ENVIRONMENTAL IMPACT STATEMENT
APPENDIX D: Monitoring and Adaptive Management Plan

SAVANNAH HARBOR EXPANSION PROJECT

Chatham County, Georgia and Jasper County, South Carolina

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US Army Corps of Engineers
Savannah District
South Atlantic Division

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Monitoring and Adaptive Management Plan

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1 BACKGROUND

The Council on Environmental Quality (CEQ) regulations for implementing the National Environmental Policy Act (NEPA) state that agencies may perform monitoring "to assure that their decisions are carried out and should do so in important cases." The Savannah Harbor Expansion Project is an important one, as it has the potential to adversely affect nationally important resources. In addition, since predictions are made about future effects to biological resources, there is a degree of uncertainty about the impacts which the recommended action would actually produce. Those uncertainties include both the accuracy of the predictive impact tools, the changes to the environment, and the biological responses that will occur as a result of changes in the environment. A site map on the following page shows the upper portion of the harbor, where natural resources are most at risk.

The approaches taken in this plan follow those described in the 2003 NEPA Task Force Report to the CEQ on Modernizing NEPA Implementation. This project will follow the following process, as described in that report:

Predict → Mitigate → Implement → Monitor → Adapt

Field investigations were conducted during the development of the EIS to identify important resources in the project area and obtain data from which to develop predictive tools for impact evaluation. Those correspond to the "Predict" step shown above. Field investigations will continue once a decision is reached on whether to implement the proposed harbor expansion. The studies will be conducted during two different phases of the "Implement" step shown above: both prior to and during construction. Other studies would be performed during the "Monitor" step. Long-term monitoring will be conducted over the life of the project. That phase is not shown in the process above. The various studies will vary by phase and may have a different purpose in each phase. These will be defined later in this document when the particular studies are discussed in detail. It should be noted that the Water Quality Monitoring Plan is included as an attachment to the Section 404(B)(1) Evaluation in Appendix H.

2 DEFINITION OF ADAPTIVE MANAGEMENT

For this project, adaptive management is defined as evaluating the accuracy of the predicted environmental impacts, assessing the effectiveness of the mitigation features, and modifying the project as needed to ensure the levels of environmental effects predicted in the Environmental Impact Statement (EIS) are not exceeded.

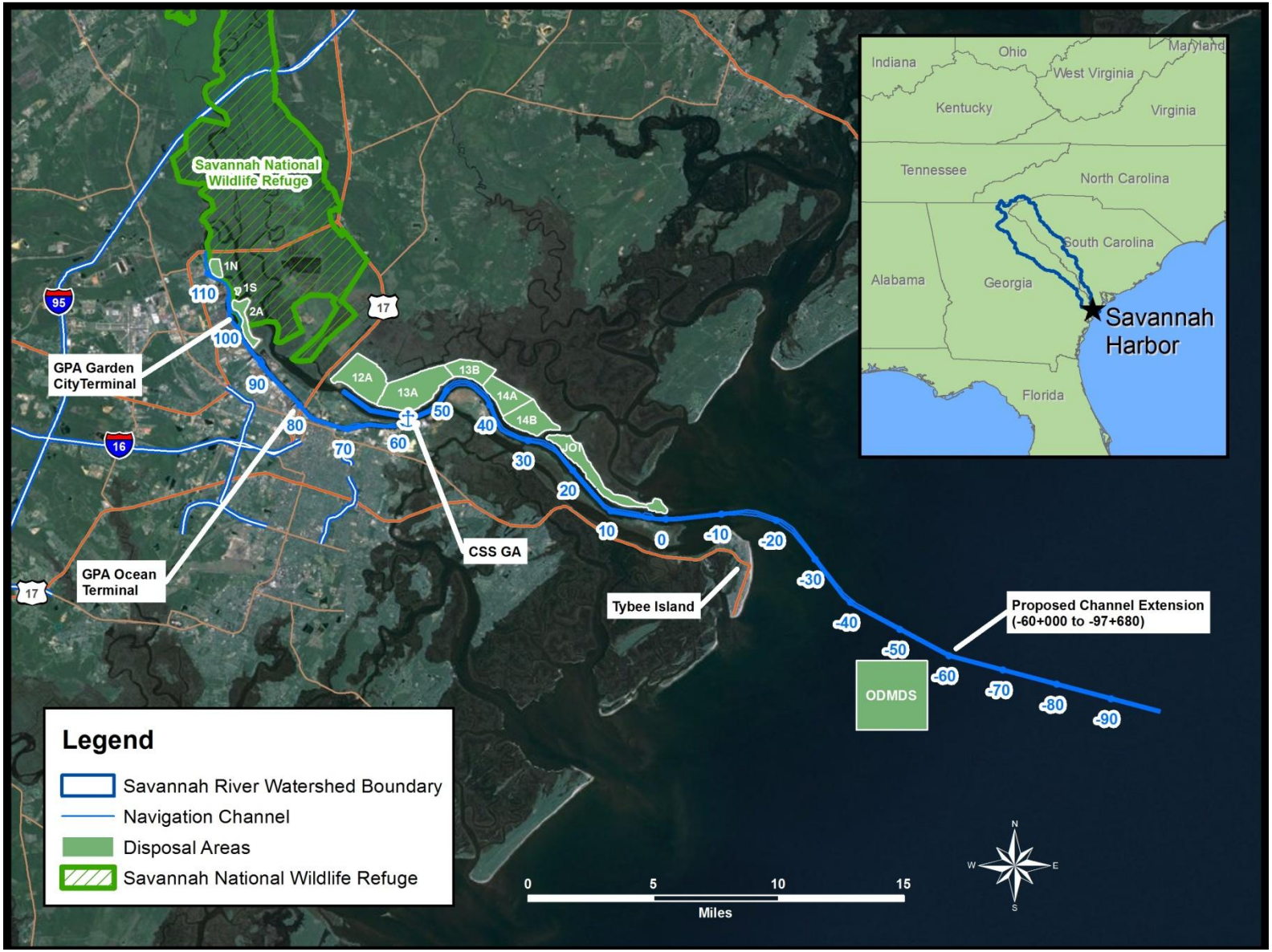

Figure 1. Savannah Harbor overview map.

3 GOALS OF AN ADAPTIVE MANAGEMENT PLAN

The definition of adaptive management as stated above has three components. There is a corresponding goal for the adaptive management program for each of those components.

The first component consists of evaluating the accuracy of the predicted environmental impacts. The corresponding goal is to improve the predictive capability of the models used to identify and quantify project-induced impacts. This includes both the hydrodynamic and water quality models. These models are explained in detail in other portions of this EIS, but they can be summarized as follows: The hydrodynamic model is a 3-dimensional computer model named the Environmental Fluid Dynamics Computer Code (EFDC) which was originally developed at the Virginia Institute of Marine Science and is now maintained by Tetra Tech under contract to the US Environmental Protection Agency (EPA). The model uses a finite difference solution scheme and a sigma-stretched vertical grid. The water quality model is the Water Quality Analysis Simulation Program (WASP), originally developed in 1983. The model includes the time-varying processes of advection, dispersion, point and diffuse mass loading, and boundary exchange. Both the water column and the underlying benthos can be included. These models are available to the public through the Total Maximum Daily Load (TMDL) Modeling Toolbox maintained by EPA Region 4. Tetra Tech applied the models to the Savannah River estuary and developed an enhanced grid which extends 61 miles upriver and 17 miles oceanward of the harbor entrance. The models' calibrations were approved by an interagency team including members of EPA Region 4, the USGS, the US Army Corps of Engineers' Engineering Research and Development Center (ERDC), the South Carolina Department of Health and Environmental Control (SC DHEC), and the Georgia Department of Natural Resources (GA DNR).

The second component consists of assessing the effectiveness of the mitigation features. Here the goal is to identify how effective the constructed mitigation feature is at reducing impacts. Physical parameters would be monitored within the estuary that describes how the system is functioning with the mitigation in place. Biota would also be monitored to determine the system's biological responses to those parameters. Natural variation will nearly guarantee that the conditions that actually occur in the first few years after construction will be different than the conditions under which the models were run during the feasibility phase. After post-construction monitoring data is available, the updated models would be rerun using the observed river flow conditions. This would provide the basis for the model's predictions for conditions under the observed conditions. Those predictions would be compared to the observed physical parameters to determine the accuracy of the models and the effectiveness of the mitigation features.

The final component is modifying the project as needed to ensure the levels of environmental effects predicted in the EIS are not exceeded. The goal for this component is to implement whatever modification is needed to the mitigation plan to keep the levels of observed environmental effects of the SHEP within the values predicted in the EIS. These modifications could occur any time during the construction or post-construction phases. If necessary, monitoring could continue beyond the length of the full post-construction monitoring program for the period needed to evaluate the effectiveness of a mitigation feature that was changed. All adaptive management project modifications would be monitored for a minimum of two years to

ensure that the modification was effective and that the observed environmental effects are then within the values predicted in the EIS.

4 IMPACT EVALUATION FRAMEWORK

The basic framework under which the project impacts are expected to occur is as follows:

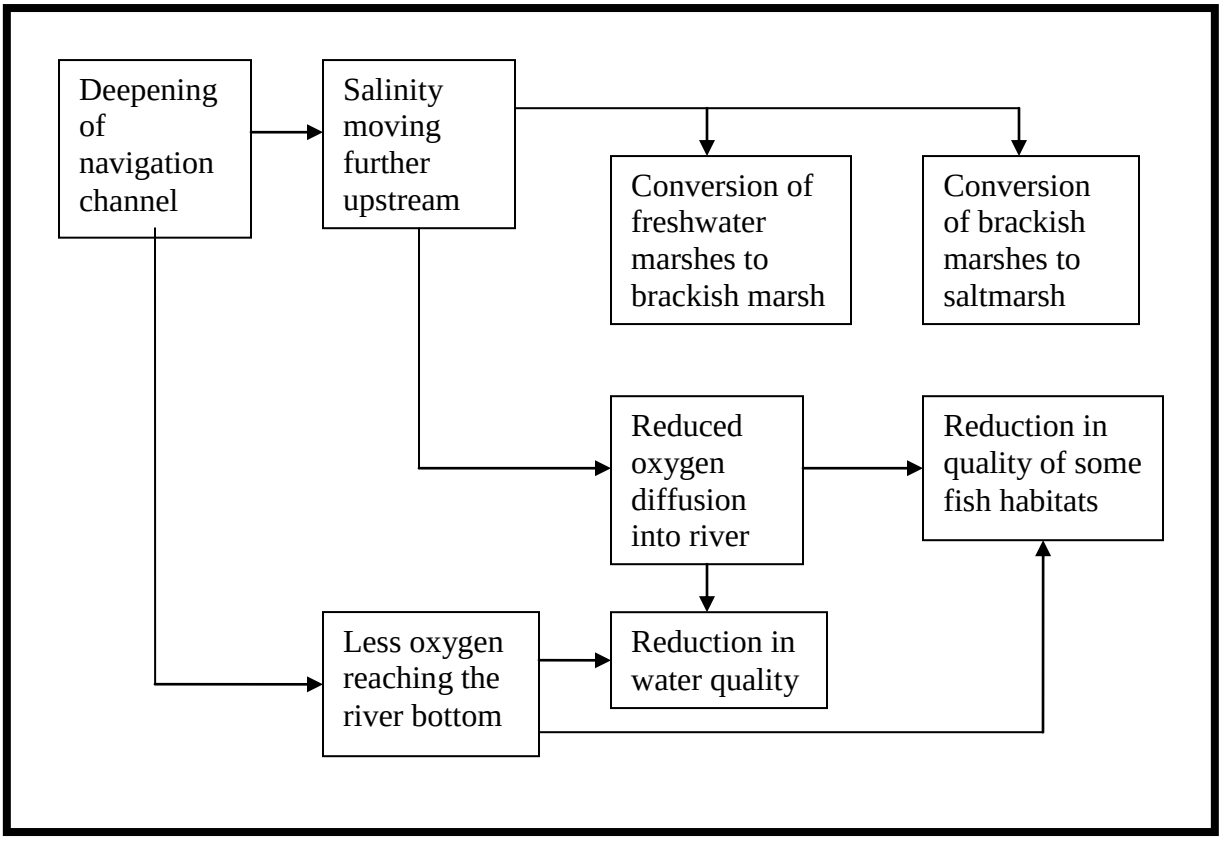

Figure 2. Impact evaluation framework.

5. PRE-CONSTRUCTION MONITORING

A. Goals. The first goal of the Pre-Construction Monitoring is to establish the baseline data bank for the Savannah Harbor estuary to assist with impact assessment during the Construction Monitoring and Post-Construction Monitoring phases of the project. Monitoring would be conducted for a period of one year before the construction begins which would affect aquatic resources in the inner harbor. This monitoring would be used to update the studies conducted during the feasibility phase and, thus, update the pre-project baseline from which impacts are measured. The Pre-Construction Monitoring would include eleven study efforts which are: (1) establishment of a baseline data bank; (2) monitoring of hydrologic and hydraulic data; (3) intense monitoring of hydrologic parameters within the lower estuary; (4) an assessment and recalibration (if required) of the hydrodynamic and water quality models; (5) groundwater monitoring; (6) monitoring of wetland sites; (7) bathymetric surveys to facilitate the assessment and recalibration of the hydrodynamic and water quality models; (8) monitoring of chloride levels within the vicinity of the City of Savannah's water intake on Abercorn Creeks; (9) Shortnose sturgeon distribution studies in the Savannah Harbor estuary; (10) Shortnose sturgeon study at the New Savannah Bluff Lock and Dam; and (11) establishment of ranges of predicted values. Prior to conducting the monitoring, the Corps would coordinate the sampling plans for the various monitoring study components with the natural resource agencies.

A second important goal will be to establish ranges of acceptable performance parameters for the Savannah Harbor estuary. While these may not be triggers for a specific action, they will indicate if the system is not performing as predicted so that the situation may be investigated. Performance will be established for specific conductance, salinity, flow, and concentration of dissolved oxygen (DO). An example for salinity is for specified flows at Clyo, ranges of modeled post project salinity values would be generated for each of the eight continuous water quality monitoring stations. From these data, graphs would be developed for each of the eight stations. A trendline and expected ranges of the modeled values would be developed. During construction and post-construction monitoring, data would be compared to these ranges to determine if the mitigation is performing as expected.

B. Major Components

1. Establishment of a Baseline Data Bank. In addition to the data that would be generated from the various Pre-construction monitoring studies, there is a wealth of existing data on resources in Savannah Harbor. The Corps would identify (with assistance from the Federal and state natural resources) existing data resources, reports, surveys, etc. that would provide useful data in regards to establishing the SHEP baseline. This information would include data on the resources of concern such as water quality, fisheries, groundwater, wetlands, etc. A baseline data bank would be established for use by the Corps, the Cooperating Agencies and the natural resource agencies. The cost to establish this data bank is estimated to be $100,000.

2. Collection of Hydrologic and Hydraulic Data. The relevant components of the Hydrologic Monitoring Plan that was developed in February 2006 by an interagency team and edited by the USGS SC Water Science Center for the Savannah River Estuary would be implemented. This monitoring would better define the complex interactions between the

estuarine ecosystem and the quantity and quality of water available. For this project, this would consist of installing and beginning to operate continuous recorders for hydrologic and hydraulic data. The project would fund USGS to perform this work for a period of one year.

The project would install and operate the following new continuous recording water quality stations:

- Middle River at GA 25, near Port Wentworth, GA
- Little Back River at GA 25, near Port Wentworth, GA
- Back River at US 17 at Savannah, GA
- Savannah River at I-95
- Lower Middle River in the fish hole

The project or project sponsor would fund operation of the following existing continuous recording water quality stations for this phase of the project:

- 02198920 Savannah River at GA25, at Port Wentworth, GA
- 021989773 Savannah River at USACE Dock at Savannah, GA
- 021989784 Little Back River above Lucknow Canal, near Limehouse, SC (independently funded by Georgia Ports Authority)

Continuous water level, streamflow, and water-quality data (water temperature, specific conductance, pH, dissolved oxygen and turbidity) would be collected on a 15-minute interval. All streamflow stations would use the new High-Data Rate (HDR) Geostationary Orbiting Earth Satellite (GOES) Data Collection Platforms (DCPs) to allow for hourly data transmissions, with one set of redundant data, during normal streamflow conditions. This would provide up to date hydrologic information. The streamflow stations would use thresholds to trigger random satellite transmissions during severe storms, and floods.

The Corps may not be able to install a piling in Middle River in the fish hole at a location that provides the information desired about that specific site, because the piling could be a hinderance to safe navigation. If further coordination reveals that a piling is not acceptable, then periodic manual sampling would be performed. The project would fund USGS or another qualified organization to perform this work.

The continuous real-time data would be available to resource managers and the general public through the USGS National Water Information System Web (NWISWeb) software or similar program. The USGS would also publish the collected data in the USGS Annual Data Report series. The PDF-report format would be available on the USGS publications web pages.

The estimated cost for this monitoring is $875,000, which is based on the following components:

Install new water quality stations	5 @ $50,000 = $250,000
Upgrade existing water quality stations	3 @ $35,000 = $105,000
Operate water quality stations for 1 year	8 @ $65,000 = $520,000
	Total = $875,000

The Corps would also include hydrologic and hydraulic data obtained by others during this pre-construction period.

Figure 3. Locations of continuous recording water quality stations.

3. Intense Monitoring of Hydrologic Parameters within the Lower Estuary. Intense monitoring of hydrologic parameters within the lower estuary would be conducted for one lunar cycle (28-day period). This work would be conducted to provide information on the hourly, daily and weekly variations in the aquatic environment of the estuary. A report would be prepared and provided by the contractor performing the work. The information would be used to update the hydrodynamic and water quality models, if the data indicated that an update was warranted.

Intense sampling would be performed within the lower estuary over a lunar cycle during the summer. Sampling will be performed at multiple depths and at least twelve stations that will be

selected by the Corps in consultation with the resource agencies. This sampling would address those constituents considered important to evaluate the water quality regime in Savannah Harbor. It would also address how parameters change over a tidal cycle and over the course of a lunar cycle. It would be performed during the summer to monitor the estuarine system when the water quality is most stressed. The sampling would focus on the parameters that most affect water quality in the estuary. Those include river discharge, flow volumes, flow velocity, flow direction, water surface elevation, depth, salinity, dissolved oxygen, and water temperature. Some sampling would also be conducted for turbidity, suspended solids, pH, specific conductance, Biochemical Oxygen Demand (BOD) 5-day and chloride. Prior to conducting the event, a detailed monitoring plan will be coordinated with the Cooperating Agencies.

The estimated cost for the field monitoring is $350,000 and is based on the cost to perform a somewhat larger effort in Savannah Harbor in 1999. The cost would include a report of the data.

4. Update (If required) of the Hydrodynamic and Water Quality Models. The data gathered from the intense monitoring and the bathymetric surveys would be used to update the hydrodynamic and water quality models if the data indicate that an update is warranted, e.g. if the modeling performance guidelines are not being met, an update would be warranted. If the calibration of a model is revised, the model would be reviewed by the natural resource agencies. A report would be prepared addressing whether an update to the calibration of the models is warranted and if so, that update. Included in the report will be documentation of the changes in the resource impacts predictions by using the recalibrated model. The cost to assess and recalibrate the hydrodynamic and water quality models is estimated to be $120,000 and is based on recent similar efforts for the feasibility phase of the Savannah Harbor Expansion Project. The work would be performed by either the Corps or a modeling contractor.

5. Groundwater Monitoring. Monitoring of chloride in the Upper Floridan aquifer would be conducted along critical groundwater flow paths where chloride migrating downward through the confining unit beneath the Savannah River could move toward Savannah area production wells. Sentry wells would be installed along critical groundwater flow paths near the top of the aquifer to monitor downward migration of chloride through the confining unit and deeper in the aquifer to monitor how horizontal flow of freshwater within the aquifer mixes with and dilutes the chloride. The sentry wells would be located west of the locations of exploratory borings SHE-11 and SHE-13, and on Cockspur Island near Fort Pulaski. Monitoring wells would also be installed upgradient of critical groundwater flow paths to provide information on background chloride concentrations associated with groundwater withdrawals in the Savannah area independent of SHEP dredging activities. Background wells would be installed near the top of the aquifer and deeper in the aquifer. Six new groundwater monitoring wells would be installed. The Georgia DNR-EPD would approve the locations and depths of the background wells. Background chloride concentrations at sentry and background wells would be established. At least four background samples would be collected from each sentry and background well and statistical methods used to establish background chloride concentrations at each sentry and background well. The Georgia DNR-EPD would approve the collection of background samples and the statistical methods used to establish background chloride concentrations. The estimated cost to monitor the wells during the pre-construction monitoring is $30,000.

The Corps, in coordination with the Georgia DNR-EPD, would establish benchmark chloride concentrations for each sentry well. The Corps would determine what chloride concentrations caused by SHEP dredging activities would result in a measurable increase in chloride concentrations at Savannah area production wells. Savannah area production wells include industrial, commercial, municipal, agricultural, and other unpermitted wells. The benchmark chloride concentrations must be protective of the Savannah area production wells. The benchmarks would be established for each pair of sentry wells and for sentry wells near the top of the Upper Floridan aquifer and deeper in the aquifer. The benchmark concentrations established would require the approval of the Georgia DNR-EPD. The Corps would also develop a remediation and implementation plan which could be implemented if it is determined that the chloride entering the Upper Floridan aquifer due to deepening through the confining unit could affect Savannah area production wells. The plan would include adaptive management measures specific to accelerated chloride intrusion into the aquifer. This plan would be submitted to the Georgia DNR-EPD for review and approval.

6. Monitoring of Wetland Sites. Six of the seven marsh sites previously monitored by the USGS Florida Fish and Wildlife Cooperative Research Unit would be monitored again as part of this project. Figure 4 shows the location of both the old and new monitoring locations.

In this phase, the distribution and density of wetland vegetation would be would be monitored for one year. The marsh transects would be sampled twice annually (June and October), and sampling protocols would follow those described in Kitchens (2003) and generally follow those performed when the USGS monitored in 2000/2001. The Coop Unit would prepare and provide a report of their findings.

The project would install and operate new continuous recording stations at the twelve tidal marsh locations where wetland vegetation would be monitored. The six new monitoring locations were chosen to expand monitoring in highly sensitive marshes, in areas where significant salinity changes are possible under a variety of scenarios, and to monitor community shifts both vertically (up and down river) and laterally (interior vs. exterior). The preliminary locations are shown in Figure 4, although some adjustments may be made prior to commencement of the work; these adjustments would be made in close consultation with the resource agencies. These tidal marsh stations would record water surface elevation, specific conductance of surface waters that flood the marsh, and specific conductance of waters in the root zone, and water depth every 30 minutes. The recorded data would be downloaded monthly. Wetland vegetation would be monitored for one year. This would include sampling over two seasons. The project would fund the USGS Florida Fish and Wildlife Cooperative Research Unit to perform the work. They would monitor the same 6 sites as they did in 2000/2001 as well as the six additional marsh locations. They would prepare and provide a report of their findings.

The estimated cost for this initial monitoring is $336,000, which is based on the following components:

Install tidal marsh stations	12 @ $10,000	= $120,000
Operate tidal marsh stations for 1 year	12 @ $20,000	= $240,000
	Total	= $360,000

The cost for this initial monitoring is somewhat higher than would be needed for a repetitive operation due to the initial equipment purchases. These costs also include the twice-a-year vegetation sampling and analysis that the Florida Coop Unit would perform as part of their marsh monitoring.

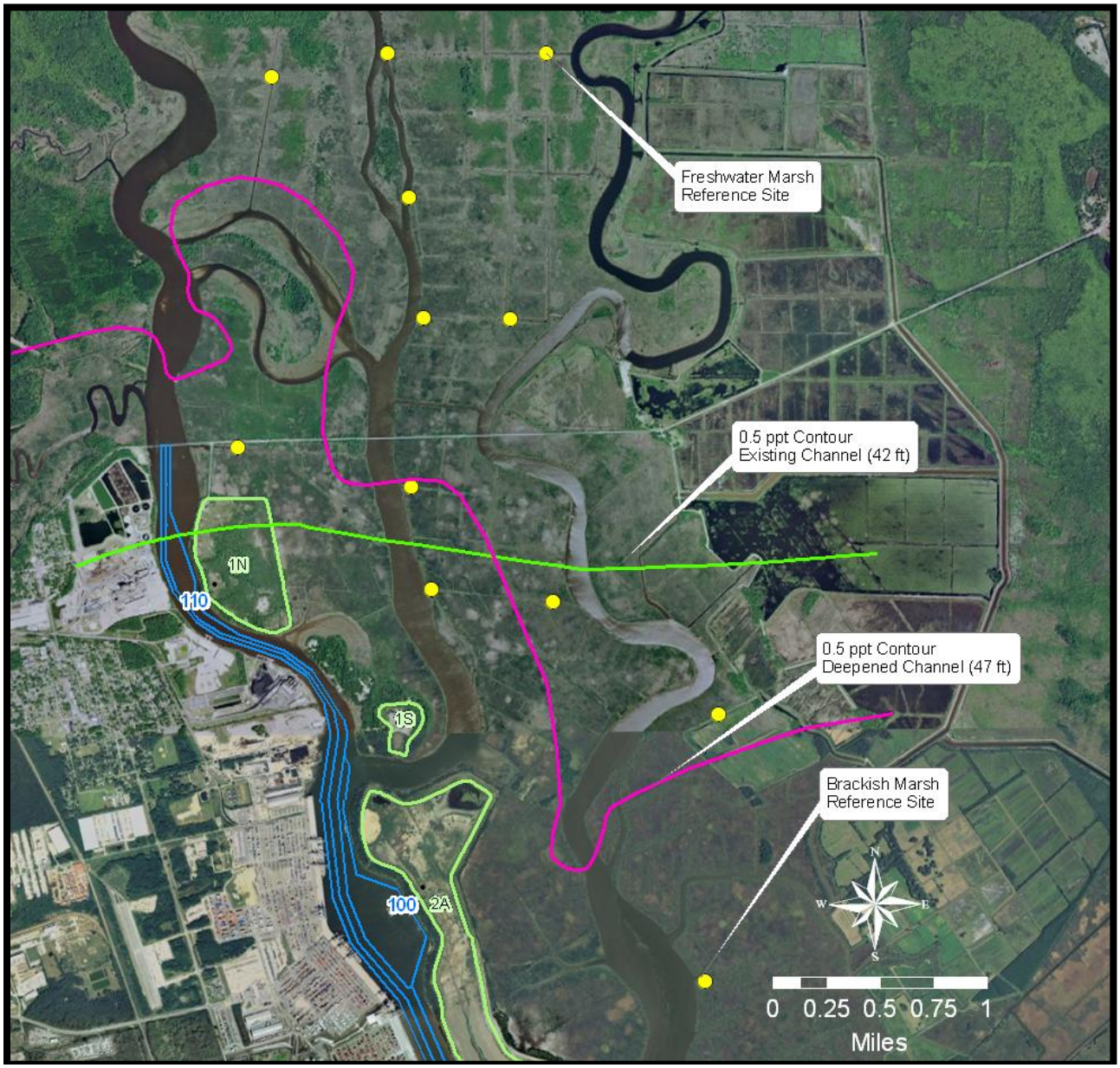

Figure 4. Wetlands monitoring locations.

7. Bathymetry Monitoring. The Corps would conduct or fund bathymetric surveys of the riverine areas not normally surveyed to obtain up-to-date information on the depth and width of the tidal rivers that are included in the hydrodynamic model. Those surveys would typically consist of bank-to-bank cross-sectional surveys performed on 500-foot intervals. These surveys would cover the Front, Middle, and Back Rivers from I-95 to Old Fort Jackson. The estimated cost for this work is $158,000.

8. Chloride Monitoring. The Corps would conduct or fund monitoring of chloride levels at the City of Savannah's water intake on Abercorn Creek. This work would consist of two components. The first component consists of an automated sampler to be installed near the City's water intake to collect samples on at least a daily basis. These samples would be collected and analyzed in a laboratory to identify chloride levels at the intake. All of the collected samples may not be analyzed, dependent upon flow and tide variables. The second component is installation of two chloride meters; one at the City intake and one in Abercorn Creek near its confluence with Savannah River. The lab analyses will be used to verify the data collected by the meters and determine their level of accuracy and reliability with the low chloride levels that are generally encountered. The meter data will also be used to provide additional detail, including trends and timing, between the lab samples. One or both of the meters are expected to be a permanent installation, whose operation and maintenance would become a responsibility of the City of Savannah when the SHEP monitoring period ends. The estimated cost for this work is $250,000.

9. Shortnose Sturgeon Distribution Study in the Savannah Harbor Estuary. The distribution of Shortnose sturgeon in the harbor would be monitored for one year, possibly by the SC DNR Marine Resources Division in much the same manner as the study conducted in 1999/2000. This monitoring would include capturing, tagging and tracking both adult and juvenile sturgeon. Water quality would be measured and documented where sturgeon are captured and later found. Monitoring would be performed in each season. The study area would include Front, Middle, and Back Rivers. The bottom substrate would be identified when fish are found to intensively use a specific area. Water quality data will also be collected at receiver location. The work would not track fish over a 24-hour period, as had been conducted in 1999/2000. That information would not be needed for this project. The Corps would coordinate with NOAA Fisheries on the scope of work before the work began. The contractor will prepare and provide a report of their findings. The estimated cost for this monitoring is $200,000.

10. Shortnose Sturgeon at New Savannah Bluff Lock and Dam. The movement of fish at the New Savannah Bluff Lock and Dam (NSBL&D) would be monitored for one year. This monitoring would include capturing, tagging and tracking Shortnose sturgeon and possibly other representative species of the NSBL&D area fish community (Striped bass, Robust redhorse, and American shad). Based on availability, up to 25 Shortnose sturgeon (and a total of 75 fish) would be collected and implanted with combined radio and acoustic transmitters. If possible, fish would be captured within 1 km of the dam by electrofishing, hook and line, or gill net.

USGS would monitor fish continuously in the vicinity of NSBL&D using a fixed station radio receiver. In addition, during the migration season they would search the river weekly between NSBL&D and the Jackson, SC Landing and NSBL&D and the Augusta Water Supply Dam for

fish with transmitters. On a monthly basis, they would search the Savannah River from the Savannah Harbor Kings Island Turning Basin to the NSBL&D, and above to the Augusta Water Supply Dam. When located, species, identification number, and location would be recorded. Temperature would be recorded several times daily using temperature loggers established at fixed locations at NSBL&D, 1, 10, 50, 100 and 200 km below the dam, and 1 km above the dam. Dissolved oxygen concentration, turbidity, and river stage at NSBL&D would be recorded at least weekly. Dam discharge will be recorded daily.

The contractor will prepare and provide a report of their findings. The estimated cost for this initial monitoring is $300,000.

11. Establish Ranges of Predicted Values. The hydrodynamic and water quality models would be used to establish ranges of predicted values for performance parameters at specific points in the Savannah Harbor estuary. From these datasets, graphs for specific monitoring points in the estuary would be created. An example graph is shown below. The graph will include a trendline and expected ranges for existing conditions at the same monitoring points for comparison to conditions observed during the construction period. Inclusion of existing conditions trends will be important to the comparison because in some locations (i.e., Front River) salinity will be increasing while in other locations (i.e., Back River) salinity will be decreasing. An example of this follows:

For specific conductance, which is a model output parameter, trendlines and expected ranges of modeled specific conductance values would be prepared for specified freshwater flows at each of the eight continuous water quality monitoring stations for post-project and existing conditions. From this data, graphs would be developed for each monitoring station (see below). The y-axis would be specific conductance values and the x-axis would be freshwater flow values as measured at Clyo. The trendline and expected ranges of the modeled values could then be compared to water quality data collected during construction.

For dissolved oxygen, another model output parameter, trendlines and expected ranges of modeled DO values would be prepared for specified freshwater flows (or another parameter) at each of the eight continuous water quality monitoring stations. However, correlation of DO datasets to freshwater flows (or another parameter) would be useful for making only general comparisons. While salinity and conductivity variations in the harbor are largely dependent on tides and freshwater flows, DO in the harbor is influenced by several other factors, including temperature and waste discharge volumes to the river. Since the industries report their waste discharge volumes to the states on a monthly basis, detailed comparisons of expected (modeled) and observed data would not be available for DO on a real-time basis.

For flow, model data would show predicted flows at the three water quality stations along the Georgia Highway 25 / South Carolina Highway 170 Bridge for various river flows at Clyo.

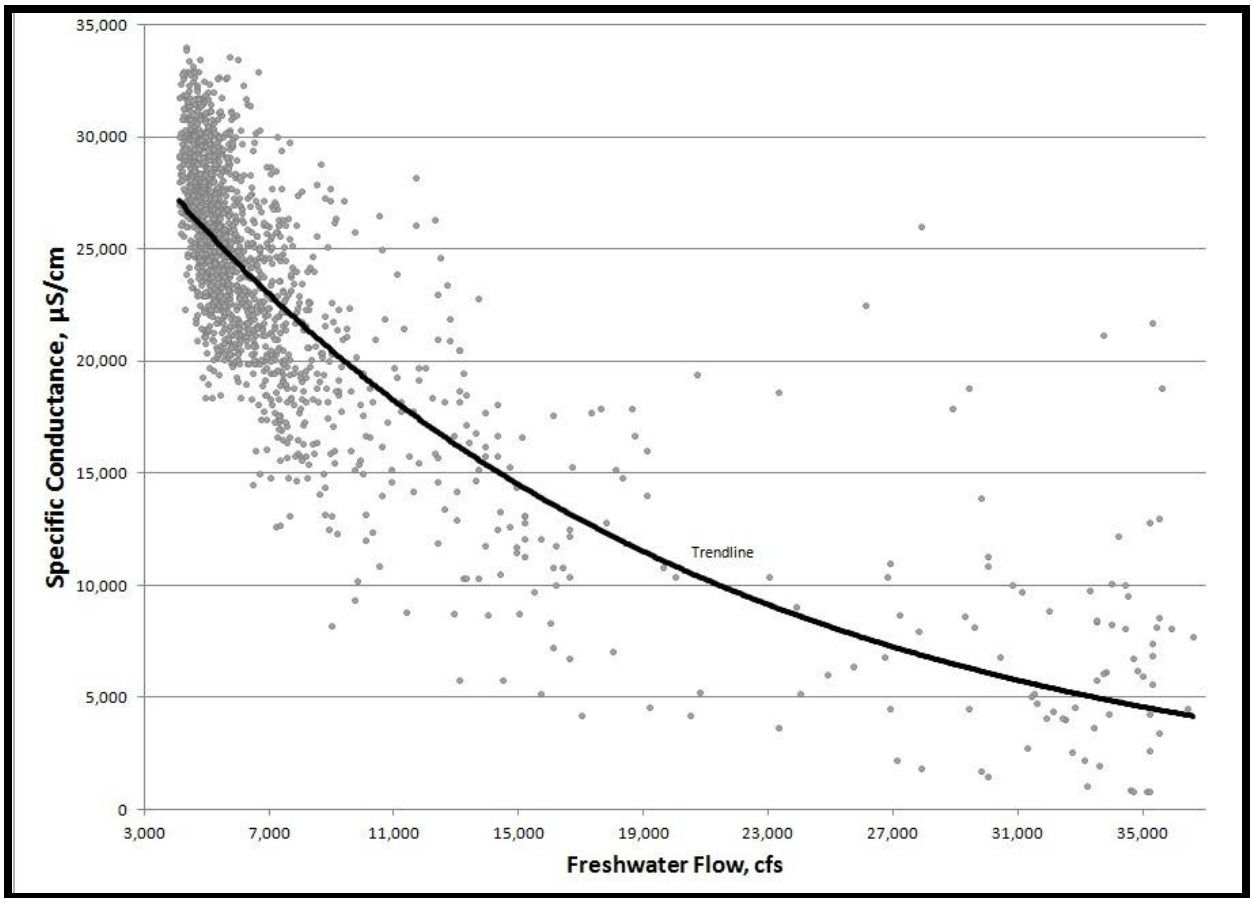

Figure 5. Example of trendline and expected ranges for specific conductance.

C. Reporting

The Corps would establish a website that is available to the public which will house data and reports that become available during the pre-construction period. Data obtained by USGS from the continuous water quality monitoring would be included in the annual reports that they post on their websites and make available to the public. A summary of reports to be provided by the Corps for the Pre-Construction Monitoring is as follows:

Report on Intensive Monitoring of Hydrologic Parameters

Report on Update of the Hydrodynamic Models

Annual Report on Groundwater Monitoring

Report on Monitoring of the 12 Wetland Sites

Report of the Monitoring of Shortnose sturgeon in the Savannah Harbor Estuary

Report on the Monitoring of Shortnose sturgeon at the NSBL&D

Report of ranges of predicted performance values for parameters at specific points in the Savannah Harbor estuary during construction

D. Cost Summary

The costs for the monitoring that would be performed during the pre-construction period are summarized as follows:

Baseline Data Bank	$100,000
Continuous Riverine Monitoring	$875,000
Intense Monitoring	$350,000
Assess & Recalibrate Models	$120,000
Bathymetry Monitoring	$158,000
Chloride Monitoring	$250,000
Groundwater Monitoring	$30,000
Wetlands	$360,000
Shortnose sturgeon-Savannah Harbor	$200,000
Shortnose Sturgeon-NSBL&D	$300,000
Reporting	$50,000
Oversight & Contracting	$100,000
Pre-Construction Total:	**$2,893,000**

6. MONITORING DURING CONSTRUCTION

A. Goals. Monitoring would be conducted during the construction period to ensure the construction is performed within the environmental constraints imposed by the EIS and the approvals of the natural resource agencies. Monitoring would also be performed to ensure that levels of impacts predicted in the EIS are not exceeded and that unexpected impacts do not present themselves. The length of the construction period will depend on the amount of funds that are received to perform the work. At present, the estimated construction period is about 4 years. The Corps would perform the monitoring described in this section for whatever length of time it takes to construct the project. The cost estimates shown below assume a 4-year construction estimate. If construction requires more than four years, monitoring during construction will be extended to ensure that levels of impacts predicted in the EIS are not exceeded and that unexpected impacts do not present themselves. Additional funding will be secured to accomplish this rather than reducing the planned post-construction monitoring and adaptive management.

B. Major Components. Monitoring during the Construction phase would include fifteen major study components. Some of these study components (five) would be a continuation of study efforts started during the Pre-construction phase, while others would be initiated to specifically address the potential impacts of the project that could occur during the construction phase.

The Corps would continue to operate the eight continuous recorders for hydrologic and hydraulic data that were established or funded as part of the Pre-Construction Monitoring. The monitoring of the 12 marsh sites would be continued (with the exception of during year 1 of construction), as would groundwater monitoring, monitoring of chloride levels at the City of Savannah's water intake on Abercorn Creek, and monitoring the distribution of Shortnose sturgeon in the Savannah Harbor estuary.

New monitoring efforts that would be conducted during the construction phase include:

- a bathymetric survey of the Sediment Basin to facilitate the model assessments
- an assessment of how well the models predict the salinity and dissolved oxygen levels during construction
- a Transfer Efficiency Study (oxygen injection systems)
- monitoring effluent from the seven CDFs that would be used for disposal of the dredged material
- monitoring dissolved oxygen concentrations in the vicinity of the dredge during the summer months
- monitoring cadmium in the inflow and effluent in CDFs 14A and 14B
- monitoring cadmium levels in the sediments placed in CDFs 14A and 14B
- wildlife use surveys in CDFs 14A and 14B
- biological monitoring of cadmium levels in birds (tissue or blood samples) that use CDFs 14A and 14B, both before and during placement of cadmium-laden sediments

On a regular basis (every four months), the Corps would assess how well the hydrodynamic and water quality models predict the salinity and D.O. levels that are occurring during the construction process. This process will serve as the mechanism to identify the emergence of any unexpected variances with the predictions about how the harbor would function after the project's construction is complete.

As part of the assessment of the hydrodynamic and water quality models predictions, the Corps would conduct bathymetric surveys of the Sediment Basin. This information would be needed to allow the hydrodynamic model to reflect the changing conditions that would occur during the construction period.

In addition to the specific construction monitoring components listed above, the Corps would perform its normal quality assurance inspections during construction. The Corps places the environmental compliance requirements that it receives from natural resource agencies for a proposed action in the contract documents that it prepares for the work. The contractor who performs the work is then responsible for performing the work in compliance with those requirements. The Corps' inspectors provide quality assurance by overseeing the work

performed by the dredging and civil engineering contractors. Those inspectors ensure the contractors perform the work within the environmental clearances obtained for the project.

C. Details of the Monitoring

1. Hydrologic and Hydraulic Data Collection. The Corps would fund operation of the continuous monitoring in the rivers. Operation of one station (Savannah River at USACE Dock) is being fully funded by another source and would not be an expense for this project. Similarly, some of the operating costs for three other existing stations are being funded by another source and would not be an expense for this project. This riverine monitoring would be performed by the USGS. The costs for this work are estimated as follows:

Operate water quality stations	4 years x 8 @ $65,000 = $2,080,000

2. Monitoring of Wetland Sites. The Corps would continue to fund monitoring of the 12 marsh sites during years 2, 3, and 4 of construction, when dredging occurs in the inner harbor. Monitoring of wetland sites would temporarily cease during year 1 when no inner harbor dredging is expected to occur. This monitoring would be performed by the USGS Florida Fish and Wildlife Cooperative Research Unit. The costs for this work are estimated as follows:

Monitor marsh sites	3 years x 12 @ $20,000 = $720,000

A report would be prepared at the end of the construction monitoring summarizing the results of this study.

3. Chloride Monitoring. Monitoring of chloride levels at the City of Savannah's water intake on Abercorn Creek would continue during the construction phase of the project. Monitoring would be performed to ensure unforeseen increases in chloride levels do not occur during the construction period. The Corps would fund or perform this work. The estimated cost for this work is as follows:

Chloride monitoring	4 years x $100,000 = $400,000

4. Groundwater Monitoring. The Corps would continue to conduct or fund monitoring of chloride levels in the Floridan aquifer. The project would use the sentry and background gradient wells that were installed during the pre-construction monitoring period for this purpose. Chloride levels would be recorded four times a year in each well. An annual monitoring report would be prepared and provided to the Georgia DNR-EPD by January 31st of each year following the initiation of dredging. The report would include the results of the previous year's monitoring. Additionally, differences in the long-term trends of chloride concentrations in the sentry and background wells would be used to evaluate the impacts of SHEP dredging activities from impacts of groundwater withdrawals on chloride concentrations in the Upper Floridan aquifer. The estimated cost for this work is as follows:

Groundwater monitoring	4 years x $7,500 = $30,000

5. Shortnose Sturgeon Distribution Study-Savannah Harbor. The Corps would fund monitoring of Shortnose sturgeon distribution in Savannah Harbor each year of the construction period. This monitoring would duplicate the work conducted in the Pre-Construction Monitoring. The costs for this work are estimated as follows:

Shortnose sturgeon monitoring	4 years x $200,000 = $800,000

A report would be prepared at the end of construction monitoring summarizing the findings of this study.

6. Bathymetric Surveys of the Sediment Basin. The Sediment Basin would be allowed to fill naturally after construction of the submerged sill at its lower end. The depths in the Sediment Basin affect water and salinity movement up Back River, and the Basin will likely be filling throughout the duration of the construction and some of the post-construction monitoring period. As a result, bathymetric surveys will be needed of the Basin on a periodic basis to perform a proper assessment of the hydrodynamic model's accuracy in predicting conditions that are being observed during the monitoring period. The Corps would perform or fund these surveys, which would be conducted every 4 months. The costs for these surveys are estimated as follows:

Bathymetric surveys of Sediment Basin	4 years x 3 x $25,000 = $300,000

7. Transfer Efficiency Study. The work would also include a Transfer Efficiency Study of the dissolved oxygen systems. That near-field study would identify the efficiency at which the systems add oxygen to the estuarine waters. The Corps would provide the resource agencies with an opportunity to review the study plan and propose methods of monitoring and data analysis. The Corps would use this efficiency rate to determine how it needs to operate the systems to add the amount of oxygen determined by the modeling to be needed to compensate for the impacts of the harbor deepening project. This Transfer Efficiency Study would be conducted when construction of the oxygen injection systems is complete. As presently scheduled, that would occur early in the schedule for construction of the overall project. The two downstream oxygen injection systems (Hutchinson Island) are scheduled to be installed and operational prior to commencement of dredging the inner harbor, and the upstream system (near Georgia Power's Plant McIntosh) is scheduled to be complete and operational within one year of that point. A report would be prepared describing the results of the study as well as prescribing the standard operating procedures for the oxygen injection systems. This study is estimated to cost $300,000.

8. Model Predictions of Dissolved Oxygen and Salinity during Construction. The Corps will regularly assess (every four months) how well the hydrodynamic and water quality models predict the salinity and D.O. levels that are occurring during the construction process. The Corps expects the dredging in the navigation channel upstream of Fields Cut to generally proceed at about 2,900 feet per month, so the hydrodynamics of the estuary would not be altered substantially on a monthly basis. The assessment would be performed by comparing the models' predictions against what is being measured at the 8 continuous water quality monitoring stations. The model grid would be updated to reflect the new bathymetry and the actual river flows would

be used. Conducting this assessment every 4 months is believed to be sufficient to identify the emergence of any unexpected results. This process would serve as the mechanism to identify the emergence of any unexpected variances with the predictions about how the harbor would function after construction is complete. The costs for these assessments are estimated as follows:

Assess Hydrodynamic and WQ models 4 years x 3 x $60,000 = $720,000

9. Monitoring of Effluent from the CDFs. The effluent from all of the CDFs used for the SHEP would be monitored to ensure that no applicable water quality standards would be violated. At the beginning of deposition of new work material, into the CDFs, the contractor would construct a 500 mg/L Total Suspended Solids (TSS) standard and determine turbidity (in NTUs) associated with the standard. The contractor would then visually compare effluent turbidity at each of the discharging weirs to the standard on a daily basis. The contractor would measure (weekly) turbidity at each outfall pipe with a discharge. Measurements would include dissolved oxygen, salinity, conductivity, temperature and turbidity. Measurements would be made with a Hydrolab or similar instrument. A water sample would be obtained from each outfall pipe every two weeks and analyzed for NTUs, TSS in mg/L. Monitoring reports would include the results of the sampling and analyses (as well as the discharge point and dates of discharge) and be submitted to the Georgia DNR-EPD , SC DHEC, and USFWS on a monthly basis. The annual cost for this monitoring is about $143,000.

10. Monitoring of Dissolved Oxygen Levels in the Vicinity of the Dredge during the Summer Months. Dissolved oxygen levels in Savannah Harbor become stressed during the summer months. The Corps is required to monitor dissolved oxygen levels in the vicinity of hydraulic pipeline dredges performing dredging in the inner harbor during the summer months. This monitoring would also be implemented during the SHEP construction. The cost for this monitoring is about $75,000 per year. The Corps will coordinate a detailed monitoring plan with Georgia DNR-EPD prior to conducting these events. The standard for the monitoring agreed upon with NMFS and the GA DNR EPD is:

> "Dredging operations must maintain a daily average of 5.0 mg/L and an instantaneous average of 4.0 mg/L throughout the water column during those times of year when the ambient condition in the waterbody has a dissolved oxygen level above these values. If it is determined that the ambient condition in the waterbody is less than these values, the criteria will revert to the "ambient condition" and the water quality standard will allow for a 0.1 mg/L deficit from the "ambient" dissolved oxygen value. Since the available dissolved oxygen deficit has already been allocated, the USACE will only be able to conduct maintenance dredging when the dissolved oxygen, one meter from the bottom, is 3.0 mg/L or greater and the maintenance dredging does not affect the dissolved oxygen levels in the Savannah River Harbor. Exceptions for maintenance dredging when dissolved oxygen levels are less than 3.0 mg/L may be allowed if coordination occurs with NMFS and GA DNR-EPD and subsequent issuance of a waiver from GA DNR-EPD."

11. Monitoring of Inflow and Effluent in CDFs Containing Cadmium-Laden Sediments. All cadmium-laden sediments would be placed in CDFs 14A and/or 14B. Detailed design could result in the deposition of all cadmium-laden sediments in a single DMCA -- #14A. Monitoring of dredging and disposal operations in areas with cadmium-laden sediments would require monitoring of the inflow and effluent from CDFs 14A and/or 14B for cadmium.

Additional monitoring of the inflow and discharges from CDFs 14A and 14B where cadmium-laden sediments would be placed would be conducted. Samples would be taken from the inflow (head section of the discharge pipe) on a weekly basis. Sampling would be conducted weekly to determine the cadmium concentrations in the effluent discharged from CDFs 14A and 14B Should the effluent dissolved cadmium concentration be found to be higher than the State standard (8.8 ug/L for South Carolina), sampling would be repeated within two days and would include both the outfall pipe sample and a receiving water sample taken approximately 100 feet down current of the point at which the effluent enters the receiving water. Should the receiving water sample be found to violate State standards, corrective action would be undertaken to eliminate the violation. Monitoring of the effluent from CDFs 14A and 14B for cadmium would continue as long as a discharge occurs and until all sediments have been dewatered, stabilized and covered. Following the installation of a clean cover, cadmium would be monitored in the effluent for one year. The above effluent monitoring plan will include a quarterly metals analytical scan with the inclusion of ammonia. The results of the effluent monitoring plan would be reported to the Georgia DNR-EPD, SC DHEC, and USFWS on a quarterly basis. The estimated cost to conduct this monitoring in CDFs 14A and 14B is $380,000.

12. Analyses of Sediments Placed in CDFs 14A and/or 14B. Sampling of cadmium-laden sediments discharged into CDFs 14A and 14B would also be conducted during construction. Once placement of the cadmium-laden sediments has been completed in the CDF, grab samples would be collected to characterize the cadmium levels of the surface sediments. This would occur prior to the placement of the cover. Approximately 86 grab samples would be collected to a depth of 15 cm of the surface of the sediments in 14A and 14B and analyzed for cadmium. After the cover has been placed, approximately 86 grab samples would be collected and analyzed to characterize the cadmium levels in the exposed cover sediments. The samples will be evenly spaced across the CDFs. If the concentrations of cadmium in the sediments are less than 4 mg/kg, the sampling would be complete. If the distribution of sediments with a cadmium concentration of 4 mg/kg or greater extends over a cumulative area of 25 acres or greater, sediments from operation and maintenance dredging would be scheduled to be placed in the area at the earliest possible time to provide an additional cover. After placement of the cover of operation and maintenance material is placed into the CDF, sediment sampling and analyses would be conducted again as previously described, except samples will be collected to a depth of 30 cm. This process would be repeated until cadmium concentrations in the sediments were less than 4mg/kg. The estimated cost to conduct this monitoring in CDFs 14A and 14B is $416,000 per year for two years. Detailed design could result in the deposition of all cadmium-laden sediments in a single DMCA – CDF 14A.

13. Wildlife Use in CDFs 14A and 14B. The Corps would perform monthly wildlife use surveys in CDFs 14A and 14B. These one-day surveys would record all birds and other major vertebrates seen within each CDF. Monitoring would be performed during placement of sediment and for a minimum of three years after placement is complete and continue as long as other cadmium-related sampling is occurring. If there is a concern about the number of birds or other animals or a particular species using the CDF, some type of hazing may be appropriate. Any hazing decisions would be coordinated with the USFWS.

14. Avian Blood/Feather Monitoring in CDFs 14A and/or 14B. During Year 1 of construction and prior to commencement of dredging in the inner harbor, baseline avian blood/feather sampling would be conducted in CDFs 14A and/or 14B to determine background avian cadmium blood levels. Blood/feather monitoring would continue throughout the remainder of the construction period (estimated to be three additional years) during placement of cadmium-laden sediments and the cap/cover in CDFs 14A and 14B. Since the CDFs would reenter the rotation program after the covering sediments have been placed, the CDFs may be dry or wet, depending on the year. Their hydrologic condition will drastically alter their bird use, as different species use the CDFs in those two conditions. The season also drastically affects bird use of the CDFs. Sampling would be timed to correspond when the majority of each species arrives and mid-season which corresponds to approximately April and September. Sampling in April would maximize exposure time for wintering species (September through April), while sampling in about September should maximize exposure time for summer nesting species (April through September). All work will be closely coordinated with the USFWS prior to commencement, including potentially substituting reference site sampling or liver tissue sampling with a smaller target sample size for the baseline dataset if agreed to by the USFWS. The estimated cost to conduct this monitoring is $100,000 per year.

D. Reporting

The Corps would post the monitoring information on the public website as it becomes available. The USGS would include the hydrologic and hydraulic data collected from the continuous recorders in their annual report to the state.

A summary of reports that would be prepared to address the various monitoring efforts that would be conducted during the construction phase is as follows:

- A report summarizing the findings of the three years of monitoring of the 12 wetland sites.
- Annual reports of the groundwater monitoring data to be submitted to Georgia DNR-EPD by January 31st of the following year.
- A report summarizing the findings of the four years of monitoring of Shortnose sturgeon distribution in the Savannah Harbor estuary.
- A report on the results of the Transfer Efficiency Study
- Twelve reports summarizing the results of the hydrodynamic and water quality model assessments. The Corps would prepare a brief technical paper after each assessment of the hydrodynamic and water quality models documenting the findings of the comparison between observed water quality data and predicted levels. The Corps would provide this

report and hydrodynamic and water quality model output data to the natural resource agencies. After a 30-day review period, the Corps would revise the report as necessary and place it on the public website.

- Monthly reports containing the data from the monitoring of the effluent from CDFs used for dredged material from the SHEP. These reports would be sent to the Georgia DNR-EPD, SC DHEC, and USFWS as wells as being posted online.
- Quarterly reports containing the data from the monitoring of the effluents from CDFs 14A and 14B for cadmium and other analytes. These reports would be sent to the Georgia DNR-EPD, SC DHEC, and USFWS as well as being posted online.
- A summary report of the findings of the monitoring efforts for the construction phase of the project. At the end of the construction period, the Corps would prepare a report of the data obtained during this phase. For the hydrologic and hydraulic data, the report would include the Corps' conclusions about the comparisons between observed water quality data and predicted levels. The Corps would provide this report to natural resource agencies and make it available to the public.

E. Cost Summary

The costs for the monitoring that would be performed during a 4-year construction period are summarized as follows:

Continuous Riverine Monitoring	$2,080,000
Bathymetry Monitoring (Sediment Basin)	$300,000
Chloride Monitoring	$400,000
Groundwater Monitoring	$30,000
Transfer Efficiency Study	$300,000
Wetlands	$720,000
Shortnose sturgeon	$800,000
Assess Hydrodynamic and WQ models	$720,000
Monitoring of DO-Dredge	$300,000
Monitoring of Effluent from CDFs	$572,000
Cadmium Monitoring-Effluent	$380,000
Cadmium Monitoring-Sediments	$832,000
Wildlife Use Studies-CDFs	$300,000
Avian Blood/Feather Monitoring	$400,000
Reporting	$200,000
Oversight & Contracting	$400,000
During Construction Total:	**$8,734,000**

7. POST-CONSTRUCTION MONITORING

A. Goals. The main goal of the Post-Construction Monitoring is to verify that the project does not produce more impacts than predicted and that the mitigation features function as they were designed.

Monitoring conducted during the Post-Construction monitoring period would include many of the same study elements performed during the Pre-Construction and construction monitoring periods including operation of the continuous hydrologic and hydraulic data monitors, monitoring of the marsh sites, bathymetric surveys, updating and assessing the hydrodynamic and water quality models, chloride monitoring at the City of Savannah's water supply intake on Abercorn Creek, groundwater monitoring at the sentry and upgradient background wells, intense hydrologic and hydraulic monitoring events (as performed in the Pre-Construction Monitoring) and monitoring of Shortnose sturgeon.

Other study elements in the Post-Construction monitoring phase include fish, crab, and shrimp distribution and abundance studies in marsh areas, an assessment of the impacts of the project on Striped bass habitat, monitoring of the marsh restoration site in Disposal Area 1S, two intense surveys (1 week) to determine the location of the freshwater interface at high and low tides, and impact assessment studies using the field data collected and the hydrodynamic and water quality models.

Although construction of the project would be complete, some cadmium monitoring would still be occurring. This monitoring would include monitoring of effluent from the CDFs during dewatering of the disposal areas, sampling, wildlife use surveys in the CDFs 14A and 14B, monitoring of cadmium levels in birds in CDFs 14A and 14B, and analysis of channel sediments prior to maintenance dredging.

Post-construction monitoring would be conducted for a period of 10 years, however, not all study elements would be conducted for ten years as described below.

B. Major Components. This phase would begin after completion of the final construction activities that would alter salinity or river flow distribution in the estuary. This consists of the channel dredging, the flow-altering components of the mitigation plan, and the dissolved oxygen system.

1. Hydrologic and Hydraulic Data Monitoring. The Corps would continue to operate the eight continuous hydrologic and hydraulic data recorders for ten years. USGS staff would perform this work. They would include the data in their state annual reports. This monitoring would help the Corps document and assess the hydrodynamic and water quality changes that resulted from the harbor deepening.

2. Intense Hydrologic Data Monitoring. The Corps would conduct two intense hydrologic monitoring events. These events would monitor conditions over a lunar cycle (28 days). One of the events would be conducted in year 1 and the other in year 5. Sampling will be performed at multiple depths and at least twelve stations that will be selected by the Corps in

consultation with the resource agencies. The parameters included in these events would be the same as those in the Pre-construction monitoring intensive survey. Prior to conducting the events, a detailed monitoring plan will be coordinated with the cooperating agencies. A report would be prepared for each sampling event to summarize the results. The Corps would use the data to update (if required) the hydrodynamic and water quality models. The Corps may collect and use data at points established as being important to the agencies.

3. Bathymetric Surveys in Unique Areas. The Corps would **c**onduct two bathymetric surveys of riverine areas not normally surveyed to obtain up-to-date information on the depth and width of the tidal rivers that are included in the hydrodynamic model. The surveys would extend from I-95 to Old Fort Jackson and include the Front, Middle, and Back Rivers. These surveys would be conducted at the same time as the intense hydrologic and hydraulic surveys. Data from these surveys would also be used to update (if required) the hydrodynamic and water quality models; if the modeling performance guidelines are not being met, an update would be warranted.

4. Hydrodynamic and Water Quality Model Assessments. The data gathered from the bathymetric surveys and the intense hydrologic surveys would be used to update (if required) the hydrodynamic and water quality models; if the modeling performance guidelines are not being met, an update would be warranted. These model assessments would occur twice during Post-Construction Monitoring. A report would be prepared summarizing both model assessments. The natural resource agencies would review these reports.

5. Identification of the Freshwater Interface. Two intense one-week studies would be conducted to identify the freshwater interface location during both high and low tides. This study would focus on salinity and dissolved oxygen. One use of the results would be to compare the locations indentified for the interface to those locations predicted by the hydrodynamic and water quality models. As flows and other environmental factors which influence the freshwater interface are variable, the exact timing of the study will be determined in consultation with all the resource agencies.

6. Chloride Levels-City of Savannah's Water Intake. The Corps would continue to monitor chloride levels at the City of Savannah's water intake on Abercorn Creek. Corps staff may perform this work. This monitoring would be conducted for a period of five years after completion of construction. The Corps would post the data on the public website. One or both of the meters are expected to be a permanent installation, whose operation and maintenance would become a responsibility of the City of Savannah when the SHEP monitoring period ends.

7. Chloride Levels-Groundwater. The Corps would continue to monitor chloride levels in groundwater at the sentry and upgradient background wells that the Corps installed to identify any unforeseen adverse impacts to the Floridan drinking water aquifer. Savannah District staff may perform this work. The Corps would post the data on the public website. These wells would be maintained and monitored throughout the Post-Construction Monitoring period and for the life of the project. Any changes to the monitoring protocol or adaptive management measures would be conducted in accordance with the GA DNR-EPD and SC DHEC water quality certifications, and the adaptive management procedures outlined below.

8. Monitoring of the Marsh Sites. The USGS Florida Fish and Wildlife Cooperative Research Unit or other qualified organization would monitor the twelve sites they monitored in the Pre-Construction and Construction monitoring in the same manner. They would perform this work for ten years. They would measure marsh salinities continuously and sample vegetation twice a year. They would prepare a report of their findings in year 5 that included data from years 1-4. They would prepare a comprehensive report at the conclusion of year 10 to include data from the entire monitoring period. The final report would also include a comparison to the Pre-Construction monitoring results, the predicted values, and their previous work at these sites. Each year, the contractor would provide a summary of data collected that year.

9. Monitoring of the Marsh Restoration Site in Disposal Area 1S. The marsh site in Disposal Area 1S would be monitored for a period of seven years. Monitoring would include identification of any invasive species, and a plan to control invasive species, if required. Annual reports would be prepared that summarize results of the monitoring. The report prepared for year 7 would summarize the results of the monitoring in years 1-7 and provide an overall assessment of the success of the marsh restoration efforts in Disposal Area 1S and any recommendations as to what further actions might be required at the site to complete the marsh restoration efforts. Release of any excess credits (only for use on the Savannah Harbor Federal Navigation Project) would occur after the long-term health/productivity of the restoration site is verified by the Federal Cooperating Agencies.

10. Shortnose Sturgeon Distribution-Savannah Harbor Estuary. SC DNR Marine Resources Division or another qualified organization would monitor the distribution of Shortnose sturgeon in the same manner as previously performed. The work would be performed for five years and a report prepared discussing each year's findings. An additional year of this monitoring would be conducted in the ninth year of the Post-Construction Monitoring. The final report which would be provided in year 10 would be a comprehensive one describing their findings both prior to and after construction.

11. Fish Distribution Study. The USGS Georgia Fish and Wildlife Cooperative Research Unit or another qualified organization would monitor fish, crab, and shrimp abundance and distribution along the edges of marshes using a drop survey method that was a component of the study performed in 2000-2001(Jennings and Weyers, 2003). They would perform this work in years 1, 3, 5, and 9 after construction and prepare a report of each year's findings. The report provided in year 10 would be a comprehensive one describing their findings both prior to and after construction.

12. Shortnose Sturgeon Passage Study-NSBL&D. The USGS Georgia Fish and Wildlife Cooperative Research Unit or another qualified organization would monitor fish movement through the New Savannah Bluff Lock & Dam off-channel rock ramp fish bypass structure and monitor Shortnose sturgeon distribution patterns in the vicinity of the dam. They would perform this work for five years and then again in year 9 of the Post-Construction Monitoring. In this phase of the project they would search the river weekly between NSBL&D and the Jackson, SC Landing and NSBL&D and the Augusta Water Diversion Dam would be searched weekly for fish with transmitters during the migration season. On a monthly basis, they would search the Savannah River from the Savannah Harbor Kings Island Turning Basin past the

NSBL&D to the Augusta Diversion Dam. This phase may include the installation and use of a series of active infrared video cameras to monitor fish movement within the fish bypass structure. The system would operate continuously and collect images of fish at the upper end of the passage facility. The recorded video would be reviewed to determine the species composition, fish orientation (upstream versus downstream) and abundance. The USGS would prepare a report of each year's findings. The report provided in year 10 would be a comprehensive one describing their findings both prior to and after construction. The findings of this effort will be used to judge the effectiveness of the fish passage facility, when compared to the goals of 75 percent upstream sturgeon passage, 85 percent downstream sturgeon passage, and causing no harm to passing sturgeon.

13. Shortnose Sturgeon and Striped Bass Habitat Assessments. Evaluations of the impacts of the SHEP on Shortnose sturgeon and Striped bass habitats would be conducted in years 2, 4, and 9 of the Post-Construction Monitoring. The field data collected in other tasks would be used in conjunction with the updated hydrodynamic and water quality models to conduct this assessment. A report would be prepared at the end of each year the evaluations are performed. The report would assess any further impacts to Shortnose sturgeon and Striped bass habitats beyond that described in the EIS.

14. Impact Assessment. Data collected from the bathymetric surveys and the intense hydrologic surveys described above would be used to assess impacts and to evaluate the effectiveness of the mitigation features. In addition, the data will be used to update the hydrodynamic and water models. The physical monitoring data would be included in the models and compared to what those models predict should have occurred under the observed conditions. If the models successfully predict salinity and dissolved oxygen levels (which will be known from field measurements) for the conditions observed during the monitoring, then they would be a reliable tool for impact assessments. This study effort would be conducted once a year for ten years. Reports for this element of the monitoring would include annual reports describing the results of the studies conducted each year during years 1-9 of Post-Construction Monitoring and a final report describing the results of the modeling performed in Year 10 as well as the overall result of all ten modeling efforts.

15. Monitoring of CDF effluents. The Corps would continue to monitor water quality discharges from the CDFs that were used for the construction. This work may extend for a year or two until the CDFs are dewatered from the new work placement. Savannah District staff would perform the work. The District would prepare an Annual Report. This monitoring would ensure the discharges comply with water quality standards.

Following the installation of a stable clean cover over the cadmium-laden sediments in CDFs 14A and 14B, cadmium would be monitored in the effluent from these CDFs weekly for a period of one year. In addition, a quarterly metals scan with the inclusion of ammonia would be conducted. All of the above information would be furnished to the GA DNR-EPD, SC DHEC, and USFWS.

After the CDFs enter the O&M phase, the Corps would monitor the CDF effluents for the life of the project following its normal procedures.

16. Wildlife Use Monitoring in CDFs 14A and/or 14B. Monitoring of wildlife use in CDFs 14A and 14B would be continued from the construction phase for a minimum of three years after placement of the cadmium-laden sediments and would continue as long as other cadmium-related monitoring events are being conducted. The monitoring would be conducted in the same manner as the monitoring conducted during the construction phase of the project.

17. Avian Blood/Feather Monitoring in CDFs 14A and/or 14B. Avian blood/feather monitoring would continue for a minimum of three years after the placement of the cadmium-laden sediments in CDFs 14A and/or 14B is complete. It would continue until cadmium concentrations are determined to not significantly differ from the baseline concentrations for three consecutive years. The monitoring would be conducted in the same manner as the monitoring conducted during the construction phase of the project. Should the proposed blood/feather sampling as described in the During and Post-Construction monitoring indicate there is a statistically significant change (95% confidence level) in the cadmium blood levels of birds in the CDFs before and after placement of cadmium-laden dredged material, then the Corps would conduct avian liver tissue sampling as outlined below in Section 8. The cost to perform this work is estimated at $100,000 per year for blood/feather sampling, plus an additional $50,000 to conduct liver tissue sampling should it be necessary.

18. Cadmium Monitoring-Channel Sediments. At the end of construction, sediment samples would be taken from the exposed channel bottom sediment surface and analyzed for grain size and metals (including cadmium). Analysis of the river bottom would provide an assessment of cadmium concentrations (as well as other metals) in sediment at the sediment-water interface.

As a condition of the Section 401 Water Quality Certification, the Georgia DNR-EPD and SC DHEC have requested sediment analyses prior to any maintenance dredging in those reaches of the channel with cadmium-laden sediments. Samples are to be taken from two locations in the channel 45 days prior to dredging, analyzed for cadmium, and the results furnished to the Georgia DNR-EPD, SC DHEC, and USFWS prior to initiation of dredging. This protocol would remain in effect through two maintenance dredging cycles. The Georgia DNR-EPD would review the results of the cadmium analyses and determine if additional such monitoring was warranted.

C. Reporting

Savannah District would place the data that is collected during the Post-Construction Monitoring and the reports that are produced onto the public website that was established during the Pre-Construction period. The District would prepare an Annual Report of data collected. The report would be provided to natural resource agencies and then placed on the public website.

A summary of reports concerning the various monitoring efforts that would be conducted during the Post-Construction Monitoring is as follows:

1. Intense Hydrologic Surveys Reports. Surveys would be conducted during years 1 and 5 of the Post Construction Monitoring.

2. Bathymetric Survey Reports. Surveys would be conducted during years 1 and 5 of the Post-Construction Monitoring.

3. Hydrodynamic and Water Model Update Reports. Model updates would be conducted after data from intense hydrologic and hydraulic surveys and bathymetric surveys become available, i.e., years 2 and 4 of the Post-Construction Monitoring Program.

4. Freshwater Interface Study Reports. Survey would be conducted during years 3 and 8 of Post-Construction Monitoring.

5. Groundwater Monitoring Reports. Annual reports will be furnished to Georgia DNR-EPD by 31st of January following the year of data collection.

6. Transfer Efficiency Study Report. One-time study that would occur either very late in construction or first part of Post-Construction Monitoring. This study is not included in the Post-Construction Monitoring Cost Summary below because it was included in the Construction Monitoring Cost Summary.

7. Marsh monitoring (12 sites) reports. Two reports will be prepared to address the ten years of Post-Construction Monitoring and changes from Pre-Construction Monitoring. One report in year 5 to address the findings of the first four years of monitoring and a report at the end of year 10 of the monitoring which would address years 5-10 of the monitoring and the overall 10-year study effort.

8. Monitoring of Marsh Restoration Site (1S) Reports. Seven reports to address seven years of Post-Construction Monitoring. The report for year 7 would be a comprehensive report to address monitoring of the site in years 1-7 and the success of the marsh restoration in Disposal Area 1S.

9. Monitoring of Shortnose sturgeon distribution in the Savannah Harbor Estuary Reports. Two reports to address six years of monitoring. One report in year six to address the findings of the monitoring for years 1-5, and a comprehensive report in year 10 to address the results of the monitoring conducted in year 9 and the overall findings of the six years of monitoring.

10. Monitoring of Shortnose sturgeon from NSBL&D to Savannah Harbor Reports. Two reports to address six years of monitoring. One report in year 6 to address the findings of the monitoring for years 1-5, and a comprehensive report in year 10 to address the results of the monitoring conducted in year 9 and the overall findings of the six years of monitoring.

11. Fish, Crab, and Shrimp Distribution Study Reports. Four reports to address four years of monitoring. Three reports would be prepared to address the results of the monitoring that would occur in years 1, 3, and 5 and a comprehensive report in year 10 to address the results of the monitoring conducted in year 9 and the overall findings of the four years of monitoring for this

study element. Reports would be provided to NMFS within 12 months of completing each year of sampling.

12. Shortnose sturgeon and Striped bass habitat assessment reports. Three reports to address the six evaluations. A report would be prepared to address the results of the studies conducted in years 2 and 4, and a comprehensive report prepared in year 10 to address the impacts of the monitoring that would be conducted in year 9 and an the overall findings of the three years of study.

13. Impact Assessment Study Reports. Annual, reports to address the findings of this study would be prepared each year for ten years. These would include a comparison of ranges of predicted performance values for parameters at specific points in the post-construction Savannah Harbor estuary to measured values.

14. Monitoring of effluent from CDFs 14A and/or 14B Reports. Annual, with the exception that Georgia DNR-EPD, SC DHEC, and USFWS would be provided a quarterly synopsis.

D. Cost Summary

The costs for this Post-Construction monitoring are estimated as follows:

Operate water quality stations	10 years x 8 @ $65,000	=	$5,200,000
Bathymetric Surveys (Unique Areas)	2 @ $158,000	=	$316,000
Intensive Monitoring	2 @ $350,000	=	$700,000
Freshwater Interface	2@ $40,000	=	$80,000
Assess Hydrodynamic and WQ Models	2 @ $150,000	=	$300,000
Chloride monitoring	5 years x $80,000	=	$400,000
Groundwater monitoring	10 years x $7,500	=	$75,000
Wetlands	10 years x 12 @ $20,000	=	$2,400,000
Monitor Marsh Restoration Site 1S			$680,000
Shortnose sturgeon monitoring	6 years x $200,000	=	$1,200,000
Fish passage at NSBL&D	6 years x $250,000	=	$1,500,000
Shortnose Sturgeon and Striped Bass Habitat Assessments	3 years x $ 70,000	=	$210,000
Fish distribution along marshes	4 years x $125,000	=	$500,000
Impact Assessment (using data and models)			$938,000
Monitor CDF effluent			$286,000
Wildlife Use Studies-CDFs 14A and 14B			$415,000
Avian Blood/Feather Monitoring			$350,000
Sampling Exposed Miocene for Cadmium			$78,000
Reporting			$500,000
Oversight			$700,000
Post Construction Total:			**$16,828,000**

Table 1. Summary of Major Monitoring Events

Element	Pre	During	Post										
			Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Post Year 10
Establish Baseline Data Bank	X												
Installation of Continuous Water Quality Data Recorders (5 new, 3 upgrade)	X												
Update Hydrodynamic and WQ Models (If Necessary)	X												
Bathymetric Surveys of Sediment Basin		X											
D.O. Transfer Efficiency Study		X											
D.O. Levels near Dredge during Summer Months		X											
Cadmium Sediment Sampling in 14A/14B		X											
CDF Effluent		X	X	X									
Monitoring of 8 Continuous Water Quality Data Recorders	X	X	X	X	X	X	X	X	X	X	X	X	4 Recorders
2 Intensive Water Quality/Hydrologic Monitoring Events	X		X				X						
2 Bathymetric Surveys in Unique Areas	X		X				X						
Hydrodynamic/Water Quality Model Assessment		X		X				X					
Freshwater Interface Determination					X					X			
Chloride Monitoring at Abercorn Creek Intake	X	X	X	X	X	X	X						
Groundwater Chloride Monitoring	X	X	X	X	X	X	X	X	X	X	X	X	8 Wells
Monitoring of 12 Marsh Sites (Chloride/Hydrologic/Vegetation)	X	X	X	X	X	X	X	X	X	X	X	X	
Monitoring of Marsh Restoration Site (1S)			X	X	X	X	X	X	X				
Shortnose Sturgeon Distribution in Estuary	X	X	X	X	X	X	X				X		
Shortnose Sturgeon Distribution at NSBL&D	X		X	X	X	X	X				X		
Fish Distribution Along Marshes			X		X		X				X		
Impact Assessment Review (Comprehensive Physical Data/Model Comparison and Review)			X	X	X	X	X	X	X	X	X	X	
Wildlife Use in 14A/14B (Avian/Terrestrial Field Counts)		X	X	X	X								
14A/14B Inflow/Effluent (Georgia)		X	X										
14A/14B Bird Tissue Analysis		X	X	X	X								
Sampling Exposed Miocene for Cadmium			X	X									
Shortnose Sturgeon and Striped Bass Habitat Monitoring				X		X					X		

8 PERFORMANCE MEASURES

A. Goals. This section will define the manner in which the findings of the monitoring would be evaluated and used in decision-making.

B. Components. The monitoring that would be conducted can be placed in one of the following four categories:

- Pre-Construction monitoring to establish a baseline prior to implementation of the harbor deepening project. The field investigations performed for this study would be conducted early in the study process and be updated to ensure information is available that reflects conditions just prior to the deepening;
- Monitoring during construction to identify any impacts that occur that are beyond the range of those expected to occur;

- Post-Construction monitoring to ensure the impacts that occur do not exceed those that were predicted and evaluate the effectiveness of the mitigation features; and
- Post-Construction monitoring to document the effects on a specific resource.

As stated in the background section of this appendix, the two aspects of performance that need to be distinguished are the accuracy of the impact assessment tools (primarily models) and the biological responses that will occur as a result of changes in the environment. The manner in which the monitoring is evaluated, therefore, would depend on the original purpose of that particular monitoring effort.

Pre-Construction Monitoring

The Pre-Construction monitoring consists of Geomorphic and Biologic components that would provide information to establish a pre-project baseline. Pre-construction monitoring would also include the establishment of a baseline data base using existing data and reports available on Savannah Harbor. The Continuous Riverine Monitoring, the Bathymetric Surveys and the Intensive Monitoring would be used to assess whether the hydrodynamic and water quality models should be recalibrated to increase their accuracy and reliability. Models that can accurately simulate conditions within the Savannah Harbor estuary are essential to examining whether biological responses that occur as a result of the project are within expected ranges. The Corps would enter the new information into the models, assess the accuracy and reliability based on the previous calibration, and determine whether that accuracy and reliability could be increased substantially if the model is recalibrated with the more up-to-date information. The Corps would use generally the same performance goals for the models that the Federal Cooperating Agencies established when the models were initially applied to Savannah Harbor with one exception. The USFWS recommended that the goal for salinity should be changed from +/- 0.5 ppt to +/- 10% when salinity is within the range of 1 to 5 ppt. While the table below reflects that recommendation, it may not be achievable. The modelers would make every effort to make the models as accurate as possible. The performance goals for the various parameters are summarized on the following page:

Table 2. Modeling Performance Goals

Parameter		Percentiles					Timing of Maxima (Min)
		5 %	10 %	50 %	90 %	95 %	
Elevation (cm)		+/- 2	-	+/- 2	-	+/- 2	+/- 30
Salinity (ppt) *	1-5 ppt	-	-	+/- 10 %	+/- 10 %	-	+/- 30
	< 1 ppt	-	-	+/- 0.1	+/- 0.1	-	+/- 30
DO (mg/L)		-	+/- 0.2	+/- 0.2	-	-	+/- 30
DO Deficit (mg/L)		-	+/- 0.2	+/- 0.2	-	-	+/- 30
Temperature (^{o}C) **		-	-	+/- 1	-	-	-
Surface Currents (m/s) ***		+/- 25%	-	-	-	+/- 25%	+/- 30
Volume Flows (m/s) ***		+/- 25%	-	-	-	+/- 25%	-

* The salinity goals have been refined for the post project-approval period
* 50% represent Absolute Mean Error for temperature
** 5% and 95% represent the max. ebb and flood conditions for current and flow

After the model has been reviewed and possibly recalibrated, model runs will be made to establish ranges of predicted data values on selected performance parameters for specific points in the Savannah Harbor estuary. The data will be used to create graphs with trendline and curves showing the expected ranges of modeled values as described in the pre-construction section of this appendix. Performance parameters will be established for specific conductance, salinity, and DO. During construction and post-construction monitoring, measured values would be compared to these predicted ranges to determine if the project is performing as expected.

Monitoring During Construction

Many variables need examination to determine whether the responses of the Savannah River Estuary that occur as a result of the project are within the expectations provided in the EIS and as monitored by the ranges described above. To make the assessment, the Corps would combine results from several monitoring efforts. All the data that is collected will be used in those evaluations. Data from the Continuous Riverine Monitoring are expected to be available on a 24-hour basis and reflect near real-time conditions. Therefore, they will be most useful in identifying whether any impacts are occurring beyond the range of those expected.

The Corps would regularly assess (every four months) how well the hydrodynamic and water quality models predict the salinity and dissolved oxygen levels that are occurring during the construction process. The assessment would be performed by comparing the model's predictions against what is being measured at the 8 continuous water quality monitoring stations. The model grid would be updated to reflect the new bathymetry and the actual river flows. If the modeling performance guidelines are not being met, recalibration of the model may be warranted.

These regular assessments also will be useful in identifying whether any impacts are occurring beyond the range of those expected. Using DO concentration as an example, the locations of the Continuous Riverine Monitoring stations correspond to zones SR, FR8, MR3, LBR2, LBR3, MR1, BR1, and FR3 in reports that supplement the GRR, and those reports contain tables that predict the frequency of particular average DO concentrations within the bottom waters of each zone during the time of year when DO is expected to be at its lowest. Near real-time results from the Continuous Riverine Monitoring stations can show whether the expectations for these zones are being met and can serve as proxies for what might be occurring elsewhere in the harbor.

Salinity provides another example. During the pre-construction monitoring period, modeled salinity and flow data at the continuous gauging station locations will be used to establish thresholds of acceptable response of the system to the harbor deepening. During and after the construction, measured salinity and flow data would be compared to modeled salinity for the observed flows at the continuous gauging stations to evaluate the ecosystem's response to the construction project. Plots will be generated showing the model projected relations between maximum, minimum, and mean salinity and streamflow. From these plots, trendlines will be developed and curves of the expected ranges of values will be computed to represent the expected range of responses of the system. The curves will provide salinity values for a corresponding streamflow at a particular site. As the real-time data is collected, the plots could be updated in near real-time to evaluate how the system is responding with respect to projected deepening conditions.

Model data for flow will show the predicted flows, as well as pre-construction flow data, at the three water quality monitoring stations along Georgia Highway 25 / South Carolina Highway 170 Bridge. Using methods similar to those described above, flow data during construction would be compared to these ranges of predicted values to evaluate if the system is responding as predicted.

Modeled data for various river flows at Clyo would be used to assess DO at the eight water quality monitoring stations.

Conducting these assessments every four months should be sufficient to assess performance of the models and the emergence of any unexpected impacts. This process would serve as the mechanism to identify the emergence of any unexpected variances with the predictions about how the harbor would function after construction is complete.

If the monitoring identifies impacts that are outside the range of those expected, the Corps would consult with the Cooperating Agencies to identify what actions may be appropriate. This could include more detailed monitoring in certain locations to obtain a better understanding of what is occurring, or a delay, reordering, or cessation of construction activities. The Corps would re-evaluate the data if a Cooperating Agency believes that the impacts are going outside the expected range.

The Corps would prepare a brief technical paper after each assessment of the hydrodynamic and water quality models documenting the findings of the comparison between observed data and

predicted levels. The Corps would provide this report to the natural resource agencies for review and comment. The Corps would then make the report available to the public.

In addition to the data from the continuous water quality monitors, the graphs of ranges of predicted values, and the use of the hydrodynamic and water quality models to assess project impacts during construction, other "tools" would also be available to measure the performance of the project during the construction phase of the project. These assessment tools would include the monitoring of dissolved oxygen levels in the harbor in the summer months, monitoring of chloride levels at the City of Savannah's water intake on Abercorn Creek, groundwater monitoring, and monitoring of effluent from the CDFs to ensure there are no violations of applicable water quality standards, analyses of cadmium concentrations of sediments placed in CDFs 14A and 14B, and monitoring of dissolved oxygen levels in the vicinity of the dredge during the summer months.

Post-Construction Monitoring

The Corps would again combine several of the monitoring efforts to evaluate model performance and identify whether any impacts occur that are beyond the range of those expected. All the data would be used in these evaluations of how the Savannah Harbor estuary and tidal marshes responded to the harbor deepening. The physical monitoring data would be included in the hydrodynamic and water quality models and compared to what those models would have predicted would occur under those conditions. The Corps would use the range of variability shown in the model performance goals to help in its assessment of the models' accuracy in predicting the observed effects. The District would continue to refine the hydrodynamic and water quality models to improve their accuracy and reduce their range of variability. It would also use the range of +/- 50 acres to assess the acreages of tidal freshwater, brackish, and salt marsh when the wetland impact and mitigation evaluations were conducted. The following table shows the predicted acres of marsh using the salinity criteria developed by the Wetlands interagency coordination team.

Table 3. Predicted Acres of Marsh Types

	Tidal Freshwater	**Brackish**	**Salt**
	<0.5 ppt	**0.6 to 4.0 ppt**	**>4.0 ppt**
Current	4072 acres	2253 acres	2806 acres
Predicted	3849 acres	3217 acres	1766 acres

In addition, monitoring data from continuous water quality monitoring stations will be compared to modeled values for those same points. Post-construction conditions within the Savannah Harbor estuary that are outside the ranges predicted would not necessarily trigger corrective action but would trigger coordination among the agencies so that the Corps may determine what action, if any, would be appropriate as described below.

Acceptability Criteria

This document does not include specific acceptability criteria for all water quality or biologic parameters which would be monitored for this project. Although identification of specific values would establish points at which action would need to be taken, it would also limit the judgment of experts about potential cumulative effects of changes in several parameters which do not exceed a single threshold. The monitoring and adaptive management plan is based on a collaborative decision making process among experts in several natural resource agencies. Establishing thresholds at this time would limit the ability of those agencies to respond to situations in a manner that they determine would be best for this estuary. Exceptions are noted in the three paragraphs below.

The Georgia DNR-EPD and South Carolina DHEC (as a condition of their Section 401 Water Quality Certifications) requested that a benchmark chloride concentration be established for each sentry well. The chloride concentration in the groundwater determined from the monitoring of sentry wells and up-gradient wells will have specific triggers for corrective action. The Corps must also determine what chloride concentrations caused by SHEP dredging activities would result in a measurable increase in chloride concentrations at Savannah area production wells. The benchmark chloride concentrations must be protective of the Savannah area production wells. The Corps would establish benchmark chloride concentrations for each pair of sentry wells near the top of the Upper Floridian aquifer and deeper in the aquifer. The establishment of the benchmark chloride concentration would be accomplished prior to the commencement of the dredging and would serve as a trigger for corrective action.

Another example is the conditional requirements under which the Corps would conduct vegetation sampling in the CDFs where cadmium-laden sediments are deposited. Vegetation sampling would be conducted in the event that elevated concentrations of cadmium (4mg/kg or greater) in a cumulative total of 25 acres or more of the covering layer. This sampling would be conducted on a quarterly basis. Sampling of vegetation would be initiated in defined "hot spots" to determine cadmium uptake by plants. Specific details of the vegetation sampling procedures would be determined in coordination with the USFWS before implementation. Samples collected from CDFs 14A and 14B would be compared to control samples derived from other low cadmium environments found in adjacent CDFs. Where at all possible, vegetation comparisons to reference will be by species and sampling would include all dominant species growing in the cover cap. If vegetations samples have significantly elevated cadmium concentrations, then efforts would be initiated to eradicate vegetation and/or place additional, low cadmium sediments over the original capping layer. These measures would eliminate wildlife exposure should vectors for uptake of cadmium be identified. When soil sampling indicates sustained cadmium concentrations are less than 4 mg/kg, the vegetation monitoring would be complete.

Similarly, there is a conditional requirement under which the Corps would conduct avian tissue analyses. Should the proposed blood sampling as described in the During and Post-Construction monitoring indicate there is a statistically significant change (95% confidence level) in the cadmium blood levels of birds in the CDFs before and after placement of cadmium-laden dredged material, then the Corps would conduct avian liver tissue sampling. Since the CDFs

would reenter the rotation program after the covering sediments have been placed, the CDFs may be dry or wet, depending on the year. Their hydrologic condition will drastically alter their bird use, as different species use the CDFs in those two conditions. Consequently, if/when the CDFs are dry, three individuals from two species (six total) would be sampled at the beginning and end of the nesting season (April and August) from species that use typically use the CDFs for nesting. Also, if/when the CDFs are dry, three individuals from two species (six total) would be sampled at the beginning and end of the wintering season (October/November and March/ April). Samples would be obtained from species that typically use the CDFs during the winter months as outlined in Appendix M. The Corps may also choose to collect baseline liver tissue data. Post-construction liver tissue data would be compared to baseline data (if available) and published avian liver cadmium toxicity levels (screening level). Project liver tissue data would have to significantly exceed baseline data and/or the screening levels to trigger additional management options.

The field data collected, ranges of predicted values at water quality monitoring stations determined during pre-construction, and the hydrodynamic and water quality models using observed river flows would be the main tools which would be used to determine how the project is performing and if the impacts are generally as expected. Even though the potential impacts of the project were evaluated under a likely range of conditions, the actual circumstances experienced after construction will be somewhat different from those used for evaluation in the project's feasibility phase. Consequently, the monitoring data will be used to evaluate the response of the system to the mitigation features. In addition, the hydrodynamic and water quality models would be used to examine post-project performance under actual conditions, e.g. high/low flows, drought, or some combination of these. The performance (accuracy) of the models would be assessed once during pre-construction monitoring and twice during post-construction monitoring and recalibrated, if necessary. This repetition in modeling assessment/ recalibration would improve their predictive accuracy by decreasing their range of uncertainty. The Corps and the resource agencies would use the modeling data (after any necessary post-construction recalibration of the models) and compare those data to actual field results to determine whether the Savannah Harbor estuary is responding to SHEP as expected. The hydrodynamic and water models would be used to evaluate project performance once a year for ten years as part of the post-construction monitoring. The Corps would prepare a report after each of the ten assessments of the hydrodynamic and water quality models documenting the findings of the comparison between observed data and predicted levels. The Corps would provide this report to the natural resource agencies for review and comment. The Corps would then make the report available to the public.

Other tools that would be available to assist with the post-construction assessment of the performance of the project would include the study of the 12 marsh sites, the monitoring of the marsh restoration site in Disposal Area 1S, data from the chloride monitoring at the City of Savannah's water intake, groundwater monitoring, the data from the Shortnose sturgeon distribution study in the Savannah Harbor estuary, the data from the Shortnose sturgeon passage study at NSBL&D, the fish distribution study, and the data from the assessment of project impacts on Striped bass habitat. These studies would be used to evaluate the performance of the project as described below.

The 12 marsh sites would be monitored for ten years after completion of the project. The data could then be compared to the predictions in the EIS, post-construction modeled impacts (using observed river flows), past reports, and data gathered during previous years (one year of pre-construction and four years of construction) to evaluate impacts of the project on marshes (especially tidal freshwater) in the project area.

The Corps would use the following revegetation rate as the acceptability criteria for restoration of brackish marsh at Area 1S. A reference marsh site would be identified in the vicinity of Disposal Site 1S to facilitate the evaluation of the marsh restoration progress.

Table 4. Revegetation Rate for Area 1S

Time Period	Percent Vegetative Cover
Construction	0
Year 1	15
Year 2	25
Year 3	40
Year 4	60
Year 5	80
Year 6	85
Year 7	90

Marsh restoration in Disposal Site 1S includes an adaptive management plan which would require continued efforts until the success criteria are achieved. These efforts may include adjusting the elevation of the site as many times as necessary to achieve success and the planting of juvenile *Spartina alterniflora* plants if the site does not naturally re-vegetate at the rate of colonization indicated in the above table. Should the restored marsh not meet the success criteria in the above table, then the ICT would identify and/or recommend corrective actions, including planting requirements and associated sprig densities, which would achieve compliance with the re-vegetation criteria in the above table. The need for corrective action(s) would be determined and/or implemented annually with agency involvement and concurrence. Annual monitoring reports would be generated over a period of seven years and provided to a Wetland ICT. If at the end of seven years the plant density at the restored marsh is not within 10 percent of the reference site, the Corps would implement further actions to achieve successful marsh regeneration on this site.

The wetland restoration in Disposal Area 1S would also include an adaptive management plan with respect to invasive species. The site would be monitored for invasive species, and an invasive species control plan would be developed and implemented, if required.

The water quality model and ten years of post-construction data from the eight continuous recorders would provide information on how the project affected the dissolved oxygen regime in the Savannah Harbor estuary.
Ten years of post-construction data from the eight continuous water quality recorders would provide information on how the project affected the salinity regime in the Savannah Harbor estuary. This data would be supplemented with data from two intense hydrologic monitoring events (years 1 and 5 of post-construction monitoring) and two studies to identify the location of the freshwater interface (years 3 and 8 of post-construction monitoring).

Five years (years 1-5 of post-construction monitoring) would be available to assess the impacts of the project on chloride levels in the vicinity of the City of Savannah's water supply intake on Abercorn Creek. This data would be used to determine if the observed values are within the range of accuracy of the predicted values and to aid the City of Savannah in their operational procedures for the raw water storage pond.

Ten years of data from the sentry and upgradient background wells would be available to assess the impacts of the project on chloride levels in the Upper Floridan aquifer. This data could be compared to the five years of groundwater monitoring data collected during the one-year of pre-construction monitoring and the four years of the construction period.

The study of the passage of Shortnose sturgeon at NSBL&D would be conducted in years 1-5, and 9 of the post-construction monitoring. This study would concentrate on fish passage at NSBL&D. The Corps would prepare a report describing the findings of the monitoring of fish passage at New Savannah Bluff Lock and Dam. That report would identify whether any modifications to the fish passage structure are recommended for the mitigation feature to function as intended. The findings of this effort will be used to judge the effectiveness of the fish passage facility, when compared to the goals of 75 percent upstream sturgeon passage, 85 percent downstream sturgeon passage, and causing no harm to passing sturgeon.

Monitoring of Shortnose sturgeon would provide information on the locations of the estuary used by the Savannah River population. Monitoring of Shortnose sturgeon distribution in the Savannah Harbor estuary would be conducted during years 1-5 and year 9 of post-construction. This data would then be compared to the five years of data collected during pre-construction and the construction period to determine if there are any trends in Shortnose sturgeon distribution that might be attributable to the project. Changes that are not explained by known habitat parameters (salinity and dissolved oxygen) may require additional investigation. If greater losses of sturgeon habitat occur than would be expected under the observed flow conditions, then additional mitigation may be warranted.

Fish, crab, and shrimp distribution studies in Savannah Harbor would be conducted in years 1, 3, 5 and 9 of post-construction monitoring. This survey would monitor fish, crab, and shrimp abundance and distribution along the edges of marshes using a drop survey. The results of this study would be compared to the data collected during a similar study in 2000-2001 to determine if there are any observable changes in fish distribution and abundance that might be attributable to the project.

The field data collected would be used with the updated hydrodynamic and water quality models to evaluate the impacts of the project on Striped bass habitat. This study would be conducted during years 2, 4, and 9 of the post-construction monitoring. Data from this study would be used to determine if impacts to Striped bass habitat exceed those predicted during feasibility, and if so, what additional mitigation may be warranted.

The Corps believes that the monitoring efforts outlined above would allow the Corps and the resource agencies to determine how the completed project is performing (including its mitigation features). Consequently, the Corps and the natural resource agencies would be able to evaluate the impacts of the project to ensure they do not exceed those that are predicted, the effectiveness of the project's mitigation features, and the project's effects on specific resources. Savannah District would prepare a final monitoring report that would summarize the results and findings from the various components of the monitoring program. It would initially provide that document to the Cooperating Agencies and then to the public.

9 ADAPTIVE MANAGEMENT - DECISION MAKING PROCESS

A. Goals. This section will define the process by which decisions are made concerning whether the mitigation features of the project – or the entire navigation project – needs to be modified. It will also describe the participants in the decision-making process, the timeline for making those decisions, any authorizations that are needed from higher authorities, and coordination that would occur with those not participating in making the decisions.

B. Decision Process. The decision process in regards to the implementation of any adaptive management measures would be ongoing throughout the Construction and Post-Construction phases of the project. The Corps would maintain close coordination with the Cooperating Agencies and the state natural resource agencies throughout the monitoring conducted during the Construction and Post-Construction Phases of the project. During the Construction phase of the project, the Corps would place monitoring data and reports as they become available on a public website. After the reports are available for a given year, the Corps would meet with the Cooperating Agencies and the state natural resource agencies to review the new information. Meetings between the Corps and the agencies would be held more frequently during the construction phase of the project if the data indicate the need to do so.

Adaptive management measures that might be implemented during the construction phase of the project would be focused on changes to how the project is being constructed or how the various monitoring efforts are being conducted. Actual data would be compared to pre-construction modeled predicted performance and the modeled performance using actual river flows. If the monitoring identifies impacts that are outside the range of those expected, the Corps would consult with the Cooperating Agencies and the natural resource agencies to identify what actions may be appropriate. This could include more detailed monitoring in certain locations to obtain a better understanding of what is occurring. The monitoring could also dictate changes in how the project is being constructed, such as modifying the operation of the CDFs to improve the water quality in the effluent or a delay in the dredging operations until a problem could be assessed and corrective measures implemented. Adaptive management measures that might be required

during construction of the project could be implemented in an expeditious manner since decisions regarding changes to the monitoring plan or the construction process are normally delegated to the District/Division level.

After construction of the project is complete, the adaptive management decision process would become more focused on the long-term mitigation features of the project. The coordination process between the Corps and the Cooperating Agencies and the state natural resource agencies during the Post-Construction Monitoring phase of the project would be much the same as in the Construction phase. Some of the post-construction monitoring efforts would be conducted over 10 years. Should one agency request it, a meeting would be held at the end of each year between the Corps, the Cooperating Agencies, and the state natural resource agencies to discuss the new data that would be available or the implementation of an adaptive management measure if the data indicates that to be required. Meetings between the Corps and the agencies could be held more frequently if the need arises. At the end of the Post-Construction monitoring period, the Corps would review and consolidate the reports of the various monitoring efforts. The consolidated report would contain pertinent information from the various reports, focusing on issues which the Corps believes are most critical to decisions on the need to modify the navigation project or the mitigation plan. The report would identify whether the Corps believes that any modifications are warranted and recommendations on what modifications should occur. That report should be available within six months of receipt of the last monitoring report and within one year of the end of the Post-Construction monitoring.

The Corps would coordinate that draft report with the Cooperating Agencies and the state natural resource agencies. The agencies would review the draft report for 30 days and provide their comments at a meeting that the Corps would host on this issue. The Corps would consider the comments and revise the report if necessary.

The Corps would then issue a final monitoring report for public comment. The Corps would review the public's comments and prepare a decision document. It would provide that document to the Cooperating Agencies (USFWS Region 4, EPA Region 4, NOAA-Southeast Regional Office, and GPA/GA DOT) for review prior to the Federal agencies (including the Corps) making a joint decision on whether any modifications are warranted. Each of the Federal agencies must concur that a specific modification is warranted for that measure to be implemented. After the agencies' joint decision, the Corps would notify the public of the agencies' final determination.

If an agreed-upon measure is included in this EIS and its implementation has thus been environmentally evaluated, no additional authorizations or environmental approvals would be required to implement the measure. If an agreed-upon measure is not included in this EIS and it has not been evaluated by the Corps in some other NEPA document, the District would prepare a NEPA document to obtain environmental approvals to implement that measure. The Corps would fund that effort using the adaptive management funds that were previously set aside. If the budgeted adaptive management funds have been expended, the Corps would request additional funds through the Construction Program budget process.

If agreement cannot be reached because one of the parties believes that additional data is needed to conclude a feature is needed, adaptive management funds could be used for an additional year of monitoring to obtain the needed information. The agencies would recognize that the additional monitoring reduces the amount of funds remaining to implement whatever measures are determined to be warranted. In this case, the group would hold the adaptive management funds for another year until the monitoring is conducted and a report made available with the additional information.

If after either the 10-year Post-Construction monitoring period is complete or after an additional year's worth of data is collected, it appears that the agencies will not be able to agree on whether a specific modification is warranted, upon the request of two of the four Federal agencies, the Corps would convene a meeting of the Federal agencies in Washington. At that meeting, Washington-level agency representatives would make a decision on the issue.

C. Decision Criteria. During the monitoring for the construction and post-construction phases, the Corps, the Cooperating Agencies, and the state Natural Resource Agencies will review the monitoring data and reports as they become available. The agencies will review the information to determine whether the impacts are generally as expected and whether changes to the project and its mitigation plan are warranted. An indicator of impacts within the expected ranges would be monitoring data for points in the estuary within the ranges determined by pre-construction modeling over a range of flow conditions. Even though the team examined the performance of the project alternatives under a range of conditions, the conditions that are experienced during and after the construction are still likely to be different from those that were examined during this feasibility phase. The team will use the post-construction monitoring data and the model predications for points in the estuary to evaluate the response of the ecosystem and the effectiveness of the mitigation features. The natural resource agencies recognized that models could not be developed to replicate conditions observed in this complex estuary with 100% accuracy. They established performance goals for the models (a portion of which is shown in the table below), which the developers were able to meet. However, there was still some inaccuracy in the models, which is discussed in the Engineering Appendix of the GRR. Predictions about the biological and physical responses of the estuary to SHEP appear in the EIS and this appendix.

As discussed previously, adaptive management measures that would be implemented during the construction phase of the project would be centered around changes to the monitoring plan or the various construction processes (dredging, disposal of the dredged material, etc.). The need to implement any adaptive management measure during the construction process would be determined through a review of the wealth of data that would be generated by the various field monitoring efforts conducted during the construction process. The decision to implement any adaptive management measure during the construction process would also be based on model predictions of dissolved oxygen and salinity that would be conducted during the construction phase of the project. The Corps would regularly assess (every four months, e.g., twelve times during the construction phase of the project) how well the hydrodynamic and water quality models predict the salinity and dissolved oxygen levels measured in the field. These assessments would be performed by comparing the model's predictions against what is being measured at the 8 continuous water quality monitoring stations. The model grid would be updated to reflect the

new bathymetry and the actual river flows. Section 8 of this appendix provides additional detail and examples of how this adaptive management process would work.

Obviously, the post-construction phase of the project would present the best opportunity to evaluate the performance of the project and its mitigation features with respect to the response of the ecosystem. Because the project would be completed, the models would be assessed and recalibrated, if required, and post-construction field data would be available. The Corps believes that the goals which the natural resource agencies (EPA, USFWS, USGS, SC DHEC, and Georgia DNR-EPD) established for the performance of the models can also serve in the post-construction phase as an effective tool for examining whether the constructed project performs as expected. If the observed results are within the expected ranges (taking into account the models' performance goals), then the project would be performing as expected. No modification to the project and its mitigation plan would be warranted.

The performance (accuracy) of the hydraulic and water quality models will be assessed and recalibrated, if necessary, both during and after construction. The present plan includes collecting detailed data (intense monitoring), assessing the models' performance, and recalibrating, if necessary, once during the pre-construction monitoring period and twice during the post-construction monitoring period. This repetition in modeling assessment/recalibration will improve their predictive accuracy by decreasing their range of uncertainty. The modeling performance goals shown below could be improved upon. (The model performance goal for salinity when salinity in the range of 1 to 5 ppt, which has been changed in the table below from +/- 0.5 ppt to +/- 10% at the request of the USFWS, may not be achievable.)

The natural resource agencies would use the accuracy and reliability of the models after the post-construction assessment/ calibration to review the performance of the project and its mitigation features. The modeling data and predictions in the EIS for the estuary's response to the project would be compared to actual field results to evaluate whether the project is performing as expected. The ranges for values predicted by the models described in Section 5 Pre-Construction Monitoring of this appendix will be compared to post-construction measured data to further assess the performance of the mitigation. An overall assessment of the project's performance would be conducted once per year for the 10 years of the Post-Construction monitoring period.

Table 5. Federal Modeling Performance Goals

Parameter		Percentiles					Timing of Maxima (Min)
		5 %	10 %	50 %	90 %	95 %	
Salinity (ppt)	1-5 ppt	-	-	+/- 10 %	+/- 10 %	-	+/- 30
	< 1 ppt	-	-	+/- 0.1	+/- 0.1	-	+/- 30
DO (mg/L)		-	+/- 0.2	+/- 0.2	-	-	+/- 30
DO Deficit (mg/L)		-	+/- 0.2	+/- 0.2	-	-	+/- 30
Surface Currents (m/s) **		+/- 25%	-	-	-	+/- 25%	+/- 30
Volume Flows (m/s) **		+/- 25%	-	-	-	+/- 25%	-

*Section 8 provides additional explanation of this table
** 5% and 95% represent the maximum ebb and flood conditions for current and flow

10 ADAPTIVE MANAGEMENT – IMPLEMENTING WARRANTED MODIFICATIONS

A. Goals. The Corps would obtain funding sufficient to implement the actions described in the following section during the project construction period. The project would remain in a construction status until all of the construction is complete, the Post-Construction Monitoring is complete, and any adaptive management measures implemented that were determined to be required. The District intends to obtain funds for adaptive management each year it obtains funds to perform regular construction activities. The Corps will develop a construction funding plan as well as a mitigation and adaptive management funding plan. The Corps will seek funding each year as identified in the funding plans. If the total adaptive management costs exceed the above estimates, the Corps would seek to obtain Corps approvals for any additional amounts needed through the normal (Construction Program) budget process. Funds for un-programmed adaptive management needs would be considered should excess construction funds become available during the year. Adaptive management funds currently estimated at $2 million per year will be sought for the entire duration of the monitoring period and for any action needed based on the monitoring results. Any project funds that are not used during the year due to unforeseen circumstances would be carried forward as needed and justified. In addition, the non-Federal sponsor, acting through the Georgia Ports Authority, has agreed to set aside, in advance, their cost-shared portion of the monitoring and adaptive management funds in an escrow account upon approval of the project. Those adaptive management funds would be expended if the modifications are deemed necessary by the Federal Lead and Cooperating Agencies.

If modifications are found to be warranted and they are contained in the group of actions described in the following section and the EIS, they could be implemented without further public coordination or environmental approvals. If then-existing programmed funding is not sufficient

to implement the above-mentioned warranted modifications, the Corps would seek to identify funds for reprogramming. Funds to be reprogrammed must first be identified as excess to another project's needs. If such funds are identified, the District will seek to obtain them to implement the needed adaptive management actions, thereby minimizing unanticipated adverse project effects.

If modifications are identified that are not in the following section, the Corps would prepare the documents needed to coordinate the proposed action with the public and the agencies to obtain the required environmental approvals.

If modifications are deemed warranted that are larger in scope than those described in the following section and require additional funding, the Corps would submit the appropriate documents to its Headquarters for approval. If additional Federal funding is required, Congressional action would likely be needed to obtain those funds.

B. Components of Approved Adaptive Management Plan. The following adaptive management features are included as part of the Savannah Harbor Expansion Project:

- Enlarging the diversion structure at the mouth of McCoys Cut;
- Enlarging the deepened area at McCoys Cut, Middle & Back Rivers;
- Constructing a diversion structure at the junction of Middle and Back Rivers;
- Removing the Tidegate sill;
- Raising or lowering the height of the submerged sill at the Sediment Basin;
- Improving fish passage at the New Savannah Bluff Lock & Dam;
- Acquisition of additional freshwater wetlands;
- Modifying the oxygen injection systems; Constructing and operating additional oxygen injection systems;
- Modifying the wetland restoration area at former Disposal Area 1S;
- Preferential placement of maintenance sediments into CDFs 14A and/or 14B as additional covering material.

Removing the Tidegate sill may increase tidal flows up Back River. This may be necessary to address water quality issues or improve fishery habitats. Enlarging the diversion structure at the mouth of McCoys Cut may be needed to draw more freshwater into the Middle and Back River portions of the estuary. Enlarging the deepened area at McCoys Cut, as well as Middle and Back Rivers would perform the same effect and could be needed in addition to enlarging the diversion structure. The additional freshwater flows down those two rivers would make freshwater vegetation more dominant in those portions of the estuary and improve some types of fish habitats in those locations. Constructing a diversion structure at the junction of Middle and Back Rivers would direct more freshwater down one of those two rivers. This additional freshwater flow down one arm may be needed to preferentially improve habitats along one of those two rivers. Fish passage at the NSBL&D could be improved by several methods, including (1) altering flows in the fish passage structure to enable that structure to attract and pass the Shortnose sturgeon, as intended, (2) modifying the fish passage rock ramp, or (3) enabling passage through the lock or gates on the dam. Acquisition of additional bottomland hardwoods/freshwater wetlands would compensate for additional impacts to freshwater marshes

beyond those that are predicted in the EIS. Additional dissolved oxygen may be needed under some flow conditions. The additional capacity would allow the systems to function as intended under all flow conditions. Modifications to the wetland restoration area at former Disposal Area 1S may be needed for brackish marsh to revegetate the site. This may include re-grading the site, depositing additional sediment, or sprigging. Additional maintenance sediments may be needed on CDFs 14A and/or 14B as additional covering material to adequately minimize the risk to wildlife using the sites. The project would pay the incremental cost of depositing O&M sediments in those sites instead of the regularly scheduled deposition site.

Any or all of these features would be implemented if post-construction monitoring finds them to be needed. Implementation of any or all of these specific features may not be needed. The adaptive management funding would be viewed programmatically. More could be spent on a given single item than is shown for the individual features identified below, but the total amount available for use in adaptive management would be the amount shown below. Which of these (or other) features would be implemented would depend on the monitoring results and the decisions of the Federal Cooperating Agencies.

C. Cost Summary. The cost to implement these features is estimated to be as follows:

Enlarging the McCoys Cut diversion structure	
Use 10% of initial cost of $2,324,082	$ 232,408
Enlarging the deepened area at McCoy's Cut, Middle, & Back Rivers	
Use 10% of initial cost of $7,287,980	$728,798
Diversion structure at Middle and Back Rivers	
Use 5% of initial cost of $1,800,688	$ 90,034
Removing the Tidegate sill	$2,908,990
Modifying the submerged berm at the Sediment Basin	
Use 10% of initial cost of $23,514,049	$2,351,405
Improving fish passage at the NSBL&D	$ 630,200
Acquiring additional freshwater wetlands	
Use 5% of initial acquisition	
$10,000/ acre x 0.05 x 2,683 acres	$1,341,500
Additional capacity in dissolved oxygen systems	
Use 10% of initial construction cost $56,643,000	$5,664,300
Modify the restoration site at Disposal Area 1S	
Use 10% of initial cost of $14,075,959	$1,407,596
Incremental cost to place O&M sediments in CDFs 14A/14B	
Use $1.00/CY x 782,500 CY x 2 CDFs	$1,565,000
Contingency Monitoring (3 x $1,000,000)	$3,000,000
Total	$19,920,231

The cost to acquire additional preservation lands shown above is based on a 48-foot depth alternative. Since the funds to be set aside for acquisition of additional lands depends on the

initial acreage to be acquired, the total adaptive management funding would be less for the other depth alternatives and would be as follows:

Table 6. Cost of Adaptive Management

CHANNEL DEPTH ALTERNATIVE	REQUIRED WETLAND ACQUISITION (ACRES)	COST OF ADDITIONAL WETLAND ACQUISITION	TOTAL ADAPTIVE MANAGEMENT COSTS*
44-FOOT	N/A	0	$ 18,579,000
45-FOOT	1,643	$821,500	$ 19,400,000
46-FOOT	2,188	$1,094,000	$ 19,673,000
47-FOOT	*2,245*	*$1,122,500*	*$ 19,701,000*
48-FOOT	2,683	$1,341,500	$ 19,920,000

*Total costs rounded to nearest $1,000

As a result of coordination with the natural resource agencies after release of DEIS, the Corps substantially increased the size of the fish bypass structure. The larger bypass would greatly increase the amount of flow passing through it (from 5% in the original design to 100% during the majority of the spawning season). The natural resource agencies now state that the percent of river flow passing through the structure roughly corresponds to the effectiveness they expect in passing SNS. Therefore, since the larger structure is more likely to pass SNS, the likelihood of needing to modify the structure after construction for it to function as intended is greatly reduced. The funds identified for adaptive management for the fish bypass should be sufficient to modify it if the post-construction monitoring indicates such action is warranted.

The adaptive management funds may be used to perform more work at a particular location than is shown above, as long as the total cost of the adaptive management stays within the total (plus contingencies) for the group of items shown above. Should other project features require adaptive management, then a portion of the funds outlined above may be used to modify those features, including performing vegetation sampling in CDFs with cadmium-laden sediments. Further, if the Cooperating Agencies believe that some other feature(s) would be more effective in addressing an identified problem, the Corps may use the funds authorized for adaptive management to implement that feature(s). The Corps may need to obtain additional environmental clearances to implement such a feature if it is not evaluated in this EIS or some other Corps NEPA document.

If the total adaptive management costs exceed the above estimates, the Corps would seek to obtain Corps approvals for those cost increases and request additional funds through the normal (Construction program) budget process and as described above.

D. Monitoring After Implementing an Adaptive Management Feature. Six of the eleven adaptive management features would alter flows in the estuary. To ensure a modification is performing as intended, additional Post-Construction monitoring would be conducted for two years after implementing the adaptive management feature. Longer focused monitoring could be necessary to demonstrate that the adaptive management feature performs as intended. The

monitoring would be focused to identify/confirm the type of effect intended by the feature. For instance, if the Tidegate sill is removed, the monitoring would focus on monitoring flows and water quality in Back River. The adaptive management funds identified in the previous section would be used to pay for this additional monitoring. Should the Cooperating Agencies determine additional monitoring is needed, then the monitoring period could be extended.

At the end of the monitoring period, the Corps would prepare a report on the effectiveness of the modification. The Corps would include a recommendation on whether further action is warranted. The Federal Cooperating Agencies (including Corps) would review the report and reach agreement on whether further action is needed.

11 LONG-TERM MONITORING

A. Goals. Monitoring would be conducted on a regular basis to ensure the project's recurring maintenance operations comply with environmental clearances and that the mitigation features continue to function as they are intended.

B. Major Components. For the project to reach this phase, the estuary would have reached its normal state of dynamic equilibrium and the Federal agencies determined that the mitigation features are effective. The Corps would inspect the mitigation features on at least an annual basis to determine if maintenance is required. Maintenance would be performed as a normal O&M activity.

Limited monitoring would be required to ensure the mitigation features continue to function as intended. Most of the mitigation features are designed to increase freshwater flows in Back and Middle Rivers. The other main physical feature located in the estuary would be the dissolved oxygen injection systems. The performance of all of these features could be assessed by monitoring salinity and water quality at specific critical points within the estuary. Therefore, the Long Term monitoring program is focused on providing that information.

The Corps would fund the USGS operation of continuous recorders for hydrologic and hydraulic data at four locations, as follows:

- 02198920 Savannah River at GA25, at Port Wentworth, GA
- 021989773 Savannah River at USACE Dock at Savannah, GA
- Back River at US 17 at Savannah, GA
- Savannah River at I-95

The Corps expects the Georgia Ports Authority to continue to fund (independent of SHEP) operation of a fifth station, 021989784 – Little Back River above Lucknow Canal, at the freshwater supply intake for the Savannah National Wildlife Refuge.

The estimated cost for this work is shown as follows:

Operate water quality stations	4 @ $69,250 = $277,000 per year

The Corps would perform a bathymetric survey every year at the following locations:

- McCoy's Cut
- Deepened area in Upper Middle River
- Deepened area in Little Back River

The estimated cost for these surveys is $60,000 per year.

The Georgia DNR-EPD and SC DHEC have mandated long-term monitoring of the sentry and background groundwater wells as a condition of their Section 401 Water Quality Certifications for the SHEP. These wells would be monitored for the life of the project, and an annual report would be prepared and submitted to the Georgia DNR-EPD summarizing the results of the monitoring. The cost to monitor the wells is estimated to be $7,500 per year.

The Corps would monitor water quality in effluent from CDFs as part of the annual O&M dredging program.

The costs to operate and maintain the dissolved oxygen systems are not included in this document. Those costs are shown elsewhere in the EIS.

C. Reporting. The USGS would include the hydrodynamic and water quality data collected at the continuous recorders in its annual state monitoring report. That report would be made available to the public. The Corps would furnish other data and internal reports to the agencies upon request.

D. Cost Summary. The annual costs for the long-term monitoring are summarized as follows:

Continuous Riverine Monitoring	$277,000
Annual Bathymetric Surveys	$ 60,000
Groundwater Wells	$ 7,500
Total	$344,500

These costs do not include the costs to operate and maintain the mitigation features. Periodic dredging may be needed to retain the flow capabilities of the flow-re-routing features. Adjustment of the rock used in these structures may be required after high river flows. Maintenance would also be needed to ensure the fish bypass at NSBL&D performs as intended. That maintenance would include periodic debris and sediment removal. The dissolved oxygen systems would need to be operated each year and maintained throughout their operating period. They would also need major rehabilitation when the equipment needs to be replaced. The annual cost to maintain the dissolved oxygen systems over the life of the project, including periodic replacement of equipment, is estimated to be $1,300,000.