Berths No. 2, 3, 4 and 5. These berths were analyzed for deepening to 45 feet. The

structural analyses concluded that cell structures and piers are satisfactory. Therefore, there is no need for structural modification due to deepening of the berths from the current maintained depth of 40 feet depth to 45 feet.

Berth Dredging (Packer). Initial dredging costs to bring the berth from 40 feet below MLW to 45 feet below MLW are displayed in Table A-12 below.

Table A-12
Initial Dredging Costs – Packer Avenue Terminal

Phil R P A, Packer Avenue	DEPTH	45					
						CONTINGENCY	TOTAL
ACCOUNT				UNIT		(In acct.	PROJECT
CODE	ITEM	QUANTITY		PRICE	AMOUNT	12.0 Z-)	COST
12.0.0.0	DREDGING						
12.0.0.1	Mobilization, Demobilization and Preparatory Work	--	Job	LS	\$88,136	\$8,814	\$96,950
12.0.2.0	Pipeline Dredging						
12.0.2.1	Site Work						
	Excavation and Disposal	0	CY	\$0.00	\$0	\$0	\$0
12.0.3.0	Hopper Dredging						
12.0.3.1	Site Work						
	Excavation and Disposal	0	CY	\$0.00	\$0	\$0	\$0
12.0.4.0	Mechanical Dredging						
12.0.4.1	Site Work						
	Excavation and Disposal	70,194	CY	\$7.13	\$500,483	\$35,034	\$535,517
12.0.5.0	Rock Excavation						
12.0.5.1	Mobilization, Demobilization	--	Job	LS	\$0	\$0	\$0
12.0.5.2	Drilling and Blasting	0	CY	\$0.00	\$0	\$0	\$0
	Subtotal, Construction Costs				\$588,619		
12.0.6.0	Contingencies					\$43,848	
12.0.7.0	Total Construction Costs						\$632,467
30.0.0.0	Planning, Engineering & Design				\$50,000	\$2,500	\$52,500
31.0.0.0	Construction Management				\$32,374	\$1,619	\$33,993
					\$670,993	\$47,967	\$718,960
	Total Project Costs					ROUNDED	\$719,000

VALERO

Berth or Storage Modification. Berth No.1 was considered for deepening to 45 feet. The analysis revealed that no structural modifications are required for deepening this berthing area. Based on an interview with representatives of Valero, it was indicated that less than \$5 million would be required to augment storage capacity with the 45-foot project.

Berth Dredging (Valero). Initial dredging costs to bring the berth from 40 feet below MLW to 45 feet below MLW are displayed in Table A-13 below.

Table A-13
Initial Dredging Costs - Valero

Valero, Paulsboro	DEPTH	45					
ACCOUNT CODE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	CONTINGENCY (In acct 12.0.Z-)	TOTAL PROJECT COST
12.0.0.0	DREDGING						
12.0.A-	Mobilization, Demobilization and Preparatory Work	--	Job	LS	\$98,317	\$9,832	\$108,149
12.0.2-	Pipeline Dredging						
12.0.2B	Site Work						
	Excavation and Disposal	0	CY	\$0.00	\$0	\$0	\$0
12.0.3-	Hopper Dredging						
12.0.3B	Site Work						
	Excavation and Disposal	0	CY	\$0.00	\$0	\$0	\$0
12.0.4-	Mechanical Dredging						
12.0.4B	Site Work						
	Excavation and Disposal	68,686	CY	\$12.17	\$835,909	\$58,514	\$894,423
12.0.5-	Rock Excavation						
12.0.5A	Mobilization, Demobilization	--	Job	LS	\$0	\$0	\$0
12.0.5B	Drilling and Blasting	0	CY	\$0.00	\$0	\$0	\$0
	Subtotal, Construction Costs:				\$934,226		
12.0.Z-	Contingencies					\$68,346	
12.0.0.0	Total Construction Costs:						\$1,002,572
30.0.0.0	Planning, Engineering & Design				\$50,000	\$2,500	\$52,500
31.0.0.0	Construction Management				\$51,382	\$2,569	\$53,951
	Total Project Costs:				\$1,035,608	\$73,415	\$1,109,023
						ROUNDED	\$1,109,000

SUNOCO (Marcus Hook)

Berth Modification. Berth 3C would be considered for deepening to 45 feet. The Pier 3C structures were analyzed for specific load capacity. Since the dredge depth of 45 feet will increase the unbraced length of the piles, the structures were analyzed to determine the effect on the load capability of the structures. The existing cell breasting structures will be replaced with new cell structures, including excavation as required to provide deeper depth of cells. This modification is estimated to be \$1,800,000.

Berth Dredging (Sunoco Marcus Hook). Dredging involves rock and silt removal. Dredging costs are displayed in Tables A-14 and A-15 below.

Table A-14
Initial Rock Dredging Costs – Sunoco Marcus Hook

Rock Sunoco @ Marcus Hook	DEPTH	45					
						CONTINGENCY	TOTAL
ACCOUNT	ITEM	QUANTITY	UNIT	UNIT	AMOUNT	(In acct.	PROJECT
CODE				PRICE		12.0.Z-)	COST
12.0.0.0	DREDGING						
12.0.0.1	Mobilization, Demobilization and Preparatory Work	--	Job	LS	\$189,079	\$18,908	\$207,987
12.0.2.0	Pipeline Dredging						
12.0.2.B	Site Work						
	Excavation and Disposal	0	CY	\$0.00	\$0	\$0	\$0
12.0.3.0	Hopper Dredging						
12.0.3.B	Site Work						
	Excavation and Disposal	0	CY	\$0.00	\$0	\$0	\$0
12.0.4.0	Mechanical Dredging						
12.0.4.B	Site Work						
	Excavation and Disposal	25,089	CY	\$14.55	\$365,045	\$25,553	\$390,598
12.0.5.0	Rock Excavation						
12.0.5.A	Mobilization, Demobilization	--	Job	LS	\$226,005	\$22,601	\$248,606
12.0.5.B	Drilling and Blasting	25,089	CY	\$137.99	\$3,462,031	\$519,305	\$3,981,336
	Subtotal, Construction Costs:				\$4,242,160		
12.0.Z.0	Contingencies					\$586,367	
12.0.0.0	Total Construction Costs:						\$4,828,527
30.0.0.0	Planning, Engineering & Design				\$100,000	\$5,000	\$105,000
31.0.0.0	Construction Management				\$233,319	\$11,666	\$244,985
	Total Project Costs:				\$4,575,479	\$603,033	\$5,178,512
						ROUNDED	\$5,179,000

Table A-15
Initial Silt Dredging Costs – Sunoco Marcus Hook

Sunoco @ Marcus Hook	DEPTH	45					
ACCOUNT CODE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	CONTINGENCY (In acct. 12.0 Z.-)	TOTAL PROJECT COST
12.---	DREDGING						
12.0 A.-	Mobilization, Demobilization and Preparatory Work	--	Job	LS	\$108,537	\$10,854	\$119,391
12.0 2.-	Pipeline Dredging						
12.0 2 B	Site Work						
	Excavation and Disposal	0	CY	\$0.00	\$0	\$0	\$0
12.0 3.-	Hopper Dredging						
12.0 3 B	Site Work						
	Excavation and Disposal	0	CY	\$0.00	\$0	\$0	\$0
12.0 4.-	Mechanical Dredging						
12.0 4 B	Site Work						
	Excavation and Disposal	65,713	CY	\$7.30	\$479,705	\$33,579	\$513,284
12.0 5.-	Rock Excavation						
12.0 5 A	Mobilization, Demobilization	--	Job	LS	\$0	\$0	\$0
12.0 5 B	Drilling and Blasting	0	CY	\$0.00	\$0	\$0	\$0
	Subtotal, Construction Costs				\$588,242		
12.0 Z.-	Contingencies					\$44,433	
12.0 --	Total Construction Costs						\$632,675
30.---	Planning, Engineering & Design				\$50,000	\$2,500	\$52,500
31.---	Construction Management				\$32,353	\$1,618	\$33,971
					\$670,595	\$48,551	\$719,146
	Total Project Costs					ROUNDED	\$719,000

SUNOCO (Fort Mifflin/Hog Island)

Berth Modification (Fort Mifflin). At the Fort Mifflin facility, Berth A will be deepened to a depth of 45 feet. Berth A structures were analyzed for specific load capacity. The analysis concluded that Berth A is satisfactory for use if dredged to 45 feet below mean low water. No modifications or dredging are necessary at Hog Island since the facility is physically interconnected with Fort Mifflin via pipeline.

Berth Dredging (Fort Mifflin). Initial dredging costs to bring the berth from 40 feet below MLW to 45 feet below MLW are displayed in Table A-16 below.

Table A-16
Initial Dredging Costs – Sunoco Fort Mifflin

Sunoco @ Fort Mifflin	DEPTH	45					
ACCOUNT CODE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	CONTINGENCY (In acct. 12.0.Z.-)	TOTAL PROJECT COST
12.-.-	DREDGING						
12.0.A.-	Mobilization, Demobilization and Preparatory Work	--	Job	LS	\$93,239	\$9,324	\$102,563
12.0.2.-	Pipeline Dredging						
12.0.2B	Site Work						
	Excavation and Disposal	0	CY	\$0.00	\$0	\$0	\$0
12.0.3.-	Hopper Dredging						
12.0.3B	Site Work						
	Excavation and Disposal	0	CY	\$0.00	\$0	\$0	\$0
12.0.4.-	Mechanical Dredging						
12.0.4B	Site Work						
	Excavation and Disposal	36,428	CY	\$7.49	\$272,846	\$19,099	\$291,945
12.0.5.-	Rock Excavation						
12.0.5.A	Mobilization, Demobilization	--	Job	LS	\$0	\$0	\$0
12.0.5B	Drilling and Blasting	0	CY	\$0.00	\$0	\$0	\$0
	Subtotal, Construction Costs:				\$366,085		
12.0.Z.-	Contingencies					\$28,423	
12.0.-.-	Total Construction Costs:						\$394,508
30.-.-	Planning, Engineering & Design				\$50,000	\$2,500	\$52,500
31.-.-	Construction Management				\$20,135	\$1,007	\$21,142
					\$436,220	\$31,930	\$468,149
	Total Project Costs:					ROUNDED	\$468,000

PHILLIPS 66 (Tosco)

Berth Modification. Dock No. 1 would be considered for deepening to 45 feet. A review of the existing facilities was undertaken to determine if deepening Dock No. 1 to 45 feet was possible. The review indicated that the deeper depth and resulting side slopes would increase the unsupported pile lengths and walkways, mooring dolphins and the down river portion of Dock No.2. It was concluded that the existing fender system, downriver breasting cell, Dock No.1 structure, and the downstream portion of Dock No. 2 structure would require modification and/or reinforcement if Dock No. 1 berth is dredged to 45 feet below mean low water. The soil support for the existing piles must be maintained by providing a retaining wall between existing soil slope and the new 45-foot depth. The existing breasting cells are satisfactory for the 45-foot dredging based on bearing on existing rock that will not be affected by the dredging. The cost for structural modification for Dock No. 1 is estimated to be \$3,600,000.

Berth Dredging (Phillips 66 - Tosco). Initial dredging costs to bring the berth from 40 feet below MLW to 45 feet below MLW are displayed in Table A-17 below.

Table A-17
Initial Dredging Costs – Phillips 66 - Tosco

Phillips 66 at Marcus Hook	DEPTH	45					
ACCOUNT CODE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	CONTINGENCY (In acct. 12.0 Z-)	TOTAL PROJECT COST
12.---	DREDGING						
12.0 A-	Mobilization, Demobilization and Preparatory Work	--	Job	LS	\$108,537	\$10,854	\$119,391
12.0 2- 12.0 2B	Pipeline Dredging Site Work Excavation and Disposal	0	CY	\$0.00	\$0	\$0	\$0
12.0 3- 12.0 3B	Hopper Dredging Site Work Excavation and Disposal	0	CY	\$0.00	\$0	\$0	\$0
12.0 4- 12.0 4B	Mechanical Dredging Site Work Excavation and Disposal	118,090	CY	\$5.07	\$598,718	\$41,910	\$640,626
12.0 5- 12.0 5A 12.0 5B	Rock Excavation Mobilization, Demobilization Drilling and Blasting	-- 0	Job CY	LS \$0.00	\$0 \$0	\$0 \$0	\$0 \$0
	Subtotal, Construction Costs:				\$707,253		
12.0 Z-	Contingencies					\$52,764	
12.0 --	Total Construction Costs:						\$760,017
30.---	Planning, Engineering & Design				\$50,000	\$2,500	\$52,500
31.---	Construction Management				\$38,899	\$1,945	\$40,844
					\$796,152	\$57,209	\$853,361
	Total Project Costs:					ROUNDED	\$853,000

COASTAL EAGLE POINT OIL CO.

Berth Modification. Piers No. 2 and 3 were reviewed for modifications to accommodate the deepening to 45 feet. The review concluded that the 45-foot dredge depth would result in tankers docking with increased dead weight tonnage, due to deeper draft, resulting in larger docking energies to be absorbed by existing fendering and increased resultant load to the structures. The entire existing fender clusters, cells, and loading platform of Dock No. 2 and No. 3 have very deep pile depths. It was concluded that the fender systems, breasting dolphins, mooring dolphins and loading platforms at Piers No. 2 and No. 3 will require no modifications and/or reinforcement if Piers No. 2 and No. 3 are dredged to 45 feet below mean low water.

Berth Dredging (Coastal Eagle Point). Initial dredging costs to bring the berth from 40 feet below MLW to 45 feet below MLW are displayed in Table A-18 below.

Table A-18
Initial Dredging Costs – Coastal Eagle Point

Coastal@ Eagle Point	DEPTH	45					
						CONTINGENCY	TOTAL
ACCOUNT CODE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	(In acct. 12.0.Z-)	PROJECT COST
12.0.0.0	DREDGING						
12.0.A.0	Mobilization, Demobilization and Preparatory Work	--	Job	LS	\$93,207	\$9,321	\$102,528
12.0.2.0	Pipeline Dredging						
12.0.2.B	Site Work						
	Excavation and Disposal	0	CY	\$0.00	\$0	\$0	\$0
12.0.3.0	Hopper Dredging						
12.0.3.B	Site Work						
	Excavation and Disposal	0	CY	\$0.00	\$0	\$0	\$0
12.0.4.0	Mechanical Dredging						
12.0.4.B	Site Work						
	Excavation and Disposal	17,073	CY	\$10.48	\$178,925	\$12,525	\$191,450
12.0.5.0	Rock Excavation						
12.0.5.A	Mobilization, Demobilization	--	Job	LS	\$0	\$0	\$0
12.0.5.B	Drilling and Blasting	0	CY	\$0.00	\$0	\$0	\$0
	Subtotal, Construction Costs:				\$272,132		
12.0.Z.0	Contingencies					\$21,846	
12.0.0.0	Total Construction Costs:						\$293,978
30.0.0.0	Planning, Engineering & Design				\$50,000	\$2,500	\$52,500
31.0.0.0	Construction Management				\$14,967	\$748	\$15,715
					\$337,099	\$25,094	\$362,193
	Total Project Costs:					ROUNDED	\$362,000

DELAWARE TERMINALS

Delaware Terminals is currently planning to establish a berth on a naturally deep section of the Delaware River in 2007 to allow access to the 40-foot channel. No associated costs were calculated for Delaware Terminals since their new berthing area will be located in a naturally deep (i.e., => 45 feet) section of the Delaware River.

A summary of associated costs for the benefiting facilities is presented in Table A-19 below.

Table A-19
Initial Associated Costs For Benefiting Facilities
May 2002 Price Level

Facility	Berth or Storage Modification	Initial Dredging to 45+1 feet	Total Facility Cost
Beckett Street	\$2,050,000	\$702,000	\$2,752,000
Packer Avenue	\$0	\$719,000	\$719,000
Valero	\$5,000,000	\$1,109,000	\$6,109,000
SUNOCO Marcus Hook	\$1,800,000	\$5,898,000	\$7,698,000
SUNOCO Fort Mifflin / Hog Island	\$0	\$468,000	\$468,000
Phillips 66 (Tosco)	\$3,600,000	\$853,000	\$4,453,000
Coastal Eagle Point Oil Co.	\$0	\$362,000	\$362,000
Motiva	\$0	\$0	\$0
Delaware Terminals	\$0	\$0	\$0
Total	\$12,450,000	\$10,111,000	\$22,561,000

3. OPERATION AND MAINTENANCE COSTS

3.1. Federal Project

3.1.1. Maintenance Dredging Analysis

As part of this reanalysis, the maintenance dredging analysis that was performed as part of the Preconstruction, Engineering and Design (PED) Study was reviewed and revised to reflect current conditions and costs.

The PED analysis of shoaling and maintenance dredging was based on contract dredging and Government hopper dredging records between 1976 and 1994, a 19-year period. Table A-20 presents a summary, by navigation range, of the average annual Operation and Maintenance (O&M) dredging quantity for each range of the existing Delaware River 40-foot channel. Maintenance dredging estimates for the proposed Delaware River 45-foot channel were also developed in the PED phase (see Table A-20). The first two columns of dredging quantities are from the PED analysis. These estimates were determined from the rates for the existing Delaware River 40-foot channel, multiplied by a factor reflecting the additional area of each range to be dredged with a 45-foot channel. Values in Table A-20 represent gross quantities of sediment removed during dredging, appropriate for planning disposal area needs. The actual pay quantities during this period averaged approximately 76%, by volume measurement, of the gross quantities.

Table A-20
Average Annual Gross Maintenance Dredging Quantities

Navigation Range	Existing 40-foot channel (cy)	Proposed 45-foot channel (cy)	Existing 40-foot channel (cy)	Proposed 45-foot channel (cy)
	1976 - 1994	Based on 1976-1994 data	1995 - 2001	Based on 1995-2001 data
Philadelphia	73,000	86,000	31,000	37,000
Eagle Point	3,000	4,000	0	0
Mifflin	65,000	65,000	88,000	88,000
Billingsport	3,000	3,000	0	0
Tinicum	9,000	9,000	19,000	19,000
Eddystone	2,000	3,000	0	0
Chester	5,000	8,000	0	0
Marcus Hook	2,164,000	2,380,000	1,720,000	1,892,000
Bellevue	34,000	72,000	0	0
Cherry Island	236,000	260,000	183,000	202,000
Deepwater	858,000	1,047,000	404,000	493,000
Bulkhead Bar	10,000	10,000	18,000	18,000
New Castle	1,126,000	1,284,000	738,000	842,000
Reedy Island	18,000	23,000	58,000	74,000
Baker	29,000	29,000	16,000	16,000
Liston	179,000	333,000	88,000	164,000
Cross Ledge	0	0	7,000	7,000
Miah Maull	13,000	86,000	25,000	165,000
Brandywine	61,000	305,000	60,000	300,000
Project Total	4,888,000	6,007,000	3,455,000	4,317,000

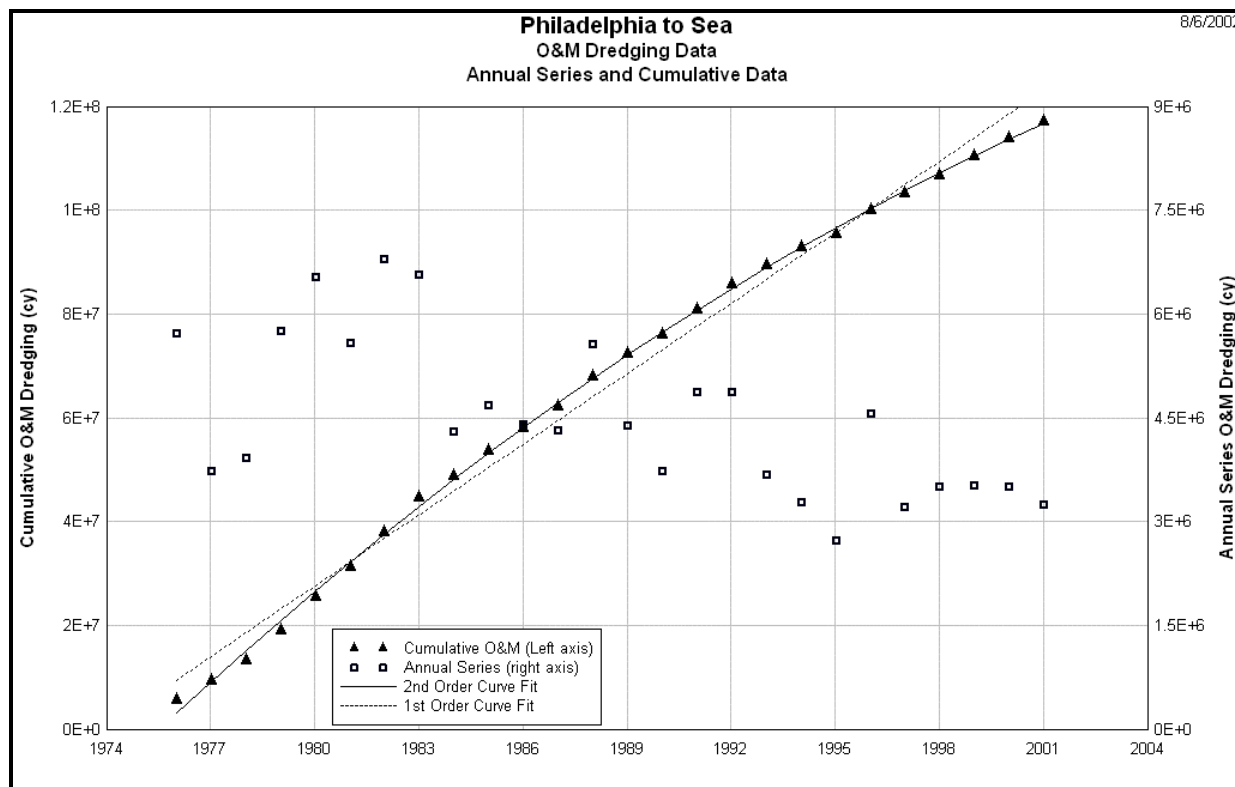
3.1.2. Revised Maintenance Dredging Analysis

Dredging records for the Delaware River, Philadelphia to the Sea Federal project for the period 1995 through 2001 were assembled and analyzed as part of this reanalysis. This analysis included examination of seven years of data for the period subsequent to that used in the PED analysis (1976 – 1994). Comparison of the 1995-2001 data with the 1976-1994 indicated a distinct and consistent trend of decreasing O&M dredging volumes. Table A-20 above provides the average annual gross O&M quantities for each navigation range, based on the period 1995 to 2001. These data are in the last two columns of the table.

Figure A-1 presents a graphical overview of the maintenance dredging history for this project, from 1976 through 2001. The open squares (“Annual Series”) represent the *annual* O&M dredging quantity for each year, and refer to the right Y-axis. The decreasing trend over the period of record is obvious. The solid triangles represent the *cumulative* O&M dredging quantity, with scale provided on the left Y-axis. Two lines are plotted through the “cumulative O&M” time series data. The dashed line is a simple first-order (linear) fit, and the solid line is a 2nd order best fit. The correlation coefficient for the 2nd order line is 0.9996. The trend of

decreasing O&M quantities over this period is evidenced by the superior fit of the 2nd order (solid), as compared to the 1st order (dashed), line.

Figure A-1



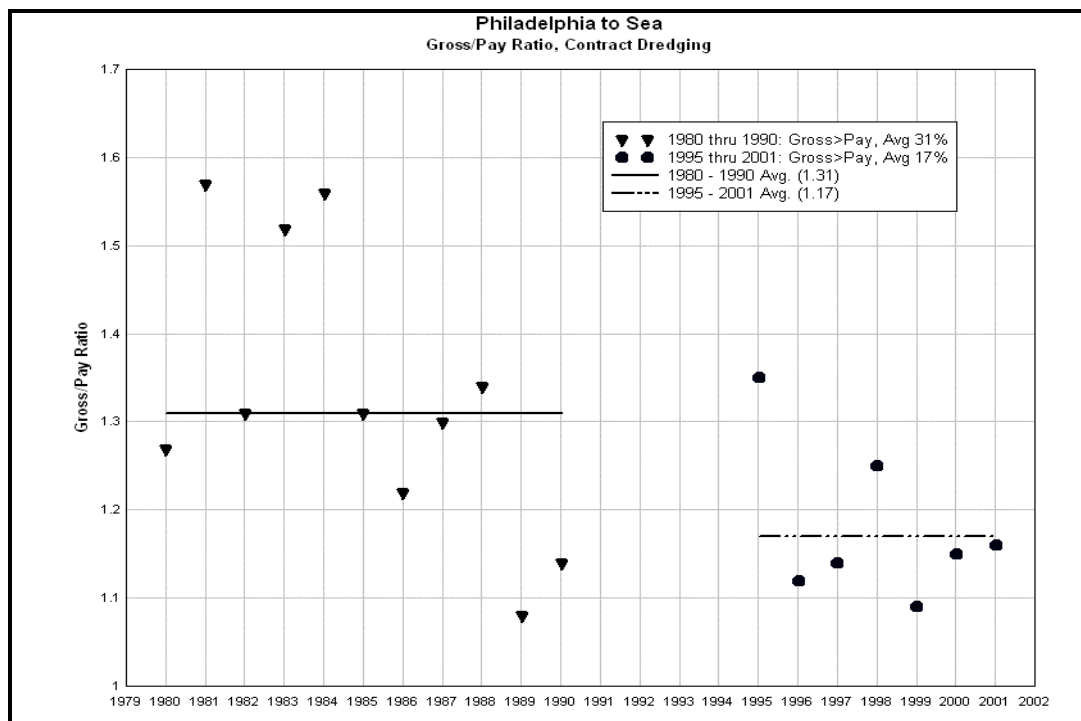
Three factors are judged to be largely responsible for the decreasing trend of O&M dredging for the project. Beginning about 1995, the Philadelphia District implemented a change in the specified allowable overdepth for dredging contracts. Prior to 1995, a value of two feet was employed, whereas the current allowable overdepth is one foot. This tighter tolerance on the pay depth for dredging contracts created an incentive for greater accuracy on the part of contractors to reduce dredged quantities beyond the pay depth, because dredging beyond the pay depth is not compensated. Figure A2 displays the change in the ratio of “gross to pay” quantities from 1980 to 2001. From 1980 through 1990, the ratio of “gross/pay” averaged 1.31 (solid line), whereas from 1995 through 2001, the same value averaged only 1.17 (dashed line.)

The second factor, more accurate dredging, in both the horizontal (location) and the vertical (depth), has become possible in the last decade with the advent of technological improvements, in particular the more widespread use of Global Positioning Systems (GPS).

The third factor is the revision of tidal datums for the Delaware Bay portion of the project. In 1997 and 1998, the District obtained controlled tidal observations at Brandywine and Ship John Lights. These observations were obtained in order to update datums that had previously been established in the 1960s. The 1997-1998 tide data were subjected to a tidal datum analysis, and

revised elevations for the plane of mean lower low water (MLLW) were calculated. The revised datum analysis demonstrated that an adjustment of about 0.3 feet was necessary, reflecting the effects generally attributed to worldwide sea level rise which has been documented as about 1 foot over the past century for the mid-Atlantic region, including the ocean coast of New Jersey and Delaware. The revised tidal datums affect approximately 40 miles of channel, all 1,000 feet wide, at the southern end of the Philadelphia to the Sea project.

Figure A-2



The data in the far right column of Table A-20 above were adjusted using the “footprint ratio” procedure developed during the PED investigation to estimate annual O&M quantities, by range, for the deepened, 45-foot channel. Values presented in Table A-20 represent gross volumes. The values shown in the last column of Table A-20 are used as the basis for calculating disposal area needs for the proposed deepening project. The estimated average annual pay quantities of O&M dredging for the deepened 45-foot project are presented in Table A-21 below. The values in Table A-21 are based on those in Table A-20 (far right column), adjusted by a factor 0.855; reflecting experience from 1995 through 2001 when the ratio of gross-to-pay dredging volumes was 1.17 (the inverse of 0.855). The values in Table A-21 thus become the basis for the calculation of average annual costs for the proposed 45-foot project.

Table A-21
Average Annual Maintenance Dredging Quantities (Pay)
Proposed 45-Foot Channel

Range	Average Annual O&M Quantity (cy)
Philadelphia Harbor	32,000
Eagle Point	0
Mifflin	75,000
Billingsport	0
Tinicum	16,000
Eddystone	0
Chester	0
Marcus Hook	1,612,000
Bellevue	0
Cherry Island	172,000
Deepwater	420,000
Bulkhead Bar	15,000
New Castle	717,000
Reedy Island	63,000
Baker	14,000
Liston	140,000
Cross Ledge	6,000
Miah Maull	141,000
Brandywine	256,000
Total	3,679,000

Estimates were prepared for maintenance dredging of both the existing 40-foot and the recommended 45-foot project for a 55-year period (5 years of construction followed by the 50-year project life). Maintenance dredging and associated costs for sections of the channel that would be completed before the base year (i.e., during the 5-year construction period) were estimated for both the 40 and 45-foot project. Estimates for the subsequent 50-year maintenance costs for the 40 and 45-foot project were also prepared. Disposal area cost estimates were developed to account for the miscellaneous dike raising during the life of the project. Costs were prepared for channel maintenance dredging, operation and maintenance of upland disposal areas including dike raisings, and operation and maintenance of wetland restoration beneficial use sites during the 50-year life of the 45-foot project. Summary maintenance costs for the 40 and 45-foot project are presented in Tables A-22 and A-23. The incremental annual operations and maintenance costs are \$3,061,377.

Table A-22
Summary of Operation and Maintenance Costs
40-Foot Project

Total Maintenance Cost - 40 FT Channel				Total Disposal Area Cost Cost - 40 FT Channel				Total PED - 40 FT Channel				Total S&A Cost - 40 FT Channel				TOTAL
Contingencies				Contingencies				Contingencies				Contingencies				
Yr -1	\$5,116,589	\$342,988	\$5,459,577	\$0	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$255,834	\$25,583	\$281,417	\$5,851,094		
Yr -2	\$6,449,142	\$427,973	\$6,877,115	\$0	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$322,457	\$32,246	\$354,703	\$7,341,818		
Yr -3	\$5,208,249	\$349,397	\$5,557,646	\$0	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$200,412	\$20,041	\$220,453	\$5,954,099		
Yr -4	\$7,316,062	\$488,657	\$7,804,719	\$0	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$305,803	\$30,580	\$336,383	\$8,317,102		
Yr -5	\$5,190,439	\$347,451	\$5,537,890	\$0	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$259,022	\$25,902	\$284,924	\$5,922,814		
Yr -6	\$6,309,502	\$460,198	\$6,769,700	\$0	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$345,475	\$34,546	\$380,023	\$7,059,723		
Yr -7	\$5,116,589	\$342,988	\$5,459,577	\$1,312,600	\$127,010	\$1,439,610	\$400,000	\$40,000	\$440,000	\$321,464	\$32,146	\$353,610	\$7,692,887			
Yr -8	\$7,316,062	\$488,657	\$7,804,719	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$365,803	\$36,580	\$402,383	\$8,317,102			
Yr -9	\$5,208,249	\$349,397	\$5,557,646	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$260,412	\$26,041	\$286,453	\$5,954,099			
Yr -10	\$6,381,692	\$458,252	\$6,839,944	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$344,095	\$34,409	\$378,494	\$7,828,438			
Yr -11	\$5,116,589	\$342,988	\$5,459,577	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$255,834	\$25,583	\$281,417	\$5,851,094			
Yr -12	\$7,407,622	\$495,066	\$7,902,688	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$370,381	\$37,038	\$407,419	\$8,420,107			
Yr -13	\$5,116,589	\$342,988	\$5,459,577	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$255,834	\$25,583	\$281,417	\$5,851,094			
Yr -14	\$6,449,142	\$427,973	\$6,877,115	\$697,300	\$65,480	\$762,780	\$400,000	\$40,000	\$440,000	\$357,322	\$35,732	\$393,054	\$8,472,949			
Yr -15	\$5,271,999	\$353,660	\$5,625,659	\$1,270,900	\$122,840	\$1,393,740	\$400,000	\$40,000	\$440,000	\$327,145	\$32,715	\$359,860	\$7,019,459			
Yr -16	\$7,084,862	\$514,473	\$7,599,335	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$384,243	\$38,424	\$422,667	\$8,732,002			
Yr -17	\$5,116,589	\$342,988	\$5,459,577	\$1,796,900	\$171,190	\$1,968,090	\$700,000	\$70,000	\$770,000	\$345,679	\$34,568	\$380,247	\$8,578,814			
Yr -18	\$6,540,702	\$434,382	\$6,975,084	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$327,035	\$32,704	\$359,739	\$7,444,823			
Yr -19	\$5,116,589	\$342,988	\$5,459,577	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$255,834	\$25,583	\$281,417	\$5,851,094			
Yr -20	\$7,748,612	\$518,036	\$8,266,648	\$972,700	\$93,020	\$1,065,720	\$400,000	\$40,000	\$440,000	\$436,066	\$43,607	\$479,673	\$10,252,441			
Yr -21	\$5,208,249	\$349,397	\$5,557,646	\$1,138,300	\$109,580	\$1,247,880	\$400,000	\$40,000	\$440,000	\$317,327	\$31,733	\$349,060	\$7,594,586			
Yr -22	\$6,449,142	\$427,973	\$6,877,115	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$322,457	\$32,246	\$354,703	\$7,341,818			
Yr -23	\$5,116,589	\$342,988	\$5,459,577	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$255,834	\$25,583	\$281,417	\$5,851,094			
Yr -24	\$7,407,622	\$495,066	\$7,902,688	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$370,381	\$37,038	\$407,419	\$8,420,107			
Yr -25	\$5,190,439	\$347,451	\$5,537,890	\$728,800	\$68,630	\$797,430	\$400,000	\$40,000	\$440,000	\$295,402	\$29,540	\$325,008	\$7,080,328			
Yr -26	\$6,817,942	\$453,789	\$7,271,731	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$340,897	\$34,090	\$374,987	\$7,756,718			
Yr -27	\$4,827,349	\$322,734	\$5,150,083	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$241,367	\$24,137	\$265,504	\$5,525,587			
Yr -28	\$6,935,162	\$461,994	\$7,397,156	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$348,759	\$34,876	\$383,634	\$7,880,590			
Yr -29	\$4,735,789	\$316,325	\$5,052,114	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$236,789	\$23,679	\$260,468	\$5,422,582			
Yr -30	\$6,592,352	\$437,998	\$7,030,350	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$329,618	\$32,962	\$362,580	\$7,502,930			
Yr -31	\$4,735,789	\$316,325	\$5,052,114	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$236,789	\$23,679	\$260,468	\$5,422,582			
Yr -32	\$6,935,162	\$461,994	\$7,397,156	\$1,200,700	\$115,820	\$1,316,520	\$400,000	\$40,000	\$440,000	\$406,793	\$40,679	\$447,472	\$9,601,146			
Yr -33	\$4,827,349	\$322,734	\$5,150,083	\$586,300	\$54,380	\$640,680	\$400,000	\$40,000	\$440,000	\$270,682	\$27,068	\$297,750	\$6,528,513			
Yr -34	\$6,068,242	\$401,310	\$6,469,552	\$1,150,000	\$110,750	\$1,260,750	\$400,000	\$40,000	\$440,000	\$360,912	\$36,091	\$397,003	\$8,567,305			
Yr -35	\$4,799,539	\$320,788	\$5,120,327	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$239,977	\$23,998	\$263,975	\$5,494,302			
Yr -36	\$7,395,522	\$494,219	\$7,889,741	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$369,776	\$36,978	\$406,754	\$8,406,495			
Yr -37	\$4,735,789	\$316,325	\$5,052,114	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$236,789	\$23,679	\$260,468	\$5,422,582			
Yr -38	\$8,080,242	\$401,310	\$8,481,552	\$1,110,100	\$106,760	\$1,216,860	\$400,000	\$40,000	\$440,000	\$359,917	\$35,992	\$394,909	\$9,521,221			
Yr -39	\$4,827,349	\$322,734	\$5,150,083	\$684,700	\$64,220	\$748,920	\$400,000	\$40,000	\$440,000	\$275,602	\$27,560	\$303,162	\$6,642,165			
Yr -40	\$7,367,712	\$492,273	\$7,859,985	\$922,900	\$88,040	\$1,010,940	\$400,000	\$40,000	\$440,000	\$414,531	\$41,453	\$455,984	\$9,766,969			
Yr -41	\$4,735,789	\$316,325	\$5,052,114	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$236,789	\$23,679	\$260,468	\$5,422,582			
Yr -42	\$6,159,802	\$407,719	\$6,567,521	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$307,090	\$30,709	\$337,799	\$7,016,310			
Yr -43	\$4,735,789	\$316,325	\$5,052,114	\$7,056,400	\$380,640	\$7,437,040	\$700,000	\$70,000	\$770,000	\$431,359	\$43,136	\$474,495	\$13,733,649			
Yr -44	\$6,935,162	\$461,994	\$7,397,156	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$348,759	\$34,876	\$383,634	\$7,880,590			
Yr -45	\$4,891,099	\$327,197	\$5,218,296	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$244,555	\$24,456	\$269,011	\$5,597,307			
Yr -46	\$6,437,042	\$427,126	\$6,864,168	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$321,852	\$32,185	\$354,037	\$7,328,205			
Yr -47	\$4,735,789	\$316,325	\$5,052,114	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$236,789	\$23,679	\$260,468	\$5,422,582			
Yr -48	\$8,923,097	\$594,587	\$9,517,684	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$440,185	\$44,019	\$484,204	\$10,119,888			
Yr -49	\$4,706,489	\$314,274	\$5,020,763	\$71,1400	\$66,890	\$778,290	\$400,000	\$40,000	\$440,000	\$270,894	\$27,089	\$297,983	\$6,537,036			
Yr -50	\$8,600,167	\$571,941	\$9,172,108	\$1,114,600	\$107,210	\$1,221,810	\$400,000	\$40,000	\$440,000	\$485,738	\$48,574	\$534,312	\$11,366,230			
Yr -51	\$4,798,049	\$320,683	\$5,118,732	\$1,231,600	\$118,910	\$1,350,510	\$400,000	\$40,000	\$440,000	\$301,482	\$30,148	\$331,630	\$7,240,872			
Yr -52	\$8,932,137	\$588,178	\$9,420,315	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$441,607	\$44,161	\$485,768	\$10,016,083			
Yr -53	\$4,706,489	\$314,274	\$5,020,763	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$235,324	\$23,532	\$258,856	\$5,389,619			
Yr -54	\$8,056,777	\$533,903	\$8,590,680	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$402,839	\$40,284	\$443,123	\$9,143,803			
Yr -55	\$4,770,239	\$318,737	\$5,088,976	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$239,512	\$23,951	\$263,463	\$5,461,339			
Total, Initial	\$331,328,416	\$22,107,915	\$353,436,331	\$23,688,200	\$1,971,370	\$25,659,570	\$11,200,000	\$1,120,000	\$12,320,000	\$17,692,471	\$1,759,247	\$19,351,718	\$40,765,819			

Table A-23
Summary of Operation and Maintenance Costs 45 – Foot Project

Total Maintenance Cost - 45 FT Channel			Total Disposal Area Cost Cost - 45FT Channel			Total PED - 45 FT Channel			Total S&A Cost - 45 FT Channel			TOTAL	
	Contingencies		Contingencies			Contingencies			Contingencies				
Yr-1	\$5,057,409	\$338,838	\$5,396,247	\$0	\$0	\$100,000	\$10,000	\$110,000	\$252,870	\$25,287	\$278,157	\$5,784,404	
Yr-2	\$6,723,732	\$447,194	\$7,170,926	\$0	\$0	\$100,000	\$10,000	\$110,000	\$339,187	\$33,919	\$369,806	\$7,650,732	
Yr-3	\$5,482,839	\$368,618	\$5,851,457	\$0	\$0	\$100,000	\$10,000	\$110,000	\$274,142	\$27,414	\$301,556	\$6,263,013	
Yr-4	\$7,320,782	\$530,987	\$7,851,769	\$0	\$0	\$100,000	\$10,000	\$110,000	\$399,039	\$39,904	\$438,943	\$8,997,412	
Yr-5	\$5,710,879	\$384,567	\$6,095,446	\$0	\$0	\$100,000	\$10,000	\$110,000	\$285,534	\$28,553	\$314,087	\$6,519,333	
Yr-6	\$9,305,342	\$627,906	\$9,933,248	\$1,324,900	\$128,240	\$1,453,140	\$1,967,000	\$40,000	\$2,007,000	\$531,512	\$53,151	\$2,060,663	\$13,978,051
Yr-7	\$5,538,569	\$372,519	\$5,911,088	\$0	\$0	\$0	\$1,667,000	\$10,000	\$1,677,000	\$278,928	\$27,893	\$304,821	\$7,892,709
Yr-8	\$12,385,262	\$843,500	\$13,228,762	\$0	\$0	\$0	\$1,667,000	\$10,000	\$1,677,000	\$619,263	\$61,926	\$681,189	\$15,586,951
Yr-9	\$5,936,409	\$400,367	\$6,336,776	\$546,700	\$50,420	\$597,120	\$400,000	\$40,000	\$440,000	\$324,155	\$32,416	\$356,571	\$7,730,467
Yr-10	\$9,583,812	\$647,399	\$10,231,211	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$479,191	\$47,919	\$527,110	\$10,868,321
Yr-11	\$5,407,479	\$363,342	\$5,770,821	\$1,880,300	\$179,530	\$2,059,830	\$700,000	\$70,000	\$770,000	\$364,389	\$36,439	\$400,828	\$9,001,479
Yr-12	\$12,039,452	\$819,293	\$12,858,745	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$601,973	\$60,197	\$662,170	\$13,630,915
Yr-13	\$5,345,129	\$358,978	\$5,704,107	\$1,129,600	\$108,710	\$1,238,310	\$400,000	\$40,000	\$440,000	\$323,736	\$32,374	\$356,110	\$7,738,527
Yr-14	\$8,651,542	\$582,140	\$9,233,682	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$432,577	\$43,258	\$475,835	\$9,819,517
Yr-15	\$8,094,359	\$405,124	\$8,499,483	\$960,700	\$91,620	\$1,052,320	\$400,000	\$40,000	\$440,000	\$349,253	\$34,825	\$384,078	\$8,265,081
Yr-16	\$12,758,262	\$869,610	\$13,627,872	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$637,913	\$63,791	\$701,704	\$14,439,576
Yr-17	\$5,844,849	\$393,958	\$6,238,807	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$292,242	\$29,224	\$321,466	\$6,670,273
Yr-18	\$8,775,342	\$590,806	\$9,366,148	\$1,334,900	\$129,230	\$1,464,030	\$400,000	\$40,000	\$440,000	\$505,507	\$50,551	\$556,058	\$11,826,236
Yr-19	\$5,377,369	\$361,235	\$5,738,604	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$269,868	\$26,987	\$296,855	\$6,144,350
Yr-20	\$12,817,812	\$873,779	\$13,691,591	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$640,891	\$64,089	\$704,980	\$14,506,571
Yr-21	\$5,936,409	\$400,367	\$6,336,776	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$298,820	\$29,882	\$328,702	\$6,773,278
Yr-22	\$9,151,262	\$617,120	\$9,768,382	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$457,563	\$45,756	\$503,319	\$10,381,701
Yr-23	\$5,844,849	\$393,958	\$6,238,807	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$292,242	\$29,224	\$321,466	\$6,670,273
Yr-24	\$12,009,342	\$817,186	\$12,826,528	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$600,467	\$60,047	\$660,514	\$13,587,042
Yr-25	\$5,441,119	\$365,098	\$5,806,217	\$1,225,100	\$114,010	\$1,339,110	\$700,000	\$70,000	\$770,000	\$333,311	\$33,331	\$366,642	\$6,282,569
Yr-26	\$9,082,092	\$612,320	\$9,694,412	\$2,199,500	\$211,450	\$2,410,950	\$700,000	\$70,000	\$770,000	\$504,110	\$50,411	\$554,521	\$13,496,483
Yr-27	\$5,499,039	\$369,751	\$5,868,790	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$274,952	\$27,495	\$302,447	\$6,281,237
Yr-28	\$11,917,782	\$810,777	\$12,728,559	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$595,889	\$59,589	\$655,478	\$13,484,037
Yr-29	\$5,538,569	\$372,519	\$5,911,088	\$1,259,500	\$121,700	\$1,381,200	\$400,000	\$40,000	\$440,000	\$339,903	\$33,990	\$373,893	\$6,106,181
Yr-30	\$9,369,092	\$632,369	\$10,001,461	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$468,455	\$46,846	\$515,301	\$10,626,762
Yr-31	\$5,381,569	\$361,529	\$5,743,098	\$940,900	\$89,840	\$1,030,740	\$400,000	\$40,000	\$440,000	\$316,123	\$31,612	\$347,735	\$7,561,573
Yr-32	\$11,921,982	\$811,071	\$12,733,053	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$598,099	\$59,810	\$657,909	\$13,486,762
Yr-33	\$5,436,689	\$365,387	\$5,802,076	\$1,038,100	\$99,560	\$1,137,660	\$400,000	\$40,000	\$440,000	\$323,739	\$32,374	\$356,113	\$7,735,849
Yr-34	\$8,944,982	\$595,681	\$9,440,663	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$442,249	\$44,225	\$486,474	\$10,037,137
Yr-35	\$5,602,319	\$376,982	\$5,979,301	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$280,116	\$28,012	\$308,128	\$6,387,429
Yr-36	\$12,845,822	\$875,725	\$13,721,547	\$1,017,700	\$97,520	\$1,115,220	\$400,000	\$40,000	\$440,000	\$693,168	\$69,317	\$762,485	\$16,039,050
Yr-37	\$5,844,849	\$393,958	\$6,238,807	\$1,265,000	\$118,000	\$1,383,000	\$700,000	\$70,000	\$770,000	\$555,492	\$55,549	\$611,041	\$8,782,846
Yr-38	\$8,844,982	\$595,681	\$9,440,663	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$442,249	\$44,225	\$486,474	\$10,037,137
Yr-39	\$5,031,559	\$337,028	\$5,368,587	\$2,293,400	\$220,840	\$2,514,240	\$700,000	\$70,000	\$770,000	\$368,249	\$36,825	\$405,074	\$9,055,700
Yr-40	\$11,912,122	\$810,387	\$12,722,509	\$871,200	\$82,670	\$953,870	\$400,000	\$40,000	\$440,000	\$629,171	\$62,917	\$692,088	\$14,588,757
Yr-41	\$5,538,569	\$372,519	\$5,911,088	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$278,928	\$27,893	\$304,821	\$6,325,709
Yr-42	\$9,743,102	\$658,549	\$10,401,651	\$1,101,100	\$105,880	\$1,206,980	\$400,000	\$40,000	\$440,000	\$492,210	\$49,221	\$541,431	\$11,520,042
Yr-43	\$5,345,129	\$358,978	\$5,704,107	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$267,256	\$26,726	\$293,982	\$6,108,089
Yr-44	\$12,078,982	\$822,061	\$12,901,043	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$603,949	\$60,395	\$664,344	\$13,675,387
Yr-45	\$5,500,439	\$369,850	\$5,870,289	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$275,022	\$27,502	\$302,524	\$6,282,813
Yr-46	\$8,024,542	\$508,250	\$8,532,792	\$919,900	\$87,740	\$1,007,640	\$400,000	\$40,000	\$440,000	\$497,222	\$49,722	\$546,944	\$11,627,376
Yr-47	\$5,849,049	\$394,252	\$6,243,301	\$1,001,500	\$95,900	\$1,097,400	\$400,000	\$40,000	\$440,000	\$342,527	\$34,253	\$376,780	\$6,157,481
Yr-48	\$12,476,822	\$849,909	\$13,326,731	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$623,841	\$62,384	\$686,225	\$14,122,956
Yr-49	\$5,538,569	\$372,519	\$5,911,088	\$1,278,100	\$123,560	\$1,401,660	\$400,000	\$40,000	\$440,000	\$340,833	\$34,083	\$374,916	\$6,127,664
Yr-50	\$9,277,532	\$625,960	\$9,903,492	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$463,877	\$46,388	\$510,265	\$10,523,757
Yr-51	\$5,436,689	\$365,387	\$5,802,076	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$271,834	\$27,183	\$298,017	\$6,211,093
Yr-52	\$13,968,257	\$947,706	\$14,915,963	\$1,106,200	\$106,370	\$1,212,570	\$400,000	\$40,000	\$440,000	\$753,723	\$75,372	\$829,095	\$17,387,628
Yr-53	\$4,939,999	\$330,619	\$5,270,618	\$1,708,400	\$162,340	\$1,870,740	\$700,000	\$70,000	\$770,000	\$332,420	\$33,242	\$365,662	\$6,277,020
Yr-54	\$10,420,687	\$699,375	\$11,120,062	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$521,034	\$52,103	\$573,137	\$11,893,199
Yr-55	\$5,473,359	\$367,954	\$5,841,313	\$0	\$0	\$0	\$100,000	\$10,000	\$110,000	\$273,688	\$27,367	\$301,055	\$6,252,348
Total, Initial	\$437,735,076	\$29,569,542	\$467,304,618	\$26,202,600	\$2,505,510	\$28,708,110	\$18,201,000	\$1,360,000	\$19,561,000	\$23,199,878	\$2,319,888	\$25,519,766	\$541,190,294

Associated costs for operations and maintenance include any increase in the annual operations and maintenance costs of benefiting entities, in excess of those needed to maintain their facilities for the existing 40 foot project. Estimated costs are shown in Table A-24. Estimates were prepared for both the 40 and 45 foot maintenance berth dredging over 50-years. The incremental maintenance costs for maintaining the 45-foot depth at the berthing area (s) (i.e., the difference between the maintenance costs of the 45 and 40 foot depths) is included in the estimate.

The maintenance dredging estimates for existing conditions (40 feet) at non-Federal associated facilities were developed from interview data provided by the owner-operator of each facility. These data were verified against Corps of Engineers' hydrographic surveys and dredging permit records for the period 1992 through 2001 and found to be reasonable. The estimates of

maintenance dredging required for the improved condition (45 feet) were established using a procedure presented in Chapter 9, "Maintenance Dredging in Channels and Harbors" in the Handbook of Dredging Engineering by John Herbich. This procedure utilizes user-selected input values for the principal hydraulic and sedimentologic characteristics of each site, as well as an empirical knowledge of the existing shoaling rates. The results of these calculations are presented in the fourth column of Table A-24 below.

Table A-24
Associated Maintenance Dredging Volumes and Cost

Facility	Area to be Dredged (Square feet)	Current Maintenance Dredging Volumes to 40 feet (Cubic yards)	<u>Incremental</u> Maintenance Dredging Volumes 40 to 45 feet (Cubic yards)	<u>Incremental</u> <u>Average</u> <u>Annual</u> Dredging Cost
SJPC - Beckett Street	325,045	10,000 every five years	3,000 every five years	\$1,546
PRPA- Packer Ave	358,620	90,000 every two years	20,000 every two years	\$55,179
Valero	747,738	0	0	0
SUNOCO - Marcus Hook	889,199	25,000 every five years	95,000 every five years	\$58,837
SUNOCO – Fort Mifflin/Hog Island	400,732	0	0	0
Tosco (Phillips 66)	667,649	125,000 every year	5,000 every year	\$21,724
Coastal Eagle Point Oil Co.	647,003	0	0	0
Delaware Terminals	0	0	0	0

4.0 SENSITIVITY ANALYSES

Two sensitivity analyses were conducted to analyze the effects of uncertainty on the project first costs (which include construction costs, engineering and design, and construction management). The first sensitivity analysis considered potential impacts on the federal dredging cost estimate from differing assumptions concerning dredging efficiency, dredge selection, and material composition. The second sensitivity analysis addressed alternative levels of contingencies in the project cost estimate.

4.1. *Federal Dredging Costs*

Sensitivity analyses were conducted to analyze the effects of uncertainty on the project first costs. The sensitivity analyses considered potential impacts on the federal dredging cost estimate

from differing assumptions concerning dredging efficiency, dredge selection, and material composition. The sensitivity analyses conducted for this analysis include the following:

Sensitivity Test #1 -an increase in the effective hopper capacity of hopper dredges for no overflow conditions from roughly 25% of hopper volume to 35% of hopper volume;

Sensitivity Test #2 -economic loading allowing for overflow;

Sensitivity Test #3 - excavation of potentially pre-blasted/fractured rock with a cutter suction pipeline dredge; and

Sensitivity Test #4 - a 25% increase in the volume of rock quantity.

The results of the sensitivity analyses are shown in Table A-25 below.

Table A-25
Sensitivity Analyses on Project Costs
(\$ Millions)

Sensitivity Analyses	First Cost (\$ millions)	Change from Base Estimate	Percent Change from Base Estimate
Base Estimate	\$208.4	\$0.0	0%
Test # 1	\$190.3	-\$18.1	-9%
Test # 2	\$180.0	-\$28.4	-14%
Test # 3	\$199.1	-\$9.3	-4%
Test # 4	\$211.6	\$3.2	2%

Tests #1, #2 and #3 act to reduce the cost compared to the base cost, whereas Test #4 results in a cost increase. Test #1 is plausible inasmuch as existing field data support the increased hopper load for no overflow. Test #2 can only be achieved with hopper overflow, but there are good reasons to consider overflow since existing field data show that overflow in the Delaware River would not adversely impact the physical environment. Test #3 considers the possibility that some previously blasted rock could be removed with another dredged type. Test #3 can be verified through further study. Test #4 is more hypothetical as the rock quantities are based on detailed geotechnical and survey information. The project benefit cost ratio remains above unity in each of these four test cases.

4.2. Contingency Estimates

In comments received during quality control and external independent technical reviews, it was suggested that a sensitivity analysis be conducted to support the contingency factors used in the project cost estimate.

In order to address this concern, simulation analyses have been performed for two representative dredging cases: the hydraulic pipeline dredge estimate for Reach C in Contract Number 1, and the hopper dredge estimate for Broadkill Beach in Contract Number 6. The rock dredging in Contract Number 5 already includes a high (20.3%) contingency factor, so further analysis of this contract estimate was unwarranted. The results of the pipeline and hopper dredge simulations are presented below, followed by printouts of the simulation models.

4.2.1. Pipeline Dredge Estimate

The pipeline dredge estimate was computed using a simulation analysis that included statistical distributions for dredge material factors for mud and silt as well as loose sand. The project cost estimate uses a factor of either 2.5 or 2.0 for mud and silt, a factor of 1.1 for loose sand. The risk analysis was prepared assuming a triangular distribution with minimum, most-likely and maximum factors of 2, 2.5 and 3.0 for mud and silt. Similarly, a triangular distribution (minimum = 1, most likely = 1.1 and maximum = 1.1) was used for loose sand.

Results of the risk analysis produced unit costs ranging from \$1.82 to \$2.55 as compared to the presently reported value of \$2.26. The contingency used for Contract 1 was 6.6%, which applied to the \$2.26 value, corresponds to a unit cost of \$2.41. The risk analysis indicates this contingency corresponds to a 92% confidence level that the estimated cost with contingency is not exceeded.

4.2.2. Hopper Dredge Estimate

The hopper dredge estimate was also evaluated using a simulation analysis that included statistical distributions for: (1) effective hopper size, (2) hopper pump-out rate, and (3) turn time. The fixed value of 1,900 cubic yards (cy) for hopper size was replaced by a triangular distribution with minimum, most-likely and maximum values of 1,600 cubic yards, 1,900 cubic yards, and 2,800 cubic yards, respectively. These values are based on estimates for existing dredges rather than a generic average dredge. The 4,200-cy/hour hopper pump-out rate was replaced with a triangular distribution characterized by a minimum of 4,200 cy/hour, a likely value of 4,200 cy/hour and a maximum of 4,500 cy/hour. Again this distribution is based on the characteristics of actual dredges rather than the generic average. Finally, the estimated turn around time of 10 minutes was characterized by a triangular distribution of 5 minutes minimum, 10 minutes most likely, and 10 minutes maximum. These numbers are based on records for other hopper dredging projects that indicate the 10-minute turn is conservative.

Results of the risk analysis produce unit costs ranging from \$6.65 to \$9.04 per cy and can be compared to the current estimate of \$8.25. A contingency of 7.4% has been used in the current estimate and, applied to \$8.25, gives \$8.86. According to the risk analysis, there is a 96% level of confidence that the actual cost will be less than the fixed cost plus the contingency included in the project cost estimate.

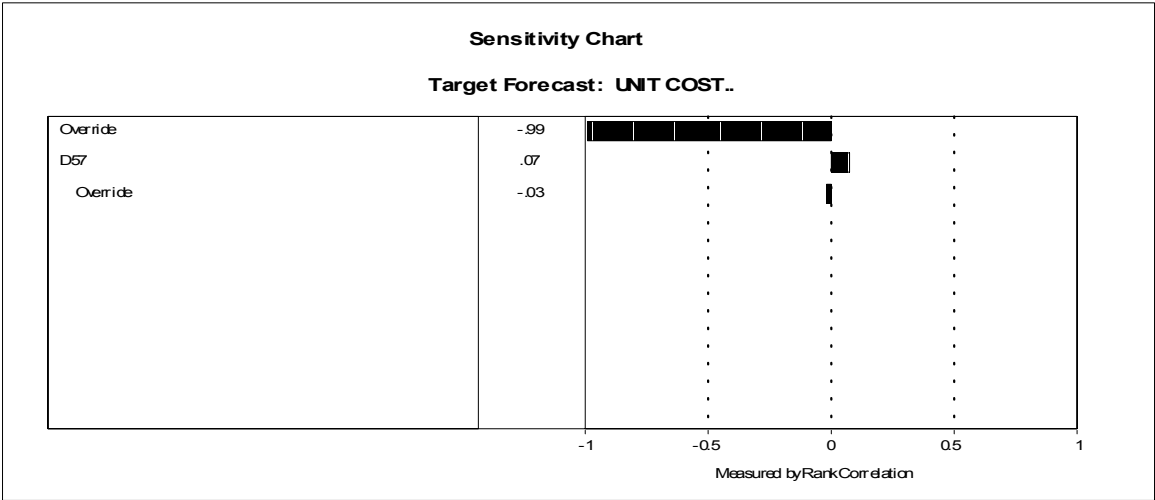
4.2.3. Summary

These results indicate that the selected contingency levels are reasonable and indicative of the fact that contract bids received for past dredging operations in the Delaware River have been consistent with the contingency factors used in the project cost estimate. Furthermore, it should be noted that it is significant that the hopper dredge estimate is conservative inasmuch as the

largest project costs are associated with hopper dredging. A review of historical estimates to bid prices is provided in the graph below.

Hopper Probability Analysis
Crystal Ball Report

Simulation started on 12/2/02 at 14:42:49
Simulation stopped on 12/2/02 at 14:46:13



Forecast: UNIT COST..

Cell: E1

Summary:

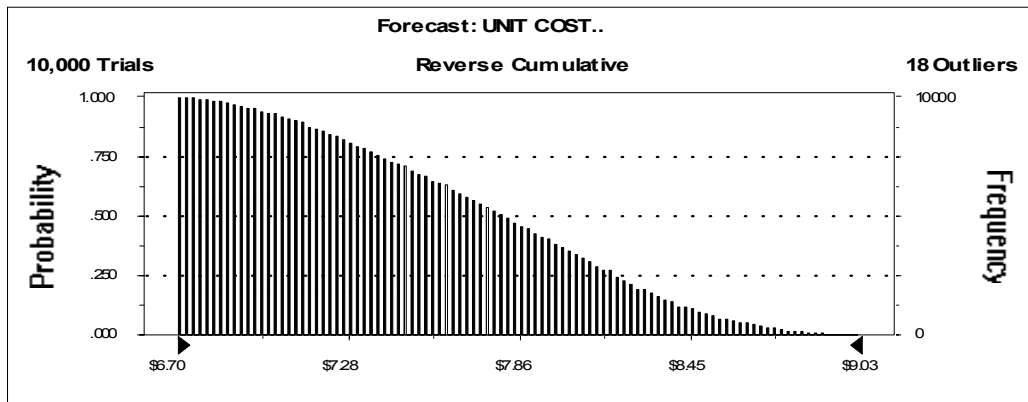
Display Range is from \$6.70 to \$9.03

Entire Range is from \$6.65 to \$9.09

After 10,000 Trials, the Std. Error of the Mean is \$0.01

Statistics:

	<u>Value</u>
Trials	10000
Mean	\$7.79
Median	\$7.80
Mode	\$8.17
Standard Deviation	\$0.52
Variance	\$0.27
Skewness	0.01
Kurtosis	2.21
Coeff. of Variability	0.07
Range Minimum	\$6.65
Range Maximum	\$9.09
Range Width	\$2.44
Mean Std. Error	\$0.01



Forecast: UNIT COST.. (cont'd)

Cell: E1

Percentiles:

<u>Percentile</u>	<u>Value</u>
0%	\$6.65
10%	\$7.10
20%	\$7.29
30%	\$7.48
40%	\$7.65
50%	\$7.80
60%	\$7.96
70%	\$8.12
80%	\$8.26
90%	\$8.48
100%	\$9.09

End of Forecast

Assumptions

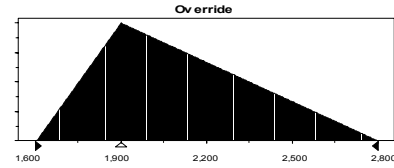
Assumption: Override

Cell: D46

Triangular distribution with parameters:

Minimum	1,600
Likeliest	1,900
Maximum	2,800

Selected range is from 1,600 to 2,800



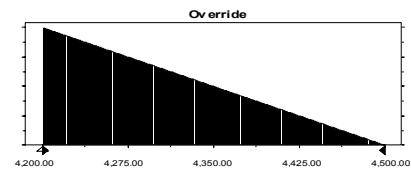
Assumption: Override

Cell: D77

Triangular distribution with parameters:

Minimum	4,200.00
Likeliest	4,200.00
Maximum	4,500.00

Selected range is from 4,200.00 to 4,500.00



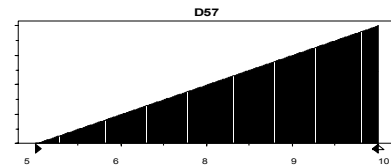
Assumption: D57

Cell: D57

Triangular distribution with parameters:

Minimum	5
Likeliest	10
Maximum	10

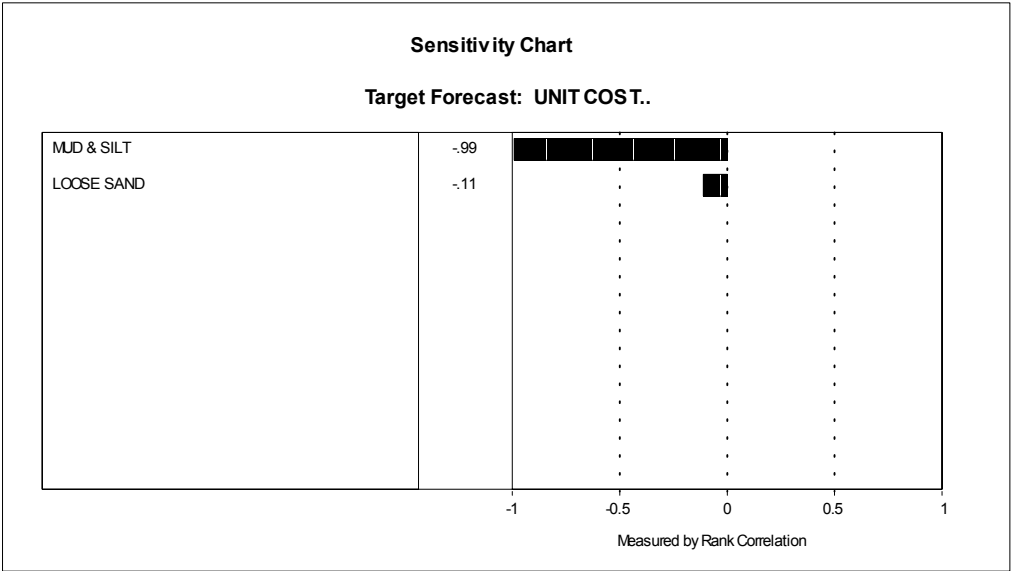
Selected range is from 5 to 10



End of Assumptions

Pipeline Probability Analysis
Crystal Ball Report

Simulation started on 12/2/02 at 14:56:05
Simulation stopped on 12/2/02 at 14:58:16



Forecast: UNIT COST..

Cell: E1

Summary:

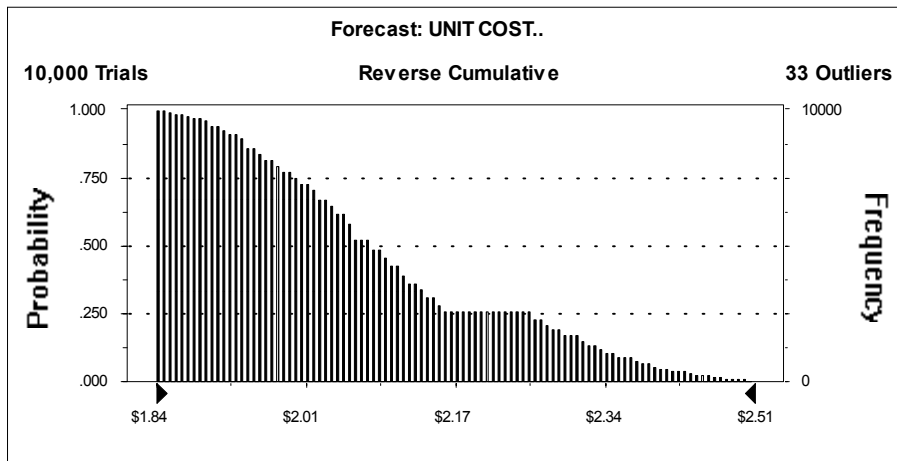
Display Range is from \$1.84 to \$2.51

Entire Range is from \$1.82 to \$2.55

After 10,000 Trials, the Std. Error of the Mean is \$0.00

Statistics:

	<u>Value</u>
Trials	10000
Mean	\$2.11
Median	\$2.08
Mode	\$2.06
Standard Deviation	\$0.16
Variance	\$0.02
Skewness	0.61
Kurtosis	2.48
Coeff. of Variability	0.07
Range Minimum	\$1.82
Range Maximum	\$2.55
Range Width	\$0.73
Mean Std. Error	\$0.00



Forecast: UNIT COST.. (cont'd)

Cell: E1

Percentiles:

<u>Percentile</u>	<u>Value</u>
0%	\$1.82
10%	\$1.93
20%	\$1.97
30%	\$2.02
40%	\$2.05
50%	\$2.08
60%	\$2.11
70%	\$2.15
80%	\$2.28
90%	\$2.35
100%	\$2.55

End of Forecast

Assumptions

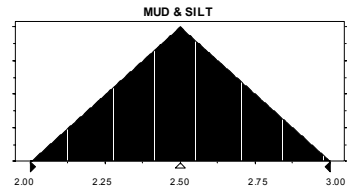
Assumption: MUD & SILT

Cell: C42

Triangular distribution with parameters:

Minimum	2.00
Likeliest	2.50
Maximum	3.00

Selected range is from 2.00 to 3.00



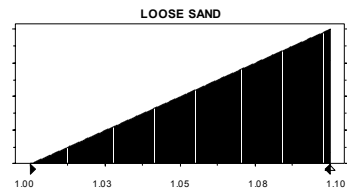
Assumption: LOOSE SAND

Cell: C44

Triangular distribution with parameters:

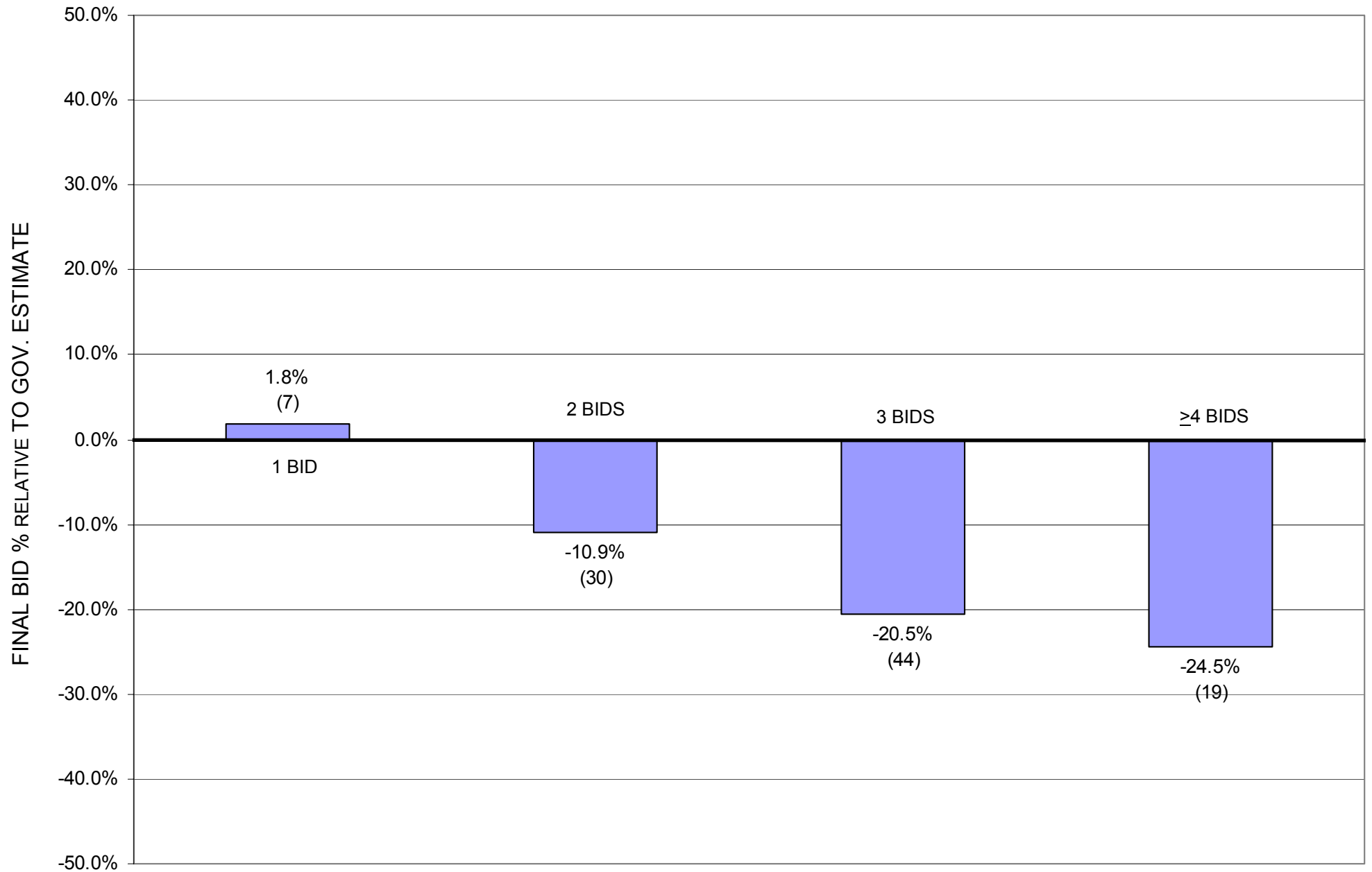
Minimum	1.00
Likeliest	1.10
Maximum	1.10

Selected range is from 1.00 to 1.10



End of Assumptions

DREDGING CONTRACTS AWARDED 1992-2001 PHILADELPHIA



*Number in parenthesis indicates number of contracts falling into that category.