being strictly managed by the Federal and State natural resource agencies to ensure the harbor's waters can provide its desired uses. The drinking water aquifer is a resource of major concern. Substantial impacts to that resource would have major economic and possibly environmental effects. Erosion of Tybee Island, located adjacent to and down-drift from the entrance channel, is a concern. Fishery resources in the harbor are a concern. The harbor contains numerous species that are managed on both the Federal and State level. Endangered species which reside in or use the harbor are a concern. The cumulative impact analysis for the SHEP is found in Appendix L in the EIS.

Savannah District believes the proposed harbor deepening could be accomplished in an environmentally-acceptable manner. The proposed alternatives contain mitigation plans for all significant adverse impacts.

10 Alternative Plan Evaluation: Costs

This chapter presents the detailed alternative plan evaluation that was conducted to identify the NED plan. The detailed alternative plan evaluation was prepared in accordance with Corps' guidance on formulation and evaluation of deep draft navigation projects as described in:

- The Planning Guidance Notebook, ER 1105-2-100 (22 April 2000);
- National Economic Development Procedures Manual: Deep Draft Navigation, IWR Report 10-R-4 (November 1991);
- Digest of Water Resource Policy and Authorities, EP 1165-2-1 (30 July 1999);
- Policy for Implementation and Integrated Application of the USACE Environmental Operating Principles and Doctrine, ER 200-1-5 (30 October 2003);
- Engineering and Design for Civil Works Projects, ER 1110-2-1150 (31 August 1999); and
- Planning in a Collaborative Environment, EC 1105-2-409 (31 May 2005).

10.1 Identification of Alternative Plan Elements

Each of the alternative plans carried forward for detailed analysis includes shared elements, which are integral to the project design, and incremental elements which constitute the differences between the alternatives. The shared elements are included in each of the alternative plans. Shared plan elements include:

- Preparation and restoration of DMCA 14A & 14B so that these disposal areas can be used to isolate cadmium-laden sediments. Preparation and restoration activities include clearing, grubbing, dike improvements, drainage modifications, geotextile placement in support of dike improvements, and habitat restoration;

- Channel widening at the three bends (Jones Island Range, Lower Flats Range, and Fort Jackson Range) identified for design vessel passage by the ship simulation analysis; and
- Extension of the Kings Island Turning Basin to a 1,600 foot diameter as identified in the ship simulation study.

The incremental elements of the alternative plans include:

- Channel deepening from the sea to Garden City Terminal in one-foot increments from -44 feet MLLW to -48 feet MLLW; and
- Channel widening to create meeting areas (locations were ships heading in opposite directions can pass each other) at two incremental locations:
    - Long Island; and
    - Oglethorpe.

10.2 Detailed Descriptions of Alternative Plans

Detailed descriptions of alternative plans include location of plan elements, description of the purpose and implementation of the plan element, and dredging and excavation quantities of each plan element. The environmental impacts of each alternative plan are presented in Chapter 8: Alternative Plan Evaluation: Environmental Impacts.

10.2.1 Shared Plan Elements

DMCA 14A Modifications

Preparation of DMCA 14A and 14B prior to the placement of cadmium-laden sediments includes clearing and grubbing vegetation and raising the DMCA 14A back confinement dike to elevation 22 MLLW using material from DMCA 14B. Material removed from Area 14B will also be used to raise the dikes at containment area 13B. Geotextile will be used beneath the back dike as a counterweight to control settlement and movement of the soft foundation beneath the improved back dike. After the last of the cadmium-laden sediments have been placed in DMCA 14A and/or 14B, the dredged sediment will be covered with approximately 2 feet of suitable clean material. After the cadmium and cover has been placed, the dikes, finger dike, weirs, and bird habitat will be raised to about elevation 28 feet MLLW. Weir and drainage modifications will be made based on the new configuration. Bird habitat on the DMCA will be restored.

Bend Wideners

Three bend wideners were recommended by the Ship Simulation Analysis conducted on the *Susan Maersk* (the design vessel). The recommendations of the analysis are:

- Widen the bend at the Jones Island Range to the north (it is currently widened to the south);
- Widen the bend at the Lower Flats Range to the north, and

- Widen the Fort Jackson Range to the north.

Kings Island Turning Basin

The Ship Simulation Analysis indicated a 1,600-foot diameter turning basin would be adequate for turning the design vessel.

Meeting Areas

A potential meeting area at Marsh Island was considered but not recommended for detailed investigation due to existing land uses. Two meeting areas were considered in this analysis: Long Island Meeting Area and Oglethorpe Meeting Area. A third alternative was considered, which include both meeting areas together. The meeting area analysis estimated benefits due to reductions in the estimated time required to navigate Savannah Harbor as a result of channel modifications (meeting areas). Transit times and transportation costs were estimated in terms of reduced vessel delays.

There are no utility relocation costs projected for the meeting area alternatives. There are cadmium laden sediments in both of the alternative meeting areas. Cadmium laden sediments from the Long Island Meeting Area will be placed in DMCA 14A/14B and Cadmium-laden sediments from the Oglethorpe Meeting Area will be placed in DMCA 14A. Therefore, modifications to DMCA 14A and 14B are a common element of meeting area construction. Construction and investment costs for the meeting area alternatives are calculated in October 2010 dollars. Average annual costs and benefits are calculated using the FY 2011 Federal discount rate of 4.125 percent.

Table 10-1 presents the Meeting Area dredged material volumes for each depth increment. These Meeting Area volumes are included in the overall deepening material volume estimates.

Table 10-1: Dredged Material Volume Estimates[1]: Meeting Areas (cubic yards)

	Project Depth (- feet MLLW)				
Meeting Area	**-44**	**-45**	**-46**	**-47**	**-48**
Long Island	350,859	384,096	417,783	450,941	484,231
Oglethorpe	362,348	384,089	405,461	426,336	446,541

[1] Includes two feet of allowable over-depth

10.2.2 Incremental Project Elements

Incremental Channel Depth

Each alternative plan is based on the full length of the channel being deepened on existing side slopes, with the exception of six channel bends which will be cut to maintain existing bottom widths, and three channel bends that require widening based on the Ship Simulation Analysis. Note that one channel bend would be deepened on existing side slopes similar to the rest of the channel. Each depth increment includes Meeting Area dredged material volumes.

Table 10-2 presents the dredged material volumes for each one-foot increment of depth, including allowable two feet of over-depth dredging. The table also presents the source area of the material (by range) and the projected dredged material placement location. Figures 1-8 and 1-9 in the sub-chapter 1.4 Existing Navigation Project identify the dredged material disposal locations.

Table 10-2: Dredged Material Volume Estimates:[1] Incremental Deepening Alternatives (cubic yards)

		Project Depth (Feet Below MLLW)				
Range (000's)	**Placement Site**	**-44**	**-45**	**-46**	**-47**	**-48**
-98 to -57	ODMDS	1,667,123	2,242,371	2,925,432	3,736,308	4,613,909
57 to -53	ODMDS	156,623	235,127	313,391	391,437	469,252
-53 to -40	ODMDS	646,796	975,843	1,304,385	1,632,346	1,959,186
-40 to -30	ODMDS	505,693	771,105	1,038,620	1,305,921	1,573,800
-30 to -20	ODMDS	529,910	801,974	1,076,638	1,352,115	1,628,379
-20 to -10	ODMDS	473,047	746,614	1,028,399	1,311,222	1,594,871
-10 to 00	ODMDS	346,997	532,621	723,394	917,064	1,110,713
00 to 4	ODMDS	101,482	166,705	235,626	305,674	375,403
4 to 6	Jones Oyster Is.	48,128	87,346	130,559	174,073	217,263
6 to 30[A]	14B	1,264,730	1,756,993	2,258,262	2,759,203	3,259,272
30 to 45[2]	14A	684,583	1,052,928	1,426,462	1,802,866	2,181,609
45 to 51[2]	14B	324,752	508,740	699,013	892,307	1,088,128
51 to 57[B]	14A	652,793	801,504	951,201	1,101,114	1,251,494
57 to 67[C]	14 A & B	588,884	807,450	1,026,002	1,244,681	1,463,393
67 to 80	13A	444,210	691,727	944,611	1,196,291	1,446,786
80 to 90	14A	380,724	570,368	759,169	946,436	1,132,066
90 to 103[D]	13A	1,438,457	1,803,823	2,169,594	2,533,434	2,895,175
Totals		10,254,932	14,553,239	19,010,758	23,602,492	28,260,699

[1]Includes 2 feet of allowable over-depth and widening for Long Island and Oglethorpe passing areas
[2] Cadmium-laden sediments from Miocene clays in ranges 24 to 45 to be placed in DMCA 14A
[A] Includes Long Island Meeting Area, Station 14 to 22
[B] Includes Oglethorpe Meeting Area, Station 55 to 57
[C] Includes Oglethorpe Meeting Area, Station 57 to 59
[D] Includes Kings Island Turning Basin

10.3 Alternative Plan Costs

Potential project costs include construction costs (including mitigation), real estate costs, economic costs (interest during construction), engineering and design, supervision and administration, and operation and maintenance costs (Engineering Appendix: Chapter 13 Cost Engineering). Project costs also include any associated non-Federal costs (non-cost shared), such as berth deepening, landside infrastructure, or other modifications that must be incurred in order for project benefits to be realized. The only associated costs included in the analysis are berth deepening costs (non-Federal). There are no other associated costs. All costs are calculated using October 2010 dollars, a 50-year project life, and all discounting is conducted at the FY 2011 Federal discount rate (4.125%).

The Current Working Estimate (CWE) is for construction and non-construction features and includes all work necessary to deepen the harbor to a new design depth ranging from 44 to 48 feet below MLLW. The existing design depth for the Savannah Harbor is 42 feet below MLLW. Existing advance maintenance depths range from 2 to 6 feet below the design depth.

The CWE includes new deepening quantities, advance maintenance and 2-feet allowable overdepth quantities, removal of incidental O&M sediment, meeting area dredge requirements, required mitigation features including oxygen injection system, raising existing disposal area dikes, cadmium sediment removal, removal of the Confederate vessel CSS Georgia, Real Estate, Planning, Engineering and Design, Construction Management, and the addition of Navigation Aids.

Cost Estimates were prepared under guidance given in the Corps of Engineers Regulation ER 1110-2-1302, *Civil Works Cost Engineering* and Engineering Technical Letter ETL 1110-2-573, *Engineering and Design: Construction Cost Estimating Guide for Civil Works*. The Corps of Engineers Dredge Estimating Program (CEDEP) was used in developing dredging costs throughout the project for medium hopper dredges and large pipeline cutterhead dredges. A Cost Risk Analysis was conducted by the Center of Expertise at Walla Walla District to support contingency percentages for risk and uncertainty.

10.3.1 Construction Cost Narrative

Construction elements which comprise the construction costs of each incremental depth alternative include:

- Modifications to DMCA 14A and 14B to isolate cadmium laden sediments;
- Removal and preservation of CSS Georgia;
- Dredging and placement of dredged material from three bend wideners;
- Dredging and placement of material from the Kings Island Turning Basin extension;
- Dredging and placement of material from channel deepening;

- Dredging and placement of material from meeting area construction;
- Real estate costs for Kings Island Turning Basin extension;
- Interest during construction;
- Engineering and design (E&D) and supervision and administration (S&A); and
- Garden City Terminal berth deepening (associated cost, not Federally cost shared).

There are no other associated costs other than berth deepening, identified above. There are no utility relocations and, therefore, no utility relocation costs associated with the alternative plans.

The following sub-sections describe the cost assumptions used to develop alternative plan costs in the Code of Accounts framework.

Lands and Damages (01) – The estimated cost was furnished by the Real Estate Division, Savannah District and is discussed in the Real Estate Appendix. A contingency of 25% was established for this account and reviewed during the Cost Risk Analysis. All real estate costs are at the October 2010 price level.

Fish and Wildlife Facilities (06) – This account includes costs for mitigation including a fish passage structure at New Savannah Bluff Lock and Dam, salinity mitigation for deepening the harbor, creation of a marsh habitat at Disposal Area 1S, removal of the Tidegate structure, a raw water storage impoundment with mechanical mixing, and oxygen injection systems to inject oxygen at three (3) locations along the harbor.

Emphasis was placed on accuracy of quantities, material characteristics, and detail costs during evaluation of alternative plans to develop the CWE Plan. The reasonableness of costs developed was evaluated based on historical data, discussions with industry, crew production rates and construction methods based on similar projects.

A Fish Passage structure at New Savannah Bluff Lock and Dam will be constructed to allow fish passage upstream of the dam. The structure would consist of an off-channel rock ramp constructed around the South Carolina side of the dam. The primary construction tasks involve excavation of approximately 275,000 cubic yards of material around the end of the dam and placement of 116,000 tons of rip rap and boulder weir stone. Existing 12 foot high overflow gates 1 and 5 would be replaced with 15 foot high lift gates, making them uniform with gates 2, 3 and 4. The fish passage will carry all of the river flow during low flow periods, up to a typical flow of 8,000 cfs, at which time the lift gates will gradually be opened to pass larger flows without causing an increase in upstream flood elevations.

A combination of features will be constructed to mitigate for potential salinity impacts in the river as described by Mitigation Plans 6A and 6B. More detail of all these features are described in Chapter 8.1 of the Engineering Appendix. McCoy's Cut Diversion feature is diverting a portion of flow from Front River into the upstream

areas at McCoy's Cut. This feature includes constructing a diversion structure with 168 tons of sheet pile wall and 7,100 tons of GADOT Armor Stone at the entrance to McCoy's Cut. Additionally, a portion of lower western McCoy's connection will be closed using over 5,100 tons of GADOT TYPE 1 stone.

McCoy's Cut and upper portions of Middle River and Little Back River will be deepened to accommodate the additional diverted flow. Estimated deepening quantities excavated for McCoy's Cut, Middle and Little Back Rivers will be 315,000 cubic yards. This material will be disposed of in the existing Dredge Confined Disposal Facilities used for dredged material disposal.

Rifle Cut waterway will be closed using 3,300 cubic yards of fill sediment and 2,500 tons of GADOT, Type 1 rip rap to improve flow diversion.

Additional features include removal/demolition of the Tidegate structure piers and abutment (elevated walkways and associated appurtenances) as well as the Tidegate embankment removal to widen the river. The approximately 1,000,000 cubic yards of embankment at the Tidegate abutments will be removed and disposed of in either the Broad Berm fill area, if it is suitable fill, or existing confined dredged material disposal areas.

A submerged stone Broad Berm will be constructed at the confluence of Back River with Front River. The berm is located downstream of the Tidegate and Sediment Basin. The berm will be constructed of 97,000 tons of GADOT, TYPE 1 stone to -9.5 MLLW. In addition, a Broad Berm fill, upstream or behind the stone broad berm, will require 1.2 million cubic yards of suitable (sandy) fill material. The suitable fill is assumed to come from existing dredge confined disposal areas and/or the embankment removal at the Tidegate.

Marsh restoration of 40.3 acres will be conducted at the current location of Disposal Area 1S to an elevation of +7.6 ft MLLW. Construction includes excavation/grading of 435,000 cubic yards of material with assumed disposal into existing confined disposal areas.

A proposed public access Boat Ramp on Hutchinson Island includes a 2-lane concrete boat ramp with floating dock, 20 space trailer parking, handicap-accessible and single car parking spaces.

Onsite oxygen injection systems will be constructed at two locations along the river to supply oxygen to three injection sites. The two oxygen injection systems sites will have multiple Speece cones to generate oxygen into the harbor.

A Raw Water Storage Impoundment will be constructed in order to stabilize and reduce any necessary chloride concentrations before being pumped into the City of Savannah's water treatment plant. An earthen embankment with HDPE liner,

mechanical mixing system, four (4) pump stations rated at 21 MGD each, and a powdered activated carbon treatment system will be included in the construction.

Navigation, Ports, and Harbors (12) – The amounts of dredged material to be removed for each project alternative will vary as described in Table 10-2.

Also included in Account 12 are costs for raising existing disposal area dike elevations/capacity, debris removal, new navigation aids, and removal/containment of cadmium sediment dredged from the river. Pricing was developed assuming both medium hopper dredges and large pipeline cutterhead dredges may be used.

Average bank heights for new work dredging are approximately 5-6 feet. Quantities include 2 feet of allowable pay overdepth (to assure sufficient depths are met for design traffic). An economic analysis of advanced maintenance was conducted for the selected plan which determined that historical advanced maintenance areas and depths should be included in the maintenance program

The Corps of Engineers Dredge Estimating Program (CEDEP) was used to determine dredging average unit costs for each reach of location along the 38 miles. Significant factors input into CEDEP for determining unit prices and dredging time includes: Dredge Area, Dredge Depth-bank height, Non-pay overdepth cubic yardage, Material Factors – silt, sand, and clay, Pumping Distance or Haul Distance to Disposal Areas, EWT- Effective Work Time when dredging, Production cy/hr when dredging, Production cy/day average, and other monthly costs – such as land equipment, field office overhead, turtle monitoring, site specific maintenance costs, pipeline wear costs and fuel pricing. All of these factors are critical for developing a reasonable price estimate for various locations and conditions. The equipment most likely to be used for dredging excavation was assumed to be:

- A hydraulic pipeline dredge for the Inner Harbor (Stations 4+000 to 103+000), about 19 miles. Dredge material will be placed into existing confined disposal areas 13A, 14A, 14B and Jones Oyster Island; and
- A combination of hydraulic pipeline (loading scows & tug hauled) and hopper dredges for the Outer Ocean Bar (Stations 4+000 to –98+600), about 19 miles. Material will be placed in the existing EPA approved ODMDS (Figure 1-9).

The cost estimate for all dredging construction anticipates two contracts and covers a four-year period of concurrent work. The Inner Harbor will be one contract and the Ocean Bar will be another contract.

Cultural Resource Preservation (18) – This account includes the costs for removal of remnants of the CSS Georgia and was provided by Savannah District archeologist. The costs are based on discussions with the various archeological firms who are experienced in removal and conservation of historical shipwrecks in tidal waters. The CSS Georgia has been impacted severely over the years due to O&M dredging operations.

Planning, Engineering and Design (30) – The costs included in this account (5% of construction costs) were furnished by those responsible for performing each activity during PED. This account includes plans and specifications, field investigations and surveys, cost estimates, engineering during construction, and project management.

Construction Management (31) – This account (2.5% of construction costs) includes supervision and administration of the contracts by construction management, hydrologic surveys during construction, contracting personnel during construction, environmental/physical monitoring, and adaptive management following monitoring phases.

Project Cost and Schedule Risk Analysis: Contingency -- An overall project contingency of 25% was developed during a cost/risk analysis conducted with the Project Delivery Team (PDT) and Walla Walla District Cost Center of Expertise. The final CRSA, Cost Risk Report, Risk Register, Cost models and sensitivity analysis are included in Appendix C-Engineering, Attachment 4.

10.3.2 Incremental Dredging-Related Costs

Total dredging related costs for navigation improvements are presented in Table 10-3. The costs to improve berthing areas are included as a project-cost because berth deepening is required to obtain project benefits and are therefore included in all benefit-cost calculations. Berth deepening is a non-Federal expense (WRDA 1986).

Table 10-3: Dredging Related Costs: Incremental Deepening Alternatives (October 2010 Dollars)

	-44 ft	-45 ft	-46 ft	-47 ft	-48 ft
Real Estate	$120,625	$160,000	$160,000	$160,000	$160,000
Dredging*	$144,964,265	$176,884,623	$202,698,168	$228,917,615	$255,112,951
Dike Raising	$13,063,316	$14,726,445	$17,771,089	$20,142,328	$22,512,789
Berth Areas	$4,326,414	$4,511,299	$4,661,629	$4,693,564	$4,964,826
Nav Aids	$5,025,000	$5,025,000	$5,025,000	$5,025,000	$5,025,000
Total	$167,499,620	$201,307,366	$230,315,885	$258,938,506	$287,775,566

*Includes debris removal, Pre-Eng & Design costs, and Construction Mgmt. Note that totals may be affected by rounding

10.3.3 Incremental Mitigation Costs

Total mitigation-related costs are presented in Table 10-4.

Table 10-4: Mitigation-Related Costs: Incremental Deepening Alternatives (October 2010 Dollars)

	-44 ft	-45 ft	-46 ft	-47 ft	-48 ft
Real Estate	$4,580,625	$15,393,250	$17,506,250	$18,445,625	$21,665,625
Dissolved Oxygen	$67,428,750	$64,053,750	$67,428,750	$70,803,750	$74,178,750
CSS Georgia	$13,914,375	$13,914,375	$13,914,375	$13,914,375	$13,914,375
McCoys Cut Modifications	$4,327,049	$13,437,024	$13,437,024	$13,437,024	$13,437,024
Rifle Cut Modifications	$828,914	$828,914	$828,914	$828,914	$828,914
Tidegate & Embankment	$21,545,225	$21,545,225	$21,545,225	$21,545,225	$21,545,225
Sediment Basin Modifications	$29,392,561	$29,392,561	$29,392,561	$29,392,561	$29,392,561
Fish Passage	$29,577,470	$29,577,470	$29,577,470	$29,577,470	$29,577,470
Boat Ramp	$624,953	$624,953	$624,953	$624,953	$624,953
Salt Marsh Restoration	$17,594,949	$17,594,949	$17,594,949	$17,594,949	$17,594,949
Striped Bass	$2,085,000	$356,250	$613,750	$3,300,000	$3,410,000
Storage Impoundment	$25,187,500	$25,187,500	$25,187,500	$25,187,500	$25,187,500
Monitoring and Adaptive Mgmt	$58,792,500	$59,818,750	$60,160,000	$60,195,000	$60,468,750
Total	$275,879,870	$291,724,970	$297,811,720	$304,847,345	$311,826,095

Includes Pre-Eng & Design and Construction Mgmt. Note that totals may be affected by rounding

Construction and investment costs for the channel deepening alternatives are calculated in October 2010 dollars. Table 10-5 presents the construction costs for each construction element, and the sum of construction costs for each depth increment. Table 10-6 shows the investment cost and the total investment costs for each alternative depth increment. Investment costs are calculated as interest during construction using the FY 2011 Federal discount rate of 4.125 percent. The construction costs of each incremental depth alternative consist largely of dredging costs. Contingencies were calculated separately for each construction element.

10.3.4 Total Incremental Construction Costs

Table 10-5 presents total construction costs for each alternative plan. Major components of construction costs including real estate, mitigation and monitoring, navigation features, pre-engineering and design, and construction management are separately identified. The Real Estate total includes the cost of navigation-related and mitigation-related real estate. The Mitigation and Monitoring total in Table 10-5 excludes real estate costs. Mitigation-related real estate costs are itemized in Table 10-4.

Table 10-5: Total Construction First Costs: Incremental Deepening Alternatives (October 2010 Dollars)

	-44 ft	-45 ft	-46 ft	-47 ft	-48 ft
Real Estate	$120,625	$160,000	$160,000	$160,000	$160,000
Mitigation & Monitoring	$275,879,870	$291,724,970	$297,811,720	$304,847,345	$311,826,095
Navigation Features	$167,378,995	$201,147,366	$230,155,885	$258,778,506	$287,615,566
Pre-Eng. & Design	$21,933,037	$23,873,642	$25,522,693	$27,257,824	$28,887,677
Construction mgt.	$10,966,519	$11,936,821	$12,761,346	$13,628,912	$14,443,838
Total	$476,279,046	$528,842,799	$566,411,644	$604,672,587	$642,933,176

Note that totals may be affected by rounding

10.3.5 Interest During Construction

Interest during construction (IDC) is the opportunity cost of capital, which is an economic cost incurred while construction funds are expended but benefits have not yet begun to accrue. Interest during construction is included in all benefit-cost calculations but is not a financial cost of the project. A preliminary four-year construction schedule from fiscal year 2013 through the end of fiscal year 2016 was used to calculated interest during construction (Table 10-6). The timing of expenditures is based on the construction schedule presented in Figure 11-1: Selected Plan Construction Schedule. A similar construction schedule was created for each depth increment, and used in the interest during construction calculations. Calculations are based on the annual cost estimates calculated in October 2010 dollars (Table 10-5) using the FY 2011 Federal discount rate of 4.125%. Costs were compounded at mid-year intervals, and land costs were included in the first year of construction.

Table 10-6: Total Investment Costs including Interest During Construction

	-44 ft	-45 ft	-46 ft	-47 ft	-48 ft
Investment Cost	$476,279,046	$528,842,799	$566,411,644	$604,672,587	$642,933,176
IDC	$39,823,189	$43,324,293	$45,897,342	$48,681,944	$50,737,498
Total Investment Cost	$516,102,234	$572,167,092	$612,308,986	$653,354,531	$693,670,675

Note that totals may be affected by rounding
Note: Costs are updated to 2012 values in Section 14 Selected Plan

10.3.6 Operation and Maintenance Costs

Operation and maintenance costs generated by the project are defined as those incremental operations and maintenance costs which are in addition to the costs already required to operate and maintain the currently authorized project under without-project conditions. Analysis of historical maintenance dredging patterns and the hydrodynamic analysis of without and with-project conditions indicate that only very minor changes in hydraulic conditions at the inner harbor (bottom width will decrease but cross-sectional area will increase) would result from channel deepening. Inner harbor operation and maintenance dredging costs will increase because material that would be removed from the Sediment Basin under existing and without-project conditions will be dispersed throughout the channel under with-project conditions. Outer harbor maintenance dredging costs will increase only slightly due to the extended channel.

Projected increases in maintenance dredging volumes and costs due to channel deepening are based on full-width maintenance of the channel. Current practice is to conduct maintenance dredging of critical shoals in the navigation channel to the limit of funding and to seek additional funding for the remainder of critical shoals and other shoals growing in the sides of the channel. Due to narrower channels (channel construction using existing side slopes), there is a possibility of project cost greater than those in Table 10-7 due to this narrower channel which may cause edge shoaling to move into the channel.

Other additional improvement-related operation and maintenance costs include:

- Annual maintenance and periodic replacement of oxygen system components;
- Periodic maintenance dredging at McCoys Cut;
- Annual debris removal at the New Savannah Bluff Lock & Dam fish passage;
- Annual maintenance of CSS *Georgia* artifacts; and
- Long-term monitoring to verify predictions and assumptions concerning mitigation affects.

Table 10-7 presents incremental annual operations and maintenance costs generated by the project. Note that operations and maintenance costs are slightly higher with a -44-foot project than with a -45-foot or -46-foot project because there are more Speece cones required for the dissolved oxygen system with a -44-foot project (see section 9.3 Dissolved Oxygen Mitigation Plan Development).

Table 10-7: Total Annual O&M Costs: Incremental Deepening Alternatives (October 2010 Dollars)

	-44 ft	-45 ft	-46 ft	-47 ft	-48 ft
Inner Harbor Dredging	$2,672,080	$2,672,080	$2,672,080	$2,672,080	$2,672,080
Outer Harbor Dredging	$46,589	$48,155	$48,938	$49,199	$50,373
Dissolved Oxygen System	$1,311,000	$908,500	$1,110,000	$ 1,210,400	$1,311,000
CSS Georgia	$20,000	$20,000	$20,000	$ 20,000	$20,000
NSBLD Fish Passage	$50,000	$50,000	$50,000	$ 50,000	$50,000
McCoys Cut	$114,000	$114,000	$114,000	$ 114,000	$114,000
Storage Impoundment	$506,000	$506,000	$506,000	$ 506,000	$506,000
Long-term Monitoring	$428,400	$428,400	$428,400	$428,400	$428,400
Total	$5,148,069	$4,747,135	$4,949,418	$5,050,079	$5,151,853

10.3.7 Total Average Annual Equivalent Costs

Table 10-8 presents the total Average Annual Equivalent (AAEQ) project costs for each alternative deepening plan and the incremental AAEQ cost for each successive deepening plan increment. All average annual equivalent costs are calculated with a 4.125% discount rate over a period of 50 years.

Table 10-8: Average Annual Equivalent (AAEQ) Project Costs: Incremental Channel Deepening Alternatives

Alternative Channel Depth	Total AAEQ Construction and Investment Costs	Annual Maintenance Costs	Total Project AAEQ Costs	Incremental AAEQ Costs
-44	$26,490,763	$5,148,069	$31,638,832	
-45	$29,156,703	$4,747,135	$33,903,838	$ 2,265,006
-46	$31,065,490	$4,949,418	$36,014,908	$ 2,111,070
-47	$33,017,246	$5,050,079	$38,067,325	$ 2,052,417
-48	$34,934,319	$5,151,853	$40,086,172	$ 2,018,847

Note: Discount rate = 4.125%, period 50 years; totals may be affected by rounding. Costs for the Selected Plan at the FY12 price level and discount rate of 4 % are shown in Section 14

10.4 Value Engineering Analysis

Even though the quality of work on this project will be thoroughly verified through the Independent, Internal Technical Peer Review and External Peer Review, it is still necessary to subject projects to the Value Engineering (VE) Study Process. The VE regulation, ER 11-1-321 Change 1, dated 1 Jan 2011 requires certification that all feasibility reports undergo the VE process. VE is a process used to assess project functions in order to determine alternative means of achieving the equivalent function while increasing the value and the benefit to cost ratio of the project. In the end, it is hoped that the project will realize a reduction in cost, but increased value is the focus of the process, rather than simply reducing cost. In September 2006, it was determined that a VE Study would be performed as early as feasibly possible on the Expansion Project. The project schedule was modified over 2006 and 2007 to incorporate additional study requirements. After the scope of the study was finalized, the VE Study was conducted in May 2008.

The VE Study process is a five-phase process as outlined below:

Phase I Information (4-12 hours)
The PDT provides information about the project and "walks" the VE Study team through the study. The better the information, the more thorough and organized the presentation, the less time the VE study will ultimately take. The Team studied drawings, figures, descriptions of project work, and cost estimates to fully understand the work to be performed and the functions to be achieved.

Phase II Brainstorming (2-4 hours)
The VE Study team brainstorms ideas for revising the proposed design of the channel and the mitigation plan with the PDT. There is no discussion, just the presentation of ideas.

Phase III Analysis (4-8 hours)
The VE Study team reviews each one of the brainstorming ideas, applying a rational decision making process as to the merits of each one. This phase incorporates relevant design criteria and policy to either accept or reject each idea.

Phase IV Development (7 days)
This phase is conducted only by the VE Study team. Viable ideas are reviewed, developed, and then published. The priority ideas are developed into written proposals by VE team members during an intensive technical development session. Proposal descriptions, along with sketches, technical support documentation, and cost estimates are prepared to support implementation of ideas.

Phase V Presentation and Final Report
Presentation is a two-step process. First, the VE Study Report is distributed for review to all appropriate project supporters and decision makers. Review comments are coordinated for decision on any proposals recommended by the study report. Final

coordination may include a formal presentation conference for recommendation of actions to be taken on specific VE proposals.

Many real and perceived issues had to be addressed before construction of the navigation improvement project could proceed. These issues have been studied by the Project Delivery Team (PDT) and have been reviewed by various governmental agencies and private concerns that have an interest in this project. All of the items addressed and the conclusions reached by the PDT are presented in this GRR. The VE Study team was briefed on the pertinent issues and on the PDT's determinations and findings. Issues that required engineering and/or construction solutions were the focus of the VE Team's examination of planning assumptions and were the basis for brainstorming alternate ways of achieving project goals.

Findings and recommendations from the VE team are presented in full in their report titled *Value Engineering Study Summary Report* which is included in Appendix C, Engineering Investigations, Attachment 3 - Supplemental Materials.

The VE Study identified $34,221,436 in potential savings for project construction. Each of the proposals included in the VE Study recommendations was evaluated by the Engineering team to determine constructability and performance to meet project requirements. A summary of the team's findings is included in Table 14.0-1 of the Engineering Appendix. Overall, all of the major design changes proposed (for savings more than $1 million) were not considered to be viable alternative designs.

The major savings identified were for proposals 4 and 7 were both for alternative methods for constructing the McCoys Cut diversion structure. After further analysis, it was determined that an error had been made in the original rock volume for this structure. When the revised volume was carried through to the cost estimate for this structure, the actual cost for construction of a rock structure was $400,000, which was much less than the cost previously estimated for this feature or the costs estimated for proposals 4 and 7. Modification of this structure was not determined to be cost effective. Some of the smaller project recommendations, such as reuse of concrete from the Tidegate or use of sand from Disposal Area 2A for the sand sill at Rifle Cut (proposals 3 and 6) may be cost effective and will be considered during the planning, engineering and design phase of this contract, when more site specific information is available.

Subsequent to the Value Engineering Study the design for the overall project was modified to include additional mitigation features. The following features were added to the project:

- Increase in the number of oxygen systems -- $21 million;
- Increase in the dimensions of the NSBL&D fish passage -- $21 million;
- Construction of a recreational boat ramp in Back River -- $600,000;
- Restoration of brackish marsh in Disposal Area 1S -- $11 million; and

- Construction of a raw water impoundment -- $25 million.

The methods of construction for the majority of the added features for mitigation are almost identical to the other methods of mitigation that were included in the VE study. Since there were no VE proposals accepted as a result of the VE study, it was determined that no additional value engineering study was required at that time. Value Engineering proposals which would result in cost savings to the project will continue to be considered through the design and construction of the project, as USACE guidance requires the project features to the re-evaluated during the design phase prior to construction.

Value Engineering Proposals which would result in cost savings to the project will continue to be considered throughout the design and construction of this project.

11 Plan Comparison

The P&G requires that the NED plan be identified and described in detail. The NED plan is the plan which maximizes net benefits and; therefore, makes the greatest contribution to the federal objective. USACE policy allows deviation from the NED plan when there is a preference for a plan that is less costly than the NED plan. Deviations from the NED plan may also be more costly than the NED plan, but the non-Federal partner must bear all project costs greater than the costs of the NED plan. The more costly plan must also provide benefits which are equal to or greater than the NED plan.

This chapter describes the plan selection process, which is based on impacts to the four accounts: National Economic Development (NED), National Ecosystem Restoration (NER), Regional Economic Development (RED), and Other Social Effects (OSE). A system of accounts analysis was used to identify and compare the impacts of no action and of each alternative plan.

11.1 Net Benefits of Alternative Plans

The alternative plan net benefits presented in Table 11-1 are calculated as the difference between the total annual average equivalent (AAEQ) costs and benefits of each alternative. The incremental net benefits of the alternative plans are decreasing with successive plan increments, but remain positive overall, which indicates that the incremental benefits of each successive alternative are greater than the incremental costs.