

SAVANNAH HARBOR EXPANSION PROJECT CHATMAN
COUNTY, GEORGIA AND JASPER COUNTY, SOUTH
CAROLINA: FINAL GENERAL RE-EVALUATION RE-
PORT AND ENVIRONMENTAL IMPACT STATEMENT
JANUARY 2012

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SAVANNAH HARBOR EXPANSION PROJECT
Chatham County, Georgia and Jasper County, South Carolina
January 2012
(Revised July 2012)

Volume 1



US Army Corps of
Engineers
Savannah District
South Atlantic Division

FINAL
ENVIRONMENTAL IMPACT STATEMENT
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

FINAL ENVIRONMENTAL IMPACT STATEMENT FOR THE SAVANNAH HARBOR EXPANSION

CHATHAM COUNTY, GEORGIA AND JASPER COUNTY, SOUTH CAROLINA

The responsible lead agency is the US Army Engineer District, Savannah. Cooperating agencies are the Environmental Protection Agency (Region IV), the Department of Commerce (acting through the National Marine Fisheries Service), the Department of the Interior (acting through the US Fish and Wildlife Service) and the Georgia Ports Authority.

ABSTRACT: Savannah Harbor is an approximately 32.7 mile long Federal navigation project located along the Savannah River in southeast Georgia. The current Savannah Harbor Navigation Project (Figure 1) has an authorized project depth of 30 feet Mean Low Water (MLW) in the inner harbor (Stations 112+500 to 105+000), 36 feet MLW (Stations 105+000 to 103+000), 42 feet MLW (Stations 103+000 to 0+000), 42 feet MLW in the entrance channel (Stations 0+000 to -14+000B), and 44 feet MLW in the remainder of the entrance channel (Stations -14+000B to -60+000B). The current channel width is 600 feet across the ocean bar to the entrance channel (Stations -14+000B to -60+000B), 500 feet from the entrance channel to Kings Island Turning Basin (Stations -14+000B to 103+000, with the exception of 400 feet wide from stations 58+000 to 59+000), 400 feet from the Kings Island Turning Basin to the Argyle Island Turning Basin, and 200 feet from the Argyle Turning Basin to the upstream limit of the authorized project. Due to rapid shoaling in the Federal navigation channel, it is difficult to maintain the exact project depth (i.e., -42 feet MLW) at all times. Allowable overdepth and advance maintenance are procedures used to accomplish this objective (See Section 3.01 for additional information on these terms). The existing Federally-maintained navigation channel includes 2-feet allowable overdepth and up to 6-feet advance maintenance (depending on location). Savannah Harbor was last deepened in 1993/1994. Since that time container traffic has greatly exceeded projections. In excess of 70% of the vessels do not call on Savannah Harbor at their maximum capacity or design draft. The "light loading" of vessels increases costs to the shipper, which are eventually passed onto the consumer. Less efficient vessels also generally result in higher shipping costs. Congress conditionally authorized deepening the harbor up to six feet in the Water Resources Development Act of 1999 (Section 102(b)(9)). The authorization is contingent upon: (1) completion of an Environmental Impact Statement, (2) approval of the Selected Plan by the Secretary of Interior, Secretary of Commerce, Secretary of the Army, and the Administrator of the Environmental Protection Agency; and (3) a determination by the Secretaries that the associated mitigation plan adequately addresses the potential environmental impacts of the project. The Corps of Engineers issued a Report of the Chief of Engineers (Chief's Report) later in 1999 which provided further direction on the additional studies that needed to be conducted. This EIS accompanies a General Re-evaluation Report. These two documents describe the work conducted and present information and analysis

to satisfy the conditional authorization, the National Environmental Policy Act (NEPA), and the direction of the Chief's Report.

The Corps evaluated a wide range of alternatives for addressing the navigation problems in the harbor, including structural and non-structural methods. An iterative alternatives evaluation revealed that channel deepening would be the only way to reasonably address the problems. Detailed evaluations were conducted on the channel deepening alternatives based on a 50-year period of analysis. This Final EIS contains information about each of those alternatives. As a result of its investigations, the Corps has identified the 47-foot depth alternative as the National Economic Development (NED) Plan – the plan that maximizes net economic benefits to the Nation and fully complies with Army policy. The Selected Plan is the 47-foot depth alternative.

The Selected Plan includes dredging most of the navigation channel and one existing turning basin (Kings Island Turning Basin at Stations 98+500 to 100+500) 5 feet deeper (to an authorized navigation depth of 47-feet), deepening eight berths at the Garden City Terminal (Berths 2, 3, 4, 5, 6, 7, 8, and 9), constructing three bend wideners (Stations -23+000B to -14+000B, 27+700 to 31+500, and 52+250 to 55+000), constructing two meeting areas (Stations 14+000 to 22+000 and 55+000 to 59+000), and constructing an approximately 38,000 foot (7.1 mile) long extension to the existing ocean bar channel from Station -60+000B to -97+680B. The existing 2-feet of allowable overdepth and up to 6-feet advance maintenance (depending on location) would be retained. Features of the existing Navigation Project that would not be improved would remain as components of the Savannah Harbor Navigation Project. Dredging methods recommended include hydraulic pipeline, hopper dredge, mechanical dredge, or similar equipment. This equipment would be used to excavate approximately 13 million cubic yards of new work sediment from the Inner Harbor (Garden City Terminal from Station 103+000 to Station 4+000) with disposal in the existing upland confined disposal facilities (CDFs) and about 10.6 million cubic yards of new work sediment for the Entrance Channel (Stations 4+000 to -97+680B) with placement in the US Environmental Protection Agency approved Ocean Dredged Material Disposal Site (ODMDS) or existing CDFs. This proposed action would result in the initial excavation of about 23.6 million cubic yards of dredged sediment. Subject to the availability of funds, the construction would likely occur over a three to four year period. The authorized depths would be maintained by periodic dredging over the 50-year period of analysis.

The proposed action would impact habitat of Striped bass and the endangered Shortnose sturgeon, tidal freshwater wetlands, and fringe brackish marshes. Impacts to these resources would occur as a direct result of sediment removal and the physical act of dredging. Additional impacts to these resources would also occur through increased salinity and changes in dissolved oxygen levels, which are indirect water quality effects resulting from deepening of the harbor. Conversion of salt marsh to brackish marsh would occur as a result of mitigation features to protect freshwater marshes. All impacts are discussed in detail in the Final EIS and impacts are avoided or minimized to the maximum extent possible. Mitigation is proposed for unavoidable impacts to significant resources such as loss of Shortnose sturgeon and Striped bass habitat, loss and/or conversion of tidal freshwater, brackish and salt marsh in the project area, and changes in dissolved oxygen levels in the inner harbor.

Council on Environmental Quality (CEQ) regulations for implementing NEPA state that an EIS *"shall be concise, clear, and to the point, and shall be supported by evidence that the agency has made the necessary environmental analyses"* and an EIS *"shall be analytic rather than encyclopedic"*. Because of the large amount of information and data involved in this project, incidental material from the September 1998 Tier I Final EIS is considered supporting documentation. This supporting documentation is incorporated by reference in this Final EIS and is available at the Savannah District, US Army Corps of Engineers.

A Notice of Intent (NOI) to prepare a Draft EIS for this project was filed with the USEPA on January 22, 2002. Within the NOI, the public and agencies were notified that a scoping meeting would be conducted for the proposed project. On February 21, 2002, a scoping meeting was held for the proposed action at the Savannah International Trade and Convention Center. Additionally, on April 12, 2002, a NEPA scoping meeting was convened. A list of commenters is presented in Section 7.01 of this EIS. All comments received on the NOI and scoping letter and/or meetings were considered during project planning and design, and writing of this EIS.

A Notice of Availability of the Draft EIS was published in the Federal Register on November 15, 2010 providing a 45-day comment period for the document. The comment period for the Draft EIS was extended an additional 15 days until January 25, 2011. A public information meeting on the Draft EIS was held at the Savannah Civic Center on December 15, 2010. Comments received on the Draft EIS as well as responses to those comments are contained in Appendix A of this document.

A Notice of Availability of the Final EIS will be published in the Federal Register providing a 30-day comment period for the document. Comments on the Final EIS may be sent to the following:

**SEND YOUR COMMENTS TO THE
DISTRICT COMMANDER:**

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If you would like further information
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**FINAL
ENVIRONMENTAL IMPACT STATEMENT
FOR
SAVANNAH HARBOR EXPANSION
CHATHAM COUNTY, GEORGIA AND
JASPER COUNTY, SOUTH CAROLINA**

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LIST OF ACRONYMS & ABBREVIATIONS

ACP	Panama Canal Authority
AFB	Alternative Formulation Briefing
AIWW	Atlantic Intracoastal Waterway
ANN	Artificial Neural Networks
ASA	Assistant Secretary of the Army
ATM	Applied Technology and Management, Inc.
ATR	Agency Technical Review
BL	Base/Bilge Line
BR	Back River
CADET	Channel Analysis & Design Evaluation Tool
CB	Container Berth
CD	Circuit Distance
CDF	Confined Disposal Facilities
CEDEP	Corps of Engineers Dredge Estimating Program
CH	High liquid limit clay
CHL	Coastal and Hydraulics Laboratory
CL	Low liquid limit clay
CSPS	Container Shipping Planning Service
CWCCIS	Civil Works Construction Cost Index System
CWE	Current Working Estimate
CZM	Coastal Zone Management
DMCA	Dredged Material Containment Areas
DMMP	Dredged Management and Material Plan
DO	Dissolved Oxygen
DOT	Department of Transportation
DOTS	Dredging Operations Technical Support
DQC	District Quality Control
EFDC	Environmental Fluid Dynamics Computer Code
EIS	Environmental Impact Statement
EN	Engineering
EPA	Environmental Protection Agency
ERDC	Engineering Research and Development Center
EWT	Effective Work Time
FCC	Fully Cellular Container Vessels
FEMA	Federal Emergency Management Agency
FIS	Flood Insurance Study
GAEPD	Georgia Environmental Protection Division
GI HIS	Global Insight
GIS	Geographic Information System
GP	Poorly graded gravels
GPA	Georgia Ports Authority
GRR	General Reevaluation Report
HH&C CoP	Hydrology, Hydraulics and Coastal Community of Practice

HTRW	Hazardous, Toxic, and Radioactive Waste
IEPR	Independent External Peer Review
IP	International Paper
IWR	Institute for Water Resources
JOI	Jones/Oysterbed Island
KITB	King's Island Turning Basin
LFA	Load Factor Analysis
LNG	Liquefied Natural Gas
LSE	Lloyd's Shipping Economist
LTMS	Long Term Management Strategy
M2M	Model-to-Marsh
MARAD	Maritime Administration
MCACES	Microcomputer Aided Cost Estimating System
MGD	Million Gallons per Day
MH	High liquid limit silt
MHW	Mean High Water
ML	Low liquid limit silt
MLLW	Mean Lower Low Water
MLW	Mean Low Water
MPC	Maximum Practicable Capacity
MPD	Maximum Practicable Draft
MPLD	Maximum Practicable Loading Draft
MR	Middle River
MSA	Metropolitan Statistical Area
MSI	Maritime Strategies International, Limited
MSL	Mean Sea Level
MSM	Marsh-succession Model
MTL	Mean Tide Level
MTRG	Modeling Technical Review Group
MXSLLD	Maximum Summer Load Line Draft
NAVD	North American Vertical Datum
NED	National Economic Development
NGVD	National Geodetic Vertical Datum
NMFS	National Marine Fisheries
NOAA	National Oceanic and Atmospheric Administration
NSBL&D	New Savannah Bluff Lock and Dam
O&M	Operations and Maintenance
ODMDS	Ocean Dredged Material Disposal Site
OH	Organic silts
OSHA	Occupational Safety and Health Administration
OSI	Ocean Surveys, Incorporated
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyls
PD	Planning Division
PDT	Project Delivery Team
PED	Planning, Engineering, and Design

PIANC	World Association for Waterborne Transport Infrastructure
PX	Panamax Vessel Class
PPX	Post-Panamax Vessel Class
PPX1	Generation 1 Post-Panamax Vessel Class
PPX2	Generation 2 Post-Panamax Vessel Class
RED	Regional Economic Development
RTG	Rubber-tired Gantries
RMSE	Root Mean Square Error
S&A	Supervision and Administration
SAD	South Atlantic Division
SAS	Savannah District
SC	Clayey sands
SCDHEC	South Carolina Department of Health and Environmental Control
SEG	Stakeholders Evaluation Group
SET	Scientific and Engineering Technology
SHEP	Savannah Harbor Expansion Project
SM	Silty sand
SNG	Southern Natural Gas
SNS	Shortnose sturgeon
SOD	Sediment Oxygen Demand
SP	Poorly graded sand
SPT	Standard Penetration Test
SPX	Sub-Panamax Vessel Class
SRBA	Savannah River Below Augusta
STS	Ship Tow Simulator
STS	Ship-to-Shore
TCSM	Transportation Cost Savings Model
TEU	Twenty Foot Equivalent Units
TMDL	Total Maximum Daily Load
TPCS	Total Project Cost Summary
TPI	Tons per Inch Immersion
TS	Technical Services
UKC	Underkeel Clearance
USACE	United States Army Corps of Engineers
USCG	United States Coast Guard
USEC	United States East Coast
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VE	Value Engineering
WASP	Water quality Analysis Simulation Package
WTS	World Trade Service

**FINAL
ENVIRONMENTAL IMPACT STATEMENT
FOR
SAVANNAH HARBOR EXPANSION
CHATHAM COUNTY, GEORGIA AND
JASPER COUNTY, SOUTH CAROLINA**

1.00 SUMMARY

Congress authorized initial construction of the Federal navigation project at Savannah Harbor in 1874. In 1896, two jetties were constructed at the mouth of the Savannah River entrance. A submerged offshore breakwater was completed in 1897 to stabilize the inlet and provide a shelter for shipping traffic entering Tybee Roads. Tybee Island is located on the south side of the entrance channel to the Savannah River.

The navigation channel of the Savannah River was deepened from 21.5-feet Mean Low Water (MLW) to a depth of 26-feet MLW in 1912 to accommodate larger ships. Depth increases were later made in 1936 to 30-feet MLW and 1945 to 36-feet MLW. The channel was widened and deepened in 1972 to a depth of 40-feet MLW. In 1994, much of the authorized depth of the channel was increased to 42-feet MLW. The navigation project includes 2-feet allowable overdepth and up to 6-feet advance maintenance (depending on location) to help maintain the authorized navigation depth, in spite of the rapid shoaling that occurs in some areas of the harbor. At present, approximately 32.7 miles of navigation channel exist, extending from Savannah Harbor across Tybee Roads into the Atlantic Ocean (see Figure 1-1).

Figure 1-1 shows the station numbering convention that is used in the harbor. The proposed oceanward extent of the Entrance Channel (or Ocean Bar Channel) for the 47-foot depth alternative is at Station -97+680B (or 97,680 feet east or oceanward of the river entrance and B stands for Ocean Bar Channel). The entrance to the river is at Station 0+000 (or near the Fort Pulaski National Monument in Georgia). Upstream of the river entrance is Fort Jackson and the CSS Georgia at Stations 55+000 to 60+000 (or 55,000 to 60,000 feet upstream of the Fort Pulaski National Monument). The upstream end of the proposed deepening of the harbor at the Garden City Terminal is at Station 103+000 (or 103,000 feet upstream of the river entrance). The upstream terminus of the entire Savannah Harbor Navigation Project is at Station 112+500. Therefore, the total project length is 210,180 feet (112,500 feet of river channel plus 97,680 feet of ocean bar channel equals 210,180 feet) or 39.8 miles (210,180 feet divided by 5,280 equals 39.8 miles), where River Mile is defined as the river Station in feet divided by 5,280 feet. For example, the upstream limit of the project is at Station 112+500 or River Mile 21.3 (112,500 feet divided by 5,280 feet per mile equals 21.3 miles). Both conventions are used interchangeably throughout the report documents.

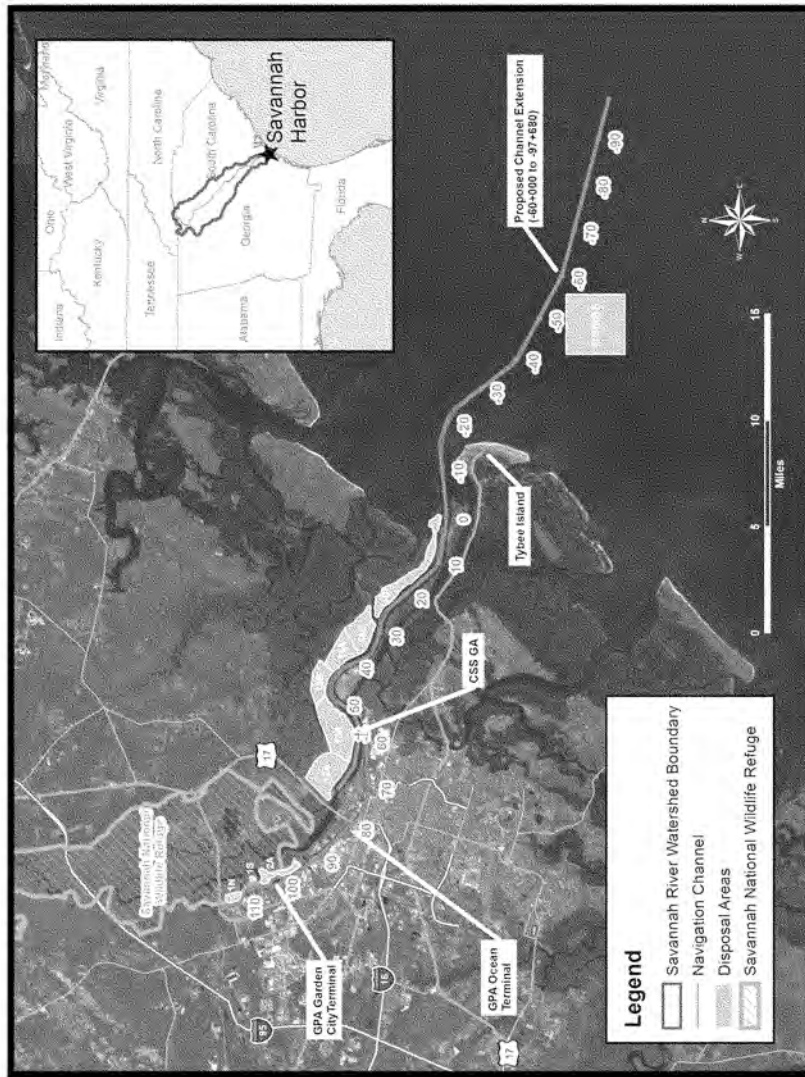


Figure I-1. Overview map of Savannah Harbor.

1.01 Background and Purpose

Following the provisions of Section 203 of the Water Resources Development Act of 1986, the Georgia Ports Authority (GPA) conducted a feasibility study of various methods of improving navigation in Savannah Harbor and the expected environmental effects of those proposals. The US Army Corps of Engineers (the Corps) adopted these documents prepared by the GPA and published a Draft Tier I EIS in May 1998 and the Final Tier I EIS in September 1998. In the Water Resources Development Act of 1999 (Section 101(b)(9)), the US Congress conditionally authorized deepening the Savannah Harbor navigation channel to a maximum depth of -48 feet Mean Low Water (MLW). Approval of additional studies and the project is required from the Administrator of the Environmental Protection Agency, the Secretary of Commerce, the Secretary of Interior, and the Secretary of the Army.

The Corps completed the Tier I EIS process when it signed a Record of Decision (ROD) in December 1999. The ROD included additional requirements, including additional review by the Corps of Engineers and approval of the Chief of Engineers to ensure that construction of the project would comply with all applicable laws and policies.

After the authorization, the GPA formed the Stakeholders Evaluation Group (SEG) in 1999 to provide a recurring public forum about the project and to assist them and the Corps in identifying scientific studies and analyses that should be performed to identify environmental impacts that may result from proposed deepening of the harbor. The SEG has as its principal charge the development of consensus amongst the participants regarding:

- A. the scope and content of the scientific investigations and analyses to be performed pursuant to the development of the Final EIS, and
- B. the appropriate increment of channel depth and the appropriate mitigation measures.

As those studies were identified, GPA and the Corps began conducting those tasks. Since its inception, the SEG provided input to GPA, Federal and State agencies on all aspects of the scientific investigations, analyses, and mitigation options for the proposed action. The Corps performed additional studies and investigations which it believed were necessary to properly evaluate the alternatives.

The Savannah District has prepared a General Reevaluation Report (GRR) and this Final Environmental Impact Statement (EIS) which evaluates engineering, environmental and economic acceptability of various alternatives for addressing the existing and future navigation issues. These alternatives are based on deepening the Savannah Harbor navigation channel in increments from the existing depth of 42-feet MLW up to 48-feet MLW, including the "No Action" alternative. The GRR and the EIS serve as decision documents regarding whether to implement the authorized deepening.

1.02 Areas of Concern and Issues

The proposed deepening of the Savannah River Federal Navigation Channel would impact habitat of Striped bass and the endangered Shortnose sturgeon, tidal freshwater wetlands, brackish marsh, and salt marsh. The project would also periodically increase chloride levels at the City of Savannah's Water Intake in Abercorn Creek. During the NEPA process for the GPA Tier I DEIS and FEIS and the GPA information meeting on July 25, 2000, a number of concerns and issues were identified that required additional study for the proposed action. Additional issues were also identified through the SEG process. These issues were listed within the NOI dated January 22, 2002. Additional concerns were identified and discussed during the subsequent scoping meetings on February 21, 2002 and April 12, 2002 for this EIS. Table 1-1 lists all these identified issues and indicates where they are discussed within the document.

All these impacts are discussed in detail in the EIS, along with measures to avoid, minimize, or mitigate the impacts as described. Mitigation is proposed for unavoidable impacts to significant resources such as the conversion of tidal freshwater marsh within the Savannah National Wildlife Refuge, dissolved oxygen (DO) levels within the inner harbor, impacts to recreational boaters, and loss of habitat for the Shortnose sturgeon and Striped bass.

1.03 Major Conclusions and Findings

Substantial efforts have been made to inform and listen to the public, the SEG, local communities, and State and Federal resource agencies regarding the proposed harbor deepening. Since its inception in January 1999 to the present day, the Corps has met with the SEG approximately 70 times to discuss the proposed action. In addition to the Public Scoping Meeting on February 21, 2002 and the NEPA scoping meeting on April 12, 2002, a number of meetings with the public and agencies have discussed the project issues including salinity, DO levels, conversion of freshwater to brackish marsh, nekton, benthos, contaminated sediments, economics, and other impacts related to the proposed harbor deepening. A public information meeting was held 30 days after release of the DEIS to provide opportunity for public and agency input. The models used to quantify impacts to water quality, DO, chlorides, salinity, fisheries, and conversion of freshwater to brackish wetlands have been reviewed and agreed to by the State and Federal agencies. Copies of memorandums recording these meetings as well as PowerPoint presentations made to the SEG, impact groups, etc. can be found at the Savannah District Office, US Army Corps of Engineers. The conclusions from these meetings and subsequent comments are incorporated into this FEIS. The dredging impacts have been minimized to the extent feasible. Additional groundwater studies and surface water modeling efforts were conducted regarding the saltwater water intrusion and DO levels within the project area. Loss of habitat for Shortnose sturgeon and Striped bass, DO levels in the harbor, conversion of tidal freshwater marsh within the Savannah National Wildlife Refuge, loss of brackish marsh, conversion of salt marsh, and increases in chlorides at the City of Savannah's water intake on Abercorn Creek will be mitigated. The results of these efforts are presented in the EIS.

Table 1-1. Issues Identified for the Savannah Harbor Expansion Project

Impacts to wetlands from changes to salinity within the project area as well as within the Savannah National Wildlife Refuge	See Sections 4.08, 5.01, and Appendix C
Impacts to Threatened and Endangered Species from changes in salinity, dissolved oxygen, and other factors	See Section 5.03, 5.11, and Appendices B and Z
Impacts to Striped Bass Spawning and Nursery Habitat from changes in salinity and dissolved oxygen	See Section 5.03 and Appendix C
Impacts to Anadromous Fish Populations (river herring, American Shad, etc.) from changes in salinity, DO and dissolved oxygen, and other factors	See Section 5.03 and Appendix C
Impacts to the City of Savannah's water quality at the intake structure on Abercorn Creek from changes in chloride levels	See Sections 4.02, 5.02.3 and Appendix C
Verification of the EFDC and WASP (3-Dimensional Hydrodynamic Models)	See Tetra Tech (2006) in References and GRR Appendix C, Attachment 3
Water Quality - Salinity Changes	See Sections 4.02.3, 5.02 and Appendix C
Water Quality - Dissolved Oxygen	See Sections 4.02.2, 5.02.1, and Appendix C
Water Quality - Chloride Concentrations	See Sections 4.02.2, 5.02, and Appendix C

Table 1-1. Issues Identified for the Savannah Harbor Expansion Project (Continued)

Tidal Freshwater Wetlands	See Sections 4.08, 5.01.2, and Appendix C
Cumulative Impacts (from previous, current and proposed dredging)	See Section 5.15 and Appendix L
Fishery Management Plans	See Appendix N
Impacts to Other Fish Species (i.e., Red Drum, etc.)	See Sections 4.04 and 5.03
Essential Fish Habitat	See Sections 4.05 and 5.14 Appendix S
Management of Contaminated Sediments	See Sections 4.01.2.1, 5.04.2.2 and Appendix M
Beach Erosion	See Sections 4.07, 5.09, and Appendix L
Channel Slope Erosion	See Sections 4.07 and 5.09
Fort Pulaski Shoreline Erosion and other impacts	See Sections 4.07 and 5.09
Agitation Dredging	See Appendix B and DMMP in GRR
Sand as a Resource or Beneficial Use of Dredge Sediment	See Sections 3.07 and 5.20
Project Economics	See GRR

Table 1-1. Issues Identified for the Savannah Harbor Expansion Project (Continued)

USACE Section 1135 Restoration Project	See Section 3.0
Bend Wideners and Meeting Areas Impacts	See Sections 3.01 and 5.01
Dredged Material Disposal Capacity and Impacts	See DMMP in the GRR
Impacts on adjacent Georgia and South Carolina properties	See Sections 2.01, and 5.01
Integration with the USACE Savannah River Basin Comprehensive Water Resources Management Study	See Sections 4 and 5
Tidal Amplitude	See Section 4
Ballast Water	See Sections 4.06 and 5.20
Drinking water aquifer (groundwater)	See Sections 4.02, 5.05 and Appendix L
Cultural and Historic Resources (CSS Georgia, Fort Jackson, Fort Pulaski, etc.)	See Sections 4.10, 5.12, and Appendices F and G
Environmental Justice	See Section 5.19
Multiport Analysis	See Section 3 and GRR
Landside Infrastructure	See GRR
Alternative Methods to Improve Transportation Efficiencies	See GRR
Alternate Sites for Terminal Operations	See Section 3, Appendices H and O, and GRR
Consistency with Coastal Zone Management Plans	See Section 5.13 and Appendices I, J, and Z

1.04 Relationship of the Proposed Action to Environmental, Legal, Regulatory, and Policy Requirements

Table 1-2 starting on the next page identifies the status of environmental requirements of the proposed action. Compliance with all applicable Federal, State, and local policies has been assessed in this Final EIS and is summarized in Section 6.0.

1.05 Previous Corps of Engineers Reports Related to Savannah Harbor

Dredging and disposal methods for the Savannah Harbor project have been addressed in previous environmental documents which were circulated for public and environmental agency review. Much of the information from these documents is included in this Final EIS for easier reference by the reader.

Previous reports include:

US Army Corps of Engineers, Savannah District. July 1991. Savannah Harbor Deepening Feasibility Report. In 1991, the U.S. Army Corps of Engineers, Savannah District, published the final interim feasibility study on a proposed deepening of Savannah Harbor. The study resulted in a 1994 project to deepen the inner harbor from the existing 38 feet to 42 feet (Stations 103+000 to 0+000), deepen the existing entrance channel from the existing 38 feet to 42 feet (Stations 0+000 to -14+000B), and deepen the entrance channel from the existing 40 feet to 44 feet (Stations -14+000B to -60+000B). Dredged sediment from the entrance channel was placed at the existing ocean dredged material disposal site and, for the first time, on the beach at Tybee Island. Sediment from the inner harbor channel was placed in the existing upland disposal areas.

US Army Corps of Engineers, Savannah District. September 1991. Environmental Improvement (Section 1135) Study. The Savannah District conducted a study to evaluate proposed modifications for environmental improvements to the Savannah Harbor Navigation Project, pursuant to the authority provided by Section 1135 of the 1986 Water Resources Development Act. The approved modification closed New Cut with hydraulic fill and ceased tide gate operation, by removal of the tide gates. The tide gate abutments along the adjacent high ground and the tide gate supports (or piers) within the sediment basin in the Back River were not removed and remain in place. The purpose of this action was intended to substantially reduce salinity levels in Back River and eliminate the flushing of striped bass eggs and larvae through New Cut to increase survival rates. A Section 1135 report and Environmental Assessment for this proposed action were completed in September 1991. Construction was completed in April 1992 at a total cost of \$2.05 million.

Table 1-2. Relationship of Proposed Action to Environmental Requirements

<u>Federal Law</u>	<u>Recommended Action</u>
Abandoned Shipwreck Act of 1987	Not Applicable
Anadromous Fish Conservation Act	Compliance, see 5.03
Clean Air Act of 1972, as amended	Compliance, see 4.03, 5.06, and Appendix K
Clean Water Act of 1972, as amended	Compliance, see 4.08, 5.01, 5.02, and Appendices C, H, Z
Coastal Barrier Improvement Act of 1990	Compliance, see 5.23
Coastal Barrier Resources Act of 1982	Compliance, see 5.23
Coastal Zone Management Act of 1972, as amended	Compliance, see 5.13 and Appendices I, J, Z
Endangered Species Act of 1973, as amended	Compliance, see 4.09, 5.03, 5.11, and Appendices B, Z
Estuary Protection Act of 1968	Compliance, see 5.13 and Appendices I, J
Federal Water Project Recreation Act of 1968, as amended	Not Applicable
Fish and Wildlife Coordination Act of 1934, as amended	Compliance, see 5.03, 7.02, and Appendix E
Land and Water Conservation Act of 1964, as amended	Not Applicable
Magnuson-Stevens Fishery Conservation and Management Act of 1976	Compliance, see 7.02 and Appendix E

**Table 1-2. Relationship of Proposed Action to Environmental Requirements
(Continued)**

<u>Federal Law</u>	<u>Recommended Action</u>
Marine Mammal Protection Act of 1972, as amended	Compliance, see 4.09, 5.11, and Appendix B
Marine Protection, Research, and Sanctuaries Act of 1972, as amended (Section 103 of MPRSA is also known as the Ocean Dumping Act or ODA)	Compliance, see 4.04, 5.14, and 6.03
Migratory Bird Treaty Act of 1918 as amended	Compliance, see 4.07 and 5.08
National Environmental Policy Act of 1969, as amended	Compliance, see EIS and GRR
National Historic Preservation Act of 1966, as amended	Compliance, see 4.10, 5.12, Appendices F and G
Prime and Unique Farmland	Not Applicable
Resource Conservation and Recovery Act, as amended (Hazardous Waste Issues)	Compliance, see 4.01, 5.24, and Appendix M
River and Harbor Act of 1970, Public Law 91-611, Section 122	Compliance, see 3.0
Safe Drinking Water Act of 1974, as amended	Compliance, see 5.02 and Appendix C
Sunken Military Craft Act	Compliance, see 4.10, 5.12, and Appendices F, G
Water Resources Development Act of 1976, Public Law 94-587, Section 150	Not applicable
Water Resources Development Act of 1986, Public Law 99-662, Section 906	Compliance, see EIS, including Appendix C and authorizing legislation for SHEP: WRDA 1999 Section 101(b)(9)
Watershed Protection and Flood Prevention Act of 1954, as amended	Not Applicable
Wild and Scenic Rivers Act of 1968, as amended	Not Applicable

**Table 1-2. Relationship of Proposed Action to Environmental Requirements
(Continued)**

<u>Executive Order</u>	<u>Recommended Action</u>
EO 11988, Floodplain Management	Compliance, see 5.10
EO 13112, Invasive Species	Compliance, see 5.01, and Appendices C and D
EO 11990, Protection of Wetlands	Compliance, see 5.01, and Appendix C
EO 11593, Protection and Enhancement of the Cultural Environment	Compliance, see 5.12, and Appendices F and G
EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations	Compliance, see 5.19
EO 13045, Protection of Children From Environmental Health Risks and Safety Risks	Compliance, see 5.19
EO 13186, Responsibilities of Federal Agencies to Protect Migratory Birds	Compliance, see 4.07 and 5.08
<u>State Law (to comply with Federal requirements)</u>	<u>Recommended Action</u>
Coastal Zone Management (CZM) Programs Georgia and South Carolina	Compliance, see 5.13 and Appendices I, J and Z
Clean Water Act Section 401 Water Quality Certifications from Georgia and South Carolina	Compliance, see 4.02.4, 5.02 and Appendix Z

Note: Compliance is defined as having met the requirements of the statute, Executive Order, or other environmental requirement for the current stage of planning.

US Army Corps of Engineers, Savannah District. August 1996. Long Term Management Strategy (LTMS). In 1996, the Savannah District developed a comprehensive plan for addressing navigation and navigation related issues in Savannah Harbor. The primary focus was channel maintenance and disposal of dredged material. The EIS prepared during the study presented a new Base Plan (Federal Standard) for harbor maintenance activities, including rotational use of disposal areas. It is a comprehensive EIS for harbor operations and maintenance including Federal and local assurer responsibilities. This plan was adopted as the baseline for evaluation of the Dredged Material Management Plan needs for this project. The Division Engineer signed the ROD on 3 February 1997.

US Army Corps of Engineers, Savannah District. 1996. Lower Savannah River Basin Environmental Restoration Study. The Savannah District completed the final interim feasibility report in 1996 on the Lower Savannah River Basin Environmental Study. The purpose of the study was to investigate the feasibility of environmental restoration of two navigation cuts and bends on the Savannah River. The Chief of Engineers report was approved 30 June 1996 and the project was authorized for construction in the Water Resources Development Act of 1996. Construction was completed in July 2002. A portion of the river flow was diverted down Bear Creek to rehydrate bottomland adjacent hardwoods.

US Army Corps of Engineers, Savannah District. Tier I Draft (May 1998) and Final (September 1998) Environmental Impact Statements, Savannah Harbor Expansion Feasibility Study Report (includes main report and appendixes A, B, and C), Completed by the Georgia Ports Authority and adopted by the Chief of Engineers.

US Army Corps of Engineers, Savannah District. September 2003. Dredged Material Management Plan (DMMP) Update. Implemented the cost sharing changes proposed in the Water Resources Development Act of 1996, as well as updating the rotation of the confined disposal facilities (CDFs) laid out in the Long Term Management Strategy (LTMS) dated 1996. US Army Corps of Engineers guidance requires that DMMP's be developed for management of dredge material from a Federal navigation project. The original DMMP was completed by the USACE, Savannah District in September 1995 and became the Federal Standard, or Base Plan for cost-effective and environmentally acceptable harbor maintenance by the Savannah District. Moreover, the LTMS dated 1996 stated that it also fulfilled the requirement for a DMMP.

US Army Corps of Engineers, Savannah District. 2004. EA/FONSI for the Savannah Harbor Navigation Project, Disposal Areas 13A and 13B, Bank Erosion Protection.

US Army Corps of Engineers, Savannah District. 2006. EA/FONSI for the Savannah Harbor Federal Navigation Channel, Chatham County, Georgia. Actions consisted of a realignment of the Federal navigation channel along Ranges 37 and 38 (referred to as the CB-8 realignment) and a separate realignment along Ranges 41, 42, and 43 (referred to as the Upper Harbor realignment).

US Army Corps of Engineers, Savannah District. August 2006. EA/FONSI for a Drought Contingency Plan Update for the Savannah River Basin. The action retained the major components of the 1989 Savannah River Basin Drought Contingency Plan and adding several new features. The new features consisted primary of different discharge rates from Thurmond Dam and changes to water management operations while in a drought.

US Army Corps of Engineers, Savannah District. July 2008. EA/FONSI for Renourishment of Tybee Island, GA. The action evaluated the planned renourishment of the Tybee Island Shore Protection Project.

US Army Corps of Engineers, Savannah District. November 2008. EA/FONSI for a Temporary Deviation to the Drought Contingency Plan for the Savannah River Basin. The action consisted of a reduction in the discharge from 3,600 to 3,100 CFS from Thurmond Dam while in Level 3 drought from November 1, 2008 through February 28, 2009.

US Army Corps of Engineers, Savannah District. October 2011. EA/FONSI for Level 4 Drought Operations in the Savannah River Basin. The action defined how the Corps would operate when a severe drought has depleted the conservation pools of its three reservoirs on the Savannah River.

1.06 Tiering

Tiering is recommended by the CEQ NEPA regulations when a broad (Tier I) EIS has been prepared and then later a (Tier II) EIS is prepared on an action included within the scope of the initial, broader (Tier I) EIS.

The 1998 Feasibility Study Report and Tier I EIS was written by the Georgia Ports Authority (GPA) and provided to the Corps and to Congress for authorization. After Congress conditionally authorized the project, the Corps completed its review of the documents. The Corps determined that the project was not formulated in accordance with applicable US Army Corps of Engineers planning procedures and that an acceptable mitigation plan was not determined. Analyses included in the SHEP Tier I EIS only evaluated the potential impacts for a -50-foot MLW channel depth. The Corps required a special report and EIS be prepared to identify the NED Plan and the appropriate mitigation. This EIS was prepared to fulfill the environmental portion of those requirements. It should be noted that the Draft EIS was referred to as a Tier II EIS, but, as discussed, the Final EIS is more appropriately considered a full EIS.

The Corps conducted a full EIS (not tiered) in this phase of the project to reconsider methods that may be available to meet the needs for the project, more completely identify and evaluate the potential impacts of project alternatives, develop acceptable mitigation plans, and conclusively determine the NED plan. These include refinement of the hydrodynamic and water quality models, and obtaining agreement from USACE and the natural resource agencies in the models' ability to reasonably predict the impacts of the proposed project alternatives, including mitigation features. In-depth investigations were performed of issues identified through the NEPA scoping process. The findings and

conclusions of these additional evaluations are complete, and the information is included in the Final GRR and EIS.

1.07 Comparison of Draft and Final Reports

A notice of availability for the Draft GRR and EIS was published in the Federal Register on November 26, 2010. The Corps has since revised to those documents as a result of Headquarters Policy Review, public and agency reviews, Agency Technical Review, Independent External Peer Review, and to provide updated information. The list below provides a summary of the changes that affected the total project cost.

- A. Incorporating a larger fish passage design at the New Savannah Bluff Lock and Dam near Augusta, Georgia, as mitigation for impacts to habitat of the endangered Shortnose sturgeon
- B. Removal from the project the construction of an underwater sill in lower Middle River
- C. Increasing Post-Construction Monitoring from 5 to 10 years for several elements
- D. Adding two Speece cones to the Dissolved Oxygen Injection System
- E. Completing additional evaluation of chloride impacts on the City of Savannah's Abercorn Creek intake and adding mitigation for those impacts
- F. Removing nearshore placement of new work dredged sediments near Tybee Island, Georgia from the project
- G. Adding real estate to address additional fish passage and chloride mitigation needs
- H. Increasing construction management costs to address additional fish passage and chloride mitigation needs
- I. Increasing the amount of Planning, Engineering and Design costs across all project features and to address additional fish passage and chloride mitigation needs
- J. Updating costs from October 2010 to October 2011 price levels

The economic analysis in the draft report depended on data and information from vessel operations and forecasts up through 2007 and 2008. The final report incorporates vessel operations information and forecasts available through 2010. Key elements incorporated include establishing a new baseline for forecasting commodity flow and traffic, updating the world fleet and Savannah vessel call information, including vessel operating costs, and inclusion of Post-Panamax Generation 2 vessels in the without-project condition.

Changes made to the Final GRR and EIS that did not affect project costs or benefits include updating the air quality evaluation, incorporating the conditions from the National Marine Fisheries Service Final Biological Opinion, conducting additional dissolved oxygen modeling in shallow areas, and documenting interagency coordination from November 2010 to the present.

2.00 PURPOSE AND NEED FOR ACTION

2.01 Project Area

The project area is located in Chatham County, Georgia, and Jasper County, South Carolina. These counties lie in the Coastal Plain physiographic province in Georgia and South Carolina. The area is roughly bisected by the Savannah River, which, including certain reaches of its tributary channels, constitutes the boundary between the states of Georgia and South Carolina. The river enters the study area flowing in a generally southeasterly direction and then bends in the vicinity of Savannah to flow in a generally easterly direction to the Atlantic Ocean. Mainland areas are separated from the ocean by a line of barrier islands and intervening salt marshes and tidal rivers. The mouth of the Savannah River is located just north of Tybee Island.

The mainland of Chatham County, Georgia, is dominated by the City of Savannah. The city center is located on the southern bluff of the Savannah River approximately 18 miles northwest of the mouth of the river. The lands south of the city center and west of the coastal marshes are primarily devoted to urban development. Urban and industrial development extends northwestward along the Georgia side of the river, gradually giving way to natural woodlands and agricultural areas in the western part of the county.

The mainland of Jasper County, South Carolina, is predominately rural. Lands opposite the city of Savannah are characterized by a system of dikes, canals, and former rice fields constructed in the 18th and 19th centuries. The South Carolina side of the Savannah River is dominated by a predominantly brackish/salt marsh system.

The Georgia Department of Transportation (GDOT) (non-Federal sponsor) has provided seven upland confined disposal facilities (CDFs) in Jasper County for use in the Savannah Harbor. These CDFs are 2A, 12A, 13A, 13B, 14A, 14B, and Jones/Oysterbed Islands. Their locations are shown in Figure 1-1 and their sizes are described in Section 3.01.1.

2.02 Purpose and Need

The purpose of the project is to address inefficiencies in the marine transportation of goods through Savannah Harbor.

The Waterborne Commerce of the United States reveals that total tonnage through Savannah Harbor has grown at an average annual rate of 6.2 percent between 1995 and 2004 (USACE 2006). Commodities are generally broken into three major categories, with one-third of the tonnage being in dry bulk form, one-third liquid bulk and the remaining third being general cargo/container commodities.

Over that 1995 through 2004 period (USACE 2006), nearly 75 percent of the volume through Savannah Harbor was comprised of the following 12 major commodities:

crude petroleum	liquid natural gas
gasoline	distillate and residual fuel oil
food and farm products	chemicals and related products
forest products, wood and chips	gypsum
building cement	basic textile products
iron and steel shapes	fabricated metal products

Because of the high handling efficiencies associated with containerized cargo, the shipping industry has evolved over the last 30 years so that the majority of the commodities are transported in containers. As described in the GRR Economic Appendix, most of the goods that move through the Port of Savannah now are within a container. The volume of loaded export and import TEUs handled at Savannah grew significantly over the last decade. Savannah is one of the rare ports that has developed a balance between its exports and imports. Export TEU volume grew 8 percent between 2007 and 2008, decreased by 5.1 percent during the recession of 2008/2009, and then rebounded to grow by 11.7 percent between 2009 and 2010. Import TEU volume rose 0.2 percent between 2007 and 2008, fell by 17.6 percent in 2008/2009, and then rebounded by 11.7 percent between 2009 and 2010. In 2010, GPA reported that loaded export TEUs totaled 1,144,554 and loaded import TEUs totaled 1,050,466. In GPA's FY2011 (which runs from July 2010 to June 2011), they handled 2,927,338 TEUs, an 11 percent increase (an additional 289,595 TEUs) over the previous year. In their most recent reporting quarter (July through September 2011), GPA reported that its container volumes grew 3.7 percent (770,190 vs. 742,593 TEUs) when compared to last year. These numbers indicate that container volumes through the port continue to grow.

The number of vessels calling at the port has grown in relation to the increase in the volume of goods moving through the port. As the volume of containerized cargo continues to increase, the size of ships that carry those containers will also increase as illustrated by the larger and larger container vessels that now call at the Port. The Corps expects the shipping industry to continue to replace older, smaller vessels with larger Post-Panamax vessels, particularly after completion of the Panama Canal Expansion.

Data on vessels calling at the GPA facilities in Savannah indicate that more than 80 percent of the vessels are considered operationally constrained (meaning that the vessels cannot carry full loads at all tides). "Light loading" of vessels or use of smaller vessels increase costs to the shipper, which are eventually passed on to the consumer.

The following specific problem statements were developed that summarize the navigation problems:

- A. Existing shippers are experiencing increased/ inflated operations costs due to light loading and tidal delays
- B. Light loading and tidal delays will increase as present harbor users increase their annual tonnage and as larger, more efficient ships replace older, smaller ones.
- C. Existing ships are experiencing problems associated with turning capabilities and overall maneuverability in certain reaches of the inner harbor.
- D. The severity of problems associated with turning capabilities and overall maneuverability in certain reaches of the inner harbor will increase as vessel size increases.

The GRR studies indicate that, based on a 50-year period of analysis, harbor deepening is the best method to solve these problems. Draft restrictions on Savannah Harbor increase the cost of shipping, and deepening the harbor to the proposed depth is expected to save current and future shipping costs. These cost savings are fully described in the GRR. Savings in liquid bulk, dry bulk, break bulk, liquefied natural gas (LNG) vessels, and containerized transportation costs would result from using more fully loaded and deeper draft vessels. Increasing the channel depth allows vessels to transport the same amount of commodities in fewer trips using the greater operating drafts or larger vessels. The Corps used regional and national forecasts and expected commerce for the South Atlantic coast to predict commerce types and levels for Savannah Harbor. The economic benefits of a harbor improvement would likely grow with increases in the volume of commerce moving through the port.

2.03 Public Concerns

As indicated in Section 1.02, areas of concern include possible adverse impacts to wetlands, endangered species, water quality, groundwater, adjacent ocean beaches, anadromous fish spawning and nursery habitat, the City of Savannah's water supply, conversion of tidal freshwater marsh to tidal brackish wetlands within the Savannah National Wildlife Refuge (SNWR), and presence of contaminated sediments. See Table 1-1 on pages 1-5 through 1-7 of the EIS for a full list of all potential effects evaluated.

2.04 Study Authority

This study was conducted under authority provided by the Congress of the United States pursuant to the Water Resources Development Act of 1999 (Public Law 106-53, Section 102(b)(9)). The wording of the authorization is as follows:

(9) SAVANNAH HARBOR EXPANSION, GEORGIA

- (A) IN GENERAL- Subject to subparagraph (B), the project for navigation, Savannah Harbor expansion, Georgia, including implementation of the mitigation plan, with such modifications as the Secretary considers appropriate, at a total cost of \$230,174,000 (of which amount a portion is authorized for implementation of the mitigation plan), with an estimated Federal cost of \$145,160,000 and an estimated non-Federal cost of \$85,014,000.
- (B) CONDITIONS- The project authorized by subparagraph (A) may be carried out only after— (i) the Secretary, in consultation with affected Federal, State of Georgia, State of South Carolina, regional, and local entities, reviews and approves an environmental impact statement for the project that includes—
 - (I) an analysis of the impacts of project depth alternatives ranging from 42 feet through 48 feet;
 - and
 - (II) a selected plan for navigation and an associated mitigation plan as required under section 906(a) of the Water Resources Development Act of 1986 (33 U.S.C. 2283(a)); and
- (III) the Secretary of the Interior, the Secretary of Commerce, the Administrator of the Environmental Protection Agency, and the Secretary approve the selected plan and determine that the associated mitigation plan adequately addresses the potential environmental impacts of the project.
- (C) MITIGATION REQUIREMENTS- The mitigation plan shall be implemented before or concurrently with construction of the project.

The 1999 Chief's Report and the Record of Decision included additional requirements, including additional review by the Corps of Engineers and approval of the Chief of Engineers to ensure that construction of the project would comply with all applicable laws and policies. A copy of the 1999 Chief's Report and Record of Decision are included in this document as Appendix X.

2.05 Planning Process

The GRR and EIS followed the six steps of the Corps of Engineers water resources planning process, which are:

- Identify Problems and Opportunities
- Inventory and Forecast Conditions
- Formulate Alternative Plans
- Evaluate Effects of Alternative Plans
- Compare Alternative Plans
- Select Recommended Plan

These six steps provided a framework for planning and are not necessarily sequential.

Appendix O provides a detailed description of the process that the Corps used to complete the first three steps of the planning process. The GRR/EIS provides a detailed description of the process used to complete the remaining steps.

2.06 Planning Objectives

The first step of planning is to identify the problems and opportunities. A portion of this work is developing the major planning objectives. For this project, the objectives are:

A. To evaluate the need for increased navigation efficiency and safety. The size of a vessel and its cargo determine its draft (i.e., depth of water required for ship to float). With the current depth of the harbor, many vessels are not able to load to their maximum capacity and travel at any tide.

B. To avoid, minimize, or compensate for adverse environmental impacts associated with the proposed action. See Section 5.0 in the EIS and the Mitigation Plan in Appendix C for a discussion of environmental commitments incorporated into the proposed plan.

C. Provide adequate dredged material disposal capacity for the construction of the project and for the 50-year period of analysis.

The remaining portion of the first planning step (Identify the Problems and Opportunities) is included in the following section.

3.00 ALTERNATIVES

This section describes the approach that was used to fully satisfy the third step in the planning process – Formulate Alternative Plans (see Section 2.05, above) – and comply with NEPA requirements to analyze alternatives. This section explains the detailed alternatives that the team developed. In addition, Appendix H, 404(b)(1) Evaluation, contains a detailed practicable alternatives analysis, which fully describes and draws together the comprehensive, iterative NEPA alternatives analysis conducted for SHEP, including analysis of other potential options or sites for the project, such as other South Atlantic ports and alternative terminal locations along the Savannah River.

Section 5.0 of the EIS and the system of accounts analysis in Section 11 of the GRR contain information that allows one to compare these alternatives, including the No Action plan.

Since the last major navigation improvements were completed by the Corps in April 1994, Savannah Harbor has experienced significant growth in containerized cargo volume, vessel traffic, and the size and frequency of container ships calling at the Port. The 1994 navigation improvements were designed to accommodate a class of container ships with a dead weight tonnage of approximately 60,000 tons and a maximum capacity of 4,024 TEUs (Twenty-foot Equivalent Units). The design vessel for the 1994 improvements had a length of 951 feet, a maximum operating draft of 42.6 feet, and a Panamax beam (106 feet). The largest vessels currently calling at the Port are rated at more than 6,700 TEUs, with a dead weight tonnage of 85,900 tons, an overall length of 984 feet, a Post-Panamax beam of 131 feet, and a maximum operating draft of 48 feet. Over the intervening years, the Georgia Ports Authority made major investments in landside infrastructure to accommodate increasingly larger vessels and burgeoning trade growth at the Port and the region it serves. At the present time, Savannah Harbor is the second busiest container port on the U.S. east coast, and the fourth busiest in the Nation.

The primary problems identified – and the need for the project -- relate to the inefficient operation of containerships in the Federal navigation channel at Savannah Harbor, which affect the Nation's international trade transportation costs. The following problem statements describe these inefficiencies:

- A. Existing shippers are experiencing increased/ inflated operations costs due to light loading and tidal delays;
- B. Light loading and tidal delays will increase as present harbor users increase their annual tonnage and as larger, more efficient ships replace older, smaller ones;
- C. Existing ships are experiencing problems associated with turning capabilities and overall maneuverability in certain reaches of the inner harbor;
- D. The severity of problems associated with turning capabilities and overall maneuverability in certain reaches of the inner harbor will increase as vessel size increases.

Potential navigation improvements include deepening and widening of navigational channels, Kings Island Turning Basin expansion, and channel wideners. The purpose of these potential improvements is to increase the efficiency of cargo vessel operations and to accommodate larger container ships, which are already calling at the Port and which are projected to use the Port in larger numbers in the near future. The improvements are aimed at alleviating the draft restrictions which impact container ship operations in the harbor. In 2008, approximately 82% of the container ships that called on the Port of Savannah had design drafts that were too deep to allow unrestricted access to the channel. These vessels were required to light-load, use tidal advantage, or both. The number of the larger vessels calling at Savannah is expected to increase in the future.

This study identified and evaluated alternatives that would:

- A. Reduce congestion in the river channel;
- B. Accommodate recent and anticipated future growth in containerized cargo and container ship traffic;
- C. Improve the efficiency of operations for container ships within the Savannah Harbor Navigation Project; and
- D. Allow larger and more efficient container ships to use the Port.

Potential methods of solving the navigation problems were identified and examined. Both structural and non-structural means were considered. Management measures that show potential for addressing navigation problem or opportunity were evaluated based on technical, economic, and environmental considerations. The evaluations were conducted in accordance with criteria established in Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (US Water Resources Council, 1983) and the policies and procedures established by ER 1105-2-100, Planning Guidance Notebook, April 22, 2000.

The District conducted analyses in the early stages of the study to examine management measures that could potentially address the identified navigation problems or opportunities. That work included the following measures:

Non-Structural

- Reduce Underkeel Clearance Requirement
- Increase Efficiency of Landside Operations
- Specialization / Optimization of Facilities
- Improve Traffic Management Practices

Structural

- Minor Modifications
 - Passing/Meeting Areas
 - Bend Wideners
 - Aids To Navigation
 - Vessel Traffic Coordination
 - River Straightening
- Alternate Terminal Locations

- Garden City Terminal
- East Coast Terminal
- Ocean Terminal
- Elba Island
- Blue Circle
- Brunswick
- Disposal Area 12A
- Disposal Area 14A/14B
- Jones-Oysterbed Island CDF / Tybee Island National Wildlife Refuge
- Offshore Transshipment Facility
- Harbor Deepening

The Corps prepared a document that described these evaluations and the conclusions (Appendix O, Formulation of Alternatives, May 2005). That document was circulated to State and Federal agencies, and the public for review and comment. As described in Appendix O, most of the conceptual alternatives were judged likely to be ineffective or inefficient in addressing the identified navigation problems or opportunities, so they were eliminated from further consideration.

The analysis included potential alternative sites in and near Savannah, including three sites in Jasper County, SC, Port Royal, SC, Brunswick, GA, and five sites in Georgia along the Savannah River. Four alternate terminal locations were judged as having either a MEDIUM or HIGH potential as a container terminal. Those four sites were then compared on their economics (including mitigation costs). When landside development costs are included, deepening to the Garden City Terminal site is the most cost-efficient project of the alternative terminal locations evaluated. The next most economically efficient site was 45 percent more expensive. Therefore, deepening to the Garden City Terminal site was the location on which the detailed evaluations were performed.

Three of the locations in Jasper County, South Carolina that the Corps considered for a container terminal either had been or have since been considered by others for a “Jasper Terminal”. The Jasper County locations included the Corps’ analysis included the Savannah Harbor Dredged Material Containment Areas (DMCAs) 12A, 14A/14B, and the Jones-Oysterbed Island DMCA/Tybee National Wildlife Refuge.

Additional navigation aid improvements were judged as not being able to improve the efficiency of cargo movement through the harbor. Ship simulation studies indicated that bend widenings may be needed to allow larger vessels to move safely and efficiently through the harbor, so those features were included in the final channel designs for detailed analyses. Similarly, meeting areas were also identified as measures that were likely to allow larger vessels to move through the harbor more efficiently. The concept of an offshore transshipment facility was judged as being premature at this time to address the problems at the Port of Savannah. The major problem identified with transshipment is that it introduces added transfer, storage, and transaction costs and times.

The Corps also conducted a Regional Port Analysis and a Multiport Analysis. The studies included potential alternative sites in the South Atlantic region (i.e. Norfolk, Wilmington, Charleston and Jacksonville). Those studies assessed the economic and environmental impact of expanding those other South Atlantic ports in lieu of modifying Savannah Harbor. The studies found that (1) the expected growth of container cargo over the next 20 years would exceed the capability of any single existing or future (Greenfield) deepwater container terminal in the South Atlantic region, (2) expansion of any existing container terminal or creation of a new terminal would cause environmental impacts, and (3) improving Savannah Harbor would not cause cargoes to shift from other ports to Savannah. The reports that document those studies are included as Attachments 4 and 6 to Appendix A of the GRR.

Upon completion of the initial steps of the Corps' six-step planning process mentioned above, to the Corps determined that harbor deepening alternatives should be evaluated in detail, with the possible addition of meeting lanes and bend wideners if they were found to be needed. The GRR contains a more detailed alternative analysis.

Six harbor deepening plans (i.e., No Action Alternative or the Without Project Condition, which is the existing project depth of -42 feet MLW, -44 feet MLW, -45 feet MLW, -46 feet MLW, -47 feet MLW, and -48 feet MLW) were developed for detailed evaluation. All of the harbor deepening alternatives would include the existing Kings Island Turning Basin (see Table 3-3), eight berths at Garden City Terminal (Berths 2, 3, 4, 5, 6, 7, 8, and 9), two proposed meeting areas (see Table 3-5), and three proposed bend wideners (see Table 3-6). However, the length of the bar channel extension varies with the proposed depth alternative (Table 3-1).

Table 3-1. Length of Bar Channel Extension Required for Depth Alternatives

Depth (Feet)	Bar Channel Extension (Stations)	Length of Extension (Feet)
44	-60+000B to -95+680B	35,680
45	-60+000B to -96+880B	36,880
46	-60+000B to -97+510B	37,510
47	-60+000B to -97+680B	37,680
48	-60+000B to -98+600B	38,600

Figure 3-1 illustrates the maximum 38,600 foot long extension of the ocean bar channel from Station -60+000B to -98+600B for the proposed 48-foot depth alternative.

All of the proposed deepening alternatives accept a narrower channel at the project depth than currently exists by maintaining the existing side slopes. By slightly decreasing the channel width by maintaining the existing side slopes at different depths, the adjacent

marine and estuarine habitat (substrate and tidal marsh) would not be adversely impacted. Moreover, by not disturbing the existing channel side slopes, sedimentation and shoaling within the new deeper channel would be minimized. The navigation channel side slopes will be 5H:1V for all channel length alternatives in the ocean bar area and 3H:1V in the rest of the harbor. 5H:1V and 3H:1V equates to a 5-foot (and 3-foot, respectively) horizontal distance, for each 1 foot change in vertical distance.

For all dredging alternatives, the proposed dredging depths would include an additional 2 feet of allowable overdepth to ensure the contractor obtains the required dredging template. The dredging depths also include advanced maintenance that help the project remain at the authorized project depth between maintenance events. The existing amounts of advanced maintenance are shown in Table 3-2. The following sections contain more detailed description of these terms.

3.01 Alternative Plans

3.01.1 No Action Alternative (Without Project Condition) - Existing -42 foot depth

The No Action alternative serves as the baseline from which potential project impacts are measured. This plan is also the “Without Project Condition”; those actions which would occur even if the alternative proposed in this EIS is not implemented. The plan consists of continued operation and maintenance of the Savannah Harbor Navigation Project at the existing -42 foot depth. This includes annual dredging to maintain authorized depths in the channel and associated areas, including advance maintenance and allowable overdepth. Federal use of the existing confined disposal areas and the EPA-approved Savannah Harbor Ocean Dredged Material Disposal Site (ODMDS) would continue. Use of the nearshore feeder berm sites or the beach on Tybee Island for deposition of suitable maintenance as authorized in the LTMS would also continue with one exception. The EPA has recently indicated that any dredged material placement sites beyond the 3-mile limit require designation as an ocean dredged material disposal site under the requirements of the Marine Protection, Research and Sanctuaries Act of 1972 (MPRSA). Therefore, any of the submerged feeder berm sites authorized in the LTMS beyond the 3-mile limit would require site designation studies and additional EPA approval. Figure 3-3 shows the approved unconfined disposal sites for maintenance of the Savannah Harbor entrance channel that are located within the 3-mile limit.

Cargoes would continue to move through the harbor. The volumes and types of those cargoes would depend on both the demand for those goods and options for ways in which those demands can be met (sources of supply, transportation methodologies and routes, etc.). Previous investigations (See Paragraph 5.4.2 of the GRR) indicate that demand for goods moving through Savannah Harbor, particularly as containerized cargoes, will increase in the future. In addition, due to ongoing ship-building trends, the size of the vessels calling at ports in the southeastern US is expected to increase. These trends are described in detail in the Economics Appendix of the GRR.

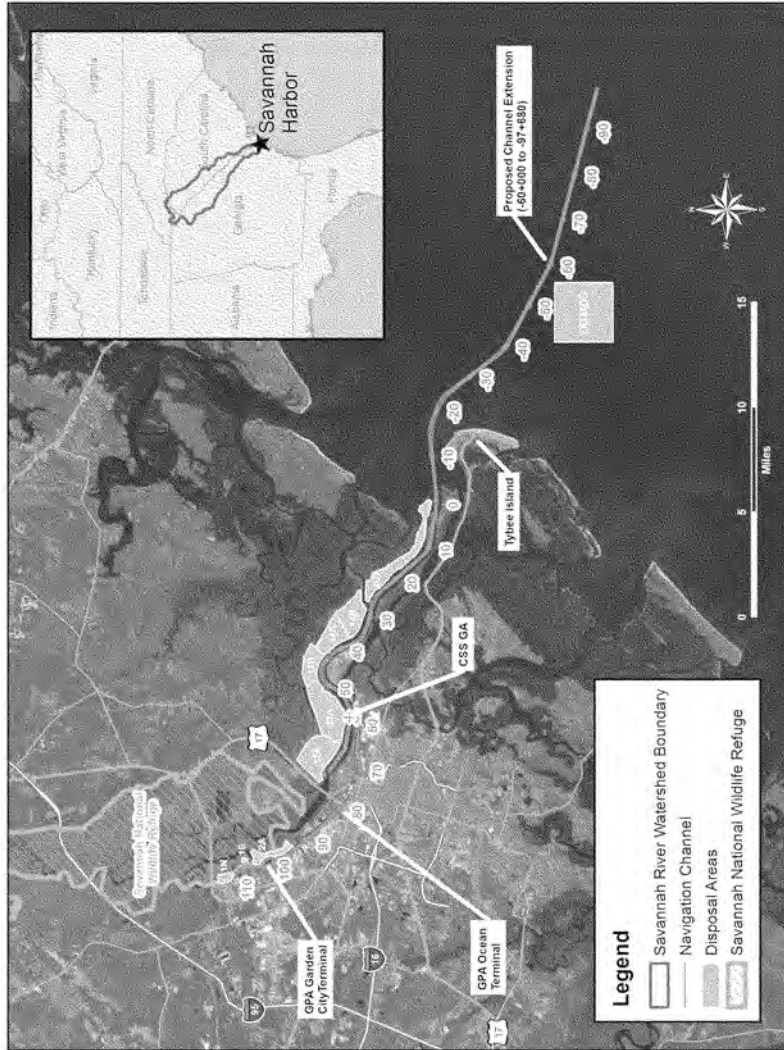


Figure 3-1. Overview map of Savannah Harbor.

Improvements to the Panama Canal are expected to be complete in 2014. Those improvements will allow larger vessels to move through the Canal and call at East Coast ports. The economic analysis contains a fleet forecast that predicts shifts to larger container vessels in the southeastern US after the Panama Canal is enlarged. The Regional Port Analysis and a Multiport Analysis found that (1) the expected future growth of container cargo along the East Coast would require expansion in the capacity of several deepwater container terminals, and (2) expansion of any existing container terminal or creation of a new terminal would cause environmental impacts. Such construction would need environmental approvals, which require a process of impact avoidance, minimization, and mitigation similar to that followed for the proposed deepening of Savannah Harbor.

The existing Savannah Harbor Federal Navigation Project is described in the paragraphs below.

3.01.1.1 General Description. Savannah Harbor is a deep-draft harbor on the South Atlantic coast 75 statute miles south of Charleston Harbor, South Carolina, and 120 north of Jacksonville Harbor, Florida. Within the inner harbor limits, the Savannah River is generally divided into two channels by a series of islands. From the Atlantic Ocean (Station 0+000) to Station 52+800 (River Mile 10), where the river converges, the harbor is separated into South and North Channels. Within this area, the navigation channel is maintained in the North Channel. After divergence of the river into Front and Back Rivers at Station 58+080 (River Mile 11), the navigation channel is maintained in Front River and passes by the business district of the City of Savannah. The navigation channel is maintained in Front River to the upper limits of the harbor at Station 112+500 (River Mile 21.3).

Figure 3-1 shows the station numbering convention that is used in the harbor. The oceanward extent of the ocean bar channel is presently at Station -60+000B (or 60,000 feet east or oceanward of the river entrance at Fort Pulaski and B stands for Ocean Bar Channel). The entrance to the river is at Station 0+000 (or near the Fort Pulaski National Monument in Georgia). Upstream of the river entrance is Fort Jackson and the CSS Georgia at Stations 55+000 to 60+000 (or 55,000 to 60,000 feet upstream of the Fort Pulaski National Monument). The upstream end of the proposed deepening of the harbor at the Garden City Terminal is at Station 103+000 (or 103,000 feet upstream of the river entrance).

A separate navigation project – the Savannah River below Augusta Project – extends from the upper limits of the harbor to River Mile 202.6 at Augusta, Georgia. The authorized channel is 9-feet deep and 90-feet wide, although it has not been maintained since 1978.

The Atlantic Intracoastal Waterway (AIWW) crosses the deep-draft navigation channel at approximately Station 26+000 (River Mile 5). The authorized depth of that channel is 12-feet deep, while the width varies from 90-feet inland and cuts to 150-feet in open waters.

3.01.1.2 Inner Harbor (Stations 112+500 to 0+000). The authorized navigation channel in the inner harbor is 42-feet below Mean Low Water and 500-feet wide upstream of Station 0+000. From Station 103+000 (River Mile 19.5) to the upstream end of the Argyle Island Turning Basin Station 105+000 (River Mile 19.9), the channel is 36-feet deep and 400-feet wide upstream. From Station 105+000 (River Mile 19.9) to the harbor's upstream limit at Station 112+500 (River Mile 21.3), the channel is 30-feet deep and 200-feet wide.

The Federal channel was last modified in 2006 through two small realignments in the upper portion of the harbor (USACE 2006). These actions consisted of a realignment of the Federal navigation channel along Ranges 37 and 38 (here on referred to as the CB-8 realignment) and a separate realignment along Ranges 41, 42, and 43 (here on referred to as the Upper Harbor realignment). The CB-8 realignment consisted of a 1,652-foot shift in the channel in the area of Ranges 37 and 38 across from GPA Container Berth 8 (CB-8). The 1,652-foot segment of the channel was moved roughly 53 feet to the north. The realignment occurred in an area that was dredged in 2005 during construction of the GPA CB-8, therefore; no new dredging was required. The Upper Harbor realignment consisted of a 100-foot realignment in Ranges 41 through 43, which create a bend in the Savannah River upper harbor near Port Wentworth (downstream of Station 103+000). That action increased the width in the bend along the northern edge of the existing channel. Width changes on the three ranges making up the bend vary from 50 to 150 feet. The centerline and the southern edge of the channel did not change. The proposed widening is located in an area with natural depths at or below the authorized project depth, so no new dredging was required.

Sections of eroding shoreline along the CDFs located in South Carolina have been protected through several actions since 1996. Portions of CDFs 13A and 13B were armored with bank protection in 2006. Environmental approvals for this work were obtained through coordination of an Environmental Assessment (USACE 2005). The work included bank protection along 4,400 feet of eroding riverbank in five non-continuous areas between Stations 43+700 and 55+250. This bank protection project has been completed. In 2009, additional bank protection was funded under the American Resource and Recovery Act. Areas 13A/B received 8,735 feet of armor stone between a Stations 56+900 and 45+500. Area 14B received 6,050 feet of armor stone along Stations 33+500 to 33+1655 and Stations 31+500 to 27+75. All work was completed in 2011. Additional bank protection work is underway at Jones/Oysterbed Island and scheduled to be completed in January 2013.

The commercially-owned, Southern Liquefied Natural Gas-El Paso (SLNG-El Paso) Terminal, on Elba Island, near Station 36+000 expanded its facility when it completed construction of a fourth storage tank in 2005. This expansion included construction of a berthing slip to accommodate larger Liquefied Natural Gas (LNG) carriers. SLNG-El Paso is presently constructing a fifth storage tank to further expand the Elba Island Facility. This tank is expected to be placed in service by 2012. These facility expansions are expected to result in increases in the number of LNG vessels calling at the SLNG-El Paso Terminal. The Economics Appendix in the GRR provides more detailed information on the expected extent of that growth.

In July 2009, GPA completed the deepening of four container berths located at the Garden City Terminal. Berths 2, 3, 8, and 9 were deepened from -42 feet MLW to -48 feet MLW.

3.01.1.3 Outer Harbor or Ocean Bar Channel (Stations 0+000 to -60+000B). Station 0+000 is located at the mouth of the harbor near the Fort Pulaski National Monument. The entrance channel is located north of Tybee Island and proceeds out to deep water in the ocean. The existing navigation channel is 44 feet deep and 600 feet wide from deep water in the ocean (mile 11.17B or Station -60+000B) to the channel between the jetties (mile 2.6B or Station -14+000B), then 42 feet deep and 500 feet wide to the harbor entrance (River Mile 0.0 Station 0+000). The existing project includes allowable over depth and advance maintenance dredging (see Table 3-2, below).

3.01.1.4 Annual Maintenance Dredging. The Corps removes approximately 7 million cubic yards of sediments each year from the Savannah Harbor Navigation Project. The dredged sediments are placed in the CDFs and the Savannah Harbor ODMDS. The nearshore feeder berm sites authorized in the LTMS are also available for the deposition of maintenance material. The LTMS also authorized the placement of suitable maintenance material onto the Tybee Island beach.

3.01.1.5 Allowable Overdepth and Advance Maintenance Dredging. The following information is provided pursuant to Guidance Memorandum dated January 17, 2006, and ER 1130-2-520: *Congress specifically authorizes Federal navigation channels by specific depth and width. There is inherent imprecision in dredging processes which vary with the physical conditions (tides, currents, and waves); the dredged material characteristics (silt, clay, sand, gravel, rock, etc.); the channel design (depths being dredged, side slopes, etc.); and the type of dredging equipment (mechanical, hydraulic, hopper, etc.). Due to these variables and the resulting imprecision associated with the dredging activity, Corps engineering design, cost estimating and construction contracting documents recognize that dredging below the Congressionally authorized project dimensions will occur and is necessary to assure the required depth and width as well as cost effective operability. To balance project construction requirements against the need to limit dredging and disposal to the minimum required to achieve the designed dimensions, a paid or allowable overdepth (including side slopes) is incorporated into the project-dredging prism. Material removed from this allowable overdepth is paid under the terms of the dredging contract. Material removed beyond the limits of the allowable overdepth is not paid.*

This subject is also discussed in a Technical Note (ERDC/TN EEDP-04-37) published by the Corps' Engineer Research and Development Center (ERDC) in June 2007 on overdepth and advanced maintenance.

Dredging contracts for the Savannah Harbor include a 2-foot allowable overdepth. To ensure the contractor obtains the required dredging template, the Corps pays the contractor for up to 2-feet of sediment that he may remove below that required depth.

When deepening with the type of dredging equipment currently available, an additional depth of sediments may be disturbed in the dredging process but not removed. This depth is typically greater with larger cutterhead dredges. The rotating cutterhead that loosens the deposited sediments extends below the elevation of the suction pipe, and the suction is only sufficient to lift sediments that have been loosened and slurried by the rotating cutterhead. However, sediments below the elevation of the suction pipe, which are also disturbed by the rotating cutterhead, will not be removed through the dredge pipe line. Slurried sediments are carried through a pipe to the dredge and ultimately pumped into a CDF for disposal. For the large 30-inch cutterhead dredges, this disturbance depth can be 3 feet. Equipment such as hopper dredges or clamshell dredges would have a disturbance depth of less than 1 foot.

Advance maintenance dredging extends the length of time during which authorized channel depths are available. This reduces the frequency of dredging, thereby increasing efficiency and reducing overall maintenance costs. This sediment management technique is performed by enlarging the channel cross-section to provide storage for deposited sediments outside the authorized navigation channel. This storage is typically below the elevation of the navigation channel, but can be on the side of a channel if sediment deposition patterns reveal that such a design would be effective. This technique increases dredging efficiency by concentrating the sediments to be removed. This lowers the unit cost of dredging thereby reducing overall maintenance costs. Under present Corps policy, a District office must request approval for all advance maintenance from higher Corps offices. Decisions to implement advance maintenance can be made at any time upon review of sediment accumulation records, and they are effective until future information indicates they are no longer necessary or cost effective. Compliance with all environmental, engineering, and economic criteria is required prior to implementation of authorized advance maintenance features. The currently authorized advance maintenance allowances by reach are displayed in Table 3-2.

Table 3-2. Present Advance Maintenance Sections

Begin Station	End Station	Authorized Advanced Maintenance (ft)	Required Contract Depth (ft below MLW)
Inner Harbor			
112+500	105+500	2.0	32.0
105+500	103+000	2.0	38.0
103+000	102+000	0.0	42.0
102+000	100+000	2.0	44.0
100+000	79+600	2.0	44.0
79+600	70+000	2.0	44.0
70+000	50+000	4.0	46.0
50+000	37+000	4.0	46.0
37+000	35+000	6.0	48.0
35+000	24+000	4.0	46.0
24+000	0+000	2.0	44.0

Begin Station	End Station	Authorized Advanced Maintenance (ft)	Required Contract Depth (ft below MLW)
Port Wentworth TB		0.0	30.0
Argyle Island TB		0.0	30.0
Kings Island TB		8.0	50.0
Marsh Island TB		0	34.0
Fig Island TB		4.0	38.0
Entrance Channel			
0+000	-14+000(B)	2	44.0
-14+000(B)	-60+000(B)	0	44.0

No advance maintenance is presently performed between Stations 58+000 and 59+000 to reduce potential impacts to the CSS *Georgia*, which is located along that reach. It should be noted that the allowable overdepths and advance maintenance depths remain the same for each depth alternative.

3.01.1.6 Turning Basins. Six authorized turning basins are located along the navigation channel to allow ships to be turned before transiting the harbor. There is also a private turning basin at Elba Island between the Jones/Oysterbed and Fig Island Turning Basins. This basin is used by the LNG vessels calling at Elba Island. The turning basins are described in Table 3-3 and shown in Figure 1-1.

Table 3-3. Existing Turning Basins in Savannah Harbor

Name	Length (ft)	Width (ft)	Depth (ft below MLW)	River Mile	Station
Port Wentworth	600	600	30	20.9	111+363 to 109+757
Argyle Island	600	600	30	19.6	104+185 to 103+085
Kings Island	1,600	1,500	50	18.8	103+085 to 97+750
Marsh Island	900	1,000	34	17.1	91+610 to 89+485
Fig Island	1,500	1,000	34	13.0	69+740 to 67+386
Elba Island (LNG Private)	2,300	1,500	42	6.8	Not Maintained
Oysterbed Island	1050	1,200	40	0.7	4+395 to 2+345
Rehandling Basin	5,000	300	40		10+175 to 4+395

3.01.1.7 Existing Upland Confined Disposal Facilities (CDFs). The Georgia DOT (non-Federal sponsor) has provided seven confined upland disposal facilities for use in the Savannah Harbor. Those areas are as follows:

Table 3-4 Existing Savannah Harbor CDFs

Area Number/Name	Location (Channel Stations)	Size (Acres)
Jones/Oysterbed	0+000 to 27+000	754
14B	28+000 to 37+000	765
14A	38+000 to 42+000	815
13B	43+000 to 47+800	628
13A	6+600BR to 57+000 (-2+000BR)	1,400
12A	6+500BR to 10+100BR	1,123
2A	93+000 to 103+000	185

NOTE: "BR" indicates the stationing in Back River as shown on the Annual Survey.

The Corps works with the Georgia DOT to develop and refine the overall management strategy for CDFs and maximize the useful life of the dredged material placement areas. As an overall strategy, beneficial uses would be pursued for the dredged sediment to (1) reduce the ultimate storage volume required, and (2) increase secondary benefits resulting from the storage and/or disposal operations. To reduce the required storage volume, sediments deposited in the CDFs will be used when fill material is needed to raise the height of the confining dikes. Disposal Area 1N is a disposal site that is no longer used. The site is within the Savannah National Wildlife Refuge, and Refuge managers have requested the Corps only deposit sands, which can be readily reused and/or removed, at that site. Disposal Area 1S is no longer used because it is not diked. Disposal Area 2A is limited to approximately 125,000 cubic yards (CY) of maintenance material every three years and will be closed in 2027. Underdrains have been installed in Disposal Areas 12A, 13A, and 13B to shorten the sediment drying time. This aids the sediment consolidation process, thereby extending the useful life of the disposal sites. A rotational program is being followed at Disposal Areas 12A, 13A, 13B, 14A, 14B, and Jones/Oysterbed Island to (1) provide wildlife habitats which the sites are being used, and (2) allow sufficient time for drying of the sediment so that construction equipment can safely work on the floor of the CDFs to remove sediments for dike raising. Based on information in the 1996 EIS, the District uses a suspended solids content standard of 500 mg/l for acceptability of its weir effluents. This ensures the discharges do not cause unacceptable impacts to aquatic life in the receiving waters. Selective placement of entrance channel sediments and other suitable sediments would be pursued when beneficial uses would be derived. As a component of the design process for maintenance dredging work, a review would be conducted of potential beneficial uses -- specifically alternative placement sites -- for sediments to be excavated during that contract. The placement location to be used for a specific dredging contract would be decided during project design and award based on identification of the least cost, environmentally-acceptable option. If placement at a certain location is found to be more desirable for environmental or other reasons, but would be more costly than one of the other

acceptable options, it can be pursued with appropriate cost sharing using Section 933 (WRDA 1986) or Section 204 (WRDA 1992) authorities.

3.01.1.8 Unconfined Placement Sites. The EPA-designated Savannah Ocean Dredged Material Disposal Site (ODMDS) is the primary unconfined placement site that has received the most material to date. Additional unconfined placement sites are feeder berm sites within the nearshore area off Tybee Island and sites adjacent to the entrance channel (see Figure 3-3). The feeder berm sites were authorized through the Savannah Harbor Navigation Project's Long Term Management Strategy (USACE 1996) pursuant to Section 404 of the Clean Water Act. The LTMS also authorized the placement of suitable maintenance material on the beach at Tybee Island.

In 1987, EPA completed formal designation of the ODMDS pursuant to Section 103 of the MPRSA and approval of the offshore site located 3.7 nautical miles east of the coastline and about 0.25 nautical miles (1,500 feet) south of the navigation channel as a dredged material disposal site. The site center is located at 31 56'54"N and 80 45'34"W. This designated site has been used for many years for placement of sediments removed from the entrance channel. Sediments are excavated from the entrance channel by hopper dredges and then transported to the Savannah ODMDS for disposal, with transport and disposal of sediments evaluated by the district in accordance with Section 103 of the MPRSA. The most recent O&M project evaluation was conducted in July 2010 and concurrence received from EPA by letter in December 2010. The site's designation as a sediment placement site extends until the site is full. Recent analyses indicate, assuming routine placement of maintenance material, the ODMDS would reach capacity in 55 years. More details on the historic use of this site can be found in Appendix R, ODMDS Placement Evaluation.

The LTMS (USACE 1996) also authorized a nearshore bird island that was constructed approximately 10,000 feet offshore of Turtle Island, about 3,000 feet north of the north jetty in South Carolina waters that averaged 6 feet of depth. The island is horseshoe in shape with flat crown at +14 feet MLW with a minimum size of 2 acres. The side slopes from Elevation (EL) +14 to +8 feet MLW are expected to be 1:10, with the slopes below +8 feet MLW being 1:35.

3.01.1.9 Sediment Control Works. The Sediment Control Works were constructed as a specifically authorized project and were added as general navigation features to the existing Savannah Harbor Navigation Project. Authorized sediment control works in the harbor consist of the Tidegate structure across Back River and a sediment basin immediately downstream of the Tidegate. These structures were designed to concentrate sedimentation outside the navigation channel in a location close to confined disposal facilities. Both the concentration of sediment and the short pumping distance, which the shoaling location provided, contributed to a reduction in the cost of sediment removal in the harbor. The Sediment Basin was authorized at a 40-foot depth, 600-foot width and approximately 2-mile length, with an entrance channel 38 feet deep and 300 feet wide. The Tidegate became operative in May 1977, but was taken out of service due to adverse environmental impacts in October 1990. A drainage canal, known as New Cut, located across Argyle Island was constructed along with the Tidegate. New Cut was closed in

1990 to reduce salinity levels in the Savannah National Wildlife Refuge (SNWR), restore approximately 4,000 acres of freshwater marsh, and reduce the flushing of striped bass eggs and larvae into the Front River.

3.01.1.10 Freshwater Control Works. The Sediment Control Works also include a Freshwater Control System. During the development of the harbor deepening and sediment control features in the 1970s timeframe, it was recognized that the saltwater wedge would move further upstream as a result of these projects. This would have produced an unacceptable level of adverse impacts at the SNWR freshwater supply intake on Little Back River and on freshwater marshes in the SNWR. To offset these impacts, a freshwater supply system was included in the project. This system had the following five components:

- A. a 5,500-foot long canal through McCoombs Cut to provide freshwater to the SNWR. The canal was constructed with a 200-foot bottom width at EL -7' MLW and 2H:1V side slopes. The design flow through McCoombs Cut was 4,000 CFS.
- B. a channel in Middle River with a 90-foot bottom width at EL -6' MLW and 2H:1V side slopes. The design flow in Middle River was 1,500 CFS.
- C. a channel in Little Back River with a 200-foot bottom width at EL -5.1' MLW and 2H:1V side slopes. The design flow in Little Back River was 2,500 CFS.
- D. a 28,000-foot long freshwater supply canal with a 28-foot bottom width at EL -4' MLW, 2H:1V side slopes, and water control structures.
- E. a 3,700-foot long connecting canal with a 6-foot bottom width at EL -4' MLW, 2H:1V side slopes.

Congress also authorized a freshwater canal extending from the SNWR to private lands located north of the US Highway 17A Bridge on the South Carolina side of the river. That canal was designed with a 6-foot bottom width at EL -4' MLW and 2H:1V side slopes.

The Federal government is responsible for maintenance of the Diversion Canal, the channels in Little Back River and Middle River, and the canals and control works for the SNWR. The non-Federal project sponsor is responsible for the canal serving private lands southeast of the SNWR. In 1982, the non-Federal sponsor entered into a supplemental agreement with the private property owners, transferring responsibility for normal dike maintenance for facilities on the private lands to those property owners. The sponsor has delivered sand to the area for the property owners' use in dike maintenance. No major rehabilitation of the system has been performed since it was constructed in the 1970's. The system continues to function, but the reliability is very low. Failure of the intake gates would drastically reduce water management ability of both the SNWR and the private landowners. Moreover, an inability to control water levels could render the SNWR unable to meet its primary mission -- providing habitat to migrating waterfowl. In October 2009, the Corps' South Atlantic Division concurred with Savannah District's

determination that this system needed to be rehabilitated. In May 2010, the Corps entered into a contract to rehabilitate a major portion of the project. The work began in July 2010. The rehabilitation work on the portion of the Freshwater Control System located on Federal lands was completed in December 2011.

3.01.2 -44 Foot Alternative (2 Feet Deeper)

The 44-foot channel depth alternative would deepen the existing project by two feet. [The existing project is defined as the current authorized depth of -42 feet MLW, plus 2 feet of allowable overdepth and any authorized advance maintenance depths (See Table 3-2).] This plan would involve dredging the inner harbor (described in Section 3.01.1, above) to -44 feet (2 feet deeper) from the mouth of the harbor (Station 0+000) to the end of the project Station 103+000. Dredging improvements in the inner harbor would also include deepening and expanding the Kings Island Turning Basin and deepening of the eight container vessel berths at Garden City Terminal (Berths 2, 3, 4, 5, 6, 7, 8, and 9). Inner harbor channel deepening would also require the construction of two meeting areas (see Table 3-5, below) and two bend wideners (see Table 3-6, below). Improvements in the entrance channel would involve deepening the existing channel to -46 feet MLW from Stations -14+000B to -60+000B and construction of a bend widener. The depth of -46 feet MLW would extend an additional 35,682 feet for the ocean bar channel extension (from Stations -60+000B to -95+680B). The entrance channel would be -44 feet MLW from Station -14+000B to Station 0+000. The total volume of excavated new work sediment associated with this project is about 10.3 million cubic yards. Estimated annual volume for maintenance dredging would be approximately 7.1 million cubic yards. Analysis of post-project shoaling conditions indicates that shoaling rates and locations would not change appreciably. Therefore, the advance maintenance requirements shown in Table 3-2 would remain the same for each depth alternative.

Table 3-5. Proposed Two New Meeting Areas

Location	Description
GA waters: Station 14+000 to 22+000	The existing 400 foot wide channel would be widened 100 feet on the south to provide an average width of 500 feet. Side slopes would be 3H:1V.
GA and SC waters: Station 55+000 to 59+000	The existing 400 foot wide channel would be widened 100 feet to the north to provide an average width of 500 feet. Side slopes would be 3H:1V.

Table 3-6. Proposed New Channel Bend Wideners

Widener	Location	Description
1	SC waters: Stations -23+000 to -14+000	76-foot bottom width plus side slope of ~20 feet. North side of channel.
2	GA waters: Stations 27+500 to 31+500	156-foot bottom width plus side slope of less than 100 feet. South side of channel.
3	SC waters: Stations 52+250 to 55+000	76-foot bottom width plus side slope of less than 100 feet. North side of channel.

3.01.3 -45 Foot Alternative (3 Feet Deeper)

The 45-foot channel depth alternative would deepen the existing project by three feet. [The existing project is defined as the current authorized depth of -42 feet MLW plus two feet of allowable overdepth and any authorized advance maintenance depths (See Table 3-2).] This plan would involve dredging the inner harbor (described in Section 3.01.1, above) to -45 feet MLW (3 feet deeper) from the mouth of the harbor (Station 0+000) to the end of the project Station 103+000. Dredging improvements in the inner harbor would also include deepening and expanding the Kings Island Turning Basin and deepening of the eight container vessel berths at Garden City Terminal (Berths 2, 3, 4, 5, 6, 7, 8, and 9). Inner harbor channel deepening would also require the construction of two meeting areas (see Table 3-5, above) and two bend wideners (see Table 3-6, above). Improvements in the entrance channel would involve deepening the existing channel to -47 MLW from Stations 000+000B to -60+000B and construction of a bend widener. The depth of -47 feet MLW would extend an additional 36,880 feet for the ocean bar channel extension (from Stations -60+000B to -96+880B). The depth of the entrance channel would be -45 feet MLW from Station -14+000B to Station 0+000. The total volume of excavated new work sediment associated with this project is about 14.6 million cubic yards. Estimated annual volume for maintenance dredging would be approximately 7.1 million cubic yards. Analysis of post-project shoaling conditions indicates that shoaling rates and locations would not change appreciably. Therefore, the advance maintenance requirements shown in Table 3-2 would remain the same for each depth alternative.

3.01.4 -46 Foot Alternative (4 Feet Deeper)

The 46-foot channel depth alternative would deepen the existing project by four feet. [The existing project is defined as the authorized depth of -42 feet MLW, plus 2 feet of allowable overdepth and any authorized advance maintenance depths (See Table 3-2).] This plan would involve dredging the inner harbor (described in Section 3.01.1, above) to -46 feet MLW (4 feet deeper) from the mouth of the harbor (Station 0+000) to the end of the project Station 103+000. Dredging improvements in the inner harbor would also include deepening and expanding the Kings Island Turning Basin and deepening of the eight container vessel berths at Garden City Terminal (Berths 2, 3, 4, 5, 6, 7, 8, and 9).

Inner harbor channel deepening would also require the construction of two meeting areas (see Table 3-5, above) and two bend wideners (see Table 3-6, above). Improvements in the entrance channel would involve deepening the existing channel to -48 feet MLW from Stations 000+000B to -60+000B and the construction of a bend widener. The depth of -48 feet MLW would extend an additional 37,502 feet for the ocean bar channel extension (from Stations -60+000B to -97+510B). The depth of the entrance channel from Station -14+000B to Station 0+000 would be -46 feet MLW. The total volume of excavated new work sediment associated with this project is about 19.0 million cubic yards. Estimated annual volume for maintenance dredging would be approximately 7.1 million cubic yards. Analysis of post-project shoaling conditions indicates that shoaling rates and locations would not change appreciably. Therefore, the advance maintenance requirements shown in Table 3-2 would remain the same for each depth alternative.

3.01.5 -47 Foot Alternative (5 Feet Deeper)

The 47-foot channel depth alternative would deepen the existing project by five feet. The existing project is defined as the current authorized depth of -42 feet MLW plus 2 feet of allowable overdepth and any authorized advance maintenance depths (See Table 3-2). This plan would involve dredging the inner harbor (described in Section 3.01.1, above) to -47 feet MLW (5 feet deeper) from the mouth of the harbor (Station 0+000) to the end of the project Station 103+000. Dredging improvements in the inner harbor would also include deepening and expanding the Kings Island Turning Basin and deepening of the eight container vessel berths at Garden City Terminal (Berths 2, 3, 4, 5, 6, 7, 8, and 9). Inner harbor channel deepening would also require the construction of two meeting areas (see Table 3-5, above) and two bend wideners (see Table 3-6, above). Improvements in the entrance channel would involve deepening the existing channel to -49 feet MLW from Stations 0+000B to -60+000B and construction of a bend widener. The depth of -49 feet MLW would extend an additional 37,675 feet for the ocean bar channel extension (from Stations -60+000B to -97+680B). The depth of the entrance channel would be -47 feet from Station -14+000B to Station 0+000. The total volume of excavated new work sediment associated with this project is about 23.6 million cubic yards. Estimated annual volume for maintenance dredging would be approximately 7.1 million cubic yards. Analysis of post-project shoaling conditions indicates that shoaling rates and locations would not change appreciably. Therefore, the advance maintenance requirements shown in Table 3-2 would remain the same for each depth alternative.

3.01.6 -48 Foot Alternative (6 Feet Deeper)

The 48-foot channel depth alternative would deepen the existing project by 6 feet. [The existing project is defined as the current authorized depth of -42 feet MLW, plus 2 feet of allowable overdepth and any authorized advance maintenance depths (See Table 3-2).] This plan would involve dredging the inner harbor (described in Section 3.01.1, above) to -48 feet MLW (6 feet deeper) from the mouth of the harbor (Station 0+000) to the end of the project Station 103+000. Dredging improvements in the inner harbor would also include deepening and expanding the Kings Island Turning Basin and deepening of the eight container vessel berths at Garden City Terminal (Berths 2, 3, 4, 5, 6, 7, 8, and 9). Inner harbor channel deepening would also require the construction of two meeting areas

(see Table 3-5, above) and two bend wideners (see Table 3-6, above). Improvements in the entrance channel would involve deepening the existing channel to -50 feet MLW from Stations 000+000B to -60+000B and the construction of a bend widener. The depth of -50 feet MLW would extend an additional 38,600 feet for the ocean bar channel extension (from Stations -60+000B to -98+600B). The depth of the entrance channel from Station -14+000B to Station 0+000 would be -48 feet MLW. The total volume of excavated new work sediment associated with this project is about 28.3 million cubic yards. Estimated annual volume for maintenance dredging would be approximately 7.1 million cubic yards. Analysis of post-project shoaling conditions indicates that shoaling rates and locations would not change appreciably. Therefore, the advance maintenance requirements shown in Table 3-2 would remain the same for each depth alternative.

3.02 Plans Considered in Detail

The five detailed alternative plans of improvement (i.e., 44-foot depth, 45-foot depth, 46-foot depth, 47-foot depth and 48-foot depth) were evaluated to identify their impacts to the environment. Although the Corps strives to avoid adverse impacts to the environment, rarely can a major construction project be implemented without causing some adverse effects. The type, location, and level of these impacts must be known before actions can be evaluated to reduce those impacts. Most impacts that could be expected to occur from this proposed project would result from either loss of uplands adjacent to the (expanded) navigation channel or changes to the aquatic environment within the harbor. Other potential impacts could also result, such as changes in shoreline erosion, salinity intrusion into the groundwater, air emissions, traffic levels, tourism, etc.

A more detailed impact analysis for these five alternatives is described in Section 5-Environmental Consequences of the Proposed Action and the Mitigation Plan in Appendix C.

3.03 Comparative Impacts of Alternatives

To evaluate changes to the aquatic system, the Corps used the services of consultants and in-house staff to enhance and apply state-of-the-art hydrodynamic and water quality models to assess potential impacts from the project. The Corps and the Cooperating Agencies followed this approach to produce the best information that could be reasonably developed to identify expected changes resulting from the project. Development and approval of these models was initiated in 1999 and completed in 2005. The process for implementing use of the models is described in detail in the Engineering Appendix that accompanies the GRR. As the models were being developed, the Corps consulted with natural resource agencies to determine what type of information they would like to see to evaluate all aspects of the proposed project. After the agencies approved use of the models, the tools were applied and the modeling was performed (2006 and 2007). This was somewhat of an iterative process. On occasion, the agencies discovered their requested model runs and analysis were not helpful. Subsequently, the agencies identified other informational needs that did enable a thorough evaluation of project impacts. Several reports were ultimately produced as a result of this process. On occasion, several versions of a particular report were produced as more information

became available, or if the Corps later responded to agency requests for additional data and different perspectives. The project-related impacts (without mitigation) predicted from the various alternatives are summarized in Table 3-7.

After the expected impacts to these resources were identified, the Corps used the hydrodynamic and water quality models to evaluate ways to reduce those impacts. A flow re-routing plan was developed for each depth alternative that minimized impacts to freshwater tidal wetlands, the resource which the agencies identified as being most at risk from this project. Additionally, for dissolved oxygen impacts, the Corps used a separate study which identified injection of dissolved oxygen (DO) as being the best method to improve DO levels in the harbor.

Using the selected flow re-routing plans, the water quality model was reevaluated to determine if changes would be required to the preliminary design of the DO injection systems. Ultimately, the need for modifications was confirmed. Changes and updates were then added to subsequent model runs to identify the remaining impacts to fishery resources.

This iterative modeling revealed that the proposed mitigation features (flow re-routing plans and oxygen injection systems) would substantially reduce project impacts to freshwater wetlands, dissolved oxygen, American shad, and Southern flounder. Table 3-8 summarizes the impacts of the depth alternatives after avoiding and reducing project impacts. The mitigation plan found in Appendix C of the EIS further discusses these issues.

3.04 Rationale for Plan Selection

The Corps developed and evaluated five channel deepening alternatives, in addition to the No Action Alternative. The following two pages summarize the results of the impact analyses for the alternative depths that were considered in detail as compared to the No Action alternative. Each channel deepening alternative contains mitigation features to address adverse environmental impacts that they would otherwise produce. With inclusion of the mitigation features, each depth alternative is environmentally acceptable. The 47-foot depth alternative is the National Economic Development (NED) Plan, the plan that maximizes net economic benefits to the Nation (See GRR). Under current Federal planning policy, the NED plan would be recommended for implementation unless there are overriding considerations that favor recommendation of another plan. Benefits that would accrue from the deepening of Savannah Harbor include reductions in light loading of vessels and vessel delays. Shippers will also be able to use larger, more efficient vessels. The economic benefits increase with each additional increment of channel deepening. Environmental impacts associated with a shallower depth would be less than those associated with the NED plan, but the lesser impacts of the 44-foot depth, 45-foot depth, and 46-foot depth alternatives are not considered sufficient to justify recommendation of these alternatives instead of the NED Plan.

Table 3-7. Summary of Project-Related Impacts without Mitigation

	DEPTH ALTERNATIVES				
	44-Foot	45-Foot	46-Foot	47-Foot	48-Foot
Salinity	Move further into estuary	Same effect, but greater amount	Same effect, but greater amount	Same effect, but greater amount	Same effect, but greater amount
Freshwater Wetlands	-551 acres	-967 acres	-1,057 acres	-1,177 acres	-1,212 acres
Brackish marsh	-7.2 acres	Same	Same	Same	Same
Dissolved Oxygen	Reductions at mid-depth and bottom	Same effect, but greater amount	Same effect, but greater amount	Same effect, But greater amount	Same effect, but greater amount
Fisheries	Loss (-) of Acceptable Habitat				
- Striped bass spawning	- 8.0 % (-83.0 acres)	- 12.2 % (-127.0 acres)	- 13.0 % (-135.0 acres)	-18.1 % (-188.0 acres)	- 19.7 % (-205.0 acres)
- Striped bass eggs	-9.7 % (-163.0 acres)	- 11.2 % (-188.0 acres)	- 15.9 % (-266.0 acres)	-20.5 % (-344.0 acres)	-24.5 % (-411.0 acres)
- Striped bass larvae	-13.5 % (-76.0 acres)	- 18.6 % (-105.0 acres)	- 21.0 % (-119.0 acres)	-13.8 % (-78.0 acres)	- 13.8 % (-78.0 acres)
- American shad (Jan)	0 %	0 %	0 %	0%	0 %
- American shad (May)	0 %	0 %	0 %	0%	0 %
- American shad (Aug)	0 %	0 %	0 %	0 %	0 %
- Shortnose sturgeon adult (January)	- 0.5 % (-20.0 acres)	- 0.5 % (-20.0 acres)	-0.8 % (-32.0 acres)	-0.8 % (-32.0 acres)	-1.1 % (-44.0 acres)
- Shortnose sturgeon adult (August)	- 3.2 % (- 45.0 acres)	- 6.4 % (- 89.0 acres)	- 9.5 % (- 132.0 acres)	-13.3 % (-185.0 acres)	- 15.80 % (- 220.0 acres)
- Shortnose sturgeon juvenile (January)	-5.0 % (-86.0 acres)	-10.4 % (-179.0 acres)	-15.9 % (-274.0 acres)	- 19.0 % (-328.0 acres)	- 21.6 % (-373.0 acres)
- Southern flounder	- 0.3 % (-6.0 acres)	- 2.4 % (-45.0 acres)	- 2.4 % (-45.0 acres)	-7.8 % (-146.0 acres)	0.0 %
Chlorides @ City's M&I Water Treatment Plant	Max hourly increase of 77 mg/L	Max hourly increase of 105 mg/L	Max hourly increase of 121 mg/L	Max hourly increase of 149 mg/L	Max hourly increase of 170 mg/L
Drinking Water Aquifer	Same type of effect, but less than 45-foot alternative	Same type of effect, but less than 46-foot alternative	Same type of effect, but less than 47-foot alternative	Same type of effect, but less than 48-foot alternative	Increase flow through confining unit by 3-4%
Hurricane Surge	Minor, max increase in WSE of 0.3 feet	Minor, max increase in WSE of 0.5 feet	Minor, max increase in WSE of 0.6 feet	Minor, max Increase in WSE of 0.8 feet	Minor, max increase in WSE of 0.9 feet
Beach Erosion	Minor, within accuracy of evaluation	Same	Same	Same	Same
Bank Erosion due to ship traffic	No measurable addition to ongoing erosion	Same	Same	Same	Same
Shoaling	Minimal upstream shift	Same	Same	Same	Same
Velocity	Theoretical reduction, but not measurable	Same	Same	Same	Same

Table 3-8. Summary of Project-Related Impacts with Mitigation

	DEPTH ALTERNATIVES				
	44-Foot	45-Foot	46-Foot	47-Foot	48-Foot
Salinity	Move further into estuary up Front River	Same effect, but greater amount	Same effect, but greater amount	Same effect, but greater amount	Same effect, but greater amount
Freshwater Wetlands (Conversion)	+ 322 acres	- 32 acres	- 201 acres	-223 acres	- 337 acres
Brackish Marsh (Conversion)	+ 488 acres	+ 861 acres	+959 acres	+964 acres	+1068 acres
Salt Marsh (Conversion)	- 808 acres	-828 acres	-757 acres	-740 acres	-730 acres
Brackish Marsh (Loss)	-15.68 acres	Same	Same	Same	Same
Dissolved Oxygen	Minimal Net improvement	Same	Same	Same	Same
Fisheries	Loss (-) or Gain (+) of Acceptable Habitat				
- Striped bass spawning	- 2.9 % (-30.0 acres)	- 9.2 % (-96.0 acres)	- 10.0 % (-104.0 acres)	-13.5 % (-140.0 acres)	- 16.1 % (-167.0 acres)
- Striped bass eggs	- 9.4 % (-157.0 acres)	+5.2 % (+87.0 acres)	0 %	-11.1 % (-186.0 acres)	-10.8 % (-181.0 acres)
- Striped bass larvae	-5.6 % (-32.0 acres)	+ 1.7 % (+9.0 acres)	+ 5.6 % (+32.0 acres)	-5.0 % (-28.0 acres)	-3.5 % (-20.0 acres)
- American shad (Jan)	-0.2 % (- 9.0 acres)	-0.2 % (-9.0 acres)	- 0.2 % (-9.0 acres)	-0.2 % (-9.0 acres)	- 0.2 % (-9.0 acres)
- American shad (May)	- 0.2 % (-12.0 acres)	- 0.2 % (-11.0 acres)	- 0.2 % (-11.0 acres)	-0.2 % (-11.0 acres)	- 0.2 % (-11.0 acres)
- American shad (Aug)	-0.3 % (-16.0 acres)	-0.3 % (-15.0 acres)	-0.2 % (-11.0 acres)	-0.2 % (-11.0 acres)	-0.2 % (-11.0 acres)
- Shortnose sturgeon adult (January)	-3.9 % (-153.0 acres)	-4.6 % (-179.0 acres)	-6.2 % (-240.0 acres)	- 6.9 % (-266.0 acres)	- 8.4 % (-326.0 acres)
- Shortnose sturgeon adult (August)	+19.0 % (+260.0 acres)	+9.8 % (+134.0 acres)	+7.3 % (+100.0 acres)	+6.5 % (+89.0)	+2.8 % (+39.0 acres)
- Shortnose sturgeon juvenile (January)	- 6.7 % (-220.0 acres)	- 7.0 % (-231.0 acres)	-7.3 % (-238.0 acres)	-7.6 % (-251.0 acres)	-11.5 % (-376.0 acres)
- Southern flounder	+74.1 % (+1387.0 acres)	+ 54.2 % (+1014.0 acres)	+ 57.3 % (+1072.0 acres)	+57.3 % (+1072.0 acres)	+ 52.9 % (+989.0 acres)
Chlorides @ City's M&I Water Treatment Plant	Max hourly increase of 4 mg/L	Max hourly increase of 4 mg/L	Max hourly increase of 4 mg/L	Max hourly increase of 4 mg/L	Max hourly increase of 4 mg/L
Drinking Water Aquifer	Same type of effect, but less than 45-foot alternative	Same type of effect, but less than 46-foot alternative	Same type of effect, but less than 47-foot alternative	Same type of effect, but less than 48-foot alternative	Increase flow through confining unit by 3-4%
Hurricane Surge	Minor, Max increase in WSEL = 0.5 ft	Minor, Max increase in WSEL = 0.6 ft	Minor, Max increase in WSEL = 0.7 ft	Minor, Max Increase in WSEL = 0.8 ft	Minor, Max increase in WSEL = 0.8 ft
Beach Erosion	Minor, within accuracy of evaluation	Same	Same	Same	Same
Bank Erosion due to ship traffic	No measurable addition to ongoing erosion	Same	Same	Same	Same
Shoaling	Minimal upstream shift	Same	Same	Same	Same
Velocity	Theoretical reduction, but not measurable	Same	Same	Same	Same

Prior to release of the Draft GRR and EIS for agency and public comment, the State of Georgia asked the Corps to consider the 48-foot depth alternative as the Locally Preferred Plan. As a result of comments received and subsequent discussions with the sponsor, the Corps declined to select the 48-foot alternative for implementation.

The 47-foot depth alternative is the Selected Plan. However, the environmental impacts of all of the channel depth alternatives considered are provided in this document to allow comparison of the impacts associated with each plan.

3.05 Selected Plan

The Selected Plan is the NED Plan (plan that maximizes net economic benefits to the Nation), which is the 47-foot depth alternative. The following paragraphs describe the features of the 47-foot depth alternative. The locations of these improvements are shown on Figure 3-1.

Deepening of the existing channel from the ocean bar to the Port of Savannah is the central feature of the proposed action. The total length of improvements is approximately 38 miles (from an upstream river limit Station 103+000 to end of the ocean bar channel - 97+680B). The proposed five foot deepening (-47 feet MLW) of the Federal navigation channel would require the removal of approximately 23.6 million cubic yards of new work sediment. Subject to the availability of funds, the construction period for the entire project would be about four years.

The Selected Plan provides for an ocean bar navigation channel of -49-feet MLW deep and 564-feet wide (Station -97+680B) from the Atlantic Ocean to the channel between the jetties (Station -14+000B). The ocean bar channel would continue at -47-feet MLW and 464-feet wide from the jetties to the harbor entrance just north of Tybee Island (Stations -14+000B to 0+000). From the harbor entrance (Station 0+000) to the upstream limit of the improvements (Station 103+000) the river navigation channel would continue at -47-feet MLW and 464-feet wide. The existing Kings Island Turning Basin, the eight berths at Garden City Terminal (Berths 2, 3, 4, 5, 6, 7, 8, and 9), three channel bend wideners and two meeting areas would also be deepened to -47 feet MLW. The recommended improvements end at the Garden City Terminal (Station 103+000), but the Savannah Harbor Federal Navigation Project extends to Station 112+500.

Channel side slopes from the oceanward end of the bar channel would be 5H:1V. Side slopes for the remaining project (including Kings Island Turning Basin, the eight berths at Garden City Terminal (Berths 2, 3, 4, 5, 6, 7, 8, and 9), three channel bend wideners and two meeting areas would be 3H:1V. Because the side slopes of the navigation channel do not change, the estimated average annual maintenance dredging is about 7.1 million cubic yards.

Two feet of allowable overdepth and up to 6 feet of advance maintenance in selected areas (see Table 3-2, above) would also be included for the proposed action.

3.06 Initial Dredging and Sediment Placement Methods

Excavation methods include use of cutterhead pipeline, mechanical (i.e., bucket and barge), and hopper dredges. A cutterhead pipeline dredge and/or mechanical dredge would be used to deepen the inner harbor channel (from Stations 4+000 to 103+000) and a hopper dredge, mechanical and/or ocean certified pipeline dredges would be used to deepen the entrance channel from Stations 4+000 to -97+680B). Approximately 13 million cubic yards of newly excavated material from the Inner Harbor channel would be placed in the seven upland CDFs. Approximately 10.6 million cubic yards of newly excavated sediment from the entrance channel would be placed in the Savannah Harbor ODMDS.

3.07 Alternative Disposal Methods or Beneficial Use of Dredged Sediments

As part of the proposed actions, a number of alternative disposal methods or beneficial use of dredged sediments were evaluated, including nearshore placement and beach nourishment, creation of shorebird nesting habitat, restoration of the riverine shoreline, creation of tidal marsh and wetlands, production of bricks, capping of the cadmium-laden sediments, and use of material for future dike raisings. Beneficial use opportunities will be employed for a portion of the inner harbor dredged materials. Material from stations 67+000 to 80+125 and from 90+000 to 103+000 will be used as either capping material for cadmium-laden sediments in 14A/B or for future dike raising materials in 13A as detailed in the GRR Engineering Appendix Section 11.0. A discussion of the use of dredged materials for nearshore placement and beach renourishment is included later in this section. Other proposed beneficial uses of the inner harbor material that were considered as part of SHEP are detailed below:

A. Using dredged material to create shorebird nesting habitat is a practice currently employed by the District. In accordance with past mitigation requirements, the District has created several "bird islands" within the existing CDFs. When the CDFs are maintained in a wet condition, these islands provide nesting and roosting habitat for shorebirds, including threatened and endangered species. Implementation of the proposed action will not affect this ongoing activity.

B. To offset shoreline erosion, the Corps considered placement of dredged materials to restore and protect the riverine shoreline in the inner harbor. The Corps determined, however, that the size of the dredging equipment employed to remove the sediments could potentially cause adverse impacts (turbidity, destruction of habitat) if the sediments were pumped onto the riverbank in large quantities.

C. Similar to shoreline restoration, the Corps evaluated using dredged materials to create tidal marsh or wetlands. The Corps determined that discharge of dredged material in open waters to create wetlands would result in adverse impacts to valuable fish and wildlife habitat in the inner harbor. Creation of such environments in the ocean is not cost effective, as the benefit of its construction would be offset by costs required to protect the created habitat from wave action.

D. The non-Federal sponsor has funded studies to assess using dredged materials within the CDFs to manufacture bricks. Should the non-Federal sponsor wish to pursue this option as beneficial use, then the Corps would support its implementation.

In light of the volume of new work sediments that would need to be removed to deepen the harbor and the limited window (December through March) in which hopper dredges are allowed to work in Savannah, the Corps evaluated other equipment and placement options that could be used to reduce the total construction period and minimize new work dredging and deposition costs. Several alternative plans were considered, including beneficial uses of dredged sediments.

The Corps followed an iterative process to develop a plan for the new work entrance channel sediments. The work started with an engineering determination of sediment quantities to be removed at various channel depths and the composition (i.e., percent fines and percent sands) of those sediments. A review of previous information was conducted, including: the LTMS (USACE 1996), the Draft 2003 ERDC Report on Nearshore Placement at Tybee Island, and changes to the GA CZM Program that incorporate Georgia House of Representatives Bill 727 (HB 727).

The LTMS (USACE 1996) authorized placing maintenance sediments in feeder berm sites within the nearshore area off Tybee Island and adjacent to the entrance channel. The LTMS also authorized placing maintenance sediments on eroded portions of Tybee Island.

Based on the sites designated and approved in the LTMS for the deposition of maintenance material into nearshore feeder berm sites, the 2003 ERDC Report refined the analyses identified several specific nearshore sites that would feed sediment to Tybee Island beach and dampen wave action on the coastline. The sites were identified in locations that would minimize subsequent migration of the sediments into the navigation channel.

The Corps then developed a sediment placement plan with cost identified as a priority criterion. The plan was reviewed from an environmental perspective with consultation from the Georgia Department of Natural Resources-Coastal Resources Division (GA DNR-CRD), which provided additional placement scenarios to consider. The Corps also discussed the work with The City of Tybee Island's (Tybee Island) coastal engineering consultant. The proposed plan was subsequently revised to incorporate the views of GA DNR-CRD and Tybee Island's consultant. During that period, Corps engineers were also consulted to determine pumping distances that could be achieved without the use of booster pumps (which would greatly increase cost) and what placement designs would not cause adverse currents or result in rapid migration of deposited sediments toward the shipping channel. The previously described information was then synthesized and integrated into a revised sediment placement plan.

The Corps provided GA DNR-CRD staff and Tybee Island's coastal engineering consultant with the updated plan at a meeting on July 13, 2006. Following the meeting,

the plan was again revised to address items identified during the meeting. The plan was later presented to the Stakeholders Evaluation Group in September 2006 and the Corps again received comments.

The proposed plan was based on a compilation of information provided by Corps geotechnical engineers; discussions with Corps coastal engineers; discussions with GA DNR-CRD for information on CZM and HB 727 compliance, recreational and commercial boat usage off of Tybee Island, and general environmental acceptability issues; and information from Tybee Island's coastal engineering consultant concerning issues that directly affect the Tybee Island beaches.

The Corps included the following assumptions in the design of the sediment placement plan for the entrance channel sediments:

A. A 30-inch pipeline dredge can pump sediment a total distance of about 3 miles without a booster pump and without substantially reducing its productivity. The placement design would be based on there not being a need for a booster pump.

B. A loaded hopper dredge generally needs about 25 feet of water under its keel. Hopper dredges (with pump ashore capability) may not be able to reach all locations, since the nearshore water depths off Tybee Island are less than 15 feet mean high water.

C. For each entrance channel reach from Stations 4+000 to -98+600, the dredge quantities in cubic yards for the greatest dredging depth (i.e., -48 foot depth) was used for all placement sites.

As a result of the extensive coordination with GA DNR-CRD and the City of Tybee Island, the Corps proposed in the DEIS to place new work and maintenance sediments in the nearshore area off Tybee Island which would provide beneficial use of dredged material and comply with the Georgia Coastal Management Program, including the changes that incorporate Georgia HB 727. The proposed dredged material placement plan also included two sites (Site 11 and Site 12) which would have been constructed from material from the entrance channel extension to provide additional fish habitat in the area. The sediment placement sites identified in this plan are shown in Figure 3-2 and described below:

A. MLW 200 has a total capacity of 217,000 cubic yards and is located west of the North Groin on Tybee Island. The sediment would be deposited at the mean low water (MLW) line and be allowed to mound up to mean sea level (MSL) or mid-tide. When filled to capacity, the placement would create a mid-tide berm about 200 feet wide and 3,200 feet long.

B. MLW 500 has a total capacity of 1.9 MCY and is located south of the North Groin on Tybee Island. The sediment would be deposited at the MLW line and be allowed to mound up to MSL or mid-tide. When filled to capacity, the placement would create a mid-tide berm about 500 feet wide and 11,000 feet long.

C. ERDC Nearshore has a total capacity of 1.2 MCY and is located below the MLW contour in the nearshore area off Tybee Island. At total capacity, the top elevation of the placement site would be -4 feet so as not to interfere with boaters but allow potential for movement of material towards the Tybee Island shoreline by wave action.

D. Site 2 has a total capacity of 3.2 MCY and is located below the MLW contour in the nearshore area off Tybee Island. At total capacity, the top elevation of the placement site would be at mean high water (Elevation +8 feet MLW). Site 2 would also provide bird and fish habitats.

E. Site 2 Extension has a total capacity of 4.4 MCY and is located below the mean low water contour (MLW) in the nearshore area off Tybee Island. At total capacity, the top elevation of the placement site would extend to -4 feet MLW.

F. Sites 3, 4, 5, and 6 are located south of the entrance channel and between the Site 2 and the ODMDS. These sites were authorized within the LTMS (USACE 1996). The top elevation of these placement sites would be at -5 feet MLW, as described in the LTMS.

G. Savannah Harbor Ocean Dredged Material Disposal Site (ODMDS). The USEPA-approved ODMDS is a 4.26 square mile (or 2,726.4 acres) site and is centered at 31 56' 54" N and 80 45' 34" W. Total capacity is about 56.8 MCY and at capacity the top elevation would be -26 feet MLW.

H. Site 11 has a total capacity of 2.1 MCY and is located below the mean low water contour (MLW) in the nearshore area off Tybee Island. At total capacity, the top elevation of the placement site would extend to -10 feet MLW. This mound would provide fish habitat. This site was authorized within the LTMS (USACE 1996).

I. Site 12 has a total capacity of 3.0 MCY and is located below the mean low water contour (MLW) in the nearshore area off Tybee Island. At total capacity, the top elevation of the placement site would extend to -10 feet MLW. This mound would provide fish habitat by establishing a variation in contours of the water bottoms.

Most of the sites were authorized in the LTMS to receive maintenance material from the Savannah Harbor entrance channel. Sites 11 and 12 were developed during SHEP planning to provide fish habitat. The specific Site 2 Extension design was developed to provide a pathway for sediments to migrate to the shoreline. The ERDC Nearshore site is also a design development of the previously approved "feeder berm" and is considered a part of the feeder berm system approved under the LTMS.

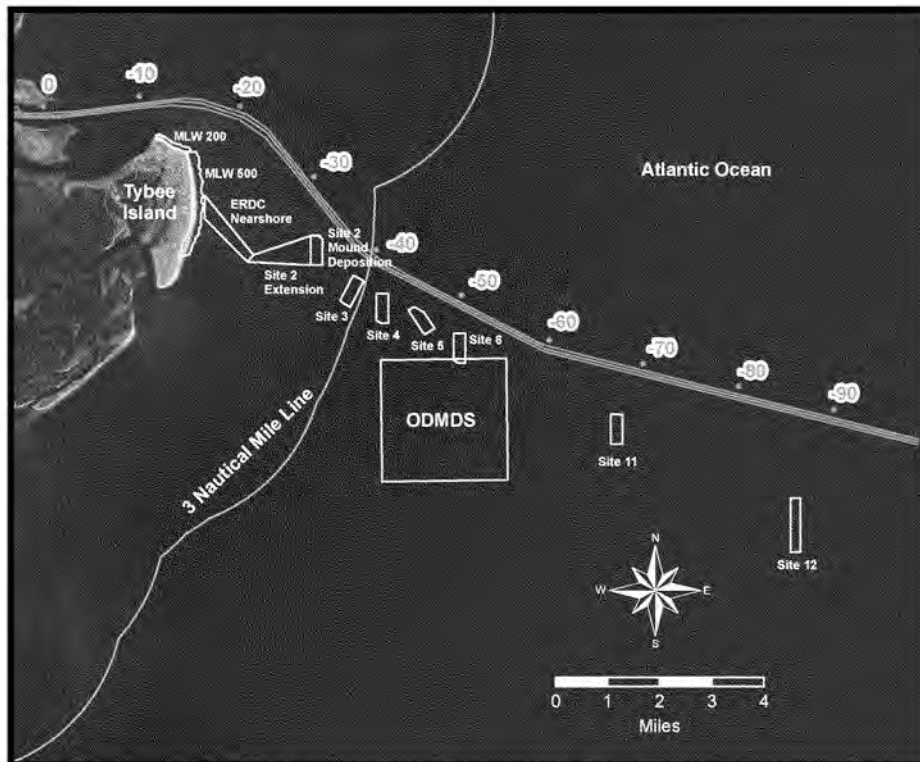


Figure 3-2. Unconfined placement areas for new work and maintenance material as initially proposed.

The new work sediment that would have been placed into the nearshore feeder berm sites would have been material with a fines content of 20 percent or less. The GA DNR-CRD and the City of Tybee Island have since requested that these sites not be used for new work sediment from the project because they prefer material with a fines content of 10 percent or less. They also requested that Sites 11 and 12 not be used because of potential adverse effects to fish habitat and commercial and recreational fishing. Based on comments from EPA, Site 4, Site 5, Site 6, Site 11, and Site 12 are beyond the 3-mile line and would also require site designation studies. Consequently, use of these dredged material placement sites for new work material was removed from the project. New work dredged sediments from the SHEP would be placed into the existing CDFs or the approved ODMDS.

For maintenance material, placing inner harbor sediments into the existing upland CDFs and entrance channel sediments into the Savannah Harbor ODMDS or Site 2 and Site 3 is the least-cost environmentally acceptable disposal alternative (Base Plan) for long-term maintenance of the proposed harbor deepening project. However, suitable maintenance sediments from both the inner harbor and entrance channel of the deepened project could be used for beach renourishment or placed into the other nearshore feeder berm sites

(MLW 200, MLW 500, ERDC Nearshore, and Site 2 Extension) approved as part of the LTMS. The Corps would coordinate with the appropriate natural resource agencies prior to initial placement in areas other than the ODMDS or existing CDFs. A non-Federal sponsor would be required to pay the expected additional costs to deposit the maintenance sediments in areas that are not included in the Base Plan (least cost and environmentally acceptable disposal alternative). Figure 3-3 shows the approved dredged material placement sites for maintenance material from the entrance channel as well as suitable material from the first portion of the inner harbor channel.

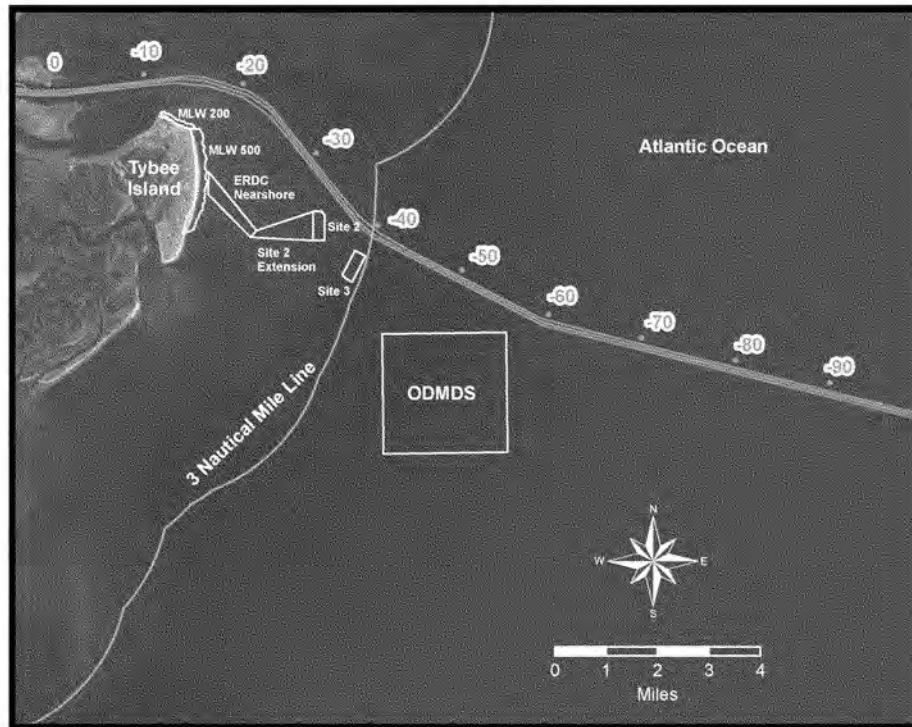


Figure 3-3. Approved unconfined placement areas for maintenance material.

3.08 Dredging Quantities for Construction of Selected Plan

The estimated volumes for construction of the Selected Plan (47-foot depth) are indicated in Tables 3-9 and 3-10 below.

Table 3-9. Estimated New Work Sediment by Reach for the Inner Harbor

Station		Estimated Total Cubic Yards
0+000 to 4+000		305,674
4+000 to 6+375		174,073
6+375 to 30+000		2,759,203
30+000 to 45+000		1,802,866
45+000 to 51+000		892,307
51+000 to 57+000		1,101,114
57+000 to 67+000		1,244,681
67+000 to 80+125		1,196,291
80+125 to 90+000		946,436
90+000 to 103+000 *		2,533,434
TOTAL		12,956,079

NOTE: Volume in Reach 90+000 to 103+000 includes 170,000 cubic yards to be removed from the GPA Container Berths at the Garden City Terminal.

Table 3-10. Estimated New Work Sediment by Reach for the Entrance Channel (Ocean Bar Channel)

Stations	Estimated Total Cubic Yards
0+000 to -10+000B	917,064
-10+000B to -20+000B	1,311,322
-20+000B to -30+000B	1,352,115
-30+000B to -40+000B	1,305,921
-40+000B to -53+500B	1,632,346
-53+500B to -57+000B	391,437
-57+000B to -97+680B	3,736,308
TOTAL	10,646,413

3.09 Maintenance Dredging Requirements

The amount of sediment entering the inner harbor (Stations 103+000 to 0+000) is dependent on river discharge while current velocities and the location of the mixing zone between fresh and salt-water influence the distribution of the shoaling. Past increases in channel depth have improved conveyance so that the full tidal prism reaches the upstream limit of the harbor. The last channel deepening in 1993/1994 did not substantially change the shoaling volume or distribution. Since the channel already captures all of the sediment that enters the harbor, future depth increases will not increase the volume of sediment that settles in the channel. An additional feature of the proposed channel deepening, which supports the prediction of no increase in dredging volume, is future depth increases would extend down along the existing channel side slopes. Deepening along the existing side slopes actually decreases the bottom width of the channel.

The ocean bar channel is a sediment sink that captures the littoral sediment. After the last deepening project (1993/1994), the annual shoaling volume initially appeared to increase. However, when longer term records were incorporated into the analysis, the data indicate that the long term shoaling volume did not increase. That said, a small increase in sediment volume is predicted with the -47-foot deepening alternative based on a 37,680-foot increase in length of the entrance channel.

The improvements included in the recommended plan would be maintained in conjunction with maintenance of the overall Savannah Harbor Navigation Project. Maintenance dredging would continue to be conducted at the same frequency, generally

every 1 to 5 years depending on the shoaling rate. Dredging methods described above (i.e., pipeline and hopper dredges, mechanical (i.e., bucket and barge), or similar equipment) will be used for maintenance. Sediment placement locations for the maintenance of the deepened channel would remain the same, that is;

A. Inner harbor maintenance sediments would continue to be placed in the upland CDFs, and

B. Entrance channel maintenance sediment would primarily be placed in the Savannah ODMDS with some material possibly being placed in a CDF or Site 2 and Site 3 south of the entrance channel. Suitable material could also be placed on the beach at Tybee Island or in the nearshore area of Tybee Island (Sites MLW 200, MLW 500, ERDC Nearshore, and Site 2 extension) provided a non-Federal sponsor pays the additional costs involved in placing the material in those locations.

Average annual maintenance dredging requirements for the recommended plan and alternatives would be essentially the same. Table 3-11 includes total maintenance dredging requirements.

3.10 50-Year Maintenance Plan and Periodic Review

Sediment placement sites have been identified that could accommodate both new work sediments and those that would result from maintenance of the authorized project. Those sites include existing CDFs and the Savannah Harbor ODMDS for new work and maintenance material. Site 2 and Site 3 submerged berms may also be used for maintenance material from the project. Dikes at the CDFs would have to be raised periodically over the 50-year life of the project to provide the needed sediment storage capacity. Similarly, the boundaries of the ODMDS would have to be expanded after capacity is exceeded, which is expected to occur in approximately 42 years. The long-term maintenance of Savannah Harbor will be reviewed periodically to consider new dredging technologies, shoaling rates, environmental conditions, laws and regulations. The GRR Engineering Appendix contains an update to Savannah Harbor's Dredged Material Management Plan. That update describes the analyses the Corps conducted to ensure sufficient sediment placement capacity would be available to maintain a deepened harbor over the 50-year evaluation period. A summary of the capacity analysis is also included as part of Appendix R of the EIS.

3.11 Future Conditions Without the Project

In excess of 80% of the vessels do not call on Savannah Harbor at their maximum capacity or design draft. The "light loading" of vessels increase costs to the shipper, which are eventually passed onto the consumer. Less efficient vessels also generally result in higher shipping costs. If the proposed project is not constructed, vessel operators will continue to incur costs due to vessel delays and light loading of vessels.

3.12 Relationship of Proposed Action to Other Federal Projects in Savannah Harbor

As indicated in Section 3.01 of the EIS, the proposed action assumes that the project features associated with the LTMS (USACE 1996), Bank Protection for CDFs 13A, 13B, 14A, and 14B and the realignment of the Federal Navigation Channel (USACE 2006) have been completed.

Table 3-11. Estimated Average Annual Maintenance Dredging Quantities Selected Plan of Improvement (in Cubic Yards)

Range	Volume of Maintenance Sediments (Cubic Yards)
Entrance Channel	
-98+600B to -57+000B	124,000
-57+000B to -53+500B	3,000
-53+500B to -40+000B	54,000
-40+000 to -30+000	325,000
-30+000B to -20+000B	281,000
-20+000 to -10+000	163,000
-10+000 to 0+000	155,000
0+000 to +4+000	76,000
Subtotal	1,181,000
Inner Harbor	
4+000 to 24+000	225,000
24+000 to 40+000	364,000
40+000 to 50+000	900,000
50+000 to 70+000	2,076,000
70+000 to 79+000	294,000
79+000 to 97+500	605,000
97+500 to 102+000	1,456,000
102+000 to 103+000	51,000
Subtotal	5,971,000
Total Annual	7,038,000

4.00 AFFECTED ENVIRONMENT

Viewed as a watershed, the following features are located within the Savannah River Basin:

A. Savannah River, with certain of its tributaries forms the boundary between the states of Georgia and South Carolina along its entire length of 313 miles (see Figure 4-1). There are three Federally-authorized reservoirs (Hartwell, Richard B. Russell, and J. Strom Thurmond) and the New Savannah Bluff Lock and Dam at Augusta, which are operated by the Savannah District (see Figure 4-1). These Corps dams and reservoirs largely control the freshwater flow within the Savannah River.

The Savannah River has a drainage area of approximately 9,850 square miles and an average discharge of 11,290 cubic feet per second (cfs) (U.S. Geological Survey 1960). The tidal influence extends approximately 45 miles upstream to Ebenezer Landing, Georgia.

B. The Savannah River Estuary contains the historic harbor established in 1733 and the Savannah National Wildlife Refuge. Industrial development is located on the Georgia side of the river and the sediment placement sites are located on the South Carolina side of the river. The estuary provides a gateway to upstream passage of fish. There are water quality problems within the harbor, with a very stringent Total Maximum Daily Load (TMDL) for Dissolved Oxygen.

The Savannah Harbor is a deep-draft harbor on the South Atlantic coast 75 statute miles south of Charleston Harbor, South Carolina, and 120 miles north of Jacksonville Harbor, Florida. In general, the study area for this analysis is continuous from the nearshore ocean (including the proposed ocean bar channel extension and ODMDS) upstream to the stream gage at Clyo, Georgia (located at river mile 61). The harbor and deep-draft navigation channel comprise the lower 21.3 miles of the Savannah River and 11.2 miles of channel across the bar to the Atlantic Ocean.

The Savannah River in the project area generally flows from west to east. The existing 42-foot-deep by 500-foot-wide Savannah Harbor ship channel extends through the approximate center of the river. Seven existing upland Confined Disposal Facilities (CDFs) are located along the northern border of the channel along much of its length. All of the CDFs are diked for deposition of dredged sediments; therefore, most of their terrestrial habitats are maintained in an early stage of succession. Salt marsh borders most of these CDFs and mainland in the project area.

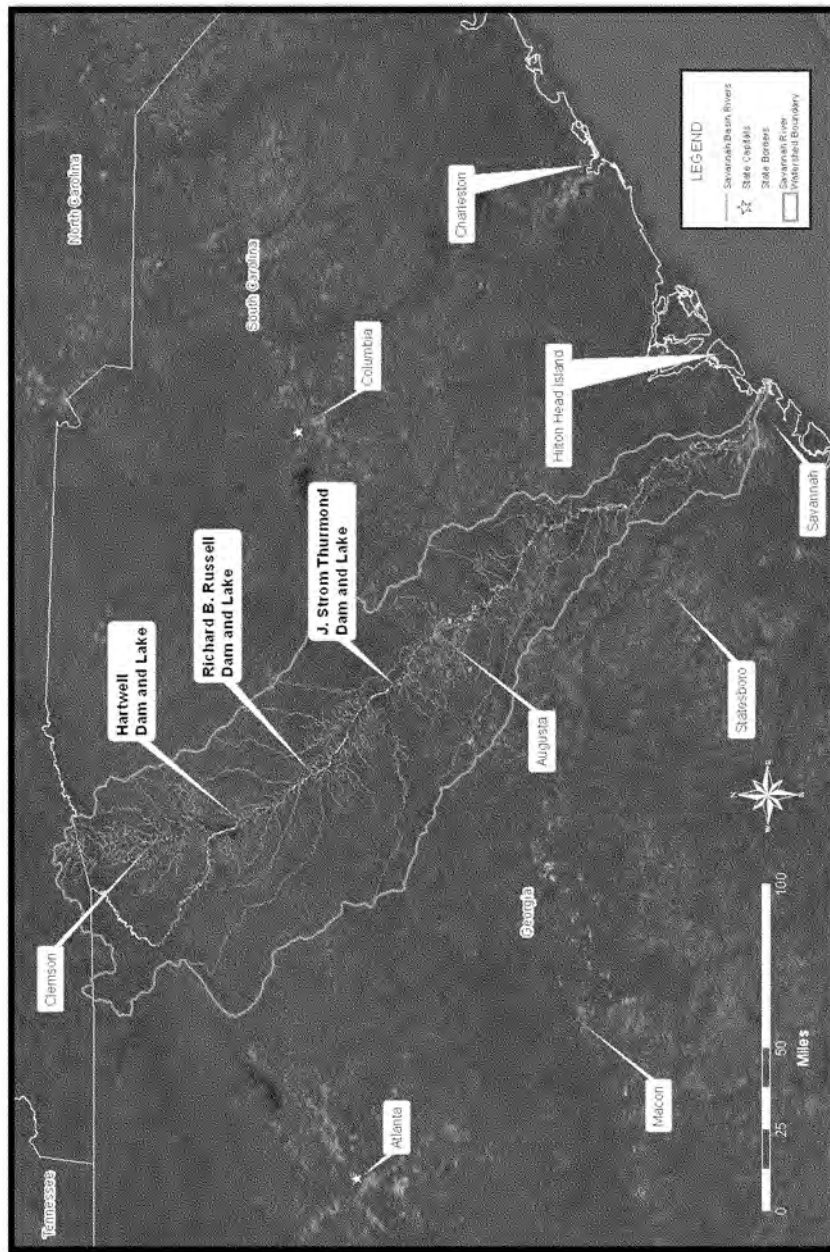


Figure 4-1. Savannah River Basin.

Savannah Harbor experiences a large semi-diurnal tide. Tidal fluctuations average 6.8 feet at the mouth of the harbor and 7.9 feet at the upper limit of the harbor. Ebb velocities are usually somewhat larger than flood velocities. Maximum velocities encountered in the navigation channel are approximately 4 feet per second on the flood tide and 5 feet per second on ebb tide.

Salinity ranges from 0 ppt in the freshwater flow coming down the river into the Savannah Harbor to seawater (35 ppt) in the ocean bar channel. The width of the river varies from roughly 2,400 feet near its mouth to 1,000 feet at the Kings Island Turning Basin (Station 100+000).

C. Watershed scale issues include surface and groundwater issues along the coast with concerns about horizontal salinity intrusion from the ocean, vertical salinity intrusion into the Upper Floridan aquifer resulting from high pumping rates, and vertical salinity seepage in the deepened navigation channel. The Tybee Island Federal Shore Protection Project at the river mouth is another landscape-scale issue, with concerns about impact to the island from the existing navigation project.

Significant resources within the project area are discussed in detail below.

4.01 Geology and Sediments

4.01.1 Geology

Savannah, Georgia is located in the Lower Atlantic Coastal Plain Physiographic Province. The majority of soils primarily have a sandy surface layer over loamy or sandy subsoil or underlying layers. These soils are nearly level or gently sloping and occur as broad, smooth areas drained by wet depressions. They generally are seasonally wet or almost always wet, except for the better drained soils on the slight ridges and dune-like relief. A band of marshes parallel the coastline and extends inland along the major streams. Limestones of tertiary and quaternary age underlying the Coastal Plain form one of the most productive aquifer systems in the country.

4.01.2 Sediments

This section characterizes the sediments found within the harbor. Information was taken from the previous report, the sediment quality evaluation conducted to assess potential contaminant impacts associated with the proposed Savannah Harbor Expansion Project, and radiological screening conducted of harbor sediments.

The maintenance sediments dredged on an annual basis from Savannah Harbor is a mixture of sands, silts, and clays. Sand is defined as grain size between 0.07 and 5.0 mm in diameter, while silt and clay measures less than 0.07 mm in diameter. Sands are dredged from the lower and upper reaches of the project, while silt is the predominant material removed from the middle harbor and sediment basin. Table 4-1 shows the most recent sediment characteristics (percentage sand versus percentage fines) by station and Table 4-2 presents a summary of historical characterization sampling events. Laboratory test results from column settling and consolidation tests performed in 1981 on the dredged sediments were used in these analyses.

The inner harbor maintenance sediments are primarily silts and clays from Station 56+000 to 103+000. The reach from Station 25+000 to 56+000 is a transition reach that has a higher percentage of sand in its distributions than the sediment distributions of the upstream reach. A notable exception is in the vicinity of Station 36+000, which has a high percentage of silts and clays and almost no sand. This location is near the confluence of the inner harbor channel and both Elba Island and Fields Cut. The inner channel sediment distributions from Station 25+000 to the mouth of the Savannah River are primarily sand, which indicates that the source of sediment from this reach is offshore.

Table 4-1. Most Recent Characterization of Bar Channel Maintenance Sediments

Station Range	No. of Samples in the Composite	Percent Sand and Gravel in the Composite	Percent Fines in the Composite
0 to -15B	5	84.8	15.2
-15 to -25B	5	87.8	12.2
-25 to -32.5B	5	87.7	12.3
-32.5 to -37.5B	5	85.2	14.8
-37.5 to -60B	5	94.2	5.8

Note: from Anamar, 2010, Sampling Conducted September 2009

Table 4-2. Summary of Historical Characterizations of Maintenance Sediments (1998 – 2002)

Station Range	Citation	% Sand and Gravel	% Silt	% Clay
+110 to +100	ENSR ¹	52.5	18.5	29
	GSRC ⁴	15	48	37
+100 to +50	ENSR ¹	25.6	23.8	50.6
	GSRC ⁴	25	51	24
	NOS ⁵	12	51.7	36.3
+50 to +27.5	ENSR ¹	73.8	9.6	16.6
	GSRC ⁴	0	65	35
	NOS ⁵	22.5	47.3	30.2
+27.5 to 0	ENSR ¹	88.2		
	Dial Cordy ²	85.2		
	ENSR ¹	89.6	6.2	4.2
	NOS ⁵	93.9	2.1	4
0 to -15B	ENSR ¹	82		
	Dial Cordy ²	77.6		
	ENSR ¹	80.4	8.8	10.8
	NOS ⁵	49.4	32.6	18
-15B to -25B	ENSR ¹	87		
	GSRC ⁴	82.6		
	ENSR ¹	79	8.4	12.6
	NOS ⁵	73	9	17.9
-25B to -50B	ENSR ¹	78.4		
	GSRC ⁴	67.6		
	ENSR ¹	75.8	9.7	14.5
	NOS ⁵	57	24.2	18.8
-50B to -60B	ENSR ¹	92.7		
	GSRC ⁴	91.4		
	ENSR ¹	96.3	1.4	2.3
Sediment Basin	ENSR ¹	8.6	20.7	70.7
	GSRC ⁴	9	59	32

Notes:

- 1 All ENSR grain size data, sampling mostly in Aug 2002, all accomplished prior to dredging, sand by #200 sieve (328 samples)(ENSR 2003, Savannah Harbor O&M Grain Size Evaluation, ENSR International, Contract GS-10F-0115K, DO DACW21-02-F-0034, June 2003).
- 2 All Dial Cordy grain size data, sampling 13-18 Dec 2000, prior to dredging 30 Dec to 9 Mar 01, sand by #200 sieve (264 samples)(Dial Cordy, 2001, Grain Size Analysis of Maintenance Sediments in the Savannah Harbor Navigation Channel, Prepared for the Savannah District by Dial Cordy and Associates, Inc., March 2001).
- 3 ENSR data from limited sampling for chemistry and biotoxicity studies, sampling Aug 2002, #200 sieve (18 samples)(ENSR 2003, Savannah Harbor O&M Sediment Evaluation, ENSR International, Contract GS-10F-0115K, DO DACW21-02-F-0034, August 2003).
- 4 GSRC data from limited sampling for chemistry and biotoxicity studies, sampling Aug 1999, sand by #200 sieve (11 samples)(GSRC 2000, Savannah Harbor Sediment Testing, Final Report to USACE Savannah District, Gulf South Research Corporation and G.E.C., Inc., July 2000, Contract Number DACW21-98-D-0019, DO 29).
- 5 NOS data from sampling for metals and selected organics, sampling Dec 1998 (13 samples)(NOS, 1999, Savannah Harbor O&M Testing, Dr. Dan Bearden & Dr. Geoff Scott, National Ocean Service, and Mr. J. Edward Buxton, General Engineering Laboratories, Inc., and Dr. Walter J. Sexton, Athena Technologies, Inc., June 1, 1999, MIPR W33SJG83416218).

The entrance or ocean bar channel sediments are primarily sand with exceptions between the jetties and at Station -45+000B, which have large silt and clay components.

As discussed in Section 3, maintenance sediments dredged from the ocean bar channel (Station 0+000 to -60+000B) are deposited in the Savannah ODMS. On occasion, some of the maintenance material from the first portion of the entrance channel is placed in a CDF. Although they have not been used in the past, the 1996 LTMS authorized the use of Site 2 and Site 3, feeder berm sites just south of the entrance channel, and the nearshore feeder berm sites (Site 2 Extension, ERDC Nearshore, MLW 200, and MLW 500) off Tybee Island for the placement of maintenance material from the entrance channel as well as the first portion of the inner harbor. Figure 3-3 shows these authorized placement sites. The LTMS also authorized the placement of suitable maintenance material directly onto the beach at Tybee Island. Since placement of maintenance material into these nearshore sites or onto the beach of Tybee Island would involve additional costs over that of the Base Plan (use of the ODMS and Site 2 and Site 3), a cost sharing non-Federal sponsor would be required.

Samples of bottom sediments from the project area have been tested to evaluate the toxicity and bioaccumulation potential of chemical contaminants which may be associated with those maintenance sediment materials. These site-specific test results indicate that the maintenance sediments meet the testing criteria of the EPA Ocean Dumping Regulations and Criteria and are, therefore, acceptable for transportation for ocean dumping under Section 103 of the Marine Protection, Research, and Sanctuaries Act of 1972, as amended. The District completed its most recent evaluation of depositing maintenance sediments in the Savannah ODMS in a Section 103 Evaluation in July 2010. EPA Region IV, concurred with the determination by letter dated December 22, 2010. The maintenance sediments are re-examined every 6-10 years to ensure they still meet the Ocean Dumping criteria. The sediment testing performed for this project (reported in EIS-Appendix M) indicates that the new work sediments are substantially the same as the substrate at the disposal site and the dredging site is far removed from sources of pollution, so as to provide a reasonable assurance that the material has not been contaminated by pollution. As a result, the new work sediments are acceptable for ocean disposal. Savannah District prepared an evaluation of depositing the new work sediments in the Savannah ODMS. That evaluation is found in EIS-Appendix R. Savannah District is conducting biological testing on the new work sediments to confirm that adverse biological effects from such placement are unlikely. That testing and evaluation are still underway. The District will prepare a Section 103 Evaluation and submit it to EPA Region IV for review and approval prior to initiating dredging.

New work sediments excavated from the inner harbor will be placed in upland confined disposal sites. Use of specific sites would be determined based on their availability and planned maintenance and improvement activities. Tables 4-3 and 4-4 contain a breakdown of the amount of new work dredged sediment by reach. The volumes to be dredged shown in those tables are based on a 47-foot deepening with allowable overdepth and advance maintenance.

Table 4-3. Approximate New Work Sediment Quantities by Reach for the Inner Harbor

Station Range	Estimated Total (Cubic Yards)
0+000 to 4+000	305,674
4+000 to 6+375	174,073
6+375 to 30+000	2,759,203
30+000 to 45+000	1,802,866
45+000 to 51+000	892,307
51+000 to 57+000	1,101,114
57+000 to 67+000	1,244,681
67+000 to 80+125	1,196,291
80+125 to 90+000	946,436
90+000 to 103+000	2,533,434
TOTAL	12,956,079

Table 4-4 provides the estimated amounts of sediment that will be excavated for the proposed Outer Harbor (Ocean Bar Channel) from Stations 0+000 to -97+680B. The volume to be removed is based on a 47-foot deepening with 100% for overdepth and advance maintenance.

Table 4-4. Estimated New Work Sediment Quantities by Reach for the Outer Harbor (Ocean Bar Channel)

Station Range	Estimated Total (Cubic Yards)
0+000 to -10+000B	917,064
-10+000B to -20+000B	1,311,322
-20+000B to -30+000B	1,352,115
-30+000B to -40+000B	1,305,921
-40+000B to -53+500B	1,632,346
-53+500B to -57+000B	391,437
-57+000B to -97+680B	3,736,308
TOTAL	10,646,413

Average annual maintenance dredging requirements for the selected plan (-47 feet MLW) would essentially be the same since the side slopes of the channel will not change. Table 4-5 includes total estimated maintenance dredging requirements.

Table 4-5. Estimated Average Annual Maintenance Dredging Quantities for the 47-Foot Depth Alternative (in Cubic Yards)

Station Range	Maintenance Volume (Cubic Yards)
Entrance Channel	
-98+600B to -57+000B	124,000
-57+000B to -53+500B	3,000
-53+500B to -40+000B	54,000
-40+000B to -30+000B	325,000
-30+000B to -20+000B	281,000
-20+000B to -10+000B	163,000
-10+000B to 0+000B	155,000
+4+000 to 0+000B	76,000
Subtotal CY	1,181,000
Inner Harbor	
4+000 to 24+000	225,000
24+000 to 40+000	364,000
40+000 to 50+000	900,000
50+000 to 70+000	2,076,000
70+000 to 79+000	294,000
79+000 to 97+750	605,000
97+750 to 102+000	1,456,000
102+000 to 103+000	51,000
Subtotal CY	5,971,000
TOTAL ANNUAL	7,038,000

4.01.2.1 Sediment Quality (Potential Contaminant Impacts). As described earlier, maintenance sediments are tested every 6-10 years to ensure they are not contaminated to the extent that special handling is required and that they are suitable for deposition in either an upland or ocean placement site. Sediment testing had been performed as part of the Tier I EIS developed for this proposed project. The Executive Summary of the Final Sediment Quality Evaluation (found in Appendix M) performed as part of this EIS summarized that effort and more recent studies as follows: *"In 1997, sediment core samples were collected and examined for sediment physical and chemical properties. The sampling area covered the entire project*

area proposed for harbor deepening, extending from deep water in the ocean to the Kings Island Turning Basin (Station 103+000). Parameters investigated included metals, PCBs, PAHs, petroleum hydrocarbons, phenols, pesticides, dioxin congeners, cyanide, organotins, and nutrients.

The evaluation found that most of the sediments did not provide any concern for potential contaminant-related impacts associated with the proposed dredging and dredged sediment placement. However, three potential issues were identified.

One issue involved sediments near the old RACON Tower site. Polycyclic aromatic hydrocarbons (PAHs) and cadmium were detected in a sample taken at about Station - 75+000B near the old RACON Tower where a spill of fuel, batteries, and paint lacquer occurred in November 1996. Subsequent sampling conducted in 2005 revealed that sediments at that location do not pose a potential for potential contaminant-related environmental impacts.

The second issue pertained mostly to whether the sediment chemistry data for pesticides, PAH's and phenols, especially achieved detection limits, were adequate for comparison to screening criteria. This issue was addressed during the 2005 sampling. The confirmatory sampling within the channel revealed there are no potential sediment contaminant concerns related to pesticides, PAH's, phenols, or metals other than cadmium.

The final issue involved the concentration and distribution of cadmium within the new work sediments. Sampling was conducted in 2005 to address this issue. Cadmium was found to occur naturally in unusually high levels within Miocene clays that would be excavated during the SHEP dredging. Evaluation of the laboratory results could not rule out the potential for adverse impacts from sediments with elevated cadmium levels in some reaches of the channel."

As a result of those investigations, additional studies were conducted. The additional sampling, testing and detailed analyses were conducted in 2007. The potential pathways by which cadmium might enter the environment were evaluated. Further discussion of those studies and the impacts of the cadmium-laden sediment on the environment is found in Section 5.04 and Appendix M of the EIS.

4.01.2.2 Radiological Screening of Harbor Sediments. Savannah Harbor is located about 120 miles downstream from the US Department of Energy, Savannah River Site in Aiken, South Carolina. The Savannah River Site processes radioactive material and over the years, releases of radioactive materials from this site have been documented. Therefore, accumulation of these radioactive materials within the harbor sediments may have occurred.

In 2002, sediment samples were collected within the harbor and sent to the Corps of Engineers' Environmental and Materials Unit located in Marietta, Georgia and examined for radiological contamination. Test results were measured in milli-Rems per hour (mRem/hr). Background values varied between 0.01 and 0.03 mRem/hr. Values from the sediment samples ranged from 0.02 to 0.04 mRem/hr. These results are consistent with the background levels, with only a few samples exhibiting an increase of 0.01 mRem/hr over the background range. This should be anticipated, since these soils contain phosphatic and glauconitic minerals, along with other clays,

that exhibit naturally-occurring levels above background levels. These results are two orders of magnitude below acceptable action levels approved by OSHA and the US Environmental Protection Agency that range between 1 mRem/hr to 5 mRem/hr. Based on these results, the levels of gross radioactivity measured in the harbor sediments are naturally-occurring and pose no hazards to the environment as documented in the Dredged Material Physical Analysis Report 2002 (see GRR, Engineering Appendix).

4.02 Water Resources

4.02.1 Groundwater

Studies were previously conducted to determine impacts of the 1993/1994 harbor deepening on the freshwater aquifer. Borings were taken to define the soil stratum at critical locations. Information from those and other borings show that the stratum bearing the drinking water aquifer would not be impacted by maintenance of channel depths in the authorized project. More than 50 feet separate the bottom of the deepest authorized excavation from the top of that water-bearing layer. According to work performed by Paul Huddleston, Georgia Geologic Survey, the US Geological Survey, and Dr. Vernon J. Henry, Georgia State University, the surfaces of the Early Miocene and Late Oligocene Age aquifers appear to be sufficiently deep to prevent damage by even a project constructed to a depth of -50 feet MLW.

An offshore geological structure known as the Beaufort Arch created an uplift to the Tertiary sediments in the vicinity of the Savannah Light (outer end of the entrance channel). This uplift resulted in the Parachucla formation (of early Miocene Age) surfacing about -90 feet MLW which is the uppermost confined aquifer in the area. A more valuable freshwater aquifer, the Late Eocene aged Ocala Limestone (Upper Floridan) aquifer, would be expected to be at no higher elevation than -190 feet MLW in this area. The uppermost freshwater aquifer is confined by the middle Miocene clays that range in thickness from less than 30 feet near the Tybee high to 160 feet near downtown Savannah. These clays are overlain by clayey sands and soft limestones. Above the Upper Miocene are soft granular Pliocene and Pleistocene age deposits in which most of the recent harbor deepening took place, along with current soft deposits of the Holocene Age. Early reports indicated that introduction of significant volumes of water into the upper Floridan aquifer would require contact with a fissure, fault, or ancient stream channel which would lead to this strata. This is possible, but not likely. Another way for water to be introduced into the Upper Floridan aquifer would be for the entire Miocene Age cap to be removed to expose the underlying limestone. This would require dredging the harbor to -100 feet MLW. Based on this information, previous studies concluded that no impact to the upper confined freshwater aquifer or the principal confined artesian drinking water aquifer in Savannah Harbor was expected from the recent harbor deepening or from continued maintenance of the 42-foot authorized Navigation Project.

The existing diked sediment containment areas are not lined, but are constructed on top of the soil substrate that was originally on the site. In most cases, soft organic soils supporting wetland vegetation previously covered the sites. Due to the unlined nature of the facility and the short-term ponding of water within the diked areas, there is a potential for migration of water down

through the soil layers to levels of shallow groundwater. Groundwater can be found at various depths in the project vicinity, while subsurface drinking water is taken only from depths more than 100 feet below the surface. As described in the previous paragraph, clay lenses of 40 to 70 feet in thickness separate the various groundwater bearing strata. Those lenses effectively limit the depth to which migration could occur from the disposal areas.

Additional groundwater studies (including groundwater modeling) were conducted as part of the Final EIS. These studies were prepared by the Savannah District and were independently peer reviewed by representatives from USGS and Virginia Polytechnic Institute and Georgia State University. The report is entitled *Supplemental Studies to Determine Potential Ground-Water Impacts to the Upper Floridan Aquifer, Savannah Harbor Expansion Project, Final Report, June 2007* and is included in the GRR Engineering Appendix.

The field work included the following major components:

- A. Detailed sub-bottom seismic survey
- B. Marine and land drilling
- C. Collection of porewater data
- D. Collection of hydraulic conductivity data
- E. Collection of head data

The results of the field work were analyzed and incorporated into a three-dimensional coupled flow and transport groundwater model. The consulting firm CDM conducted the groundwater modeling. Additionally, the field data was used to develop a comprehensive Geographic Information System (GIS) of the area.

The sub-bottom seismic survey was conducted from Stations 30+000 to -30+000B, where the Miocene confining unit is naturally thin and paleochannels are known to have further incised into the confining layer. The survey provided detailed information about all major paleochannels within the area of concern. The location, attitude, and extent of all paleochannels were mapped and incorporated into the Miocene surfaces created for the GIS and the groundwater model. These results are summarized in Chapter 5 and discussed in detail in the Engineering Appendix of the GRR.

The three-dimensional groundwater model simulated the specific effects of deepening the existing navigational channel on water quality in the Upper Floridan aquifer. Model simulations were run for no future dredging (future conditions without the project), the proposed deepening (up to 6 feet or -48 feet MLW) plus an additional 3-foot removal of confining material (i.e., up to -51 feet MLW), and varying the hydraulic conductivity of the confining layer. The reason the additional three feet was included in the model was because of inconsistencies in the equipment used to deepen the channel. As discussed previously (see Section 3.01, above), hydraulic (cutterhead pipeline and hopper) and mechanical dredges (clamshell bucket and barge) have inherent inaccuracies in their removal of sediment within the channel.

The following information was taken from USACE (2007): *The results of the groundwater model indicated that the proposed deepening activities to the -48 foot depth MLW would*

contribute a minimal amount of downward flow through the confining layer and the resulting differences between the proposed deepening (to -48 foot MLW) and no deepening scenarios were minor. The simulated chloride concentrations decrease significantly upon entering the Upper Floridan aquifer due to considerable horizontal flow of fresh water within the aquifer mixing with and diluting the relative very low volume of salt water migrating downward from the Savannah River. The model simulations also projected that regardless of the proposed deepening to -48 foot depth MLW, chloride concentrations in the Upper Floridan aquifer are expected to increase significantly in the lower reaches of the Savannah River over the next 100 to 300 years if the present rate of aquifer withdrawal remains constant. Under current conditions, the maximum expected chloride concentrations in the Upper Floridan aquifer directly beneath the river ranged from 500 to 1,400 mg/l depending on the hydraulic conductivity of the confining layer and the proposed deepening to -48 feet MLW was projected to contribute an additional 10 to 200 mg/l to these concentrations.

4.02.1.1 Fractures within the Miocene Confining Unit. Another groundwater-related issue that was identified at the end of the Tier I EIS process and during the 2002 scoping for the Final EIS, is the possible existence and influence of fractures or joints within the Miocene confining unit underlying the navigation channel. Fractures within the Miocene aquitard could significantly affect the rate of saltwater intrusion into the Upper Floridan aquifer. These issues are addressed within the report entitled *Supplemental Studies to Determine Potential Ground-Water Impacts to the Upper Floridan Aquifer, Savannah Harbor Expansion Project, Final Report, June 2007* found in the GRR and discussed in Section 5.05 of the EIS.

4.02.2 Surface Water

4.02.2.1 Surface Water Salinity. Savannah Harbor is in a partially-mixed estuary in which the vertical mixing of salt and freshwater is not complete over the length of saltwater intrusion. Surface salinities are appreciably less than the bottom salinities and there is a large zone of mixing between fresh and saltwater. Seaward of this mixing zone, the net bottom flow over a tidal cycle is upstream. Landward of this mixing zone, the net bottom flow is downstream. The converging bottom flows carry shoaling material to the location of no net bottom flow, which tends to be an area of high shoal volumes. Shoaling in the Savannah inner harbor channels oceanward of Station 28+000 is due to sand carried into the channel from the ocean by the strong bottom flood currents. The shoal material in the lower river is almost entirely sand, while the shoal material upstream of Station 28+000 is silt and clay. The sand is deposited during slack tide and the weaker bottom ebb currents cannot carry the sand back to the ocean source. Results from the physical model tests indicate that the bottom flood currents at Station 4+000 are a foot per second faster than the bottom ebb currents and that the net bottom flow in the lower portion of the harbor is upstream.

Pritchard (1967) described four hypothetical circulation patterns for estuaries, two of which may be applicable to Georgia estuaries. The *moderately stratified estuary* is one in which tidal action serves as the dominant force mixing fresh and salt waters. The Savannah River exhibits this type of circulation. In an estuary with no tide or friction, undiluted sea water would extend upstream along the bottom to a point where the river surface was approximately at sea level. The less dense fresh water would flow seaward on top of the salt water. When there is tidal action, as in

the moderately-stratified estuary, turbulence carries fresh water downward and salt water upward. The salt content of both layers increases toward the sea, but at any given point the bottom layer is more saline than the top. *Vertically homogeneous estuaries* occur where tidal mixing is vigorous and freshwater input is low. In this case, vertical salinity stratification breaks down.

There exists a definite salinity gradient with depth. The lower reaches of the estuary may have bottom salinities ranging from one-half to three times greater than surface salinities. However, turbulence within the river frequently does not allow the formation of a distinct saltwater wedge. The salinity of the estuary is constantly changing due to tidal action, freshwater inflow and wind, so that for any location within the river the salinity might range from a few parts per thousand (ppt) to almost normal ocean salinity (35 ppt).

4.02.2.2 Water Quality Classification. The water quality classifications for the states of Georgia and South Carolina are summarized below.

South Carolina Standards. South Carolina Department of Health and Environmental Control (SC DHEC), dated June 23, 2006, in its Water Classifications and Standards, Regulation 61-69, has classified the Savannah River from the headwaters of Lake Russell to the Seaboard Coastline Railroad as Class FW, from the Seaboard Coastline Railroad to Fort Pulaski as SB (Dissolved Oxygen not less than daily average 5 mg/l and minimum 4 mg/l), and from Fort Pulaski to the Atlantic Ocean as Class SA waters.

Class FW is defined as freshwaters suitable for primary and secondary contact recreation and as a source for drinking water supply after conventional treatment in accordance with the requirements of the Department. These freshwaters are suitable for fishing and the survival and propagation of a balanced indigenous aquatic community of fauna and flora. They are suitable also for industrial and agricultural uses.

Class SB is defined as tidal saltwater suitable for primary and secondary contact recreation, crabbing, and fishing, except harvesting of clams, mussels, or oysters for market purposes or human consumption. These waters are also suitable for the survival and propagation of a balanced indigenous aquatic community of marine fauna and flora. The dissolved oxygen standard for Class SB is not less than 4 mg/l.

Class SA is defined as tidal saltwater suitable for primary and secondary contact recreation. These waters are also suitable for uses listed in Class SB, with the same exceptions. The dissolved oxygen standard for Class SA is a daily average of 5 mg/l with a minimum of 4 mg/l.

The SC DHEC standards also contain a provision for cases where natural conditions may cause a depression of dissolved oxygen in surface waters while existing and classified uses are still maintained. The Department shall allow a dissolved oxygen depression in these naturally low dissolved oxygen waterbodies, defined as a waterbody that, between and including the months of March and October, has naturally low dissolved oxygen levels at some time and for which limits during those months shall be set based on a critical condition analysis. These waters shall not be

cumulatively lowered more than 0.1 mg/l for dissolved oxygen from point sources and other activities.

A fish consumption advisory has been issued by SC DHEC for mercury and includes the Savannah River within this watershed.

Georgia Standards. The State of Georgia, through its Rules and Regulations for Water Quality Control, Chapter 391-3-6, Revised January 29, 2009, has classified the Savannah River from Station 0+000 (mile 0) at Fort Pulaski to the open sea (including the littoral waters of Tybee Island) as "Recreation Waters". From Fort Pulaski (Station 0+000) to the Seaboard Coastline RR Bridge (about Station 144+672 or Mile 27.4), the river is classified as "Coastal Fishing". The latter stretch of the Savannah River used to be classified as Industrial/Navigation. However, studies were conducted by the Georgia Department of Natural Resources during the fall of 1985 which resulted in the reclassification of that stretch of the river to "Coastal Fishing".

The GA Department of Natural Resources (GA DNR) (Water Quality in Georgia, 1990-1991) lists the harbor from US Highway 17 to South Channel as not fully supporting the designated use of coastal fishing due to the violation of fecal coliform and copper criteria due to urban runoff/urban effects and municipal facilities incapable of providing sufficiently high quality effluent. In 2000, the US Environmental Protection Agency (EPA) established a Total Maximum Daily Load (TMDL) for the harbor for fecal coliform. EPA determined the critical period to be in July and August. The TMDL stated that upstream point sources were not believed to be the cause of high fecal counts in the harbor since those sources are located far enough upstream to allow their fecal coliform loads to decay to background levels.

In October 2006, EPA finalized a TMDL for Savannah Harbor to satisfy a consent decree obligation established in *Sierra Club v. EPA*, Civil Action No: 94-CV-2501-MHS (N.D.GA). In summary, the TMDL concluded that Savannah River cannot accept anthropogenic oxygen-demanding substances and still provide acceptable habitat for critical aquatic life that reside in those reaches of the river. This finding means that the States will have to revise their permits for point source discharges in those reaches as they expire and come up for renewal. As part of its analysis, EPA evaluated the dissolved oxygen requirements for several different fish species and the natural conditions for the river. For Savannah Harbor, the applicable DO site-specific criteria established by Georgia "are minimum instantaneous and will apply throughout the water column. The DO criteria were no less than 3.0 mg/l in June, July, August, September, and October; no less than 3.5 mg/l in May and November, and no less than 4.0 mg/l in December, January, February, March, and April."

In 2009, the State of Georgia revised its DO standard for Savannah Harbor. The new standard calls for a daily average in the dissolved oxygen to be no less than 5.0 mg/L throughout the year, with an instantaneous minimum of 4.0 mg/L. If it is determined that the "natural condition" in the water body is less than the values stated above, then the criteria will revert to the "natural condition" and the water quality standard will allow for a 0.1 mg/l deficit from the "natural" dissolved oxygen value. Up to a 10% deficit will be allowed if it is demonstrated that resident aquatic species shall not be adversely affected. These new standards apply throughout the water column and they match the South Carolina standard for waters of the same use classification.

EPA published a Revised Draft TDML for dissolved oxygen in Savannah Harbor in April 2010. This TDML requires a reduction in loading from about 600,000 lbs/day Ultimate Oxygen Demand (UOD) to about 130,000 lbs/day.

4.02.2.3 Section 401 Water Quality Certifications. The dissolved oxygen regime in Savannah Harbor is characterized by low levels of dissolved oxygen during the summer months, with much of the estuary typically dropping below the state standards. The Corps is required to monitor dissolved oxygen levels in the effluent from its sediment disposal areas, as well as in the vicinity of its dredging operations during the summer months. When dissolved oxygen levels fall to 3.0 mg/liter or less, the Corps is required to cease dredging operations unless a waiver is obtained from GA DNR-EPD.

Water Quality Certifications have been received for operation of the existing Savannah Harbor Navigation Project from both Georgia and South Carolina in their administration of Section 401 of the Clean Water Act.

Water Quality Certification -- State of Georgia. In a letter dated September 5, 1995, the State of Georgia, Department of Natural Resources, Environmental Protection Division (GA DNR-EPD) issued a Section 401 Water Quality Certification for the Long Term Management Strategy. Conditions in the certification are listed below. The District received clarification from the State on three of the conditions by letters dated February 6 and 28, 1996. The conditions below reflect those clarifications. Further discussions with GA DNR staff confirm that conditions 5 and 6 apply only to hopper dredges.

The Georgia certification was issued contingent on the following conditions:

A. All work performed during construction will be done in a manner so as not to violate applicable water quality standards.

B. No oils, grease, materials or other pollutants will be discharged from the construction activities which reach public waters.

C. No dredging operations will be conducted during the Striped bass spawning period from March 16 to May 31. This was modified in 1998 to avoid possible impacts to the Striped bass population of the Savannah River. The condition now in effect is that dredging will be restricted in the harbor (upstream of Station 63+360 or River Mile 12.0) during the period from March 16 to May 31 of each year.

D. Prior to initiation of dredging activity between July 1 and September 30, the dredge operator must establish the following procedures. Dissolved oxygen levels in the Savannah River contiguous with the immediate dredging activity will be determined at a depth of one meter above the hard bottom or 2 to 3 meters above an indeterminate bottom. This determination must be made within 24 hours prior to the commencement of dredging activity. If dissolved oxygen levels are less than 3.0 mg/l dredging activity will not be permitted.

Monitoring of the dredging activity will be conducted within 4 hours of the commencement of dredging, but no earlier than 2 hours after the commencement of dredging. In the event of 24 hour operation (around the clock) of the dredge, dissolved oxygen will be determined daily. The monitoring station will be located at mid-channel, 500 feet downstream of the ongoing dredging activity. Dissolved oxygen levels will be determined at a depth of one meter above a hard bottom or 2 to 3 meters above an indeterminate bottom. If dissolved oxygen levels fall below 3.0 mg/l, dredging will be suspended until dissolved oxygen levels are 3.0 mg/l or greater.

Results of this monitoring must be submitted to the Georgia DNR Environmental Protection Division, the Georgia Wildlife Resources Division, and the Georgia Coastal Resources Division within 30 days of the completion of each dredging operation. Failure to maintain satisfactory compliance with these conditions may result in prohibition of dredging operations in the Savannah River during the period of July 1 to September 30 upon written notice to the applicant.

E. Dredging should be conducted during December through March. These are the times when sea turtles are least abundant in the area of the Savannah Ship Channel. Dredging outside these months should be coordinated with the Georgia Department of Natural Resources (DNR) Non-game Wildlife Program. Dredging in May will require the implementation of a conservation plan approved by the Georgia DNR. This plan should include trawling to remove turtles from the path of the dredge.

F. During December through March, dredge and support vessels should have a trained whale observer on watch during daylight hours. At night, or when visibility is reduced by fog or sea states greater than Beaufort 3, dredges must slow to 5 knots or less if whales have been spotted within 15 nautical miles (nm) of the vessel's path within the previous 48 hours. Normal operational speeds can be resumed after 48 hours if visibility has not improved and no whales have been observed by dredge observers. These procedures are consistent with the "Recommended Safe Operating Procedures for Large Vessels Transiting the Right Whale Calving Area Critical Habitat Off Georgia and Florida During March-December" that have been developed by the Southeastern US Implementation Team for the Recovery of the Northern Right Whale.

Water Quality Certification -- State of South Carolina. On May 10, 1996, the State of South Carolina, Department of Health and Environmental Control (SCDHEC) issued a Section 401 Water Quality Certification for the Savannah Harbor Long Term Management Strategy (LTMS) Project. That certification included the following conditions:

A. To ensure water quality standards are maintained, the Division of Water Quality and Shellfish Sanitation must be notified and any alternate disposal site must be reviewed and approved prior to its use if the proposed disposal areas cannot be utilized by the COE or the GA DOT.

B. The applicant must implement a water quality monitoring plan to insure that the effluent is in compliance with state water quality standards and to coordinate with the Department if any discharge is violating any state water quality criteria, as proposed. The applicant must conduct monitoring in accordance with an approved sampling plan specifying the

location of sampling stations, parameters sampled, when samples will be collected, and how the sampling data will be reported. Appropriate ambient data from the Wright River must also be submitted.

C. The applicant must install flap gates at underdrain discharge points so that no effluent is discharged during low flow periods in receiving waters.

D. The applicant must monitor water quality 100 feet downstream of underdrain discharges to test for water quality standards compliance, as proposed. In addition, the applicant must conduct monitoring in accordance with an approved sampling plan specifying the location of sampling stations, parameters sampled, when samples will be collected, and how the sampling data will be reported.

E. The applicant must adhere/comply with recommendations of the SC DNR regarding the timing of placing dredged material for beach nourishment to insure continued protection of various species of sea turtles.

F. The applicant must provide compensatory mitigation for wetlands impacts associated with the proposed work. All wetlands impacts must be compensated for on at least a 1:1 basis. If mitigation includes creation, restoration, or enhancement, the plan must include monitoring. This mitigation plan must be submitted to the Water Quality Division for review and approval within 6 months of Section 404 permit issuance.

4.02.2.4 City of Savannah – Abercorn Creek Water Intake. During preparation of the 1998 Feasibility Report for the Savannah Harbor Expansion Project, Savannah City officials questioned whether chlorides may increase at the City's municipal and industrial (M&I) raw water intake on Abercorn Creek. The City's M&I water intake is located along Abercorn Creek approximately 1 mile upstream of the confluence of the creek with the Savannah River. Abercorn Creek is located upstream of the I-95 bridge (see Figure 4-2, below).

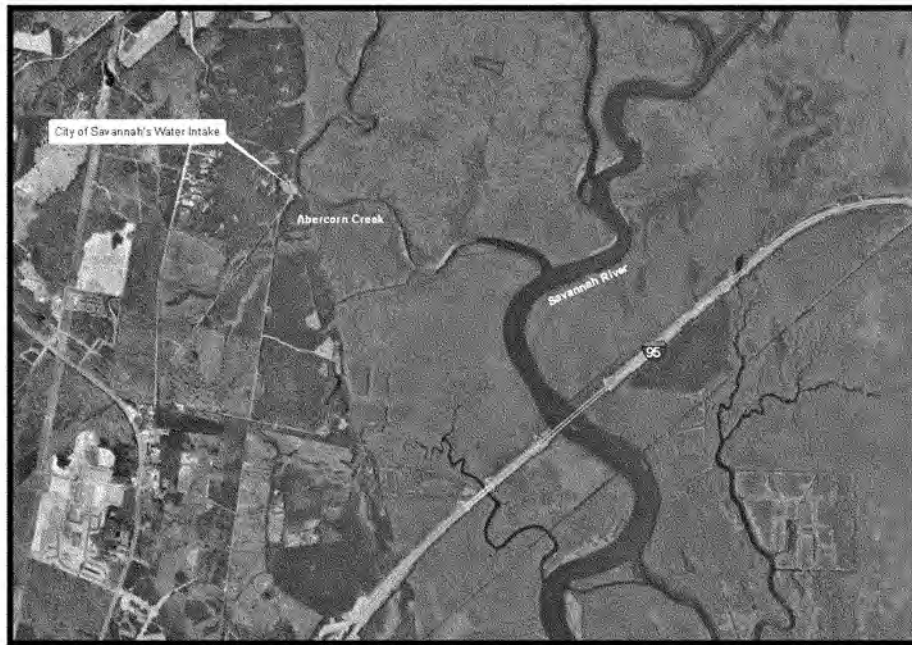


Figure 4-2. City of Savannah municipal and industrial water intake on Abercorn Creek.

Presently the City withdraws water from Abercorn Creek for both municipal and industrial uses. In the past, the City's contracts with its industrial customers included a provision that the water provided must possess a chloride concentration not greater than 12 mg/l (or 12 ppm). That criteria is not included in the present contracts, but the industries still require water with very little chlorides. Municipal water requires that chlorides be within the 250 mg/l (or 250 ppm) drinking-water standard established by the GA DNR-EPD. Seawater has a chloride concentration of about 19,400 mg/l (or 19,400 ppm).

In ATM's 1999 Report for GPA, "*preliminary evaluation of water samples collected at the City's intake shows that historically the raw water at the intake has had chloride levels in violation of the contracted maximum concentrations. These violations occur primarily during periods of low flow. To date, the industries have dealt with the violations through internal treatment and process modification.*" Because of the sensitivity of chloride levels at the City's water intake, the Corps evaluated the potential effects of harbor deepening with respect to the waters in Abercorn Creek.

4.03 Air Quality

The Georgia Department of Natural Resources, Environmental Protection Division, Air Protection Branch (GA DNR-EPD, APB) and the South Carolina Department of Health and Environmental Control, Bureau of Air Quality (SC DHEC, BAQ), have air quality jurisdiction for the project area for Chatham County, Georgia and Jasper County, South Carolina, respectively. The ambient air quality for Chatham County, Georgia and Jasper County, South Carolina has been determined to be in compliance with the National Ambient Air Quality Standards, and both counties have been designated as attainment areas (Personal Communication, 20 February 2007, Jim Kelly, GA DNR-EPD, APB and Fatina Washburn, SC DHEC, BAQ).

The Corps prepared an air quality analysis as part of the Savannah Harbor Expansion Project. A copy of this report is found in Appendix K. The analyses documented in the report describe the air emissions associated with container vessels calling on the Georgia Ports Authority (GPA) Garden City and Ocean Terminals in Savannah Harbor. Emission estimates for those operations are presented in the report for the period 2004 through 2050, both with and without implementation of the proposed harbor deepening project.

The Corps provided the 2006 Air Quality Analysis report to the EPA Region IV for review and comment. As a result of their review, EPA requested the analysis be expanded to include (1) the emissions from landside equipment that service these vessels, (2) the air toxics emitted by both the vessels and the landside equipment, and (3) similar analyses associated with the privately-owned terminals in the harbor. EPA recognized that the emissions associated from vessels calling at the privately-owned terminals were not likely to be affected by the proposed harbor deepening, but they desired the comprehensive air quality assessment of the harbor to be able to more accurately place any expected increase in emissions resulting from the proposed harbor deepening in its proper context.

As a result of EPA Region IV request, the Corps completed an Air Emission Inventory for the Port of Savannah, dated May 2008. The objective of this inventory was to expand the Corps' 2006 air quality analysis to the entire harbor to more completely assess air quality impacts from the proposed harbor deepening. This more detailed assessment evaluates the air emissions from all cargo-carrying vessels and landside cargo handling equipment at both the GPA and privately-operated terminals at the port. It also compares these emissions for both the "With" and "Without Project" (No Action) alternatives. In addition to the criteria pollutants that are traditionally evaluated when one discusses air emissions, estimates of air toxics and greenhouse gases emitted at the Port were also calculated. The primary focus of this work is a comparative assessment of the air emissions associated with the operation of the port before and after project implementation, in conjunction with consideration of the current status of air quality in the Savannah area.

This 2008 inventory was updated in 2011 in response to questions received from EPA during their review of the DEIS. The updated emission inventory and air impact assessment is found in Appendix K. Project impacts on air quality are discussed in Section 5.06 of the EIS.

4.04 Marine and Estuarine Resources

4.04.1 Fish and Shellfish Resources

The State of Georgia performed a fishery survey in the Savannah River from July 1980 to June 1985 (Schmitt and Hornsby, 1985). They found that numerically, the Striped mullet (*Mugil cephalus*) was by far the most abundant species sampled in the estuarine habitat followed by largemouth bass (*Micropterus salmoides*) and bowfin (*Amia calva*). Biomass in the estuary was composed primarily of common carp (*Cyprinus carpio*), bowfin and spotted sucker (*Minytrema melanops*). Compared to the non-game species, game fish were poorly represented in the estuarine habitat. The principal species harvested in the estuarine portion of the river were shown to be croaker/spot (*Micropogon undulatus* / *Leiostomus xanthurus*), White catfish (*Ictalurus catus*), Silver perch (*Bairdiella chrysura*), and Spotted seatrout (*Cynoscion nebulosus*). Weights of fish harvested were represented principally by White catfish, Red drum (*Sciaenops ocellata*), Striped bass (*Morone saxatilis*), Spotted seatrout, Hardhead catfish (*Arius felis*), Bluefish (*Pomatomus saltatrix*), and Channel catfish (*Ictalurus punctatus*). Anadromous fish collected in the estuarine habitat included Striped bass, American shad (*Alosa sapidissima*), Hickory shad (*Alosa mediocris*), and Blueback herring (*Alosa aestivalis*).

Each spring and fall, the main Savannah River, Back River, Middle River, and the numerous interconnecting tidal streams are hosts for the migration of three members of the herring family - American shad (*Alosa sapidissima*), Hickory shad (*Alosa mediocris*), and Blueback herring (*Alosa aestivalis*), and the Striped bass (*Morone saxatilis*), which are very important game and/or commercial fish. American shad enter the Savannah River in mid-January and begin spawning in mid-April. The river temperature at spawning is between 54 degrees F and 70 degrees F. The young shad leave the river in autumn; all are gone by December. American shad spawn in the freshwater portion of the main river further upstream than do striped bass and well outside the

impact limits of SHEP. The American shad is the most valuable commercial anadromous fish in the southeast.

Hickory shad enter the Savannah River in early January, begin spawning in the tributaries in March and complete spawning in April. Water temperature at spawning is between 64 degrees F and 69 degrees F. The young hatch two to three days after eggs are laid and leave the river from July to October. Blueback herring, which also enter the river in March and April, must have water temperatures of around 70 degrees F to spawn. The catadromous American eel, (*Anguilla rostrata*) is also widely distributed in the Savannah River estuary.

Anadromous striped bass enter the Savannah River for their spring spawning runs in March, April, or May. The river temperature must be between 58 degrees F and 64 degrees F, and the salinity must be less than 1.7 parts per trillion (ppt) for optimum spawning success. The Striped bass is a free spawner; the eggs must be suspended in the water, as they float with the river currents before they hatch 36-72 hours after being laid. The last eggs to be observed in the river are usually found at the end of May. Adult Striped bass leave the river in August. One group of juveniles leaves the river in October and November when the water begins to cool; a second group apparently does not migrate. The largest traditional spawning site in the Savannah River basin is in Back River, 23 miles upstream from the mouth of the Savannah River. However, population levels have been much lower in the last 20 years and a higher proportion of the spawning now appears to be occurring in the Savannah River a few miles upstream of the harbor (over 21 miles upstream from the mouth of the Savannah River).

Most Striped bass along the east coast are considered to be anadromous; however, some populations have been found to complete their lives entirely in fresh water (Scruggs and Fuller 1955, McIlwain 1968). An upstream and downstream race of Striped bass has been identified in the Cooper River, South Carolina (Raney 1952), and other races of these fish have been identified in particular rivers (Morgan et al. 1973). Studies done on Striped bass in the Savannah River indicate they spend much of the year in freshwater, much like those elsewhere in the southeast (Dudley et al. 1976). The Savannah River population appears to be primarily riverine, rather than anadromous, (Dudley, Mullis, and Terrell, 1976), and reproduces in the various river channels near Savannah. Research conducted by Environmental and Chemical Services, Incorporated, in 1983 for E. I. duPont de Nemours and Company to determine density and distribution of ichthyoplankton in the upper Savannah River, indicated that some Striped bass spawn in the vicinity of the Savannah River Plant. From the available research done on Striped bass in the Savannah River, it appears that some are riverine, while others are anadromous. A major spawning ground for Striped bass in the estuary was historically located in the Back River upstream of New Cut (Gilbert et al. 1985), while other spawning takes place in the Savannah River above the upper limits of the harbor. Back River functioned as a major spawning site prior to construction and operation of the Tide Gate. However, recent studies found very few eggs in the Back River, with most eggs collected from the harbor being found in the Front River. Low population levels have occurred in the Savannah River Striped bass population in the last 10 years.

More recent studies on Striped bass (Will and Jennings 2001) indicate that historically the Savannah River was Georgia's most important Striped bass fishery. According to Dudley and

Black (1979), "the majority of Striped bass spawning occurred in the Back River" and according to Wallin et al (1995) "nursery areas for juvenile stripers were found in the Back and Middle Rivers". Wallin et al. (1995) stated that "adult Striped bass also used the Back and Middle Rivers to over winter and spawn and younger ones used it year round." The Striped bass population suffered a severe decline in the 1980s. As stated in Will and Jennings (2001), this decline was attributed to "increased salinity in the spawning and nursery grounds in the Back River and accelerated transport of eggs and larvae to areas of toxic salinity" (Van Den Avyle and Maynard 1994). In order to decrease the salinity in the traditional Striped bass spawning and nursery areas, in 1991 the Corps removed the existing tide gate on the Back River and in 1992 filled the Cutoff Diversion Canal. Latham and Kitchens' (1996) study indicated that salinity in the historic spawning grounds in the Back River was acceptable because of "lower interstitial salinities and increased freshwater plant abundance and diversity". In the spring of 2000 (Will and Jennings 2001), "a total of 943 Striped bass eggs were collected and mean egg density for all sampling stations was 0.95 eggs/100 cubic meter (SD=4.28) in comparison to 0.21 eggs/100 cubic meter (SD=1.96) in 1999." Will and Jennings (2001) indicates that "if egg densities continue to increase in ensuing years, establishment of self-sustaining Striped bass population may only be a few years away. The viability of the self-sustaining Striped bass population probably will depend on the availability of suitable nursery habitat for the developing (Striped bass) larvae and juveniles."

In addition to the Striped bass spawning in the estuary, another location may be used by some members of the population -- near the fall line. This is evidenced by the results of the study discussed above that indicates that some Striped bass spawn in the vicinity of the Savannah River Plant. According to Martin and Paller 2007 (<http://sti.srs.gov/fulltext/WSRC-MS-2007-00076.pdf>), "Historically striped bass (*Morone saxatilis*) spawning occurred as far up the Savannah River as the Fall Line (also known as the Augusta Shoals) at about 7 river kilometer (RK) 326; however, currently striped bass have difficulty migrating in any numbers past the New Savannah Bluff Lock and Dam."

The following information (in italics) that characterizes fishery resources in the project area was taken from Johnson et al (1974): *"Most invertebrates of commercial importance (e.g., crabs, oysters, and shrimp) have been extensively studied. Following is a brief discussion of blue crabs, oysters, and brown and white shrimp."*

Studies by Durant (1970) indicate that in Georgia, oysters (Crassostrea virginica) begin to spawn when the temperature is about 73° F. Spawning was observed to begin in May and to continue until October, with peak periods in July, August, and September (Durant 1970). Larval stages last for 2-3 weeks (Wallace 1966), after which the young attach to some substrate. Galtsoff (1964) states that only soft mud and shifting sand are totally unsuitable. However oysters may convert a mud bottom to a more suitable habitat if a few settle on a hard object and themselves become objects of attachment. Galtsoff describes the soft mud bottom of the South Atlantic as being only marginally suitable for oysters. He further states that oysters need a free exchange of water salinities of 5-30 parts per thousand (ppt), and temperatures from 34°F to 86°F. Conditions are ideal for feeding when the water, free of pollution and containing a low concentration of small diatoms and dinoflagellates, moves over the bottom in a nonturbulent flow.

The negative factors influencing oyster production are described by Wallace (1966) as "pollution, predators, and people." He reports that oyster production is inversely proportional to human population growth in New England and the mid-Atlantic states. Only in the southeastern and Gulf states does oyster production even approach that of 20 years ago. Wallace (1966) concludes that pollution is the primary cause of the decline of the oyster industry. Sewage is detrimental because it covers the bottom with sludge that smothers oysters and reduces oxygen (Galtsoff 1964). When *Escherichia coli*, bacteria associated with fecal matter and used as an index for pollution, reach certain numbers, the oyster grounds are closed for health reasons. Industrial wastes also affect oysters. Galtsoff (1964) reports that red liquor and black liquor, both wastes from pulp mills, reduce the length of time the oyster shell remains open, thereby reducing the time available for feeding. Butler (1966) found that shell deposition is decreased in the presence of chlorinated hydrocarbon insecticides (e.g., DDT, DDD, and DDE) at concentrations as low as 10 parts per billion (ppb). Oysters are especially susceptible to pollution because of their stationary mode of existence and their ability to concentrate pollutants in their tissues. Predators include flatworms, mollusks, echinoderms, crustaceans, fish, birds, and mammals (Galtsoff 1964).

The predominant species of marine shrimp occurring in Georgia waters are the white shrimp (*Penaeus setiferus*) and the brown shrimp (*P. aztecus*), both of which are important commercially. The life cycles of white and brown shrimp are basically similar. The bottom-dwelling (benthic) adults release their eggs freely into the waters offshore. Within a short time, the eggs hatch into planktonic larvae. After passing through several intermediate stages, the young shrimp (postlarvae) move into the estuary and adopt a benthic existence (Anderson 1955). After very rapid growth, they assume the adult form. Marking studies indicate that after migrating offshore the shrimp do not move into deep water but make seasonal migrations parallel to the shoreline (Anderson 1955). White shrimp penetrate the estuary to a greater degree, arrives later, and stays for a longer period of time than the brown. Salinity optima for young penaeid shrimp are in the range of 5-20 ppt, although shrimp can tolerate salinities from 1 to 600 ppt (Kutkuhn 1966). A complex interaction of factors including circulation, temperature, salinity, and fertility of waters and type of vegetation and substratum determines distribution, survival, and growth of young shrimp (Kutkuhn 1966). Optimum conditions are approached in the nursery grounds of the marsh-estuary complex.

Nichols and Keney (1963) report that the identity and distribution of crabs of the genus *Callinectes* on the southeastern coast of the United States is uncertain. Rathbun (1930) reported two species, *C. sapidus* and *C. ornatus*, occurring between New Jersey and Indian River Inlet, Fla. Lunz (1958) found that only 30% of the crabs caught by trawlers in South Carolina were *C. sapidus*. The two species are not recognized as such by fishermen and are combined as blue crabs in catch data reported for coastal Georgia.

Van Engel (1958) reports that in the Chesapeake Bay area *Callinectes sapidus* begins mating early in May and continues into October. Females probably mate only once, at the time of the last molt. Sperm live in the female receptacles for at least a year and may be used as often as the female spawns (two or more times). The females migrate to saltier waters after mating, some passing out of the bay and into the ocean. Spawning is delayed at least 2 months after mating. When laid, the eggs are attached to the abdomen of the female where they remain about 2 weeks

until hatching. Van Engel (1958) reports that there are two larval stages, four or five zonal stages, and the megalops. These stages are passed through in about 1 month, after which the first crab stage is reached. Costlow and Bookout (1959) observed seven zonal stages in laboratory-reared animals. Nichols and Keney (1963), based on the occurrence of early stage larvae, believe that spawning occurs throughout the year. Peak numbers of first-stage larvae were found in Georgia waters during July, August, and September, and large numbers of first and second stage zoeae were found near the beaches with progression to advanced stage zoeae 20-40 miles offshore. Van Engel (1958) reported that early in August many crabs reach the "first crab" stage and begin migrating into waters of lower salinity. Male crabs remain in less saline waters year round.

Thus blue crabs are a part of both the benthic and planktonic communities, and they use both inshore and offshore waters."

Figure 4-3 has been adapted from a map provided by Mr. Dominic Guadagnoli, Shellfish Program Leader with the Georgia Department of Natural Resources – Coastal Resources Division and shows the two commercial shellfish lease areas and one recreational shellfish harvest area in the project area (data provided in 2009).

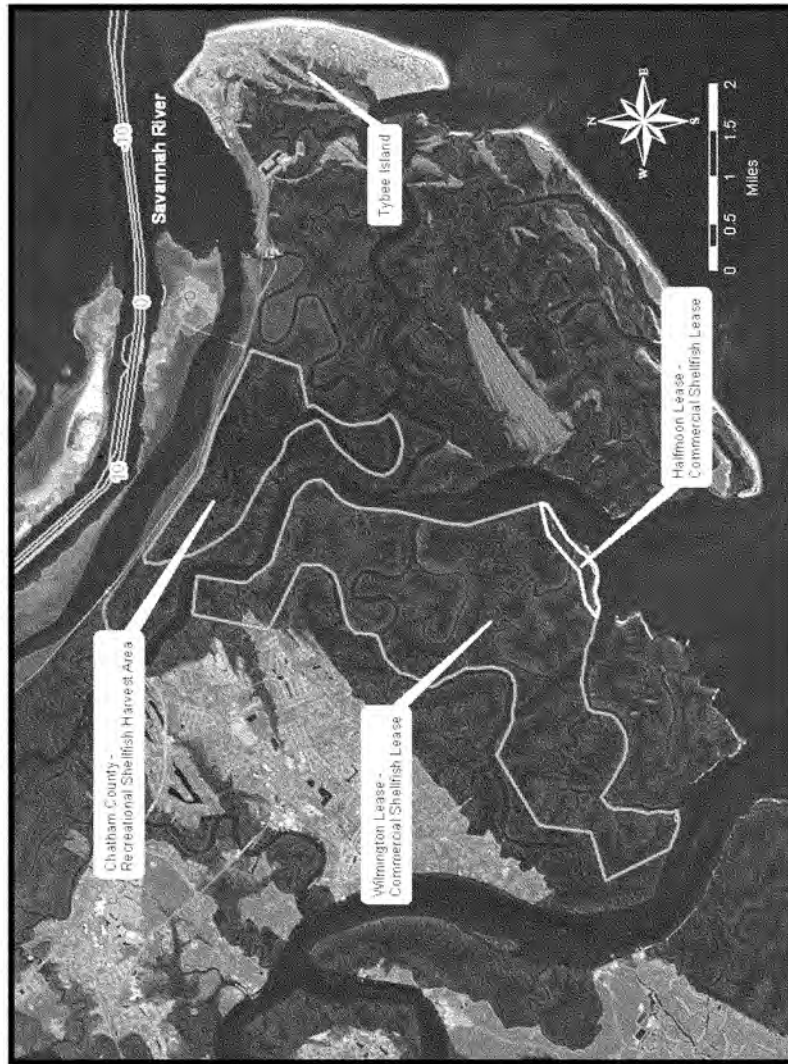


Figure 4-3. Shellfish harvest areas near Savannah Harbor.

4.04.2 Project Studies on Estuarine Dependent Fish

As part of the Savannah Harbor Expansion Project, staff at the USGS Georgia Cooperative Fish and Wildlife Research Unit conducted a two-year study of the Savannah River estuary (SRE) from 2000-2001 to document and characterize the present condition of fishery resources. The study is documented in a report titled "Temporal and Spatial Distribution of Estuarine-Dependent Species in the Savannah River Estuary" by Jennings and Weyers in 2003. Jennings and Weyers collected 91 fish species and 67,826 individuals. This study indicated the following: "Bay anchovy, Atlantic menhaden, Atlantic croaker, and spot were the most abundant species in the SRE and comprised 81% of the catch. Total two year catch from ichthyoplankton pushnets yielded 40,299 individuals from 57 species; year 1 samples yielded 8,840 more fish than year 2 samples, but both years had the same number of species (52)." Fish abundance and diversity were also identified (Jennings and Weyers 2003); fish density and species richness were low in the fall, increased in late winter and summer. According to Jennings and Weyers (2003) "the largest increase in fish abundance occurred in the spring, when clupeids, sciaenids, flatfish, and gobies contributed to the assemblages." This study also indicated that "commercial and recreational species documented within the SRE included marine/estuary species Gray snapper, Red drum, Spotted seatrout, Striped bass, weakfish, ladyfish, tarpon, Spanish mackerel, Jack crevalle, and Striped mullet and freshwater species Largemouth bass, catfishes, Black crappie, sunfishes, and carp." Jennings and Weyers (2003) indicated that the majority of the fish communities were able to tolerate a wide range of salinities (5.0 to 15 ppt).

As part of the SHEP, staff at the South Carolina Department of Natural Resources conducted a similar study in the lower portion of the SRE over the same general time period. The study is documented in a report titled "Temporal and Spatial Distribution of Estuarine-Dependent Species in the Savannah River Estuary" by Collins et al (2001). The following information is summarized and the figures (Figures 4-4, Black Drum and Figure 4-5, Seatrout used by permission) were adapted from Collins et al (2001): *Members of the sciaenid family include some of the most recreationally important inshore fishes in the southeastern U.S.* This group includes the Red drum (*Sciaenops ocellatus*), Spotted seatrout (*Cynoscion nebulosus*), Weakfish (*Cynoscion regalis*), and Black drum (*Pogonias cromis*); which are target species in this study. These fishes create signature noises in a chorus to attract mates, thus allowing surveys through use of passive acoustic techniques. They are highly prized gamefish sought by recreational anglers in the Savannah River, with the Red drum being South Carolina's most important recreational fish and the Spotted seatrout being Georgia's. The populations of both are dwindling and until this study, it was not known whether they spawned in the Savannah River.

To avoid an impact on spawning aggregations of these sciaenids during dredging operations this study was conducted to determine if, when, and where these fishes spawned in the areas where the proposed harbor expansion and maintenance activities would take place. Acoustic hydrophones were used to detect male sciaenids while they were drumming and locate their spawning sites; and the habitat features of these sites were then characterized with depth, temperature, dissolved oxygen concentration, salinity, current velocity, and associations with adjacent structures.

Six large spawning aggregations of Spotted seatrout, one of Weakfish, and one of Black drum were located within a reach from River Kilometer 0 to 12.2, and all were found in mid to high (16-32 parts per thousand) salinity concentrations. Although spawning sites were in close proximity, they did not overlap one another in space and time. A Red drum spawning site was not located but they were heard in the mouth of the river and the ocean portion of the shipping channel. Water temperature appears to define the beginning and end of the spawning seasons, while day length or sunset appears to cue spawning behavior, which tends to be around dusk (from an hour before sunset to three hours after), presumably because that would make it harder for predators to see the eggs. See Figure 4-4, adapted from Collins et al (2001), for a map of spawning locations. Fertilized eggs hatch in approximately one day, depending on water temperature and the larval fish are carried with currents.



Figure 4-4. Spawning sites of Black drum, Weakfish, and Spotted seatrout (adapted from Collins, et al. (2001).

Interference with sciaenid spawning aggregations while dredging could negatively impact spawning success, thus exacerbating the problem of declining stocks. Potential disturbances include the direct increased suspended sediment loads and noise levels, as well as indirect disturbances such as decreased dissolved oxygen levels, changes in salinity regimes, and physical modification of spawning areas (temperature regime, velocities, presence/absence of eddies, and presence/absence of structures upon which aggregations orient).

This study has identified the times, places, and conditions in which sciaenid spawning occur. The results could be used to schedule certain dredging activities to minimize direct impacts to valuable fish populations.

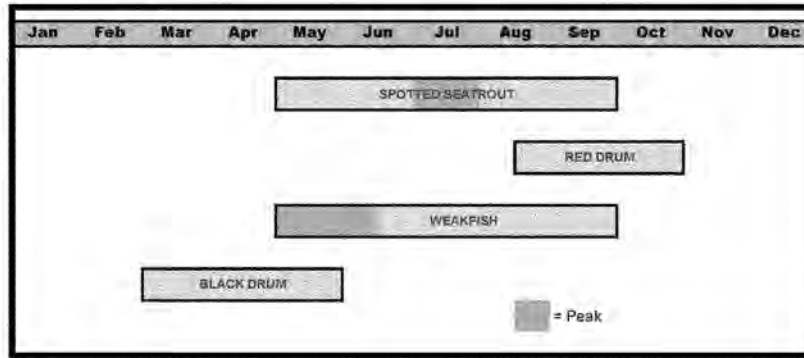


Figure 4-5. Spawning seasons of Spotted seatrout, Red drum, Weakfish, and Black drum (adapted from Collins, et al. (2001).

4.04.3 Representative Fish Species in the Savannah River Estuary

Savannah District consulted the Fisheries Interagency Coordination Team (ICT) to determine which estuarine fish species are critical in the estuary, which may be representative of a guild or group of similar species, and those that are likely to be sensitive to the physical changes expected to result from deepening the harbor. The Interagency Team identified the following species as being appropriate to identify potential project-induced impacts to fishery resources in the harbor:

- A. Striped bass
- B. Shortnose sturgeon
- C. Southern flounder
- D. American shad

The interagency team then defined the conditions under which the hydrodynamic and water quality models should be run to identify Suitable and Unsuitable habitat for each of those species. The criteria that the ICT developed to define acceptable habitat can be found in Appendix P (Fishery Habitat Maps). The modeling conditions required to highlight those biological criteria consist of river flow rates and time of year. The agencies determined that average river flows are most representative of conditions experienced over the long term and should, therefore, form the basis of the impact evaluations. For some species, additional runs would also be performed with high (80% exceedance) and low (20% exceedance) river flows to ensure unusual impacts would not develop during those less-typical years. Maps that show the locations of suitable and unsuitable fishery habitats for these four representative species are shown on the following pages.

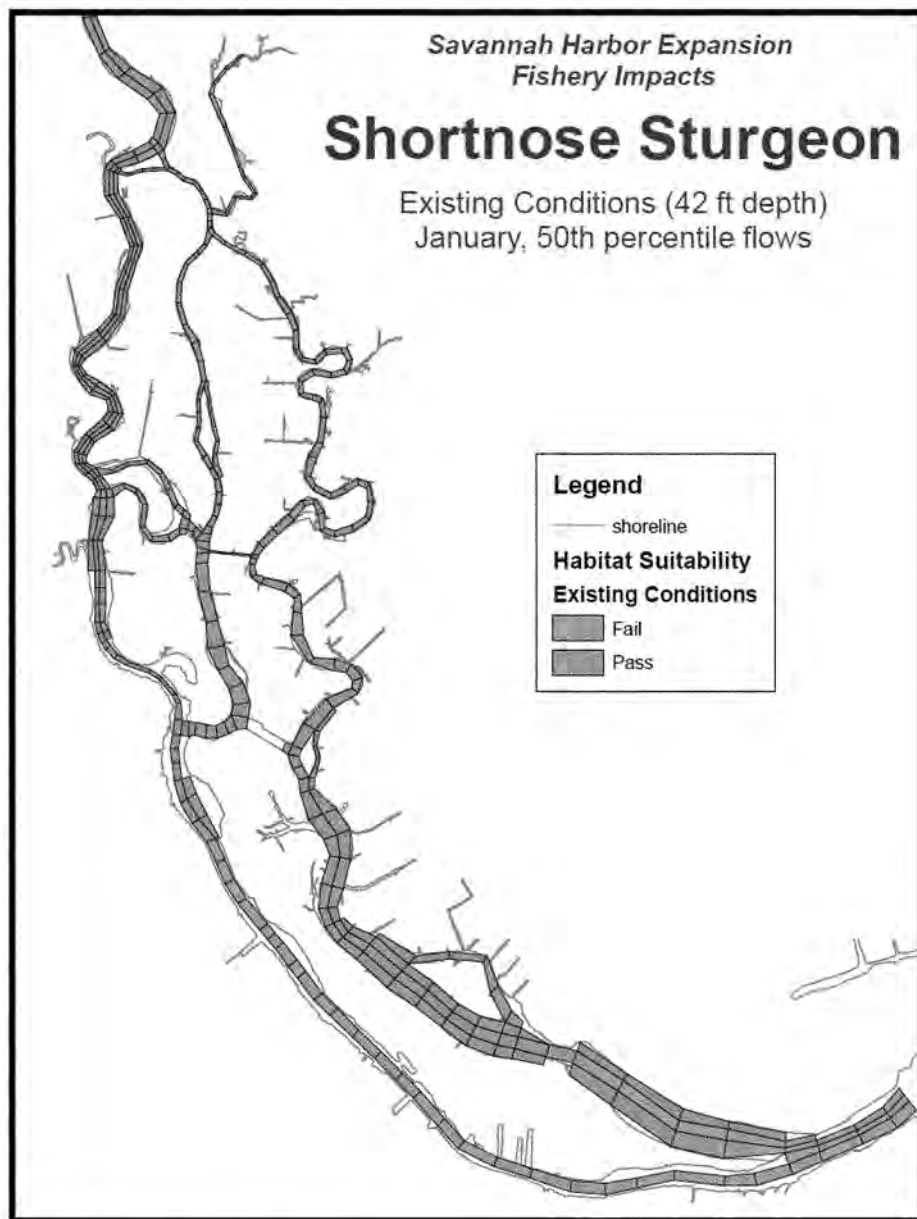


Figure 4-6. Shortnose sturgeon habitat for existing conditions (42-foot channel).

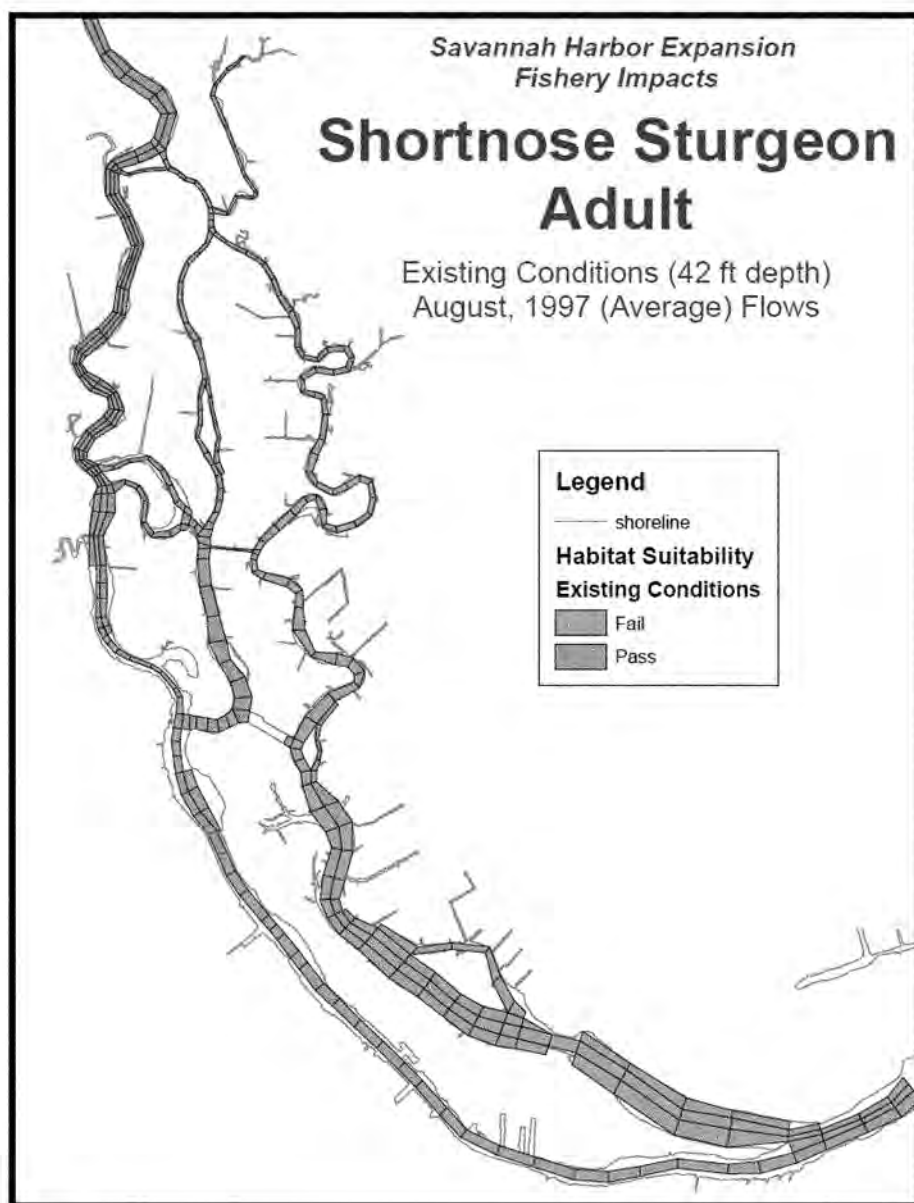


Figure 4-7. Shortnose sturgeon adult habitat for existing conditions (42-foot channel).

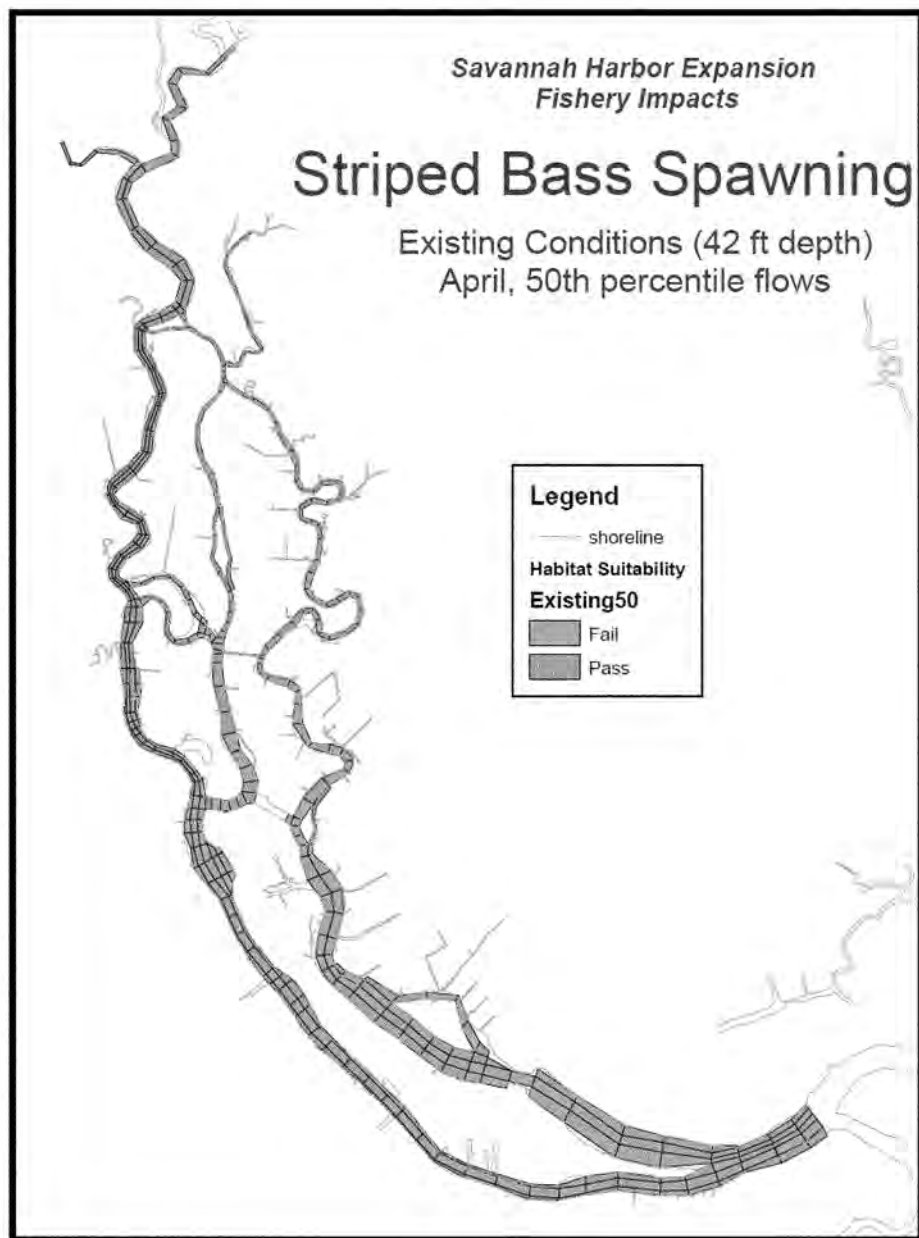


Figure 4-8. Striped bass spawning habitat for existing conditions (42-foot channel).

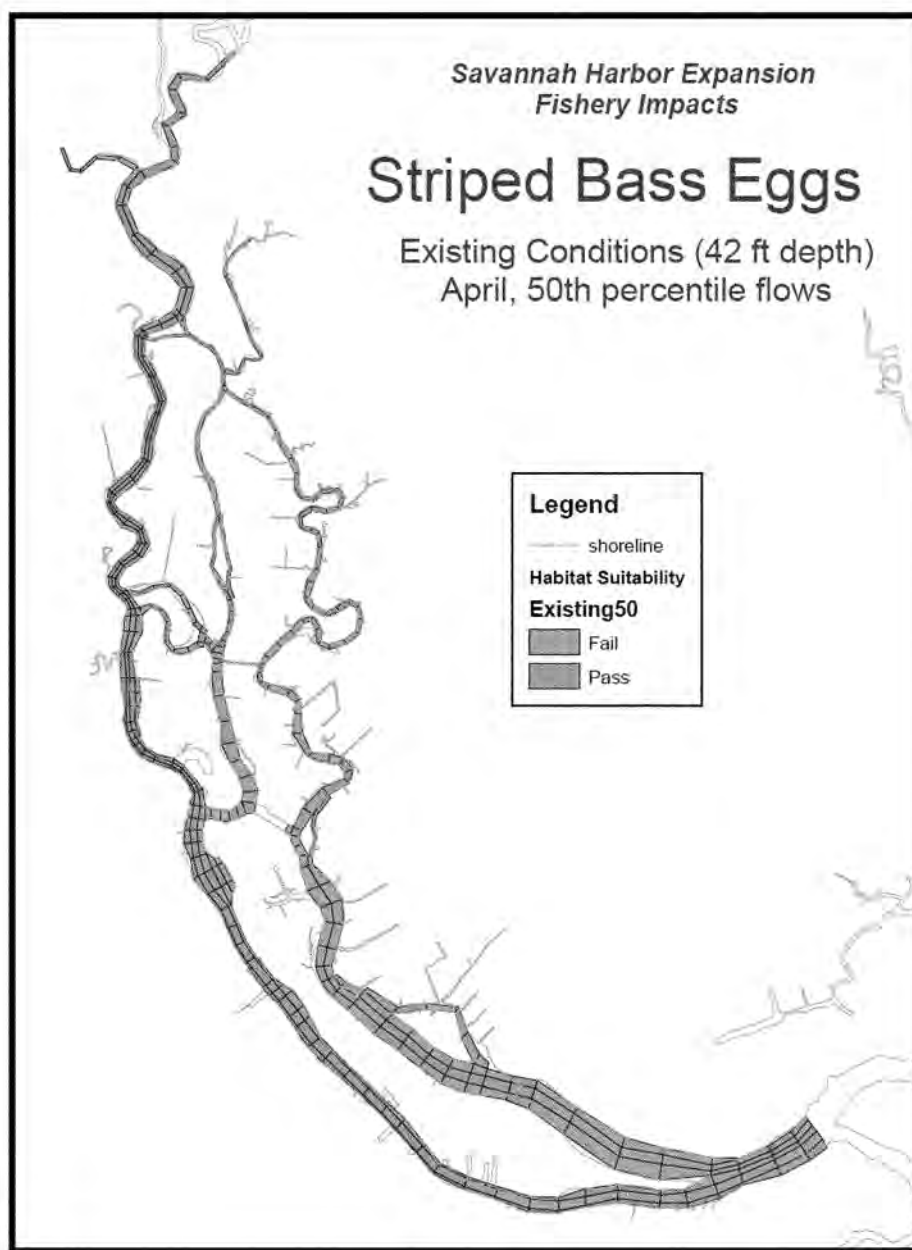


Figure 4-9. Striped bass egg habitat for existing conditions (42-foot channel).

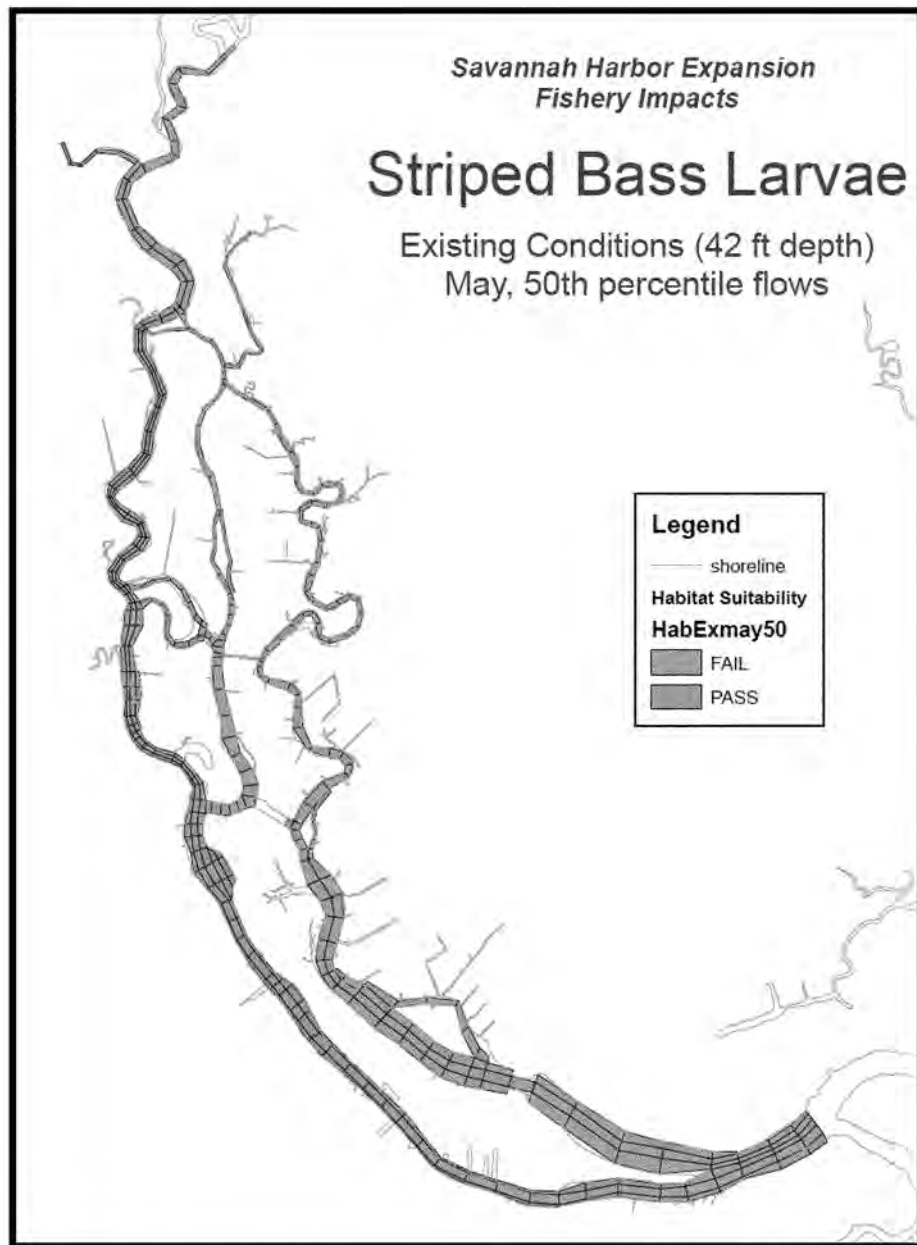


Figure 4-10. Striped bass larvae habitat for existing conditions (42-foot channel).

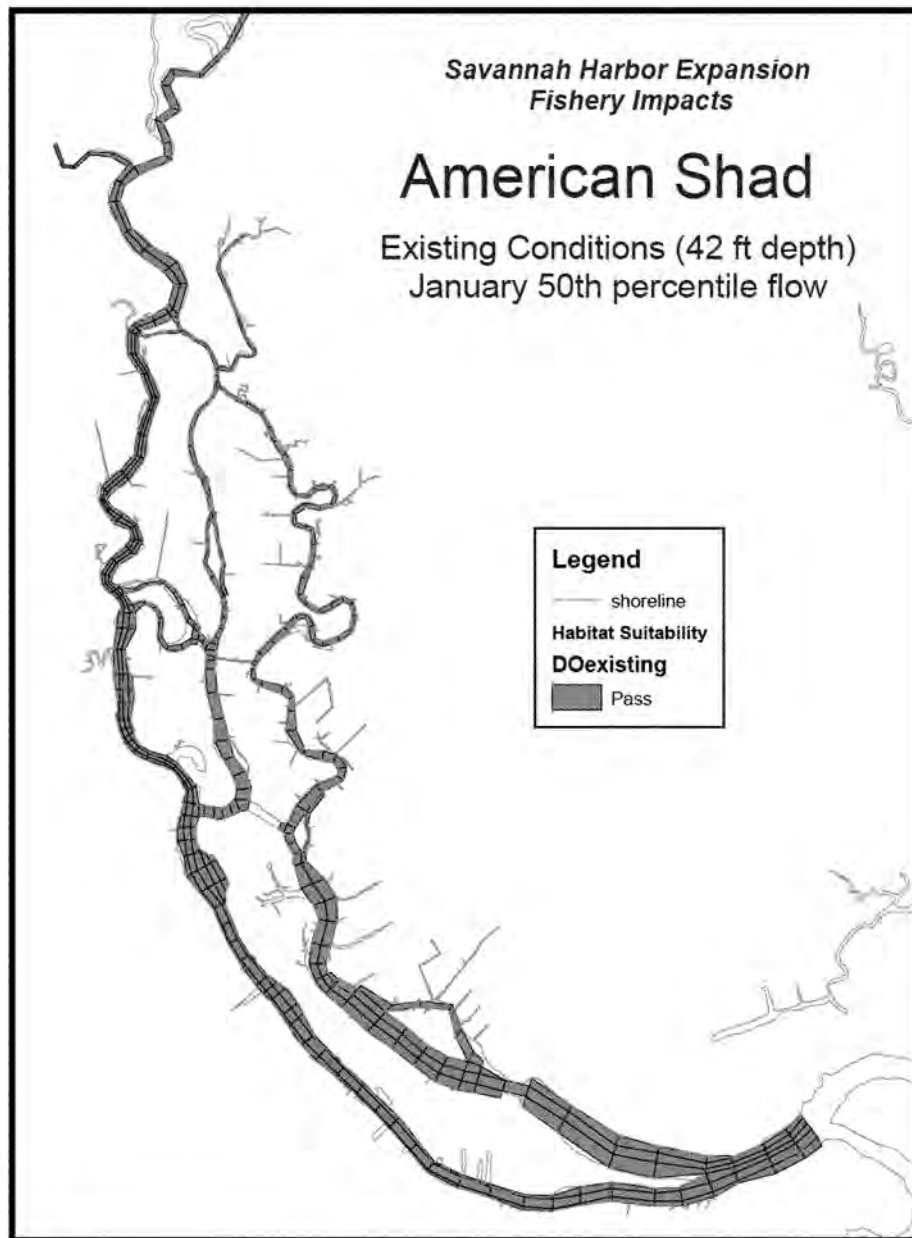


Figure 4-11. American shad habitat for existing conditions (42-foot channel) - January.

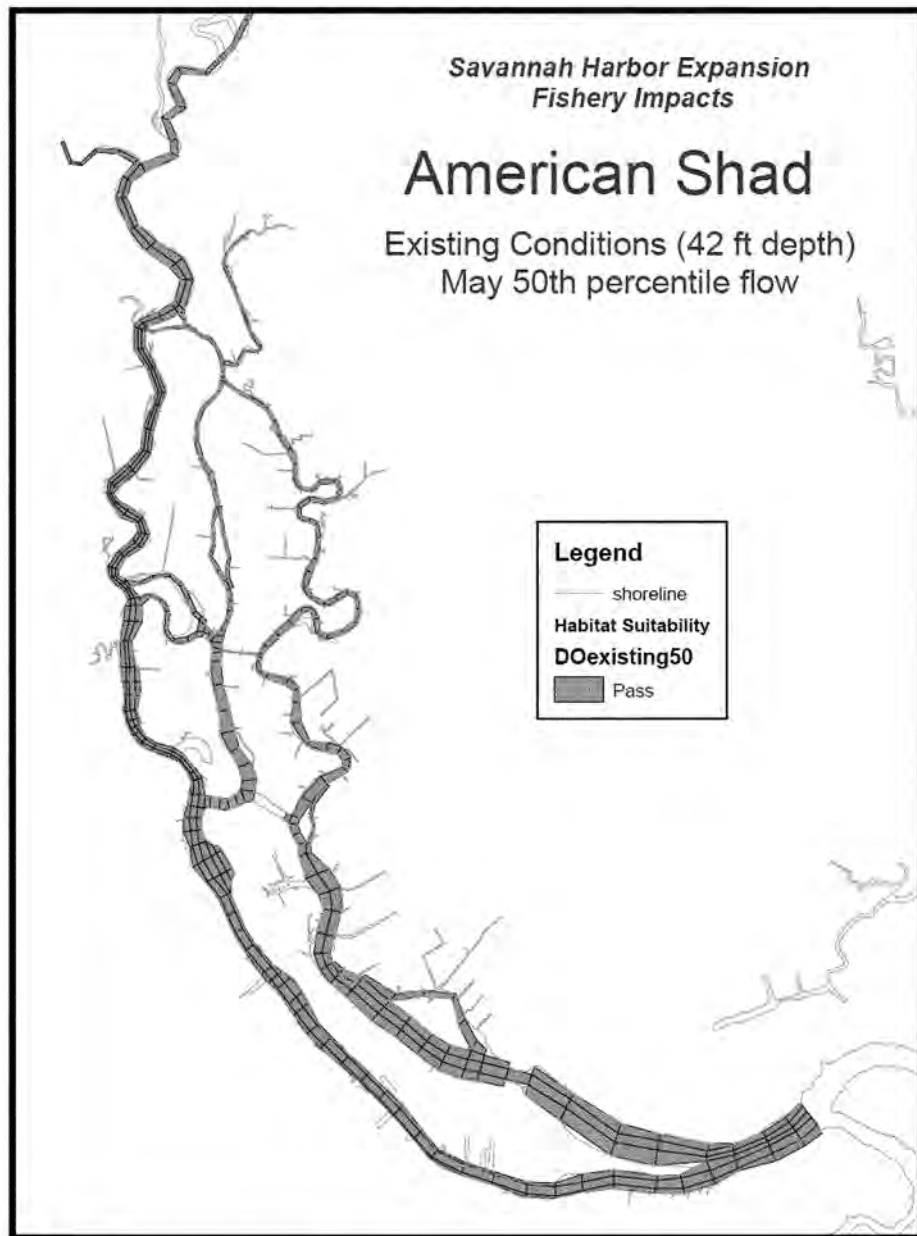


Figure 4-12. American shad habitat for existing conditions (42-foot channel) – May.

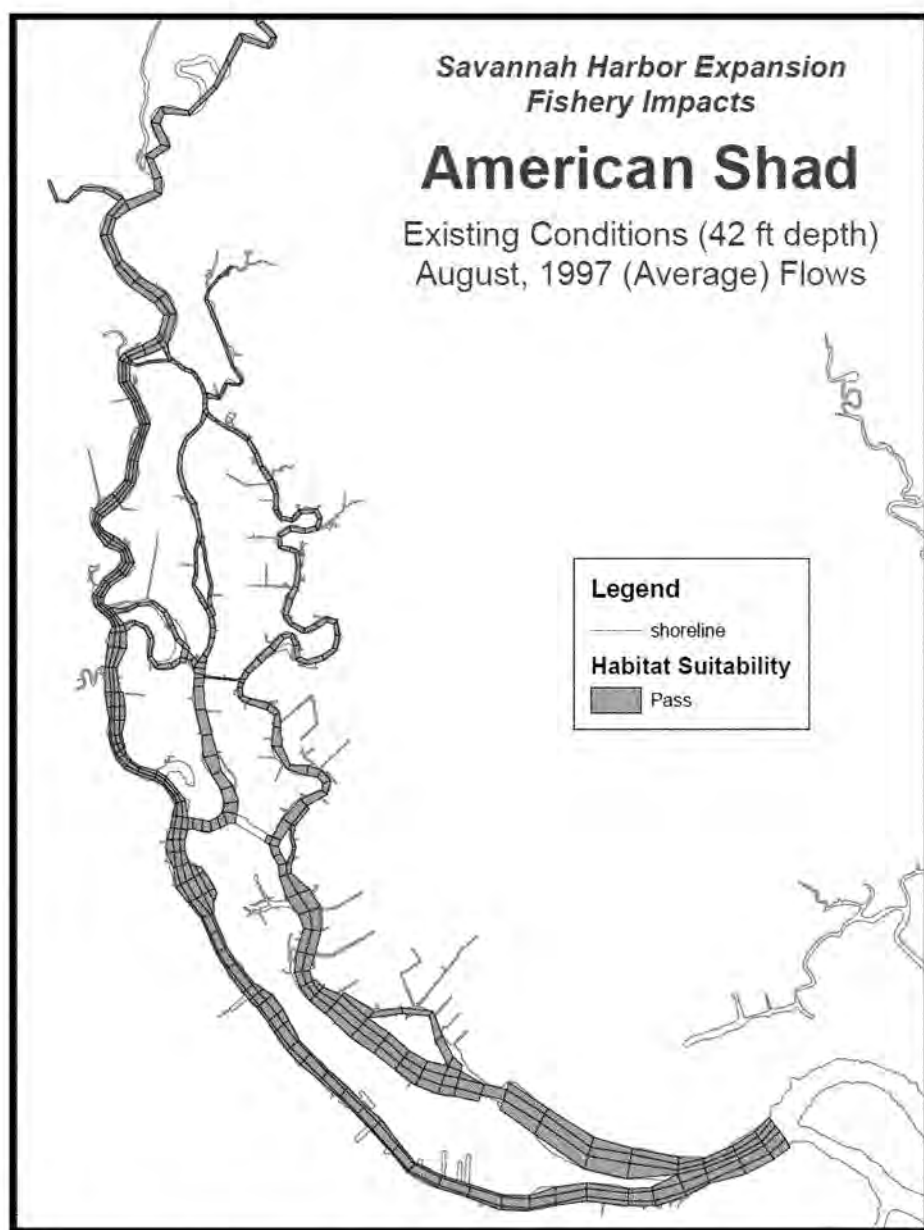


Figure 4-13. American shad habitat for existing conditions (42-foot channel) – August.

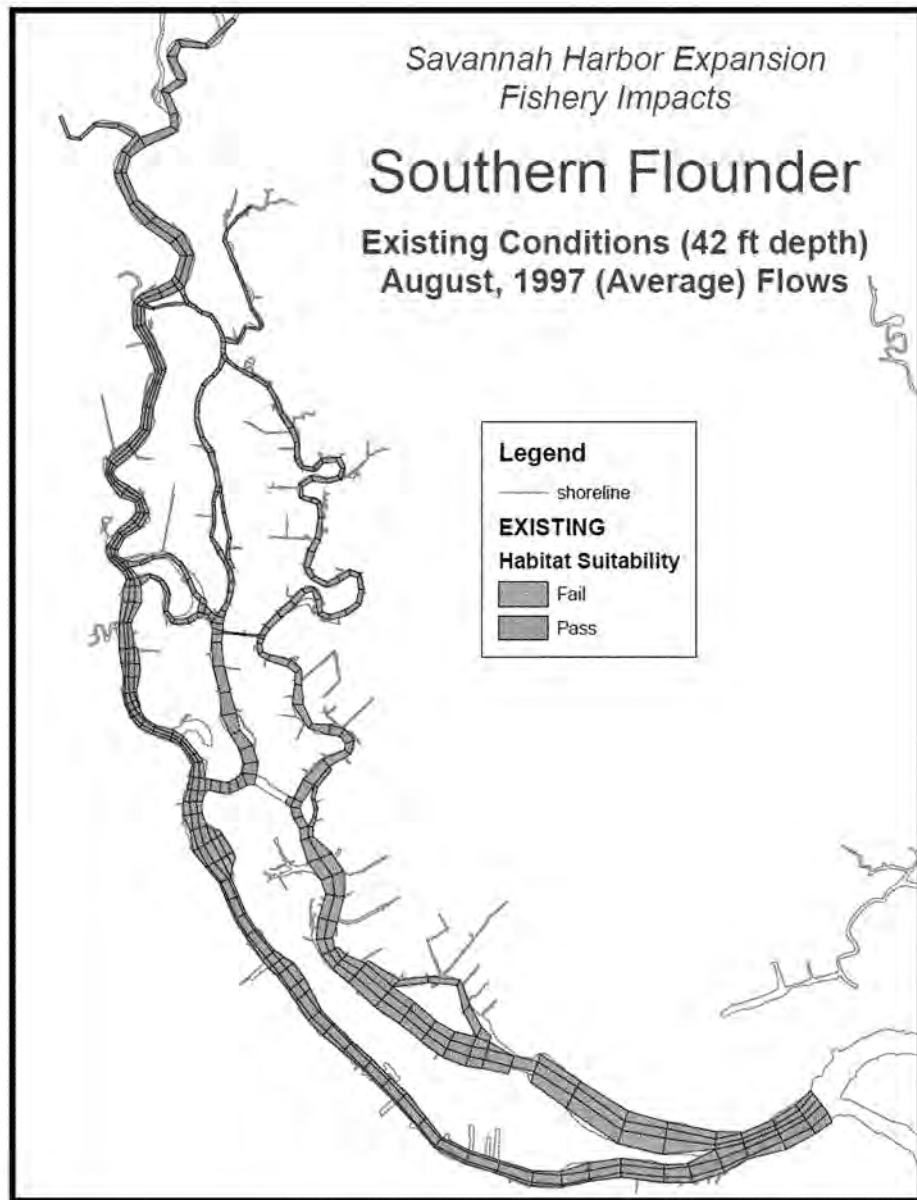


Figure 4-14. Southern flounder habitat for existing conditions (42-foot channel).

4.04.4 Plankton Community Characterization

The following information was also taken from Collins et al (2001): "In addition to fish eggs, plankton tows yielded many larval sciaenids, including Red drum, Spotted seatrout, croaker, weakfish, Black drum, and spot. In fall tow catches also typically included bay anchovies (*Anchoa mitchilli*), larval Atlantic menhaden (*Brevoortia tyrannus*), other larval fish including sea robin (*Prionotus* spp.), and invertebrates including ctenophores (also called comb jellies or jelly balls), copepods, grass (*Palaemonetes pugio* and *Palaemonetes vulgaris*), and other shrimp (*Penaeus* spp.), mysids, isopods (*Agathoa* spp.), jellyfish, larval crabs and other crustaceans. In the mouth of the river, ctenophores overwhelmingly dominated the catch in all seasons. They were less dominant by volume in the upriver sites, yet still very abundant. Mysids, grass shrimp, and other small invertebrates captured in plankton tows are favored prey of the juvenile target sciaenid species (Daniel 1988)."

4.04.5 Benthic Community Characterization

In June 2001, Barry A. Vittor & Associates conducted benthic sampling and analysis in about 2,500 acres of the nearshore area south of the entrance channel for Savannah Harbor. Their report states that the benthic habitats of that nearshore area were "a uniform sand or gravel (shell hash)/sand sediment with a macroinvertebrate assemblage typical of the region" (Barry A. Vittor & Associates 2001). They found no significant difference in station density or taxa richness within the sampled area. Polychaetes, malacostracans, gastropods, and bivalves were the most numerous taxa collected. Spionid polychaetes were the most abundant family in this area representing 14% of the total number of individuals collected. The study agreed with previous work conducted on the Atlantic continental shelf and coastal waters that found that coarse-grained sediments generally support greater numbers of macroinfauna than fine-grained sediment. Vittor & Associates also conducted a benthic macroinvertebrate assemblage sampling near Brunswick Harbor, Georgia (Vittor and Associates 2000) and near Hilton Head Island, South Carolina (Vittor and Associates 2001). The results of these studies indicate that the benthic assemblages at both Brunswick and near Hilton Head, South Carolina were similar to those found in Savannah Harbor.

4.05 Essential Fish Habitat

The 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) set forth requirements for the National Marine Fisheries Service (NMFS), regional Fishery Management Councils (FMC), and other federal agencies to identify and protect important marine and anadromous fish habitat. These amendments established procedures for the identification of Essential Fish Habitat (EFH) and a requirement for interagency coordination to further the conservation of Federally-managed fisheries. Table 4-6 lists the Federally-managed fish species of Georgia and South Carolina for which Fishery Management Plans have been developed by the South Atlantic Fishery Management Council (SAFMC), Mid-Atlantic Fishery Management Council (MAFMC), and NMFS. In addition, this table shows EFH by fish life stage and ecosystem type for those species that have designated EFH. Tables 4-7 and 4-8 show the categories of EFH and Habitat Areas of Particular Concern (HAPC) for managed

species which were identified in the Fishery Management Plan Amendments affecting the South Atlantic area. The fish species and habitats shown in these tables require special consideration to promote their viability and sustainability. The potential impacts of the proposed action on these fish and habitats are discussed in Section 5.03.

Essential Fish Habitat areas are identified in Fishery Management Plan Amendments for the South Atlantic and Mid-Atlantic Fishery Management Councils. Geographically Defined Habitat Areas of Particular Concern are identified in Fishery Management Plan Amendments affecting the South Atlantic Area. Areas listed in the table were derived from "Essential Fish Habitat: A Marine Fish Habitat Conservation Mandate for Federal Agencies" February 1999 (Revised 10/2001) (Appendices 4 and 5).

**Table 4-6. Essential Fish Habitat (EFH) Species for the Project Area
(Georgia and South Carolina)**

Management Plan Agency	Fishery Management Plan (FMP)	Common Name of Species	Scientific Name of Species	EFH for Life Stages by Ecosystem		Habitat Areas of Particular Concern
				Marine Estuarine		Identified by SAEMC
SAFMC	Snapper Grouper	Black Sea Bass	<i>Centropristis striata</i>			
SAFMC	Coastal Migratory Pelagics	Cobia	<i>Rachycentron canadum</i>	ELPIA	LPJA	Snapper Grouper HAPC- oyster shell, inlets, state nursery areas
SAFMC	Snapper Grouper	Creville Jack	<i>Caranx hippos</i>			
SAFMC	Red Drum/Habitat	Red drum	<i>Sciaenops ocellatus</i>	ELPISA	PISA	Red Drum HAPC-tidal inlets, state nursery habitats, spawning areas
SAFMC	Snapper Grouper	Sheepshead	<i>Archostargus probatocephalus</i>			
SAFMC	Shrimp	Brown shrimp	<i>Farfantepenaeus aztecus</i>	ELA	PJA	Penaeid Shrimp HAPC - tidal inlets, state nursery and overwintering habitats
SAFMC	Shrimp	White shrimp	<i>Litopenaeus setiferus</i>	LA	PJS	
SAFMC	Coastal Migratory Pelagics	Spanish mackerel	<i>Scomberomorus maculatus</i>	JA	J	
SAFMC	Snapper Grouper	Gray snapper	<i>Lutjanus griseus</i>	LA	PJA	
SAFMC	Snapper Grouper	Lane snapper	<i>Lutjanus synagris</i>	A	J	
SAFMC	Council Authority (no FMP)	American Shad	<i>Alosa sapidissima</i>	A	ELPJS	
SAFMC	Council Authority (no FMP)	Hickory Shad	<i>Alosa mediocris</i>	A	ELPJS	
SAFMC	Council Authority (no FMP)	Blueback Herring	<i>Alosa aestivalis</i>	A	ELPJS	
SAFMC	Council Authority (no FMP)	Striped Bass	<i>Morone saxatilis</i>	A	ELPJS	
SAFMC	Council Authority (no FMP)	Shortnose Sturgeon	<i>Acipenser brevirostrum</i>	A	ELPJS	
SAFMC	Council Authority (no FMP)	Atlantic Sturgeon	<i>Acipenser oxyrinchus</i>	A	ELPJS	
MAFMC	Bluefish	Bluefish	<i>Pomatomus saltatrix</i>	LJA	JA	
MAFMC	Summer Flounder	Summer flounder	<i>Paralichthys dentatus</i>	LJA	LJA	
NMFS	Highly Migratory Species	Atlantic sharpnose shark	<i>Rhizoprionodon terraenovae</i>	J		
NMFS	Highly Migratory Species	Blacknose shark	<i>Carcharhinus acronotus</i>	J		
NMFS	Highly Migratory	Bonnethead	<i>Sphyrna tiburo</i>	JA		

Management Plan Agency	Fishery Management Plan (FMP)	Common Name of Species	Scientific Name of Species	EFH for Life Stages by Ecosystem	Habitat Areas of Particular Concern
				Marine Estuarine	Identified by SAFMC
	Species	shark			
NMFS	Highly Migratory Species	Bull shark	<i>Carcharhinus leucas</i>	J	
NMFS	Highly Migratory Species	Dusky shark	<i>Carcharhinus obscurus</i>	J	
NMFS	Highly Migratory Species	Finetooth Shark	<i>Carcharhinus isodon</i>	ELPISA	
NMFS	Highly Migratory Species	Lemon Shark	<i>Negaprion brevirostris</i>	J	
NMFS	Highly Migratory Species	Sandbar shark	<i>Carcharhinus plumbeus</i>	J	
NMFS	Highly Migratory Species	Sandtiger shark	<i>Odontaspis taurus</i>	J	
NMFS	Highly Migratory Species	Scalloped hammerhead	<i>Sphyrna lewini</i>	J	
NMFS	Highly Migratory Species	Spinner shark	<i>Carcharhinus brevipinna</i>	JA	

Note: 1. These Essential Fish habitat species were compiled from *Essential Fish Habitat: A Marine Fish Habitat Conservation Mandate for Federal Agencies*; February 1999 (Revised 10/2001) Appendices 2, 3, 6, 7, and 8). Although 49 species are listed in Appendix 3 under National Marine Fisheries Service management, only 35 of these species have EFH listed in Appendix 8.

2. Organizations responsible for Fishery Management Plans include: SAFMC = South Atlantic Management Council; MAFMC = Mid-Atlantic Fishery Management Council; NMFS = National Marine Fisheries Service.

3. Life stages include: E = Eggs, L = Larvae, P = PostLarvae, J = Juveniles, S = SubAdults, A = Adults

Table 4-7. Categories of Essential Fish Habitat in the Project Vicinity and Potential Impacts

	Potential Presence		Potential Impacts	
	In/Near Project Vicinity	Project Impact Area	Dredge Plant Operation	Sediment Placement Activities
Estuarine Areas				
Estuarine Emergent Wetlands (Loss through direct impact)	Yes	Yes	Moderate	No
Estuarine Emergent Wetlands (Impact through salinity changes only)*	Yes	Yes	Significant	No
Estuarine Scrub/Shrub Mangroves	No	No	No	No
Submerged Aquatic Vegetation (SAV)	No	No	No	No
Oyster Reefs & Shell Banks	Yes	No	No	No
Intertidal Flats	Yes	No	No	No
Palustrine Emergent & Forested Wetlands (Impact through salinity changes only)*	Yes	Yes	Yes	No
Aquatic Beds	No	No	No	No
Estuarine Water Column	Yes	Yes	Minor and Temporary	Minor and Temporary
Marine Areas				
Live/Hard Bottoms	Nearshore	Yes	No	Possible
Coral & Coral reefs	Offshore	No	No	No
Artificial/Manmade Reefs	Offshore	No	No	No
Sargassum	Offshore	No	No	No
Water Column	Yes	Yes	Temporary	Temporary

* Potential long term impacts of the proposed deepening on estuarine emergent, palustrine emergent, and forested wetlands in the Savannah River estuary are discussed in Section 5.01 and in the Mitigation Plan found in Appendix C.

Table 4-8. Habitat Areas of Particular Concern in the Project Vicinity and Potential Impacts

	Potential Presence		Potential Impacts	
	In/Near Project Vicinity	Project Impact Area	Dredge Plant Operation	Sediment Placement Activities
Area Wide				
Council-designated Artificial Reef Special Mgt Zones	Yes	No	No	No
Hermatypic (reef-forming) Coral Habitat & Reefs	Offshore	No	No	No
Hard Bottoms	Nearshore Ocean	No	No	No
Hoyt Hill	Distant Offshore	No	No	No
Sargassum Habit	Offshore	No	No	No
State –designated Areas of Importance of Managed Species (PNAa)	Yes	No	No	No
Submerged Aquatic Vegetation (SAV)	No	No	No	No
Georgia				
Gray's Reef	Offshore	No	No	No
South Carolina				
Charleston Bump	Distant Offshore	No	No	No
Hurl Rocks	Distant Offshore	No	No	No
Broad River	Distant Coastal	No	No	No

4.06 Invasive Species

The introduction of non-native or invasive species can have detrimental effects on an ecosystem. As defined by Executive Order 13112 (February 3, 1999) an invasive species is an alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health. Invasive species may be spread through several pathways including ballast water, aquaria release, boat hulls, accidental release from aquaculture or research facilities, bait dumping, and intentional introduction for biological controls (GA DNR 2009). E.O. 13112 charges the Federal government with not authorizing, funding, or carrying out actions that it believes are likely to cause or promote the introduction or spread of invasive species in the United States or elsewhere unless, pursuant to guidelines that it has prescribed, the agency has determined and made public its determination that the benefits of such actions clearly outweigh the potential harm caused by invasive species; and that all feasible and prudent measures to minimize risk of harm will be taken in conjunction with the actions.

Shipping moves over 80% of the world's commodities and transfers approximately 3 to 5 billion tons of ballast water internationally each year (<http://globallast.imo.org/>). A similar volume may also be transferred domestically within countries and regions each year. Ballast water is essential to the safe and efficient operation of modern shipping, providing balance and stability to un-laden ships (http://water.epa.gov/type/oceb/habitat/invasive_species_factsheet.cfm). Ballast water is water from a port or other location that is taken onboard a ship and stored in tanks to add weight, thereby maintaining the ship's trim and stability. For example, ballast water is often taken onboard as cargo is unloaded, and discharged as cargo is loaded. Depending on where the ballast water is taken onboard, it may be freshwater, brackish, or saltwater, and might contain organisms that are not native to the port area where ballast water will be discharged. Prior to departure or while en route, a ship may need to take ballast water onboard to maintain its stability and safety or to maximize its propulsion efficiency. On entry into a port, the ship may need to discharge ballast water to lighten the ship in order to maintain clearance under the keel in navigational channels or berthing areas, or to offset additional weight resulting from the loading of cargo or fuel (http://water.epa.gov/type/oceb/habitat/invasive_species_factsheet.cfm).

Ballast water is a major source for introducing non-native species into aquatic ecosystems where they would not otherwise be present (Georgia DNR 2009). Invasive species are characterized by high reproduction rates, long life spans, broad diets, and the ability to withstand a wide range of environmental factors (Power et al 2008). If the non-native species become established, they can adversely impact the economy or the environment, or cause harm to human health (Power et al 2008).

Although ballast water exchange is not 100% effective, at present it is the most cost-effective management tool to reduce the risk of ballast-mediated invasion. Ballast water exchange involves replacing coastal water with open-ocean water during a voyage. This process reduces the density of coastal organisms in ballast tanks that may be able to invade a recipient port, replacing them with oceanic organisms with a lower probability of survival in nearshore waters (<http://www.serconline.org/ballast/fact.html>).

Other ballast water treatment technologies, such as filtration, heating, ultraviolet light and certain biocides have the potential to help reduce the risk of ballast-mediated invasion, however, at this time, mid-ocean ballast water exchange is the only ballast water treatment strategy approved by the United States Coast Guard as required by Federal regulation (Albert et al 2010). Until new treatments and strategies are available and approved, ships that have operated outside the United States Exclusive Economic Zone (EEZ) must either retain their ballast on board or must undergo ballast water exchange (http://www.serc.si.edu/labs/marine_invasions/vector_ecology/bw_exchange.aspx).

4.06.1 Locally Occurring Invasive Species

Three invasive species have been documented to occur on Tybee Island, the green porcelain crab (*Petrolisthes armatus*), the green mussel (*Perna viridis*) and the titan acorn barnacle (*Megabalanus coccopoma*) (Alan Power, pers. Comm. 2008). The green mussel is a native of the Indo-Pacific region. It was first documented in Tampa Bay, Florida in 1999 with ballast water being the most likely means of introduction (Power et. al. 2004). In 2003, it was recorded in Jacksonville Beach, Florida and in the offshore waters of Brunswick, GA (Power et. al. 2004). The first green mussel was found on Tybee in November 2003 (Power et. al. 2004). It is believed the mussel was introduced to Georgia from boats and equipments being transferred between coasts without adequate cleaning of attached organisms and draining of bilge water (Power et. al. 2004).

In 2006, the University of Georgia, Marine Extension Service received a grant from the National Aquatic Invasive Species Council to monitor (as well as other topics) for aquatic invasive species in the Port of Savannah (Georgia DNR, 2009). That study was completed in October 2009 and is available at: http://www.anstaskforce.gov/Meetings/2009_November/Georgia%20Aquatic%20Nuisance%20Species%20Management%20Plan%20Sept%202009.pdf. Of the eight objectives of the Plan, one applies directly to SHEP. It is "Coordinate local, state, regional, federal and international activities and programs pertaining to aquatic nuisance species."

As discussed in Section 5.20, the risk of ballast-mediated invasives is managed by the US Coast Guard. All vessels entering the Port of Savannah comply with National Aquatic Invasive Species Act (NISA) and the US Coast Guard guidelines mandated by this regulation.

Additionally, the Wildlife Resources Division of the Georgia Department of Natural Resources published the Georgia Invasive Species Strategy in August 2009. This publication is available on their website (<http://www.georgiawildlife.com/assets/documents/GeorgiaInvasiveSpeciesStrategy.pdf>).

4.06.2 National Invasive Species Act (NISA)

In response to national concerns about aquatic nuisance species (ANS) within ballast water, the National Invasive Species Act of 1996 (NISA) was enacted. This NISA required the US Coast Guard to establish mandatory ballast water management guidelines. The US Coast Guard is the primary Federal agency charged with establishing controls on ballast water discharges. It is

working closely with EPA and other Federal agencies to improve ballast water management by ships and to reduce the potential for introduction of invasive species by ships. The US Coast Guard requires vessel operators to submit mandatory ballast water reports under the rules of 33 CFR 151. In June 2004, the US Coast Guard published regulations establishing penalties for ships headed to the U.S. that fail to submit water management reporting forms. These regulations also increase the number of vessels subject to these provisions by expanding the reporting and the recordkeeping requirements on ships, increasing the Coast Guard's ability to determine the patterns of ballast water movement as required by NISA.

In recent years there has been increased focus on Ballast Water Management (BWM) due to the ecological, economic, and potential health threats caused by the spread of ANS from ballast water. The Coast Guard is responding to these concerns through a comprehensive national BWM program. This program applies to all vessels equipped with ballast water tanks that operate in U.S. waters and are bound for ports or places in the U.S. Highlights of the program are: (1) requires mandatory ballast water management practices for all vessels that operate in U.S. waters; (2) establishes additional practices for vessels entering U.S. waters after operating beyond the EEZ; and (3) requires the reporting and recordkeeping of ballasting operations by all vessels.

The following mandatory practices apply for all vessels with ballast tanks on all waters of the US (for a list of exemptions, refer to the US Coast Guard, <http://www.uscg.mil/hq/cg522/cg5224/bwm.asp>):

- A. Avoid ballast operations in or near marine sanctuaries, marine preserves, marine parks, or coral reefs.
- B. Avoid or minimize ballast water uptake:
 - 1. Where infestation, harmful organisms and pathogens are located.
 - 2. Near sewage outfalls.
 - 3. Near dredging operations.
 - 4. Where tidal flushing is poor or when a tidal stream is known to be more turbid.
 - 5. In darkness when organisms may rise up in the water column.
 - 6. In shallow water or where propellers may stir up the sediment.
 - 7. Areas with pods of whales, convergence zones and boundaries of major currents.
- C. Clean ballast tanks to remove sediment regularly.
- D. Only discharge minimal amounts of ballast water in coastal and internal waters.
- E. Rinse anchors and anchor chains during retrieval to remove organisms and sediments at their place of origin.
- F. Remove fouling organisms from hull, piping, and tanks on a regular basis and dispose of any removed substances in accordance with local, state and federal regulations.
- G. Maintain a vessel specific ballast water management plan.
- H. Train vessel personnel in ballast water and sediment management and treatment procedures.

There are additional mandatory practices for all vessels transiting to US waters with ballast water that was taken on within 200 nautical miles of any coast after operating beyond the US Exclusive Economic Zone. They are that the vessel must conduct one of the following:

- A. conduct mid-ocean ballast water exchange prior to entering U.S. waters;
- B. retain the ballast water on board while in U.S. water; or
- C. use a Coast Guard approved alternative environmentally sound method to treat the ballast water.

The following describes the vessel's reporting and recordkeeping requirements:

The master, owner, operator, person in charge, or vessel agent of any vessel equipped with ballast water tanks that is bound for ports or places of the United States, must ensure complete and accurate Ballast Water Reporting Forms are submitted in accordance with 33 CFR 151.2041, and signed ballast water records are kept on board the vessel for a minimum of two years in accordance with 33 CFR 151.2045.

The Coast Guard may impose a civil penalty of up to \$27,500 per day or Class C Felony charge for non-submittal of ballast water records. Vessels are strongly encouraged to electronically submit ballast water management reporting forms via email and/or web-based methods available at the National Ballast Information Clearinghouse web site:
<http://invasions.si.edu/nbic/submit.html>

Vessel Discharges Require a Permit Beginning February 6, 2009. On December 18, 2008, EPA issued a new NPDES general permit to regulate 26 types of discharges from vessels operating in U.S. waters. Approximately 61,000 domestically flagged commercial vessels and 8,000 foreign flagged vessels need to comply with the permit starting February 6, 2009.

As a result of a court ruling and a subsequent extension, vessel owners and operators who have previously been exempt from Clean Water Act requirements for the last 35 years were required to obtain a permit by February 2009.

"EPA met the deadline and delivered a protective and practical permit to protect the nation's waterways from ship-borne pollution and to avoid an environmental and economic shipwreck," said Assistant Administrator for Water Benjamin H. Grumbles. The permit covers non-recreational vessels 79 feet in length or longer, such as cruise ships or oil and cargo tankers, but excludes fishing vessels of any length, unless they discharge ballast water. The new permit incorporates the Coast Guard's mandatory ballast water management and exchange standards, and provides technology-based and water-quality-based effluent limits for other types of discharges, including deck runoff from rain or cleaning, ballast water used to stabilize ships and "gray water" from showers, sinks and laundry machines. It also establishes specific corrective actions, inspections and monitoring, recordkeeping and reporting requirements.

In 2009, Congress responded to the court ruling in part by enacting a law to exempt recreational vessels from the permitting requirement and requiring further analysis and action by EPA and the Coast Guard.

4.06.3 International Regulation of Invasive Species

The International Maritime Organization (IMO) developed a treaty in February 2004 that, once it goes into effect, will help control the discharge of ballast water and sediments from ships on international voyages in order to reduce the risk of introduction of invasive species.

The International Convention for the Control and Management of Ships Ballast Water & Sediments was adopted by consensus at a Diplomatic Conference at IMO in London in February 2004. The Conference was attended by representatives of 74 States, one Associate Member of IMO; and observers from two intergovernmental organizations and 18 non-governmental international organizations. The main features of the Convention are outlined below.

A. Entry into force. The Convention will enter into force 12 months after ratification by 30 States, representing 35 percent of world merchant shipping tonnage.

B. General Obligations. Parties undertake to give full and complete effect to the provisions of the Convention and the Annex to prevent, minimize and ultimately eliminate the transfer of harmful aquatic organisms and pathogens through the control and management of ships' ballast water and sediments.

C. Survey, Certification, and Inspection. Ships are required to be surveyed and certified and may be inspected by port State control officers who can verify that the ship has a valid certificate; inspect the Ballast Water Record Book; and/or sample the ballast water. If there are concerns, then a detailed inspection may be carried out and "the Party carrying out the inspection shall take such steps as will ensure that the ship shall not discharge Ballast Water until it can do so without presenting a threat of harm to the environment, human health, property or resources."

D. Annex – Section A General Provisions. This includes definitions, application and exemptions. Under Regulation A-2 General Applicability: "Except where expressly provided otherwise, the discharge of Ballast Water shall only be conducted through Ballast Water Management, in accordance with the provisions of this Annex."

Ships are required to have on board and implement a Ballast Water Management Plan. The Ballast Water Management Plan is specific to each ship and includes a detailed description of the actions to be taken to implement the Ballast Water Management requirements and supplemental Ballast Water Management practices.

Ships must have a Ballast Water Record Book to record when ballast water is taken on board, circulated or treated for Ballast Water Management purposes; and discharged into the sea. It should also record when Ballast Water is discharged to a reception facility and accidental or other exceptional discharges of Ballast Water.

Other methods of ballast water management may also be accepted as alternatives to the ballast water exchange standard and ballast water performance standard, provided that such methods ensure at least the same level of protection to the environment, human health, property or

resources, and are approved in principle by IMO's Marine Environment Protection Committee (MEPC).

E. Annex – Section B Management and Control Requirements for Ships. Under Regulation B-4 *Ballast Water Exchange*, all ships using ballast water exchange should:

Whenever possible, conduct ballast water exchange at least 200 nautical miles from the nearest land and in water at least 200 meters in depth, taking into account Guidelines developed by IMO;

In cases where the ship is unable to conduct ballast water exchange as above, this should be as far from the nearest land as possible, and in all cases at least 50 nautical miles from the nearest land and in water at least 200 meters in depth.

Other pathways for invasive species to enter the Savannah Harbor through vessel operations include insects in pallets and plants, and seeds in soil on/in containers. Various measures are undertaken to minimize the spread of invasive species through these avenues. The Animal and Plant Health Inspection Service-Plant Protection and Quarantine (APHIS- PPQ) of the US Department of Agriculture inspects container cargo agricultural products for invasive species, as well as places monitoring traps around the port environment for early detection of new species. The APHIS-PPQ also develops and implements response plans, along with state cooperators, for eradicating, controlling or managing new invasive species when they are discovered (Georgia Invasive Species Strategy 2009).

4.07 Terrestrial Resources

Several environmental resources exist in the harbor that deserve special recognition and concern. Actions which could impact those areas may affect multiple resources, such as water quality, wetlands, aquatic species, benthic communities, and wildlife. To ensure these areas receive the recognition and concern which they warrant, they will be described separately and potential impacts to those sites will be evaluated separately. The special resources which warrant special concern include the Savannah National Wildlife Refuge, the Tybee Island National Wildlife Refuge, Turtle Island Wildlife Management Area, and the Confined Sediment Placement/Disposal Facilities (CDFs).

4.07.1 Savannah National Wildlife Refuge

The Savannah National Wildlife Refuge is located in the upper portion of the harbor and consists of 29,175 acres of freshwater marshes, tidal rivers and creeks, and bottomland hardwoods. The Refuge was established in 1927 and is managed primarily for waterfowl and wildlife observation. The facility contains both impounded and unimpounded wetlands.

The Refuge is located at the upstream end of the harbor and both its location across the river from highly developed port facilities and its original purpose as a freshwater refuge presents significant challenges to harmonious operation of the harbor with adjacent landowners. Refuge habitats have been impacted by increases in salinity which has accompanied previous harbor

improvement projects, primarily channel deepening which allows saline water to travel further upriver. A Freshwater Control System was constructed in 1977 to mitigate for the salinity increase expected from the harbor deepening and sediment control features authorized in 1965. The Tidegate was removed from operation in 1990 and New Cut closed to alleviate impacts caused by those structures. The extensive unimpounded marshes are most susceptible to salinity impacts.

4.07.1.1 Unimpounded Refuge Marshes. The Refuge also contains extensive unimpounded wetlands along the Savannah, Middle and Back Rivers. Wetlands located below US Highway 17 are vegetated predominantly by salt marsh and brackish marsh species, while those above that point are predominantly freshwater or brackish species. It is the unimpounded wetlands which have experienced the most impact from development of the harbor, as the additional channel depths have introduced salinity further upstream. Operation of the Tidegate also allowed saline water to progress further up Back River.

Savannah District funded monitoring of tidal marsh adjacent to Back River by the USFWS to record changes after the closure of New Cut and removal of the Tidegate from operation. Four sites within unimpounded Refuge wetlands were evaluated as follows:

<u>FORMER SALINITY REGIME</u>	<u>APPROXIMATE LOCATION</u>
Freshwater (less than 0.5 ppt Salinity)	9,000 feet upstream of U.S. Highway 17
Oligohaline (from 0.5 to 5.0 ppt)	1,500 feet upstream of U.S. Highway 17
Strongly Oligohaline	2,200 feet downstream of U.S. Highway 17
Mesohaline (from 5.0 to 18.0 ppt)	500 feet downstream from Clydsdale Creek

Field sampling performed in June and October 1993 found that interstitial water salinities were lower at each of the four sites observed, with freshwater conditions (less than 0.5 ppt) being observed at all sites. Vegetation changes at formerly oligohaline and mesohaline sites indicate that freshwater conditions have been restored. Changes in species composition were most evident at the strongly oligohaline site. Based on this monitoring, closure of New Cut and removal of the Tidegate from operation was found to reduce salinity levels in Back River and its adjacent marshes. Restoration of Refuge unimpounded wetlands to freshwater species has been found to take longer than changing salinity levels in the tidal waters. The range of salinities in which some vegetation can grow, as well as competition for open soil substrates on which to grow caused the vegetative response to be slower than the water quality response to the closure of New Cut and removal of the Tidegate from operation.

4.07.1.2 Impounded Refuge Marshes. The USFWS currently manages 5,700 acres of diked impoundments for waterfowl in the Refuge. Those impoundments include 3,000 acres of freshwater pools. Two management schemes are primarily used for the impoundments; draw-down pools and permanently flooded pools. The draw-down pools are drained annually between March 15 and May 15 and manipulated to promote growth of emergent waterfowl food plants. These areas are re-flooded in the fall of each year. Permanent pools remain flooded all year to promote growth of submerged aquatic plants and to provide wood duck brood rearing and

alligator habitat. Permanently flooded pools are drained, dried, burned, and mowed when undesirable vegetation becomes a problem or productivity of desirable plants decreases. These pools may require additional water at any time to make up for transpiration and evaporation. The USFWS also has an agreement with local landowners to provide them with freshwater after the first 20 days of each month.

Since the Tidegate was taken out of operation and the salinity decreased in Back River, freshwater is available for flooding of the impoundments at all times during average and high river flow conditions. Under low flow conditions, the Refuge staff must still time the flooding of the pools around the lunar cycle as unacceptable salinity levels still occur at the intake during some portions of the month.

4.07.2 Tybee National Wildlife Refuge

The Tybee National Wildlife Refuge was established in 1938 as a breeding area for migratory birds and other wildlife. The Refuge consists of 400 acres of wetlands and diked low lands located at the mouth of the Savannah River across the river from the Fort Pulaski National Monument. Much of the site is diked and is used for placement of sediment dredged from the Savannah Harbor Navigation Project. The vegetated portions of the upland areas are densely covered with red cedar, wax myrtle, and groundsel. Saltwater marsh borders parts of the island. The low tide shoreline provides feeding and resting areas for shorebirds and migratory birds. The site is closed to public use.

4.07.3 Turtle Island Wildlife Management Area (WMA)

The Turtle Island WMA is located adjacent to the Tybee National Wildlife Refuge on its northern side and is operated by the SCDNR. The 1,700-acre island was donated to the state in 1976 for waterfowl management purposes. The site is within Unit SC10P of the Coastal Barrier Resources System, so it receives protection from development which is specified in the Coastal Barrier Resources Act. The WMA contains 1,170 acres of low salt marsh, 90 acres of palm/palmetto forest with a wax myrtle and yaupon understory, and 50 acres of beach and dunes. High ground is situated in roughly parallel strips which encircle 420 acres of high salt marsh. The high salt marsh provides the best habitat for waterfowl management and hunting. Public use includes waterfowl hunting, marsh hen hunting, beachcombing, fishing, bird watching, picnicking and camping (designated areas only). Public use is generally low since access is available only by boat.

4.07.4 Confined Sediment Placement/Disposal Facilities (CDFs)

The existing sediment placement/disposal facilities (CDFs) that are used by the Navigation Project are shown in Figure 3-1.

4.07.4.1 Flora. The majority of the undeveloped uplands found along the harbor consist of the CDFs used for harbor operations and generally located on the north side of Savannah Harbor. As a result of dredged sediment deposition, the CDFs are expected to continue to support mixed early successional stage plant communities within diked areas. These communities will probably

continue to be dominated by common reed (*Phragmites communis*), broadsel (*Baccharis halimifolia*), and *Tamarisk* species.

4.07.4.2 Fauna. The CDFs are also inhabited by numerous species of wildlife similar to those found at the Savannah NWR and surrounding areas. Nesting terns and plovers can be found on the more sandy areas during spring and summer. Along the canals and inner ditches, wading birds and shore birds congregate and feed. Depending on the amount of water available and time of year, large numbers of waterfowl can be found in the impounded CDFs. A portion of one CDF extends onto the Tybee National Wildlife Refuge. Reptiles and amphibians that inhabit the area include toads, green tree frogs, moles, various turtles, various snakes including rat snakes, diamond-backed rattlesnakes, water moccasins, banded watersnakes, black racers, king snakes, and rough green snakes. Feral hogs, deer, raccoons, bobcats, armadillos, opossums, otters, mink, coyote, rodents, and other mammals are also found in the areas.

4.07.4.3 Migratory Birds. Many species of migratory birds use the harbor's CDFs. A variety of species of birds are regularly observed in the scrub/brush habitat that surrounds the confined sediment placement/disposal facilities. That habitat is present to some degree on other uplands throughout Chatham and Jasper Counties. However, the existing CDFs provide unique habitat in the Project area for certain species of migratory birds. The sediment placement areas provide nesting habitat for only a limited number of migratory bird species; but, those species include some of special concern such as least tern, black-necked stilt, and Wilson's plover. Many other species of birds use the CDFs outside the breeding season, some in high numbers.

Avian use of the disposal areas can be viewed in several ways. First, the CDFs provide important nesting habitat for a number of waterbirds, and birds associated with beaches and bare ground (referred to by the general term "shore birds"). This group is broken down below into those species that are currently common nesters and those that either nest infrequently or in low numbers. In the species entries, where no fledging times are available, 28 days is assumed to be the fledging period (time in which flightless young would be present at the site). It is also assumed necessary to have nesting habitat available two weeks prior to egg laying for courtship and nest site selection. Many other species of birds nest within the disposal areas. Survey efforts have not concentrated on these species. Only their names are provided below.

The disposal areas also provide feeding habitat for a large number of waterfowl and shorebirds. High counts for these species are provided below. Survey efforts on shorebird and waterfowl use are continuing.

4.07.4.4 Common Nesting Waterbirds/Shorebirds. This group consists of those birds which are known to breed in the CDFs on a regular basis.

Least tern. The nest for Least terns is a shallow depression, usually in sand. Egg dates are April 28 to August 3 (COE CDF data). Chicks are expected to leave the nest within one day of hatching, but remain in area. Fledging is reported to occur 20 days after hatching (Wilbur, 1974, in COE, 1980). Flightless young would be expected no later than about August 23.

A. Nesting habitat: High, open sandy areas, especially with scattered pebbles and small shells. Generally nest on gradual hillside slopes. Areas usually have sparse scattered vegetation and other wood debris. Nesting area should be available April 10 to August 31.

B. Feeding habitat: Open water. Often seen feeding in the Wright River area. Have also been seen feeding in deep water within the CDFs.

C. Resting habitat (after nesting is complete): Open flats and bars associated with shallow water.

Black-necked stilt. Nests are usually loose collections of decaying plant stems. These may be formed of loose collections of shell and clay fragments. Egg dates are April 21 to July 14 (COE CDF data) and estimated to extend to July 27. Chicks are expected to leave the nest within 1 day. Flightless young are expected no later than about August 27.

A. Nesting habitat: Nesting areas should be available April 9 to August 31. This species has been observed to nest in several different habitats within the CDFs; (1) sandy ridges with scattered vegetation close to open water ditches, (2) silt/clay substrates, (3) bare mounds in rough broken terrain within 50 yards of open shallow water; mounds are generally 1 to 4 feet in diameter and raised 1 to 2 feet above the surrounding dirt, (4) small (no more than 1 by 2 foot) slightly elevated bare mounds surrounded by open shallow water, (5) open flats, and (6) in scattered vegetation at the foot of dikes where water is being held. Nests may also be built on mounds with scattered vegetation. Howe (1989) lists the following nesting sites as being typical for this species:

1. Open flats or the edge of short grassy vegetation, usually where visibility is excellent in all directions.

2. Clustered nesting (semi-colonial) rather than evenly distributed in suitable habitat. "Interest distance" may be 10 to 100 feet, as the birds adjust nest density to habitat conditions.

3. Small islands in large pools are particularly favored nest sites.

B. Feeding habitat: Open shallow water and water edges within the CDFs. Adults have also been seen feeding at low tide on mud flats along Wright River.

C. Resting habitat (after nesting is complete): Open flats, bars, open shallow water, water edges, gently sloping grass hillsides (late in season).

Wilson's plover. The nest is a shallow depression in sand, often associated with wood debris and sometimes lined with small pebbles. Egg dates recorded in the Corps' CDF Data include: April 28, 1993, 2 eggs; and July 30, 1993, 1 egg and 2 chicks. Bent (1926) lists egg dates of April 14 to June 21. Chicks are expected to leave the nest within 1 day. Flightless young might be expected no later than about August 28.

A. Nesting habitat: Similar to the least tern, but may include areas with taller vegetation and more debris. Nesting habitat should be available from April 12 to August 28. According to Howe (1989), nests are rarely closer together than 35 m.

B. Feeding habitat: Seen foraging in nesting habitat. Also seen foraging in open damp areas adjacent to open shallow water.

C. Resting habitat (after nesting is complete): Generally the same as the feeding habitat. Most often seen resting on open flats and flats with scattered vegetation.

Willet. The nest is made of grasses and placed on the ground in open grassed areas or open areas with scattered grass and herbs, usually under overhanging grass stems. Earliest egg date in the CDFs is 18 April (based on nest with 4 eggs found on April 21). Latest egg date is presumed to be about July 5 (based on 2 small chicks seen on July 7, 2001). Chicks expected to leave nests within 1 day. Flightless young are expected no later than about July 20 (based on two small flightless juveniles seen in the CDFs on July 13, 2007).

A. Nesting habitat: Nests within the disposal areas in tall grass areas (1 to 2 feet tall) where the grass grows in clumps, usually nests on road shoulders and sometimes in open flat sandy areas with scattered herbs and grass clumps. Nesting habitat should be available March 1 to July 14. According to Howe (1989), willets nest throughout the high marsh and neighboring grassy dunes or man-made upland habitats, but ideal nesting cover is dense *Spartina patens*.

B. Feeding habitat: Within the CDFs, feeds on damp and wet flats with or without scattered vegetation. The birds were also seen feeding along edge of water.

C. Resting habitat (after nesting is complete): Generally the same as the feeding habitat. Most often seen resting on open flats and flats with scattered vegetation.

Nighthawk. Egg dates for the CDFs are from Apr 28 (1 egg in 1995) to July 15 (2 nests in 2009). Small downy chicks have been found as late as July 18 (1 in 1995), indicating eggs should be present well into July. Young are expected to remain flightless for about 3 weeks (Bent, 1926).

A. Nesting habitat: Adults are seen on sand hills and flat sandy areas with scattered wood debris. Young chicks are found in open sandy area near wood debris and scattered weeds. Nesting habitat should be available April 14 to about August 5.

B. Feeding habitat: Open air. Catches insects while flying. Feeds in open areas or above woods.

C. Resting habitat: Seen resting on wood debris in open areas with sparse vegetation. Will also rest in trees with open branches and on bare ground.

Killdeer. The nest is an open depression lined with pebbles or shell fragments. Egg dates range from March 8 (nest with 2 eggs in 2007) to August 28 (adult incubating 2 eggs on August 28, 1995). Chicks are expected to leave the nest within one day. Flightless young are expected usually no later than about August 6, but may occur as late as about September 25.

A. Nesting habitat: Nests in open areas. Areas may or may not contain scattered to moderate grasses and weeds. Nesting habitat should be available March 1 to August 31.

B. Feeding habitat: Seen feeding in nesting habitat. Also frequents damp flats and edges of water, with or without scattered short vegetation.

C. Resting habitat: Same as feeding habitat.

Common moorhen (common gallinule). Reported egg dates are from April 9 to July 18 (Post & Gauthreaux, 1989). Nesting evidence in the CDFs ranges from May 24 (adult seen incubating in nest in salt cedar in 2007) to October 14 (adult with large downy flightless chick found in 2005). Young are expected to leave the nest within 1 day of hatching. Flightless young could be expected until about October 31. Nesting habitat consists of damp and wet areas with tall vegetation. Found mostly in areas that stay wet for a long time. Feeding and resting areas would be the same. Nesting habitat should be available March 26 to October 31.

Mottled duck. Few nests have been found within the CDFs. However, flightless young have been seen between April 8 (hen with 10 small ducklings seen in 1997) and August 15 (hen with 6 medium flightless ducklings seen in 2007). These birds are generally thought to be descendants of released birds. No egg dates are reported. Nesting habitat consists of damp and wet areas with tall vegetation. This species is found mostly in areas that stay wet for a long time. Feeding and resting areas would be the same. Occasionally seen resting on grassed dike shoulders. Nesting habitat should be available from early March to August 31.

Mallard. The status of the wild population has become unclear with the appearance since 1997 and 1998 of apparently released birds. USFWS collected 7 dead and dying ducks in the Areas, all banded with SCWA bands, on June 28, 1999. Nesting evidence ranges from April 24 (hen with 6 ducklings in 12A in 2005) to July 6 (hen with 7 juveniles in 2003 and hen with 5 juveniles in 2006).

4.07.4.5 Sporadic/Uncommon Nesters. This group consists of those birds which are known to breed in the CDFs, but not on a regular basis.

Gull-billed tern. Has been observed nesting on bare sand mounds within CDF 12A during the general period of 1970 to 1974 (USFWS, John Robinette, personal communication). Has nested on the CDF 14B and CDF 12A nesting islands when they are clear of vegetation and surrounded by water. Nest building has been observed as early as April 23 (one pair in 2005), presumed incubation seen as early as May 7 (10 birds in 2006). The latest incubation was recorded on July

29 (1 bird in 1999). Did not nest in the areas in 2008, but did nest in the areas in 2009-2011. It is estimated that nesting habitat should be available from April 9 to August 31. Feeds on insects while flying low over marshes. Also seen carrying anoles and fiddler crabs.

Black skimmer. Has been observed nesting on bare sand mounds within CDF 12A during the general period of 1970 to 1974 (US FWS, John Robinette, personal communication). Egg dates in South Carolina are from May 10 to July 20 (Post & Gauthreaux, 1989). Has nested on the bird islands within CDFs 14B and 12A when they were free of vegetation and surrounded by water. Apparent incubation has been recorded as early as 29 April (1 bird in 2010). The earliest nests were found on May 20 (3 in 2005). The latest eggs were documented on August 20 (7 nests found in CDFs 14B in 1999). One large downy flightless juvenile was still present on the CDFs 14B nesting island on September 1, 1999. It is estimated that nesting habitat should be available from April 12 to September 8. This species would be expected to feed on small fish, primarily on the surface of tidal creeks outside the CDFs.

Least bittern. Has recently been observed nesting in cattails in CDF 13B (US FWS, John Robinette, personal communication). One flightless juvenile was found in CDF 12A on June 17, 2008, and another in CDF 14A on July 20, 2006. Egg dates in South Carolina are April 17 to July 20 (Post & Gauthreaux, 1989). It is estimated that nesting habitat should be available from April 3 to August 16. Nests are placed in cattails and other vegetation above shallow water (Bent, 1923). This species would be expected to feed in wet, but exposed areas within the CDFs.

Pied-billed grebe. Sightings of downy young were reported in the CDF 13B in 1993 (US FWS, John Robinette, personal communication). Egg dates in South Carolina are April 5 to September 18. Nesting evidence within the CDFs ranges from June 5 (3 juveniles seen in CDF 14A in 2005) to August 21 (one bird seen sitting on a nest in CDF 12A in 1996). It is estimated that nesting habitat should be available from March 22 to October 16. Floating nests are usually built over water less than 3 feet deep (Bent, 1919). This species would be expected to feed in inundated vegetated areas within the CDFs.

Black-bellied whistling duck. First seen in 2001. Three breeding records: a pair with about 18 small ducklings (estimated to have recently hatched) was seen in 12A on July 26, 2007 (the pair was also seen in CDF 12A with 14 small/medium ducklings on August 15, 2007. Two adults and two half-grown juveniles were seen in Area 14A on 11 November, 2005, along with 16 other adults. Two adults with 3 half-grown ducklings were seen in CDF 13B on September 5, 2008. The juveniles were re-sighted almost fully grown, along with one more juvenile, on September 19, 2008.

Double-crested cormorant. Breeding evidence ranges from July 6 to September 22. Two nests, one with one juvenile, were seen in the CDF 14A rookery on July 6, 2006. Single adults have been seen sitting on nests in CDF 14A on August 17, 2006, and on September 8 and 22, 2006. Nesting of the species, along with the Anhinga, herons, egrets, and ibis depends on the presence of woody vegetation surrounded by water. Little of this habitat has been present in the areas in recent years.

Anhinga. Nesting evidence includes adults seen nest building on April 1, 2002, and on nests and presumed to be incubating eggs from April 29 (1 in 1999) to August 20 (1 in 1999). On September 13, 1999, the latter nest was observed to contain 2 half-grown downy chicks with dark wing and tail feathers. Juveniles have been seen in the rookery as late as September 18 (15 juveniles in the CDF 13A rookery in 2001).

Great egret. Often nests in rookeries in shrubbery surrounded by water within the disposal areas. Nesting activity has been found from May 3 (3 nests in CDF 14A in 1997) to July 20 (one adult incubating in 2006) and August 25 (one juvenile seen in the CDF 13B rookery in 2000).

Snowy egret. Often nests in rookeries in shrubbery with cattails and other tall grasses surrounded by water within the disposal areas. Nesting activity recorded from April 17 (about 190 individuals perched in CDF 14A rookery, at least 11 on nests in 2005), to September 7 (one juvenile was on a nest in the CDF 14A rookery in 2003, and 2 adults and 4 juveniles were present in the CDF 13A rookery in 2003).

Little blue heron. Nesting activity recorded from April 18 (two individuals perched in rookery in CDF 14A) and May 9 (4 seen on nests 9 May 06) to July 27 (one adult was seen incubating on a nest in CDF 14A in 2003) and August 18 (3 juveniles seen in the CDF 13B rookery in 2000).

Tricolored heron. Nesting activity has been recorded from April 14 (17 birds seen sitting on nests in cattails in CDF 14A in 1997) to August 24 (one juvenile seen in a nest in CDF 14A in 2003) and September 7 (two juveniles seen in the CDF 14A rookery in 2003).

Cattle egret. Breeding evidence ranges from May 14 (2 birds on nests in 1997) to September 7 (1 adult seen on nest in CDF 14A in 2003, at least 4 other juveniles seen in the rookery).

Green heron. Nesting evidence ranges from April 20 (adult standing next to nest in CDF 12B in 2003) and May 10 (adult incubating on nest in 14A in 2007) to August 14 (2 flightless young seen in CDF 12B brush pile in 2003 were still in the brush pile, but much larger, on August 30, 2003).

Black-crowned night heron. Breeding evidence ranges from April 17 (2 birds sitting on nests in the 14A rookery in 2005) and July 27 (2 adults on nests in 2003), to August 30 (two juveniles seen in separate nests in CDF14A in 2003) and September 13 (3 juveniles seen in the CDF14A rookery in 2003).

Yellow-crowned night heron. Breeding evidence ranges from May 18 (one individual observed carrying nesting material to a salt cedar in CDF 13B in 1999) to July 27 (5 adults and 14 juveniles recorded in the CDF14A rookery in 1999).

White ibis. Breeding evidence ranges from May 13 (6 individuals on nests in the CDF14A rookery in 2006) to August 17 (one nest with 4 medium juveniles and 65 other juveniles in trees in CDF 14A in 2006) and September 22 (one juvenile seen sitting in shrubbery in the CDF 14A east rookery in 2006).

Glossy ibis. Breeding evidence ranges from April 17 (3 birds were seen sitting on nests in the CDF 14A rookery in 2005) to July 20 (1 adult was seen on a nest in CDF 14A in 2003) and August 25 (1 adult was seen feeding a juvenile in the CDF 13B rookery on August 25, 2000).

Purple gallinule. A pair with 4 medium sized downy chicks was seen in CDF14A on September 1, 1999. One adult was seen feeding a chick what appeared to be a small minnow. Reported as being seen in the disposal areas in a list dated 1970-1977 (Pat and Sam Young, Tom Smith, Gerald Knighton*1).

Coot. There are four nesting records from May 30 (adult on nest in 1996) to July 27 (adult on nest in shading position in 2003).

Blue-winged teal. Nesting evidence ranges from June 3 (hen with 7 ducklings in CDF 12B in 2003) to June 27 (hen with two small ducklings in 12B in 2003).

Ruddy Duck. There are seven breeding records from June 3 (pair with 5 small ducklings seen in CDF 12A in 2008) to September 6 (hen with 5 small ducklings seen in 13A in 2000).

Laughing gull. Have nested in small numbers on the CDF14B bird nesting island. Breeding evidence ranges from May 19 (one bird nest building in 2000) to July 7 (one bird apparently incubating in 2001). Maximum number of nests is 15 on May 27, 2011 on the CDF 12A south island.

Although not part of the CDFs, Tomkins Island, the offshore bird nesting island (east of Turtle Island, SC, and just north of the entrance channel jetties), provides bare ground nesting habitat for a number of species, many of which have not nested within the CDFs. Nesting species include: brown pelican, American oystercatcher, royal tern, and laughing gull. Occasional nesters include the gull-billed tern and black skimmer.

4.07.4.6 Other Nesting Birds. Several other species nest in vegetation within the CDFs. Many other species nest within older vegetation existing along the outside of the dikes. A list of confirmed nesting species is shown below. Those found nesting inside the CDFs are marked with an asterisk.

Pied-billed grebe*
 Double-crested cormorant* (6 July 06 in CDF 14A).
 Anhinga*
 Least bittern*
 Great egret*
 Snowy egret*
 Little blue heron*
 Tricolored heron*
 Cattle egret*
 Green heron*
 Black-crowned night heron*
 Yellow-crowned night heron*

White ibis*
 Glossy ibis*
 Turkey vulture*
 Canada goose*
 Black-bellied whistling duck*
 Mottled duck*
 Blue-winged teal*
 Wood duck*
 Ruddy duck*
 Osprey
 Redtail
 Bobwhite
 Purple gallinule*
 Common gallinule*
 Coot*
 Wilson's plover*
 Killdeer*
 Black-necked stilt*
 Avocet* (eggs found, but did not nest successfully)
 Willet*
 Laughing gull*
 Gull-billed tern*
 Least tern*
 Black skimmer*
 Mourning dove*
 Yellow-billed cuckoo
 Nighthawk*
 Chuck-wills-widow
 Red-bellied woodpecker
 Eastern kingbird
 Rough-winged swallow
 Fish crow
 Carolina wren
 Blue-gray gnatcatcher
 White-eyed vireo*
 Common Yellowthroat*
 Yellow-breasted chat*
 Catbird*
 Mockingbird
 Brown thrasher*
 Cardinal*
 Blue grosbeak*
 Indigo bunting*
 Painted bunting*
 Towhee*
 Red-winged blackbird*

Boat-tailed grackle*
 Brown-headed cowbird*
 Common grackle
 Orchard oriole*

It is highly likely, because they are seen commonly throughout the summer, but confirmed nesting has not been documented (2): Ground Dove* pair (old nests found) June 2007, Marsh Wren* agitated, many empty nests, Downy Woodpecker, Carolina Chickadee.

4.07.4.7 Non-breeding Birds. This group consists of non-breeding birds that have been observed in the CDFs.

Shorebirds. At least 37 species of shorebirds have been recorded in the CDFs in recent years. Peak spring migratory periods for the southeast are reported as late March to late May (Helmers, 1992) and mid-April to late May (Howe, 1989). Peak fall migration is reported as August to early November (Helmers, 1992) and mid-July to mid-September (Howe, 1989). The highest numbers of migrating shorebirds in the CDFs have recently been observed to occur between late April to early June (highest in May) and early July to early November (highest from July to September). The highest number of species usually occurs in late April, May, and July. Bird counts often exceed 20,000 to 30,000 birds during peak migration. Highest counts of wintering shorebirds occur from December to February, including stilt sandpipers.

The CDFs are well known for attracting large numbers of migrating shorebirds, with several species being recorded there in larger numbers than anywhere else in South Carolina. Post & Gauthreaux (1989) list the harbor's CDFs as the location for the highest counts of avocets (450) and black-necked stilts (450). Recently (July 16, 1993), 976 black-necked stilts were observed in the CDFs. Other shorebird species have recently been recorded in the CDFs in numbers that exceed the maximums listed for South Carolina in Post & Gauthreaux (1989). The species for which this has occurred are as follows (in bold):

- A. Black-bellied plover. A maximum of **859** was seen on March 8, 2007 (recorded on film).
- B. Wilson's plover. A maximum of **47** was seen on June 27, 2009.
- C. Semipalmated plover. A spring maximum of **1,600** was seen on May 18, 1993. The previous record was 1300 in May 1984 (P&G, 1989).
- D. Killdeer. A maximum of **355** birds was seen in one flock in 12A on October 30, 1996 (ties maximum record).
- E. Black-necked stilt. A maximum of **976** was recorded on July 16, 1993.
- F. Avocet. A maximum of **1,120** was recorded on November 12, 2008.
- G. Solitary sandpiper. A spring maximum of **60** birds was recorded on April 24, 2009.

H. Greater yellowlegs. A maximum of 237 was observed on November 11, 2006. A winter (Dec-Jan) maximum of **162** was observed on December 5, 1996, with 73 observed on January 10, 1997. The spring maximum is 115 seen on March 13, 2006.

I. Lesser yellowlegs. Highest numbers are usually recorded in the spring, with a maximum of **4,823** birds recorded on April 28, 1995. The fall maximum is 2862 found on August 3, 1999. A near-winter maximum of 465 was seen on November 11, 2000. Winter maxima (Dec-Jan) are **299** birds seen on December 21, 1996, and **298** seen on January 29, 1998. The previous winter record was 22 recorded on December 22, 1980 (P&G, 1989).

J. Semipalmated sandpiper. A maximum of **29,115** was found on May 19, 2000.

K. Western sandpiper. The spring maximum is 3860 recorded on April 2, 2004, and fall maximum is **7,500** birds recorded on November 21, 2004.

L. Least sandpiper. A maximum of **9,730** birds was recorded on April 23, 2000.

M. White-rumped sandpiper. Maximum spring count is **171** birds on June 4, 1993. Maximum fall count is 57 birds on September 6, 2000. The previous record was 35 in May 1986 (P&G, 1989).

N. Pectoral sandpiper. The fall maximum is **244** birds on August 18, 2000.

O. Dunlin. A maximum of **5,500** was recorded on November 12, 2003.

P. Stilt sandpiper. A spring maximum of **1,169** was recorded on May 14, 2011. The fall maximum is **898** recorded on July 27, 1999. The previous record was 40 in 1984 (P&G, 1989).

Q. Buff-breasted sandpiper. Rare spring migrant. Three records: April 13, 2002(1), April 28, 2005(1), and May 5, 2011(1). A maximum of **42** birds was recorded on September 8, 2007.

R. Long-billed dowitcher. A spring maximum of **910** was recorded on April 27, 2003. The fall maximum is 490 recorded on October 24, 2004. Winter maxima are **505** (January 23, 2008) and 395 (December 31, 2007).

S. Common snipe. A maximum of **470** was recorded in one large flock at the east end of disposal area 14B on January 18, 1995.

T. Wilson's phalarope. May 3, 1997 (**37**, high count). There are many fall records for the CDFs. Only one fall record is listed for South Carolina in Post and Gauthreaux, 1989 (William Post and Sidney A. Gauthreaux, Jr. Status and Distribution of South Carolina Birds. 1989. Contributions from the Charleston Museum, 18).

Waterfowl (ducks, geese, and swans). Thirty-four species of waterfowl have been recorded in the CDFs. Dominant species migrating or wintering in the areas are blue-winged teal (HC 2,150 on October 13, 2003), northern shoveler (HC 6,300, November 22, 2003), green-winged teal

(HC 7,450, February 18, 1998), ring-necked duck (HC 6,595, November 19, 2005), lesser scaup (HC 3,455, March 6, 2008), hooded merganser (HC 2,495, November 26, 2008), and ruddy duck (HC 3,991, January 23, 2008).

Hérons, egrets, ibis, and wood stork. Most species, except the cattle egret and wood stork can be expected to occur in the CDFs throughout the year, but more commonly during the summer months. Highest numbers are usually encountered from May to June and September to October. Cattle egrets are most likely to be seen during the summer, while wood storks are most likely to occur from August to October. High counts for the most abundant species are: great egret – 731, September 18, 2009, snowy egret – 3,049, September 18, 2009, August 31, 2007, tricolored heron – 680, June 9, 2000, white ibis – 2,370, September 8, 2007, and glossy ibis – 645, July 12, 2000. The high counts for roseate spoonbill is 372 on September 9, 2009, and the high count for the wood stork is 415 on October 17, 2008.

Gulls and terns. Various gulls feed near the head section discharge pipe when sediment placement operations are underway, primarily laughing gull, ring-billed gull, and a few herring gulls. Open flat areas, usually near water, serve as resting areas for many species throughout the year. With the exception of least terns gull-billed terns, black skimmers, and laughing gulls, which nest in the CDFs, other species of gulls and terns feed and rest on open flats and bars at various times throughout the year. Twenty-three species of gulls and terns have been recorded in the CDFs. The most abundant species are laughing gull (HC 2,300, July 28, 2011), Bonaparte's gull (HC 595, March 5, 1997), ring-billed gull (HC 1,586, April 7, 2011, Caspian tern (HC 411, October 13, 2003), Forster's tern (HC 542, September 5, 2008, least tern (HC 978, July 24, 2008), black tern (HC 906, August 31, 2009), gull-billed tern (HC 266, June 9, 2000), royal tern (HC 291, August 15, 2002), and black skimmer (HC 639, July 21, 2011).

Other birds. The woodlands and grassy areas bordering the CDFs contain a large variety of birds, with the species composition and numbers dependent on the time of the year. Large numbers of tree swallows feed at the CDFs at certain times of the year (over 10,000 individuals have been seen feeding over the CDFs in October, and 140,000 in April), and the northern waterthrush has been observed in the winter.

The scrub areas inside and outside the CDFs provide important habitat for a number of neotropical migrants including catbird (HC 721, October 13, 2003, yellow warbler (HC 212, August 8, 2008, prairie warbler (HC 68, August 8, 2008), palm warbler (HC 202, September 29, 2010), northern waterthrush (HC 60, August 28, 2002), and common yellowthroat (HC 329, October 5, 2002). In addition, small numbers of many uncommon species have been sighted in the areas from time to time.

Several distinct areas constitute the existing major bird habitat features at the middle harbor CDFs. Sandy areas at the head sections are generally available and used for nesting by least terns and other species. None of the areas are isolated from predators and some nesting islands surrounded by water are generally available each year. Least terns, gull-billed terns, and black skimmers have nested on these islands successfully. Savannah District has produced approximately 14.6 acres of successful ground nesting habitat in the past five years. At least 3 acres of successful sandy nesting area have been present each year. An additional area of at least

50 acres of black-necked stilt habitat is generally available, although it is usually subject to drying and nesting failures. At least 100 acres of spring and fall migrant shorebird feeding habitat has been available, and probably the same amount of winter waterfowl/shorebird habitat.

Analyses were performed to identify the amount of acreage of various bird habitats which occur for some period of time within each middle harbor CDFs. Those analyses are summarized in Table 4-9.

Table 4-9. Approximate Acreage of Bird Habitat Middle and Lower Harbor Confined Disposal Facilities (in acre-years)

Placement Area	Usable Size	Bare Ground Nesting	Wetland Nesting	Shorebird Feeding	Waterfowl Feeding
12A	990	12.1	264.4	304.2	367.2
13A	1,307	--	1.2	8.3	2.6
13B	520	1.4	92.8	70.8	73.7
14A	728	0.8	285	125.5	197.3
14B	725	0.5	55.6	52	9.5
J/O	890	--	111	72.4	21.8
TOTAL	5,820	14.8	1,194	633.2	672.1

NOTE: Usable areas determined from 2008 surveys. Figures are based on averages of 2006-2010 data.

The estuarine marshes which line the Savannah River at locations along its entire length are also areas which support wildlife. Cormorants, seagulls, mergansers, hawks, herons, egrets, ibis, rails and terns can be found resting and feeding in many of these areas. Diamondback terrapins and occasionally alligators also inhabit these estuarine wetlands, along with such mammals as otters, raccoons and minks.

4.07.5 Shoreline Erosion

Erosion is experienced on an ongoing basis along the Savannah River and the ocean shoreline near the harbor entrance. In some locations, that erosion is severe, with rates as high as 20 feet per year occurring at some of the CDFs on the South Carolina side of the river. Other areas experience much slower erosion rates, but the erosion still results in significant impacts because the eroding land is highly valued or protects nearby structures. Concerns were expressed about this erosion during the scoping for the SHEP studies performed after completion of the Tier I EIS. The proposed harbor deepening could increase the present shoreline and/or beach erosion along the channel shoreline, from Savannah to Tybee Island. As a result of these concerns, Savannah District conducted several investigations, including the following: Ship Wake Analysis, Bank Erosion Analysis, and the Coastal Erosion Study at Tybee Island. The results of those analyses are discussed in Section 5.09, Existing Shorelines Adjacent to the Federal Navigation Channel.

4.08 Wetlands and Floodplains

Wetlands are those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support a prevalence of vegetation typically adapted for life in saturated soil conditions (33 C.F.R. § 328.3). Wetlands possess three essential characteristics: hydrophytic vegetation, hydric soils, and wetland hydrology.

4.08.1 Wetlands

The 1982 Planning Aid Report, prepared by the U. S. Fish and Wildlife Service, for the Savannah Harbor Comprehensive Study included detailed mapping of wetland resources in the harbor area. The imagery used for the wetland assessment was taken in about 1979. The Tidegate was put in operation in 1977 at the same time the harbor was deepened to a 38-foot authorized depth. Therefore, the data reflect a wetland system that was likely still in a state of transition. However, the findings still provide value in their general characterization of wetland communities in the Savannah estuary. That 1982 report defined the following cover types as occurring in the Savannah Harbor area.

A. Salt marsh cordgrass: estuarine intertidal emergent wetland dominated by *Spartina alterniflora*.

B. High salt marsh one: estuarine intertidal emergent wetland vegetated primarily with one or more of the following: *Salicornia* spp., *Distichlis spicata*, *Batis maritima*, *Spartina alterniflora*.

C. High salt marsh two: estuarine intertidal emergent wetland vegetated primarily with *Borrchia frutescens* and/or *Iva frutescens*.

D. Black needlerush: estuarine intertidal emergent wetland dominated by *Juncus roemerianus*.

E. Giant cordgrass: estuarine intertidal emergent wetland dominated by *Spartina cynosuroides*.

F. Sand/mud: estuarine intertidal unconsolidated shore with sand or mud substrate.

G. Spoil: dredged sediments placed on a diked area. May be vegetated or unvegetated depending on time since last dredging cycle.

H. Giant cutgrass: riverine tidal emergent and estuarine intertidal emergent wetland dominated by *Zizaniopsis miliacea*.

I. Mixed fresh marsh: riverine tidal emergent wetland vegetated with species such as *Amaranthus cannabinus*, *Carex* spp., *Cladium jamaicense*, *Cyperus* spp., *Eleocharis* spp., *Erianthus giganteus*, *Orontium aquaticum*, *Peltandra virginica*, *Pontedaria cordata*, *Sagittaria*

spp., *Scirpus validus*, *Scirpus* spp., *Spartina cynosuroides*, *Typha* spp., *Zizania aquatica* and *Zizaniopsis miliacea*.

J. Cypress: palustrine forested wetland dominated by *Taxodium* spp.

K. Gum: palustrine forested wetland dominated by *Nyssa aquatica*, *Nyssa sylvatica* and *Liquidambar styraciflua*.

L. Cypress/gum: palustrine forested wetland dominated by *Taxodium* spp., *Nyssa* spp., and *Liquidambar styraciflua*.

M. Deciduous forested: palustrine forested wetland with species such as: *Acer rubrum*, *Quercus nigra*, *Quercus michauxii*, *Nyssa* spp., *Liquidambar styraciflua* and *Fraxinus pennsylvanica*.

N. Scrub-shrub: palustrine scrub-shrub wetland vegetated by such species as: *Cephalanthus occidentalis*, *Taxodium* spp., *Nyssa* spp., *Acer rubrum* and *Salix* spp.

O. Mixed brackish marsh: estuarine intertidal emergent wetland vegetated with such species as: *Cladium jamaicense*, *Juncus* spp., *Scirpus* spp., *Spartina cynosuroides* and *Typha* spp.

P. Bullrush/cattail: estuarine intertidal emergent wetland dominated by *Scirpus* spp. and *Typha* spp.

Q. Deciduous forest: greater than 50 percent cover of upland hardwood (not wetland)

R. Diked impoundments: shallow impoundments formed by diking off estuarine emergent or riverine tidal emergent wetland.

S. Pine forest: greater than 50 percent cover of pines (not wetland).

T. Open water: primarily estuarine, subtidal, unconsolidated bottom wetlands but includes borrow pits located in upland areas.

U. Mixed fresh marsh/scrub-shrub: mixture or interspersed of types 9 and 14.

V. Pasture: included old fields in addition to pasture (not wetland).

W. Developed: residential/commercial areas including some small gardens/truck farms adjacent to housing (not wetland).

That USFWS report also included (as Table 2) the following information on the extent of emergent wetlands:

Table 4-10. Marsh Vegetative Coverage Types for Emergent Wetlands

No.	Cover Type	Acreage	Percent
1	Salt marsh Cordgrass	2,160	9.5
2	High Salt marsh One	217	1.0
3	High Salt marsh Two	431	1.9
4	Black Needlerush	3,908	17.2
5	Giant Cordgrass	2,025	8.9
8	Giant Cutgrass	1,068	4.7
9	Mixed Fresh Marsh	4,572	20.1
15	Mixed Brackish Marsh	2,407	10.6
16	Bullrush/cattail	1,774	7.8
18	Diked Impoundment	4,157	18.3
Total		22,719	100.0

The USFWS report included (as Table 3) the following information on the extent of forested wetlands:

Table 4-11. Marsh Vegetative Coverage Types for Forested Wetlands

No.	Cover Type	Acreage	Percent
10	Cypress	349	4.1
11	Gum	1,463	17.0
12	Cypress-Gum	4,330	50.5
13	Deciduous Forested	230	2.7
14	Scrub-Shrub	2,205	25.7
Total		8,577	100.0

It is likely that the percentages of those various wetland community types have changed over time. However, the Corps is not aware of similar information that is more recent. Some studies have identified vegetative distributions within small portions of the estuary (such as the SNWR), while other studies have examined the acreage of a subset of the community types. The following information shows how vegetation in the tidal marsh on the Savannah National Wildlife Refuge has changed over the past 25 years (Kitchens, 2003).

Table 4-12. Changes in Vegetation Types in Savannah Marshes

Map Class and Community Type	Percent of Mapped Refuge Area			
	1986-1987	1993	July 2000	October 2000
Shrub/Forest	5.8	8.1	7.7	8.8
<i>Zizaniopsis</i> /Shrubs	1.5			
<i>Zizaniopsis</i> /Fresh Mix/Shrubs			20.9	15.2
Fresh Mix/Shrubs			5.2	
Fresh Mix	8.3			
<i>Zizaniopsis</i> /Aster/Fresh Mix				14.1
<i>Zizaniopsis</i> /Scirpus/Aster/Fresh Mix		8.5		
<i>Zizaniopsis</i> /Scirpus/Fresh Mix		3.0	18.2	
<i>Zizaniopsis</i>	10.7			
<i>Zizaniopsis</i> /Scirpus	19.5			14.3
<i>Zizaniopsis</i> /Scirpus/Typha/Salix		21.0		
Typha/ <i>Zizaniopsis</i> /Scirpus	11.9			
Scirpus/ <i>Zizaniopsis</i> /Typha			9.5	
<i>Scirpus validus</i>	22.8			
<i>Scirpus</i> / <i>Spartina</i>	4.6			
<i>Scirpus</i> / <i>Spartina</i> /Typha and/or <i>Zizaniopsis</i>		41.0	25.3	28.3
<i>Spartina</i> spp.	2.3			3.9
Spoil/Developed	0.8	3.9	1.0	3.2
Water	11.9	14.5	13.1	12.3

4.08.2 Floodplains

The 100-year floodplain is established by the Federal Emergency Management Agency (FEMA) and is identified on Federal Insurance Rate Maps. Base flood elevations for flood zones and velocity zones are also identified by FEMA, as are designated floodways.

In general, development initially occurs outside the floodplain on lands that are not subjected to the risk of flooding. Some land uses -- such as commercial shipping -- are tied closely to the water and are located adjacent to the harbor. Development of lands along the harbor to support such activities usually includes filling the site to raise the ground elevation above the 100-year floodplain.

The historic portion of the City of Savannah is located on a bluff along the river. Development started on the bluff but expanded to low-lying areas that were filled. Much of the land along the northern side of the harbor remains low-lying wetlands. Some of those lands are now within the Savannah National Wildlife Refuge and are expected to remain in a natural state. Other lands along the South Carolina shore closer to the ocean were filled to create sediment placement sites. With the legal protections that have been provided to wetlands, large-scale filling of wetlands within the floodplain are not expected in the future.

4.09 Threatened and Endangered Species

Pursuant to Section 7 of the Endangered Species Act of 1973, lists of Federally Threatened and Endangered (T&E) species for the project area were obtained from NMFS (Southeast Regional Office, St. Petersburg, FL) and the USFWS (Field Office, Charleston, SC and Athens, GA). These were combined to develop the following composite list, which includes T&E species that could be present in the area based upon their geographic range (see Table 4-13). However, the actual occurrence of a species in the area would depend upon the availability of suitable habitat, the season of the year relative to a species' temperature tolerance and migratory habits, and other factors.

Savannah District prepared a Biological Assessment for Threatened and Endangered Species (BATES) (see EIS-Appendix B) to evaluate the potential impacts of the proposed action on Federally threatened and endangered species. That document was coordinated with the USFWS and NMFS pursuant to Section 7 of the Endangered Species Act of 1973, as amended. Additionally, the BATES discusses the potential impacts of the project on Georgia and South Carolina State-listed species of concern. Appendix Z contains the responses from the USFWS and NMFS. The USFWS concurred with the BATES. The NMFS concurred with the BATES for some of the species and stated that the project, with implementation of reasonable and prudent measures, would not jeopardize the continued existence of the four other species of concern under its purview.

Table 4-13. Federally Threatened and Endangered Species Potentially Present in Chatham County, Georgia and Jasper County, South Carolina

Species Common Name	Scientific Name	Federal Status
Vertebrates		
Kirtland's warbler	<i>Dendroica kirtlandii</i>	Endangered
Bachman's warbler	<i>Vermivora bachmanii</i>	Endangered
Right whale	<i>Eubaleana glacialis</i>	Endangered
Sei whale	<i>Balaenoptera borealis</i>	Endangered
Sperm whale	<i>Physeter macrocephalus</i>	Endangered
Blue whale	<i>Balaena musculus</i>	Endangered
Finback whale	<i>Balaenoptera physalus</i>	Endangered
Humpback whale	<i>Megaptera novaeangliae</i>	Endangered
Shortnose sturgeon	<i>Acipenser brevirostrum</i>	Endangered
Atlantic sturgeon	<i>Acipenser oxyrinchus</i>	Endangered
Green sea turtle	<i>Chelonia mydas</i>	Threatened
Hawksbill turtle	<i>Eretmochelys imbricate</i>	Endangered
Kemp's Ridley sea turtle	<i>Lepidochelys kempii</i>	Endangered
Leatherback sea turtle	<i>Dermochelys coriacea</i>	Endangered
Loggerhead sea turtle	<i>Caretta caretta</i>	Threatened
West Indian manatee	<i>Trichechus manatus</i>	Endangered
Piping plover	<i>Charadrius melodus</i>	Threatened
Red-cockaded woodpecker	<i>Picoides borealis</i>	Endangered
Wood stork	<i>Mycteria americana</i>	Endangered
Eastern indigo snake	<i>Drymarchon corais couperi</i>	Threatened
Flatwoods salamander	<i>Ambystoma cingulatum</i>	Threatened
Vascular Plants		
Pondberry	<i>Lindera melissifolia</i>	Endangered
Chaffseed	<i>Schwalbea Americana</i>	Endangered
Canby's dropwort	<i>Oxypolis candyi</i>	Endangered

¹Green turtles are listed as threatened, except for breeding populations in Florida and on the Pacific Coast of Mexico, which are listed as endangered.

KEY:

Endangered - A taxon "in danger of extinction throughout all or a significant portion of its range."

Threatened - A taxon "likely to become endangered within the foreseeable future throughout all or a significant portion of its range."

Proposed - "are those candidate species that were found to warrant listing as either threatened or endangered and were officially proposed as such in a Federal Register notice after completion of a status review and consideration of other protective conservation measures."

Table 4-14 below is a list of Georgia's known occurrences of special concern animals and plants near Savannah Harbor. The list was obtained from the Georgia Department of Natural Resources, Wildlife Resources Division, Nongame Conservation by email dated January 4, 2010.

Table 4-14. Georgia's Known Occurrences of Special Concern Animals and Plants On or Near Savannah Harbor, Chatham County, Georgia**

Status	Species Scientific Name	Species Common Name
Animals		
US	<i>Caretta caretta</i>	Loggerhead
GA	<i>Clemmys guttata</i>	Spotted turtle
US	<i>Eubalaena glacialis</i>	Northern Right whale
GA	<i>Haematopus palliatus</i>	American oystercatcher
GA	<i>Haliaeetus leucocephalus</i>	Bald eagle
	<i>Himantopus mexicanus</i>	Black-necked stilt
	<i>Nycticorax nycticorax</i>	Black-crowned Night heron
	<i>Passerina ciris</i>	Painted bunting
	<i>Pseudacris brimleyi</i>	Brimley's Chorus frog
	<i>Pseudorca crassidens</i>	False Killer whale
GA	<i>Rynchops niger</i>	Black skimmer
GA	<i>Sterna antillarum</i>	Least tern
GA	<i>Tyrannus dominicensis</i>	Gray kingbird
US	<i>Trichechus manatus</i>	West Indian manatee
	<i>Ammodramus maritimus</i>	Seaside sparrow
GA	<i>Charadrius wilsonia</i>	Wilson's plover
	<i>Crotalus adamanteus</i>	Eastern Diamond-backed rattlesnake
GA	<i>Gopherus polyphemus</i>	Gopher tortoise
GA	<i>Moxostoma robustum</i>	Robust redbreast
	<i>Nyctanassa violacea</i>	Yellow-crowned Night heron
GA	<i>Passerina ciris</i>	Painted bunting
GA	<i>Rana capito</i>	Gopher frog
	<i>Stereochilus Marginatus</i>	Many-lined salamander
	<i>Umbra pygmaea</i>	Eastern mud minnow
Plants		
GA	<i>Forestiera segregata</i>	Florida Wild privet
	<i>Physostegia leptophylla</i>	Narrowleaf Obedient plant
GA	<i>Sarracenia minor</i>	Hooded pitcherplant
GA	<i>Sageretia minutiflora</i>	Climbing buckthorn
GA	<i>Sapindus marginatus</i>	Soapberry
	<i>Scutellaria mellichampii</i>	Mellichamp's skullcap
	<i>Sporobolus pinetorum</i>	Pineland dropseed

** "US" indicates species with federal status (Protected, Candidate or Partial Status). Species that are federally protected in Georgia are also state protected. "GA" indicates Georgia protected species. All other are "species of concern" in Georgia.

The following list of Georgia's Conservation Areas near Savannah Harbor was provided by the Georgia Department of Natural Resources, Wildlife Resources Division, Nongame Conservation in 2006 and revised based on US FWS comments in 2012.

Conservation Areas

Fort Pulaski National Monument [National Park Service]	near project area
Greenspace [Chatham County]	near project area
Hunter Army Airfield [U.S. Department of Defense]	near project area
Little Tybee-cabbage Island Natural Area [Georgia DNR]	near project area
Savannah NWR [U.S. Fish and Wildlife Service]	on site
Savannah River [High Priority Stream]	on site
Skidaway Island State Park [Georgia DNR]	near project area
Tybee Island Tract [Georgia DNR]	near project area
Tybee National Wildlife Refuge [U.S. Fish and Wildlife Service]	on site
Wormsloe Historic Site [Georgia DNR]	near project area

Table 4-15 shown below is a list of South Carolina's Rare, Threatened, and Endangered Species of Jasper County. The list was obtained from the South Carolina Department of Natural Resources website at the following website:

https://www.dnr.sc.gov/pls/heritage/county_species.select_county_map.

**Table 4-15. South Carolina's Rare, Threatened, and Endangered Species of Jasper County
(Date of information – January 4, 2010**)**

Legal Status	Global Rank	State Rank	Scientific Name	Common Name
Animals				
FE/SE	G3	S3	<i>Acipenser brevirostrum</i>	Shortnose sturgeon
SC	G3	S3	<i>Amphispiza aestivalis</i>	Bachman's sparrow
FT/SE	G2G3	S1	<i>Ambystoma cingulatum</i>	Flatwoods salamander
SC	G4	S?	<i>Anodonta couperiana</i>	Barrel floater
ST	G5	S5	<i>Clemmys guttata</i>	Spotted turtle
SE	G3G4	S2?	<i>Corynorhinus rafinesquii</i>	Rafinesque's Big-eared bat
SC	G4	S3	<i>Crotalus adamanteus</i>	Eastern Diamondback rattlesnake
SC	G2G3	S?	<i>Elassoma okatie</i>	Bluebarred Pigmy sunfish
SC	G4	S?	<i>Elliptio congaraea</i>	Carolina slabshell
SE	G3	S1	<i>Gopherus polyphemus</i>	Gopher tortoise
SE	G4	S2	<i>Haliaeetus leucocephalus</i>	Bald eagle
SC	G2	S?	<i>Heterodon simus</i>	Southern Hognose snake
SC	G5	S5	<i>Hyla avivoca</i>	Bird-voiced treefrog
SC	G5	S?	<i>Kinosternon baurii</i>	Striped mud turtle
SC	G4	SA	<i>Kogia breviceps</i>	Pygmy Sperm whale
SC	G3G4	S?	<i>Lampsilis cariosa</i>	Yellow lampmussel
SC	G3	S?	<i>Lampsilis splendid</i>	Rayed Pink fatmucket
FE/SE	G4	S1S2	<i>Mycteria Americana</i>	Wood stork
SC	G5	S3S4	<i>Neotoma floridana</i>	Eastern woodrat
SC	G5T5	S3S4	<i>Neotoma floridana floridana</i>	Eastern woodrat

Legal Status	Global Rank	State Rank	Scientific Name	Common Name
Animals				
SC	G3	S?	<i>Ophisaurus mimicus</i>	Mimic Glass lizard
FE/SE	G3	S2	<i>Picoides borealis</i>	Red-cockaded woodpecker
SC	G4T3?	S2	<i>Pituophis melanoleucus mugitus</i>	Florida Pine snake
ST	G5	S2	<i>Pseudobranchius striatus</i>	Dwarf siren
SC	G5T4	S3S4	<i>Pseudotriton montanus flavissimus</i>	Gulf Coast mud salamander
SC	G5	S?	<i>Pyganodon cataracta</i>	Eastern floater
SC	G5	S4	<i>Sciurus niger</i>	Eastern Fox squirrel
SC	G5	S?	<i>Seminatrix pygaea</i>	Black Swamp snake
ST	G4	S3	<i>Sterna antillarum</i>	Least tern
SC	G5	S?	<i>Utterbackia imbecillis</i>	Paper pondshell
SC	G4	S?	<i>Villosa delumbis</i>	Eastern creekshell
Plants				
SC	G4?	S?	<i>Agalinis linifolia</i>	Flax Leaf false-foxglove
SC	G4G5	S1	<i>Agarista populifolia</i>	Carolina dog-hobble
SC	G4G5	S?	<i>Aleris ovovata</i>	White colicroot
SC	G4	?	<i>Andropogon brachystachyus</i>	Short-spike bluestem
SC	G5T3T4	S1	<i>Andropogon perangustatus</i>	Narrow-leaved bluestem
SC	G5	S?	<i>Anthrenanthea rufa</i>	Purple silky scale
SC	G4?	S?	<i>Aristida condensata</i>	Piedmont Three-awned grass
SC	G3G5	S1	<i>Bacopa cyclophylla</i>	Coastal-plain water-hyssop
SC	G4	S?	<i>Baldinia uniflora</i>	One-flower baldinia
SC	G4?	S4	<i>Canna flaccida</i>	Bandana-of-the-everglades
SC	G5	S?	<i>Carex amphibola</i>	Narrowleaf sedge
SC	G4	S?	<i>Cavapontia boykinii</i>	Cay aponia
SC	G4G5	S?	<i>Chilona monophylla</i>	Buckwheat-tree
SC	G3G5	S?	<i>Coreopsis glandulata</i>	Southeastern tickseed
SC	G5	S?	<i>Crotonopsis linearis</i>	Narrowleaf tickseed
SC	G4	S?	<i>Cyperus tetragonus</i>	Piedmont flatsedge
SC	G4G5	S1	<i>Dicerandra odoratissima</i>	Rose balm
SC	G4G5	S?	<i>Dichanthelium aciculare</i>	Broomsedge
SC	G2G3	SR	<i>Eupatorium anomalum</i>	Florida thorough-wort
SC	G4	S1	<i>Forestiera segregata</i>	Southern privet
SC	G5	S1	<i>Halesia diptera</i>	Two-wing silverbell
SC	G?	S?	<i>Halesia parviflora</i>	Small-flowered silverbell-tree
RC	G2G3	S1	<i>Hypericum adpressum</i>	Creeping St. John's wort
SC	G4G5	S?	<i>Lepuropetalon spathulatum</i>	Southern lepuropetalon
SC	G4G5	S?	<i>Licania michauxii</i>	Gopher-apple
SC	G4	S?	<i>Listera australis</i>	Southern twayblade
SC	G3	S3	<i>Listea aestivalis</i>	Pondspice
SC	G5	S1	<i>Lyonia ferruginea</i>	Rusty Lyonia
SC	G5	S1	<i>Lysimachia furida</i>	Land-leaf loosesstrife
SC	G2G3	S?	<i>Macbridea caroliniana</i>	Carolina bird-in-a-nest
SC	G4G5	S	<i>Nyssa ogeche</i>	Ogeechee tupelo
SC	G3G4	S?	<i>Orbexilum lupinellum</i>	Sampson snakeroor, scurf pea
SC	G5?	SR	<i>Panicum neuranthum</i>	Needleleaf Rosette grass
SC	G3	S?	<i>Plantago aparsiflora</i>	Pineland plantain
SC	G3G4	S2	<i>Platanthera integrifolia</i>	Yellow Fringeless orchid
SC	G3	S1	<i>Polygala hookeri</i>	Milkwort
SC	G5	S1S2	<i>Polygala nana</i>	Dwarf milkwort
SC	G5	S?	<i>Potamogeton foliosus</i>	Leafy pondweed
SC	G2	S2	<i>Pteroglossaspis ecristata</i>	Crestless Plum orchid

Legal Status	Global Rank	State Rank	Scientific Name	Common Name
Plants				
SC	G5?	S?	<i>Pycnanthemum nudum</i>	Pinelands Mountain mint
SC	G5	S?	<i>Quercus myrtifolia</i>	Myrtle-leaf oak
SC	G3G5	S1	<i>Rudbeckia mollis</i>	Soft-hair coneflower
SC	G4	S2	<i>Sageretia minutiflora</i>	Tiny-leaved buckthorn
SC	G5T2	S?	<i>Sagittaria graminea</i> <i>va weatheriana</i>	Grassleaf arrowhead
FESE	G2	S2	<i>Schwalbea americana</i>	Chaffseed
SC	G4	S1S2	<i>Scleria baldwini</i>	Baldwin nutrush
SC	G3	S?	<i>Spiranthes langilabris</i>	Giant Spiral ladies' tresses
SC	G3	SR	<i>Sporobolus floridanus</i>	Florida dropseed
SC	G4	S?	<i>Thalia dealbata</i>	Powdery thalia
SC	G5T4T5	SR	<i>Xyris difformis</i> <i>var floridana</i>	Florida Yellow-eyed grass
SC	G3G4	SR	<i>Xyris serotina</i>	Acid-swampy Yellow-eyed grass

G RANK: The Nature Conservancy rating of degree of global endangerment:

- G1 - Critically imperiled globally because of extreme rarity or because of some factor(s) making it especially vulnerable to extinction
- G2 - Imperiled globally because of rarity or factor(s) making it vulnerable
- G3 - Either very rare throughout its range or found locally in a restricted range, or having factors making it vulnerable
- G4 - Apparently secure globally, though it may be rare in parts of its range
- G5 - Demonstrably secure globally, though it may be rare in parts of its range
- GH - Of historical occurrence throughout its range, with possibility of rediscovery
- GX - Extinct throughout its range
- G? - Status unknown
- T? - Status of infraspecific taxa (subspecies or varieties). Rankings similar to G#.

S RANK: The Nature Conservancy rating of degree of state endangerment:

- S1 - Critically imperiled state-wide because of extreme rarity or because of some factor(s) making it especially vulnerable to extirpation
- S2 - Imperiled state-wide because of rarity or factor(s) making it vulnerable
- S3 - Rare or uncommon in state, found only in a restricted range, or factors making it vulnerable
- S4 - Apparently secure in state. Uncommon but not rare, and usually widespread
- S5 - Secure: Common, widespread, and abundant
- SA - Accidental in state (usually birds or butterflies that are far outside normal range)
- SE - Exotic established in state
- SH - Of historical occurrence in state, with possibility of rediscovery
- SN - Regularly occurring in state, but in a migratory, non-breeding form
- SR - Reported in state, but without good documentation
- SX - Extirpated from state
- S? - Rank not yet assessed

Other Qualifiers:

- B - Breeding
- N - Non-breeding
- ? - Denotes inexact or uncertain numeric rank

LEGAL STATUS:

- FE - Federal Endangered
- FT - Federal Threatened
- NC - Of Concern, National (unofficial - plants only)
- RC - Of Concern, Regional (unofficial - plants only)
- SE - State Endangered (official state list - animals only)
- ST - State Threatened (official state list - animals only)
- SC - Of Concern, State
- SX - State Extirpated
- DM - Delisted Taxon, Recovered, Being Monitored First Five Years
- PE/PT/C - Proposed or candidate for federal listing

4.10 Cultural Resources

Cultural resources consist of prehistoric and historic districts, sites, structures, artifacts, objects, or any other physical evidence of human activity considered important to a culture, subculture, or community for scientific, traditional, religious, or other reasons. Cultural resources can be divided into two major categories: Prehistoric and Historic resources; and American Indian resources. Prehistoric and Historic resources include archaeological resources (prehistoric and historic) and architectural resources. American Indian resources are also known as traditional cultural properties.

Under the National Historic Preservation Act (NHPA), as amended, only cultural resources included in or eligible for inclusion on the National Register of Historic Places (NRHP), defined as 'historic properties', warrant consideration with regard to adverse impacts from a proposed action. Historic properties generally must be more than 50 years old to be considered for protection under the NHPA. To be considered eligible for the NRHP, cultural resources must meet one or more criteria as defined in 36 CFR 60.4 for inclusion on the NRHP. These criteria include association with an important event, association with a famous person, embodiment of the characteristics of a type, period or method of construction, or the ability to contribute to scientific research. Resources must also possess integrity (i.e., important historic features must be present and recognizable). Historic properties may be sites, buildings, structures, historic districts, or objects.

The Savannah area, including Savannah Harbor, is a culturally rich area, with respect to both archaeological and architectural resources. Some of the most abundantly found prehistoric sites in the Savannah area date to the Archaic Period which spans from 8000 B.C. to 1000 B.C. These sites are usually represented by shell middens or shell rings. The region also contains evidence of habitation from other prehistoric periods, namely the Woodland Period (1000 B.C. to A.D. 1150) and Mississippian Period (A.D. 1150 to European Contact).

The seaport has been a vital component of the city since settlement by General James Oglethorpe in 1733. As a result, extensive maritime facilities have been constructed along the shoreline, and vast quantities of cargo have moved through the port for over 250 years. In addition, the Savannah Harbor and vicinity was the site of many war-time activities during the Civil War. Fortifications were built along the river, some of which remain today.

4.10.1. Area of Potential Effects

Area of potential effects (APE) means the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist. Savannah Harbor is an approximately 32.7 mile long Federal navigation project. For the proposed project the area of potential effects is defined as the following areas where ground disturbing activities and placement of dredged material will occur:

- A. Channel bottom and side slopes of bar channel extension;
- B. Channel bottom and side slopes of existing navigation channel;

- C. Channel bottom and side slopes of bend wideners and channel side slopes where full-channel-width dredging will occur;
- D. Channel bottom and side slopes of the Kings Island Turning Basin;
- E. Channel bottom and side slopes in proposed passing lane areas;
- F. Existing sediment placement sites; and
- G. Environmental mitigation features.

4.10.2. Previously Disturbed Areas within the Area of Potential Effect

Due to previous dredging and other maintenance activities that have occurred within the Savannah Harbor, several areas within the APE have sustained considerable disturbance. The potential for cultural resources is extremely low in these areas and no initial or follow on investigations for historic properties will be conducted. These areas are as follows:

A. The existing navigation channel bottom between Stations 103+000 and -52+000B has been dredged to a depth well below historic harbor depths. Historically, the deepest place in the inner harbor was a 30-foot-deep hole located near Station 57+000 and the average channel depth was less than 15 feet. Any historic properties that were once located in the dredged channel bottom were removed by previous harbor deepening projects.

B. That portion of the existing bar channel bottom located between Stations -52+000 and -60+000 was surveyed for the harbor deepening project conducted in the 1990s. No historic properties were located.

C. The side slopes and adjacent tops of slopes of the existing navigation channel between Stations +103+000 and -60+000B were surveyed for the harbor deepening project conducted in the 1990s. Historic properties that would be affected by construction of that project were identified and mitigated. Since much of the proposed project is to be constructed in a manner that will not alter existing channel side slopes and tops of slopes, these areas will not be investigated for historic properties, except in places where previous surveys have identified historic properties located immediately adjacent to the existing project.

D. Those portions of proposed bend wideners and the proposed passing lane that overlap existing harbor turning basins and channels that have been dredged to a depth of 38 or more feet, well below historic channel depths, will not be surveyed. Historic properties located in these areas would have been removed as part of previous dredging projects.

E. The bottom of the Kings Island Turning Basin has been dredged to a depth well below that which could have contained historic properties. This area will not be surveyed.

F. The existing Savannah Harbor dredged sediment placement sites have been used for a number of years. Original land surfaces that may contain historic properties are buried under 30

or more feet of dredged sediment. Existing offshore sediment placement sites were designed to avoid impacts to any sonar targets or magnetic anomalies identified during the planning process.

4.10.3. Management of Cultural Resources

Management of cultural resources in Savannah Harbor is an ongoing effort and will be accomplished via compliance with applicable cultural resource laws and regulations, and agreement documents prepared specifically for the Savannah Harbor Navigation Project. In 1992, Savannah District, the South Carolina and Georgia State Historic Preservation Offices, and the Advisory Council on Historic Preservation entered into a Programmatic Agreement to address impacts of the Savannah Harbor Navigation Project and the then proposed harbor deepening project. That deepening project was completed in 1994. All stipulations of the agreement have been carried out.

In 1992, Savannah District, the South Carolina and Georgia State Historic Preservation Offices, and the Advisory Council on Historic Preservation entered into a Programmatic Agreement to address impacts associated with the closing of New Cut and removing the Tidegate from operation in Savannah Harbor. Compliance with all stipulations in the Programmatic Agreement with the exception of Stipulation 12 has been carried out.

Stipulation 12 states: "In consultation with the Council, the GASHPO, and the SCSHPO, Savannah District will prepare a Memorandum of Agreement to outline procedures for identifying, evaluating, and mitigating and/or removing adverse effects of the Savannah Harbor Navigation Project upon the CSS *Georgia*, a property listed in the National Register of Historic Places." These studies and the results are discussed later in Section 5.12.

4.10.4. Status of Cultural Resources Investigations

Savannah District has conducted numerous cultural resources investigations within the Navigation Project since 1992 to identify and evaluate historic properties that may be impacted by undertakings in the Savannah Harbor. Areas that were investigated previously or those that are to be investigated for historic properties include: 1) Channel bottom and side slopes of bar channel extension; 2) Sides slopes of the existing navigation channel between Stations 103+000 and -98+600B in areas where the full channel width must be dredged to facilitate ship movements and in areas where historic properties abut the existing navigation channel; 3) Bottoms and side slopes of bend wideners where they do not overlap existing turning basins; 4) Sides slopes of the Kings Island Turning Basin; 5) Bottom and side slopes of proposed passing lanes; 6) Lands and water bottoms proposed for enhancement for project-related impacts to environmental resources; and 7) Proposed mitigation sites. Completed or in progress investigations include:

A. The portion of the existing Navigation Project that was deepened in 1994 (Stations 103+000 to -96+600B plus the Kings Island Turning Basin) was surveyed at that time and historic properties were investigated and mitigated.

B. Remote sensing surveys were conducted of the Back River Sediment Basin area and portions on upper Back River were surveyed as part of the studies required under the terms of the 1992 Programmatic Agreement for the closing of New Cut and the removal of the Tidegate from operation. The survey area included the Back River, from shore to shore, from the mouth of the Sediment Basin at its juncture with the Savannah Harbor navigation channel to Hog Island.

C. Investigations of the *CSS Georgia* to identify past, present, and future impacts from the existing Navigation Project and the effects of the proposed Expansion Project have been conducted. The reports of these investigations have been coordinated with the Georgia and South Carolina State Historic Preservation Offices.

D. In 2003, Savannah District contractor Panamerican Consultants, Inc., completed a survey of the proposed channel design.

E. In 2005, Savannah District contractor Panamerican Consultants, Inc., conducted a survey of new design elements and conducted diver investigations of 10 magnetic anomalies and/or sonar targets located within the area of potential effect.

F. Savannah and Wilmington Districts conducted a study to determine the incremental effect of the proposed Expansion Project upon Ft. Pulaski National Monument.

G. In 1992, as part of the New Cut Closure Project studies, Savannah District contractor Tidewater Atlantic Resources, Inc., conducted low water shoreline and remote sensing surveys of the Back River from its mouth to the lower end of Hog Island in Little Back River. Thirty-one archaeological sites and 26 magnetic anomalies and/or sonar targets were recorded.

H. In 1993 and 1994, Savannah District archaeologists conducted archival research, archaeological survey, site documentation and monitoring, and diver investigations of the sites and anomalies/targets identified in Back River above the Tidegate during the 1992 survey. A number of the sites were determined eligible for inclusion in the National Register of Historic Places. The report concluded that the New Cut Closure Project had caused erosion at some of the resources, but, these sites had since stabilized and the detailed research and documentation conducted by Savannah District was adequate to mitigate this effect.

I. Savannah District recovered core samples from an area of a proposed off-shore bend widener, where analysis of sub-bottom profiler data indicated the presence of a Pleistocene stream channel. The cores were analyzed and the results reported by New South Associates in 2005.

As a result of the investigations conducted by Savannah District that are related to the Savannah Harbor Navigation Project and investigations conducted by others in the vicinity of the APE, several archaeological and architectural resources have formally been determined eligible for the NRHP, listed on the NRHP or have pending nominations for listing to the NRHP. The identified resources are described below, and their current statuses are summarized below in Table 4-16.

Fort Pulaski National Monument (GA): Station -2+000B to 8+000. Constructed during the 1830s and 1840s, Fort Pulaski is operated and maintained as an historic site by the National Park Service. It is included in the National Register of Historic Places at the national level of significance for its architecture, association with significant events, association with significant people, and archaeological research potential. Erosion is an on-going problem on the channelward side of monument property. While the fort itself is not endangered by the erosion, associated archaeological deposits may be. The shoreline is well outside the channel side slope and the erosion is unassociated with channel maintenance dredging.

The Monument has expressed concern about the incremental effect of wakes from deeper-draft ships that would transit a deeper navigation channel. Savannah and Wilmington Districts conducted an engineering study to determine the nature and scope of this incremental effect. This study concluded that the proposed expansion project would result in a negligible increase in erosion. No further studies are recommended.

Savannah National Historic Landmark District (GA): Stations +72+000 to +79+000. The Savannah National Historic Landmark District is located along the south shore of the Savannah Harbor navigation channel. The district is listed in the National Register of Historic Places at the national level for its architecture. All but one small area is protected by modern bulkheads, wharves, or rip rap. The exception is located near Station +75+500 where a brick-faced wharf constructed during the last quarter of the nineteenth century forms an alcove in the modern bulkhead. This area is used for small boat mooring. Proposed channel improvements will have no effect upon the landmark district.

Fort James Jackson National Historic Landmark (GA): Station +58+000 and +59+000. Fort Jackson is located at the top of the channel side slope on the south shore of the Savannah Harbor navigation channel. It is owned by the State of Georgia and is operated and maintained as a historic site by the Coastal Heritage Society. It is listed in the National Register at the national level of significance for its architecture and association with significant events and historic figures. In 2003, in accordance with a Memorandum of Agreement between Savannah District and the Georgia State Historic Preservation Office, the District completed a bank stabilization project to protect this property from harbor operation and maintenance activities. The potential for future harbor deepening was considered in the design process. No further protection is required for this property.

CSS *Georgia* (SC & GA waters): Station 58+500 to 59+000. The wreck of CSS *Georgia* is included in the National Register of Historic Places at the national level of significance for architecture, association with significant events, association with significant people, and archaeological research potential. The National Register boundary includes the channel side slope, the top of slope, and an area extending 50 feet into the authorized navigation channel. The boundary between South Carolina and Georgia runs through the wreck site. Since 1984, Savannah District has had an agreement with both states to avoid the site area during dredging by 50 horizontal feet for a distance of 1,000 feet along the channel. No dredging has been conducted of any portion of the existing navigation channel located between Stations 58+000 and 59+000 since 1992.

A 1992 Programmatic Agreement required Savannah District to determine past, present, and future effects of the existing Savannah Harbor Navigation Project upon this resource and to identify and evaluate alternatives to mitigate these effects. The Corps conducted the study in 2003 in conjunction with studies to determine the incremental effect of the proposed Expansion Project. The studies demonstrated that past, present, and future operation and maintenance activities have, and will continue to have, an adverse effect upon the wreck site. In addition, the proposed meeting area that would be constructed as part of the Expansion Project would adversely affect the site. The report of these investigations has been coordinated with the Georgia and South Carolina State Historic Preservation Offices. The Savannah District will conduct archaeological data recovery prior to new work dredging near the CSS *Georgia*. The SHEP will be responsible for final clearance of explosive ordnance prior to deepening the channel and constructing the meeting area.

The Savannah and Ogeechee Canal (GA): Station 79+000. The river lock and northern terminus of the Savannah and Ogeechee Canal is located on the south shore adjacent to the Highway 17 Bridge. The canal was constructed during the 1830s. It is listed in the National Register of Historic Places at the state level for architecture and archaeological research potential. The proposed project will have no effect upon the canal.

Pennyworth Island (Back River, GA). During 1993 and 1994, Savannah District archaeologists conducted archival research, shoreline inspection, and documentation of sites along the shoreline of Pennyworth Island in support of the New Cut Closure Project. As a result of these investigations, Savannah District recommended that Pennyworth Island was eligible for inclusion in the National Register of Historic Places at the local level for its ability to provide information on 19th century rice culture along the Savannah River. The island had a diverse history spanning the period from 1825 to the early 20th century and was one of the last active rice plantations on the river. The investigations documented all historic shoreline features, noted that shoreline erosion had been on-going for many years, and recommended that no further work be conducted for the New Cut Closure Project.

The island was in private ownership at the time of the fieldwork. Recently, it was purchased by Chatham County. The County used the 1993/1994 research to prepare a nomination to the National Register of Historic Places. The nomination is pending approval. The island may be affected by the proposed environmental mitigation measures included in the Savannah Harbor Expansion Project. Potential effects may include increased shoreline erosion or accretion and will be addressed in accordance with the Programmatic Agreement.

Fig Island Channel Site (GA): Station 72+000 to 73+500. The Fig Island Channel Site is located on the north side slope and shore of the existing navigation channel. The site has been determined eligible for inclusion in the National Register of Historic Places at the state level for its archaeological research potential. The site area was once a channel between Fig and Hutchinson Islands. The channel was used for disposal of wrecked and derelict vessels during the eighteenth and nineteenth centuries.

The eastern third of the site has been bulkheaded and lies beneath the US Army Corps of Engineers' Depot. The western two-thirds of the site has been the subject of a number of archaeological investigations. The District excavated and documented three vessels as

mitigation for the effects of a 1980s channel widening project. During the 1993/94 deepening project, the District excavated and documented parts of 20 vessels. The vessels spanned the period ca. 1770 to 1900 and were located within the area of potential effect for that deepening project.

In 2000, portions of the site's 1854 pile dam wall were illegally removed. In 2003, the extreme western portion of the site was investigated as part of planning for a Chatham County project that included bulk heading the adjacent slip. One eighteenth century hull was located within the project's potential area of effect. This project requires a Department of the Army Permit that would be issued under the authority of Section 10 of the Rivers and Harbors Act of 1899 and Section 404 of the Clean Water Act of 1972. Federal permitting and consultation under Section 106 is proceeding as part of that project. A Memorandum of Agreement has been completed identifying mitigation procedures for effects to this resource.

The remaining non-bulkheaded portions of the site have been purchased by a developer who intends to bulkhead the shoreline and construct residential and commercial buildings on the site. The bulkhead would require a Department of the Army permit.

The Fig Island Channel Site area will not be affected by bend widener construction or full-channel-width dredging, however, since the channel side slope has been determined eligible for inclusion in the National Register of Places, the District has conducted a slope stability analysis study to determine if incremental erosion would occur at the site. The analysis indicated that there would be no impact to the side slope.

Mansfield/Shafsbury Plantation—09CH685 (Back River, GA). Savannah District archaeologists conducted archival research and field documentation for this plantation as part of the 1993/1994 New Cut Closure Project studies. The plantation was recommended eligible for inclusion in the National Register of Historic Places at the local level of significance for its ability to provide information on historic rice culture along the Savannah River. No further investigations were recommended for this resource as part of the New Cut Closure Project. The site may be affected by increased shoreline erosion or accretion as part of the Savannah Harbor Expansion Project. Impacts to the site will be identified and addressed in accordance with the Programmatic Agreement.

Poplar Grove Plantation—38JA203 (Back River, SC). Savannah District archaeologists conducted archival research and field documentation for this plantation as part of the 1993/1994 New Cut Closure Project studies. The plantation was recommended eligible for inclusion in the National Register of Historic Places at the local level of significance for its ability to provide information on historic rice culture along the Savannah River. No further investigations were recommended for this resource as part of the New Cut Closure Project. The site may be affected by increased shoreline erosion or accretion as part of the Savannah Harbor Expansion Project. Impacts to the site will be identified and addressed in accordance with the Programmatic Agreement.

Shubra Plantation—38JA204 (Back River, SC). Savannah District archaeologists conducted archival research and field documentation for this plantation as part of the 1993/1994 New Cut

Closure Project studies. The plantation was recommended eligible for inclusion in the National Register of Historic Places at the local level of significance for its ability to provide information on historic rice culture along the Savannah River. No further investigations were recommended for this resource as part of the New Cut Closure Project. The site may be affected by increased shoreline erosion or accretion as part of the Savannah Harbor Expansion Project. Impacts to the site will be identified and addressed in accordance with the Programmatic Agreement.

Table 4-16. Location and Status of Known Cultural Resources in the APE

Resource Name/Site Number	Location	NRHP Status
Fort Pulaski National Monument (GA)	Station -2+000B to 8+000	Listed as National Monument
Savannah National Historic Landmark District (GA)	Stations +72+000 to +79+000	Listed as National Historic Landmark
Fort James Jackson National Historic Landmark (GA)	Station +58+000 and +59+000	Listed as National Historic Landmark
CSS <i>Georgia</i> (SC & GA waters)	Station 58+500 to 59+000	Listed
The Savannah and Ogeechee Canal (GA)	Station 79+000	Listed
Pennyworth Island	Back River, GA	Nomination Pending Approval
Fig Island Channel Site	Station 72+000 to 73+500	Determined Eligible
Mansfield/Shafsbury Plantation—09CH685	Back River, GA	Recommended Eligible
Poplar Grove Plantation—38JA203	Back River, GA	Recommended Eligible
Shubra Plantation – 38JA204	Back River, SC	Recommended Eligible

4.11 Aesthetic and Recreational

Broad expanses of salt marsh exist between developed high ground areas and the barrier islands. This broad vista is one of the highly enjoyed features of living in coastal Georgia. The tidal creeks which wind through those marshes also provide avenues for recreational users for the coastal area. Kayaking in those creeks has grown into an activity that is enjoyed by many residents and coastal visitors. Large live oaks are common throughout the area and with their draping Spanish moss they provide stunning visual views no matter where they are found.

As a historic city, Savannah attracts numerous tourists, many of which visit the harbor area. A significant portion of the riverfront has been restored. It is known as River Street and is a

popular tourist destination, with hotels, restaurants and small shops. A lengthy promenade, approximately 1/2 mile, has been established and is well used by both tourists and residents. Events are regularly held which draw thousands of attendees. Therefore, extensive recreational use does occur along portions of the harbor. These uses stem from the historic and cultural aspects of the city, whose origin was directly tied to the harbor. Those uses have expanded to widespread commercial operations which serve both tourists and local residents. In 1733, General Oglethorpe laid out the city in a series of grids that allowed for open streets and shady public squares. In the 1990's, more than 50 million people came to visit Savannah, drawn by its architecture, fountains and green squares.

The City of Tybee Island is an urbanized beach community characterized by single-family dwellings, condominiums, and small hotels. The aesthetic values of this beach community are evidenced by the popularity of the area for family-oriented use and tourism. The total environment of ocean, estuaries, and inlets attract many residents and visitors to the area to enjoy the sights, sounds, winds, and marine environment.

4.12 Recreational and Commercial Fishing

Recreational and commercial fishing are important industries in coastal Georgia. Commercial shrimp trawling is common in the immediate vicinity of the dredged entrance channel, since this is a natural corridor for emigrating shrimp. The GA DNR Coastal Resources Division (Personal Communication, 26 February 2007, Mr. Spud Woodward, Assistant Director for Marine Fisheries) indicates that Georgia's territorial waters south of the channel are open to food shrimp trawling during the established season, which is typically mid-June through December. Trawling occurs off the beach at Tybee Island, but is limited because of water depth.

The GA DNR Coastal Resources Division (Personal Communication, 26 February 2007, Mr. Spud Woodward, Assistant Director for Marine Fisheries) stated there is limited commercial fishing for blue crabs in the lower Savannah River. The Division knows of one commercial crabber who works that area. There may be other fishermen in the spring when female crabs are moving toward the ocean to release their eggs. The Division prohibits deployment of traps in marked navigation channels, which obviously limits the area of the lower Savannah that is open to commercial blue crab fishing. The Division has never known commercial blue crab fishing to occur in the area outside the river entrance and in the nearshore area off Tybee Island. In Georgia, commercial fishing for blue crabs occurs throughout the year with the least activity during the winter.

The following table provides a summary of fish and shellfish landings in Georgia. This table was developed by the GA DNR, Coastal Resources Division and used by permission.

Table 4-17. Summary of Georgia Fish and Shellfish Landings by Broad Category

Year	Food Shrimp	Hard Blue Crabs	Bait Shrimp	Hard Clams	Potatoes	Offshore Demersals	Shad	Other Finfish	Misc. Crustacean & Mollusks	Whole	Oysters	Total
1994	lbs 4,581,070	8,853,564	60,833	10,824	180,057	417,159	75,785	196,631	65,782	672,617	13,624	15,127,946
	value 19,783,714	4,510,691	562,552	73,158	122,826	653,338	80,945	163,725	211,057	377,323	29,764	26,571,093
1995	lbs 7,255,073	9,298,860	59,753	9,763	96,548	398,103	172,525	170,141	83,673	557,129	6,340	18,107,908
	value 27,002,973	5,020,608	572,736	64,974	78,981	698,915	131,350	163,436	257,288	336,654	15,571	34,343,486
1996	lbs 4,132,607	5,791,688	53,798	31,647	69,187	339,553	152,241	161,044	108,745	425,534	4,269	11,270,313
	value 16,335,208	3,018,151	519,561	194,409	35,166	576,617	109,285	152,500	368,962	254,717	9,227	21,573,803
1997	lbs 4,543,631	6,808,290	58,376	16,281	35,386	262,831	125,872	184,650	179,622	621,230	7,480	12,843,649
	value 22,254,286	3,835,798	590,563	114,521	32,290	443,529	93,540	174,552	512,564	389,437	18,428	28,479,507
1998	lbs 4,370,638	5,037,747	59,887	17,416	19,354	276,170	136,881	95,645	140,892	582,515	6,956	10,744,101
	value 19,080,321	2,604,625	634,375	122,891	18,189	502,850	86,370	88,690	490,918	406,942	17,212	24,053,412
1999	lbs 4,380,827	3,901,236	59,918	24,912	120,017	306,670	45,905	106,779	239,458	591,161	6,608	9,783,481
	value 18,364,973	2,045,493	665,633	153,074	71,328	666,778	45,496	103,670	460,301	414,597	17,325	22,958,068
2000	lbs 3,534,630	3,202,634	52,363	25,352	40,681	385,481	58,051	72,438	496,320	421,248	3,800	7,891,298
	value 17,309,053	2,077,587	565,352	212,821	40,738	779,277	33,457	72,298	399,445	277,485	9,733	21,777,246
2001	lbs 2,761,313	2,702,493	62,759	24,872	52,946	425,927	34,611	32,380	1,225,170	325,761	8,528	7,656,660
	value 10,459,975	2,500,657	576,654	186,644	40,280	849,034	27,729	32,853	496,320	245,330	22,254	15,437,730
2002	lbs 3,397,290	2,027,491	76,016	48,611	100,986	424,841	27,699	42,112	1,553,296	63,585	7,996	7,769,923
	value 11,140,950	1,967,968	688,185	319,413	64,948	830,321	22,682	42,519	440,057	49,621	19,997	15,586,661
2003	lbs 3,519,644	1,855,396	79,219	74,983	62,471	285,688	36,076	25,306	1,591,403	90,169	10,976	7,631,331
	value 9,815,906	1,901,797	723,316	520,515	41,318	552,420	27,024	28,852	401,035	69,393	31,019	14,112,595
2004	lbs 3,223,113	3,066,234	69,833	69,826	44,791	304,817	42,582	30,491	1,160,738	3,581	5,108	8,021,114
	value 10,023,570	2,272,500	634,951	426,048	37,414	645,037	34,418	33,448	429,375	3,941	14,859	14,555,561
2005	lbs 2,882,969	4,386,837	60,844	112,483	34,761	292,511	45,556	28,623	325,250	2,688	5,268	8,176,566
	value 8,539,787	3,019,314	564,190	658,175	32,017	621,393	44,083	31,491	206,917	2,768	20,473	13,739,648
2006	lbs 2,457,065	4,076,881	67,441	46,086	18,745	177,890	65,288	27,136	72,551	4,709	14,480	7,028,272
	value 7,089,816	2,881,119	634,732	299,292	19,158	461,343	67,961	31,027	120,449	5,729	55,231	11,665,859
2007	lbs 1,777,112	4,399,402	43,214	59,360	32,188	207,417	44,639	18,477	376,649	1,074	15,976	6,975,528
	value 6,024,147	3,536,959	404,991	405,746	32,710	519,332	45,060	26,438	297,800	1,315	65,250	11,359,138
2008	lbs 1,947,419	4,180,334	54,064	67,113	22,171	191,291	33,976	24,545	1,281,953	4,488	13,168	7,820,522
	value 7,330,941	3,666,172	467,390	523,449	20,217	550,296	36,827	31,228	416,931	5,878	55,321	13,104,647
2009	lbs 2,146,048	3,694,146	61,862	90,277	26,935	221,768	34,807	21,797	572,950	16,365	19,016	6,815,971
	value 6,335,710	3,418,446	551,619	603,283	25,692	535,973	35,340	27,366	682,619	17,380	81,265	12,314,693
2010	lbs 180,813	176,201	1,138	12,050				7,572	2,080,243	15,699	6,496	2,480,212
	value 314,484	227,800	9,847	65,460				8,839	195,138	18,844	28,125	868,537
Average 1994-2010	lbs 3,558,310	4,315,848	57,736	43,639	59,827	307,582	70,781	73,275	656,058	298,797	9,182	9,184,988
	value 12,776,813	2,853,274	550,979	290,816	44,580	614,278	57,598	71,343	377,394	169,280	30,062	17,794,217

Values are ex-vessel
Shrimp weights are pounds of tails
Crab and fish are pounds of whole animals

2009 and 2010 data are incomplete and subject to change
Adapted from GSA DMS4-CDD

Commercial and sport fishing within Savannah Harbor is low due to heavy vessel traffic levels and high shoaling rates which limit benthic communities and required recurring maintenance dredging. Marine finfish taken around the mouth of the harbor include spotted sea trout, spot, croaker and other bottom species. Cobia and tripletail provide for a limited amount of sport fishing in the outer channel.

GA DNR, Coastal Resources Division indicates the area of the navigation channel commonly known as Tybee Roads and eastward is a popular location for recreational fishing for king and Spanish mackerel during the late spring and summer. One ocean fishing pier is located on Tybee Island (Tybee Pavilion Ocean Pier off 16th Street) and is considered an important recreational facility. The ocean pier, private recreational vessels, charter boats, and head boats that use the nearshore waters also contribute to the local economy. Recreational surf fishing is not extensive on Tybee Island since the natural water depth is shallow near the beach and very gradually deepens offshore.

4.13 Socio-Economic Resources

4.13.1 Land Use

The City of Savannah dominates the mainland on the south side of the harbor. The city's historic downtown area is located on a bluff approximately 18 miles upstream from the river's mouth. Heavy industry and shipping facilities are located along the south side of the harbor upstream from the city's historic area to the upper limits of the authorized deep-draft navigation channel. Additional heavy industries and a few shipping facilities line the harbor downstream from the city historic area to the Atlantic Intracoastal Waterway. The Savannah National Wildlife Refuge, Tybee National Wildlife Refuge, Fort Jackson Historic Site, and Fort Pulaski National Monument are located within the project area. From the Atlantic Intracoastal Waterway to the river's mouth, both sides of the harbor are predominately undeveloped areas consisting of islands, marshes, upland confined dredged sediment placement facilities, and other undeveloped sites.

Land use on the South Carolina side of the Savannah River is basically agricultural, silvicultural, with some recreation. Substantial growth in residential development is occurring in Jasper County, South Carolina. The rate of that growth has slowed as a result of the recent economic downturn, but continued growth is expected in the future. Wetland habitat types found along Savannah Harbor include saltwater aquatic, saltwater coastal flats, saltwater marshes, freshwater aquatic, freshwater flats, and freshwater marsh.

4.13.2 Population

4.13.2.1 Georgia. Georgia had a population of 9,687,653 based on 2010 US Census data. This was an increase of 18.3% from the 2000 census population of 89,186,453, which was an increase of 26.4% since the 1990 census. Chatham County, Georgia had a population of 265,128 in 2010, an increase of 14.3% from the 232,048 in 2000. The City of Savannah, located in Chatham County, had a 2009 estimated population of 134,699, also growing 2.4% since 2000.

4.13.2.2 South Carolina. South Carolina had a population of 4,625,364 in 2010, increasing by 15.3% from 4,012,012 in 2000. The 2000 population also grew 13.1% since the 1990 census. Jasper County, South Carolina, that borders Savannah, had a population of 24,777 in 2010. This is an increase of 19.8% from the 20,678 according to the 2000 Census.

4.13.3 Income and Employment

4.13.3.1 Georgia. Economic data from the Bureau of Labor Statistics indicates that in November of 2011 Georgia had a labor force of 4,748,200. The unemployment rate in Georgia was 9.9% which is 0.5% drop from November 2010. Chatham County's labor force in November 2011 was 130,625 with an unemployment rate of 8.7%, a 0.5% decrease from November 2010. In 2010, the City of Savannah had a labor force of 175,700 and an unemployment of 9% which was an increase of 0.7% from the 2009 rate. The US Census Bureau reports that the personal per capita income of Georgia in 2009 was \$25,098 and \$25,240 per capita in Chatham County. According to the US Department of Commerce, the personal per capita income in Savannah for 2010 was \$38,899.

4.13.3.2 South Carolina. Using the same data sources listed above, South Carolina's labor force in November 2011 was 2,165,000. South Carolina's unemployment rate dropped 1.0% from 10.9% to 9.9% in from November 2010 to November 2011. Jasper County had a labor force of 10,399 and 8.3% unemployment rate in November 2011, a drop of 1.7% in unemployment from November 2010. The US Department of Commerce Bureau of Economic Analysis data shows that the personal per capita income in 2009 was \$31,646 in South Carolina and \$26,625 in Jasper County.

5.00 ENVIRONMENTAL CONSEQUENCES OF THE PROPOSED ACTION

The Corps coordinated its evaluation of potential environmental effects from the Savannah Harbor Expansion Project with various experts within the Federal and State natural resource agencies through a series of Interagency Coordination Teams. These groups were formed around specific natural resources, as follows:

- A. Wetlands
- B. Water Quality
- C. Fisheries
- D. Sediment Placement
- E. Groundwater

The agencies involved are those that must provide some type of approval or certification for the Project before construction could occur. This includes, for example, such agencies as the SC Department of Health and Environmental Control because of the Project's need to obtain a South Carolina water quality certification, and the GA DNR Coastal Resources Division because of the need to obtain concurrence in the District's Coastal Zone Management Consistency Determination, as well as the USEPA, US Department of Commerce, and the US Department of the Interior, who must approve the Selected Plan and associated mitigation plan. The intent of that coordination was to ensure that the SHEP study team; (1) conducted the necessary evaluations, (2) used evaluation tools that are acceptable to the agencies, (3) evaluated the alternatives under conditions determined by the agencies to be appropriate, and (4) developed the type of information the agencies would need to reach their decision about the project. The Corps sought to obtain incremental approval of the technical work that was conducted on the project to reduce potential lost effort and time. Copies of meeting records and decision documents are found in Appendix N.

The expected effects or impacts of the proposed harbor deepening alternatives, including cumulative impacts of the proposed action on significant resources, are described in this section.

5.01 Wetlands

5.01.1 Impacts from Excavation of Wetlands

5.01.1.1 Impact Identification. Approximately 15.68 acres of brackish marsh would be lost as a result of various excavation requirements of the project. The excavation requirements (in regards to the amount of wetlands that would be affected) for all five channel depth alternatives are the same. Figures 5-1, 5-2, and 5-3 show the six locations where brackish marsh would be excavated. The first two locations are in the SNWR where approximately 2.2 acres would be removed at Station 102+600 and 0.8 acres would be removed as part of the Kings Island Turning Basin expansion. The project would remove brackish marsh from two locations on Hutchinson Island where approximately 3.4 acres would be excavated at Station 88+000 and 0.8 acres at Station 70+000. The project also provides for removal of the Tidegate structure abutments on both the Georgia and South Carolina sides of the river. Removal of the Tidegate structure

abutment on the Georgia side would result in the loss of about 7.63 acres of brackish marsh while about 0.85 acres would be lost on the South Carolina side of the River as shown below in Table 5-1.

Table 5-1. Wetland Direct Impacts

Location (Channel Station)	Affected State	Wetland Acres Affected by Excavation
Refuge Lands		
102+600	Georgia	2.2
Kings Island Turning Basin	Georgia	0.8
Non-Refuge Lands		
88+000	Georgia	3.4
70+000	Georgia	0.8
Tidegate	Georgia	7.63
Tidegate	South Carolina	0.85
Total		15.68 acres

The SHEP would require oxygen injection at three sites. These systems would include construction of support facilities on high ground (oxygen production facilities, etc.) as well as pipelines to withdraw river water and return oxygenated water to the river. Two of the injection sites are located on Hutchinson Island. Every effort would be made to avoid the discharge of fill material into estuarine emergent wetlands located at these sites. If this impact cannot be avoided, the Corps would determine the extent of impacts and provide appropriate mitigation. Restoration of Disposal Site 1S would provide an excess of wetland mitigation credits designated for use by other activities associated with the Savannah Harbor Navigation Project. These excess wetland mitigation credits should be more than sufficient to satisfy any wetland mitigation requirements associated with construction of the oxygen injection support facilities.

Impacts to non-tidal wetlands could occur from construction of the raw water storage impoundment that would mitigate for expected impacts to water quality at the City of Savannah's water intake in Abercorn Creek. Section 5.02.15 describes the impoundment that would be constructed. Although it would be located on high ground in an existing industrial park, construction of the storage impoundment including its pumping station and inflow and outflow pipes) could result in adverse impacts to a small amount of wetlands. Savannah District will conduct detailed surveys during the final design and follow the interagency-approved Savannah District Regulatory SOP to quantify the extent of any mitigation that may be needed. The Corps would coordinate the results of the SOP calculations with GADNR and the Federal natural resource agencies.

5.01.1.2 Mitigation. During the natural resource agencies' review of a preliminary version of the DEIS, the agencies requested "in kind" mitigation for direct impacts to brackish marsh. Each of the proposed harbor deepening alternatives would result in the loss of approximately 15.68 acres of brackish marsh. USEPA recommended use of a salt marsh mitigation bank, the preferred choice of mitigation specified in the USEPA/USACE Final Compensatory Mitigation Rule, which was published in the Federal Register on March 31, 2008. However, there are currently no salt marsh mitigation banks serving coastal Georgia (One salt marsh mitigation bank was approved by the Interagency Review Team (IRT) in 2007, but the owner declared bankruptcy before the bank was operational). As a result, the Corps explored other mitigation opportunities. The Corps evaluated several sites within coastal Georgia, but the USFWS subsequently indicated a preference for mitigation of these impacts within the Savannah River Basin. Ultimately, a previously used sediment placement area (Disposal Area 1S) within Savannah Harbor was identified as having the greatest opportunity to support the long-term success of a restored salt and brackish marsh system.

Disposal Area 1S is located adjacent to the confluence of Front River and Middle River, and it is located within the boundaries of the Savannah National Wildlife Refuge (see Figure 1-1). Much of the site is currently "high ground" as a result of the previous sediment disposal actions, which were terminated at least 20 years ago. The Corps hosted a site visit on August 10, 2009, and the agencies approved the concept of grading down the site to restore it to a marsh. The proposed restoration area is approximately 40.3 acres. The site would be restored by grading it down to an elevation that would allow the growth of *Spartina alterniflora* (i.e., +7.6 to +7.7 MLLW). These elevations were identified based on the elevation of adjacent marsh. Once the new elevations have been established, the site would be allowed to naturally vegetate. A 1.7 acre site adjacent to the 40.3 acre SHEP mitigation site was graded down by GPA several years ago as mitigation for work at their facilities. The SHEP wetland mitigation site and GPA's existing saltmarsh acreage (1.7 acres) would provide a contiguous 42 acre wetland. The Corps used the Regulatory SOP to determine the number of acres that would be required to restore to adequately compensate for the direct excavation impacts. The 15.68 acres of direct impact to brackish marsh equates to approximately 138 mitigation credits. Calculations derived from the SOP indicate that approximately 28.8 acres of restored marsh would be required to mitigate for the 15.68 acres of impact. A copy of the SOP calculation sheets can be found at the end of Appendix C. While the Corps intends to restore approximately 40.3 acres of brackish marsh at Disposal Area 1S, only 28.8 acres of the restored area would be required to satisfy the SHEP wetland mitigation requirements for the excavation areas. However, additional wetland mitigation credits may be required for minor impacts to wetlands associated with other aspects of the SHEP. Consequently, the remaining 11.5 acres of excess restored brackish marsh would be used to satisfy any additional wetland mitigation credits needed for the SHEP, or credited to the Savannah Harbor Navigation Project as "advance mitigation" and used when the need arises for small amounts of marsh mitigation to compensate for wetland impacts from approved O&M actions. Release of any excess credits for use on the Savannah Harbor Navigation Project (O&M) would not occur until after the long-term health/productivity of the restoration site is verified by the Federal Cooperating Agencies.

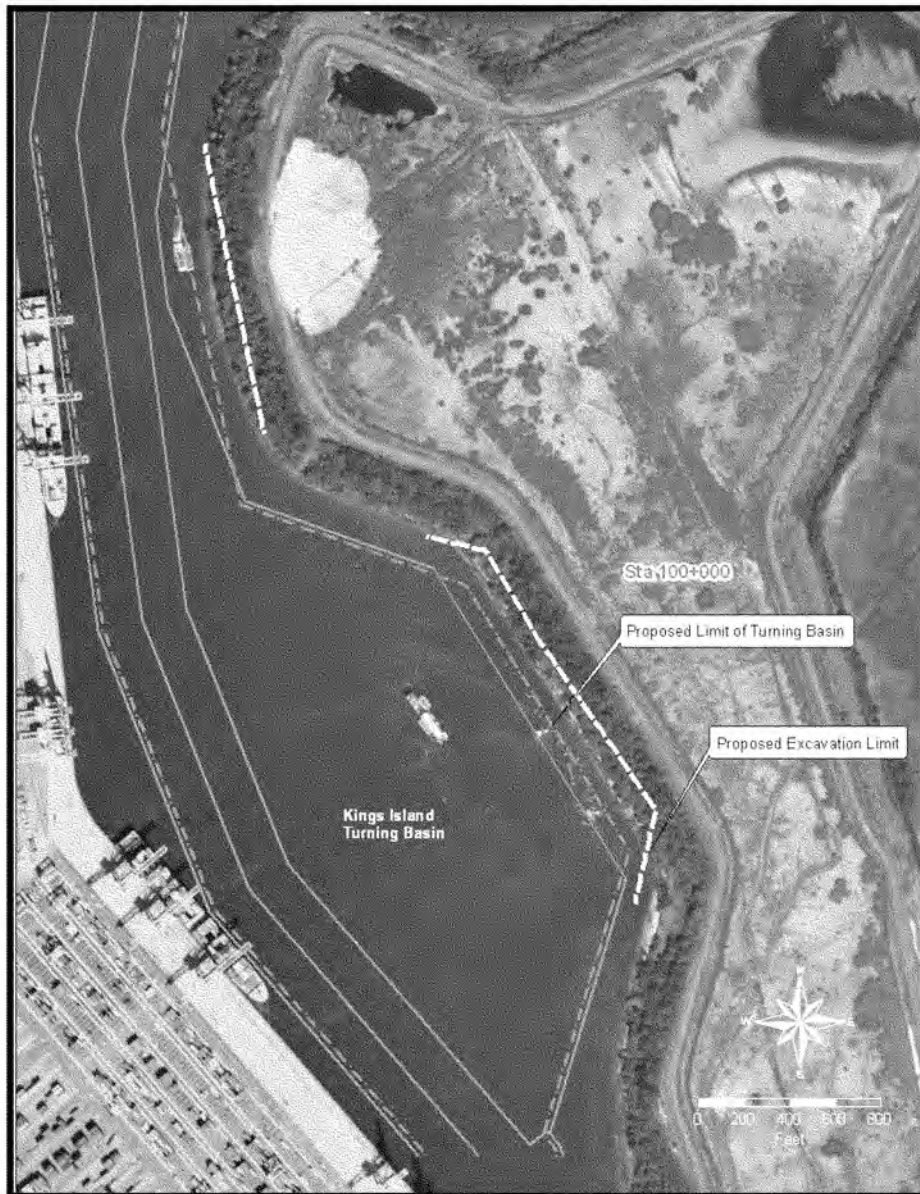


Figure 5-1. Excavation area at Kings Island Turning Basin.



Figure 5-2. Excavation area on Hutchinson Island.



Figure 5-3. Excavation area at Tidegate.

Restoration of the Disposal Area 1S site would occur by grading it down to an elevation that would allow the growth of *Spartina alterniflora* (i.e., +7.6 to +7.8 MLLW) (Figure 5-4). The Corps selected that elevation range after inspecting and surveying the elevations of natural marsh that is immediately adjacent to the proposed restoration site. Once the new elevations have been established, the approximately 40.3-acre site would be allowed to naturally vegetate. As requested by the USFWS, a “feeder creek” system would be constructed toward the interior of the restored marsh. The creek would provide another mechanism of ensuring adequate exchange of brackish, surface water with pore waters that are located on the interior of the site. The Corps would let the site naturally revegetate, which is expected at the rate shown in Table 5-2. Revegetation success would be determined by comparing restoration site 1S to a reference marsh site in the vicinity.

Table 5-2. Revegetation Rates for Created Marsh

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

The Corps would monitor the site for a period of seven years, and the success of the brackish marsh would be based on meeting or exceeding the annual values defined for the percent of vegetative coverage for *Spartina alterniflora* shown in the above table. The marsh transects would be sampled twice annually (June and October). The Corps would provide annual reports of the performance monitoring to the Wetland Interagency Coordination Team (ICT) for review.

If the site does not revegetate at those rates, the Corps would plant *Spartina alterniflora* to provide the basis for subsequent growth across the entire site. The ICT would identify/recommend corrective actions, including planting requirements and associated sprig densities, which would achieve compliance with the reported percentages in the above table. The site would be monitored to assess the success of the marsh planting.

It is unlikely that invasive species (*Phragmites australis*) would significantly colonize the restoration site given the density of *Spartina alterniflora* and associated seed stock in the immediate vicinity. Likewise, the site’s salinity/tidal range are conducive to supporting a robust growth of *Spartina alterniflora*. However, the restoration of wetlands at Site 1S would also include a monitoring plan for invasive species and an invasive species control plan that could be implemented if required. If invasive species are identified, they would be removed from the site via hand grubbing or another method approved by the Wetland ICT.

The marsh restoration site (Disposal Area 1S) is located within the SNWR. However, the Corps and the GA DOT still maintain a dredged material disposal easement on the site. The Corps and the GA DOT would relinquish this easement.

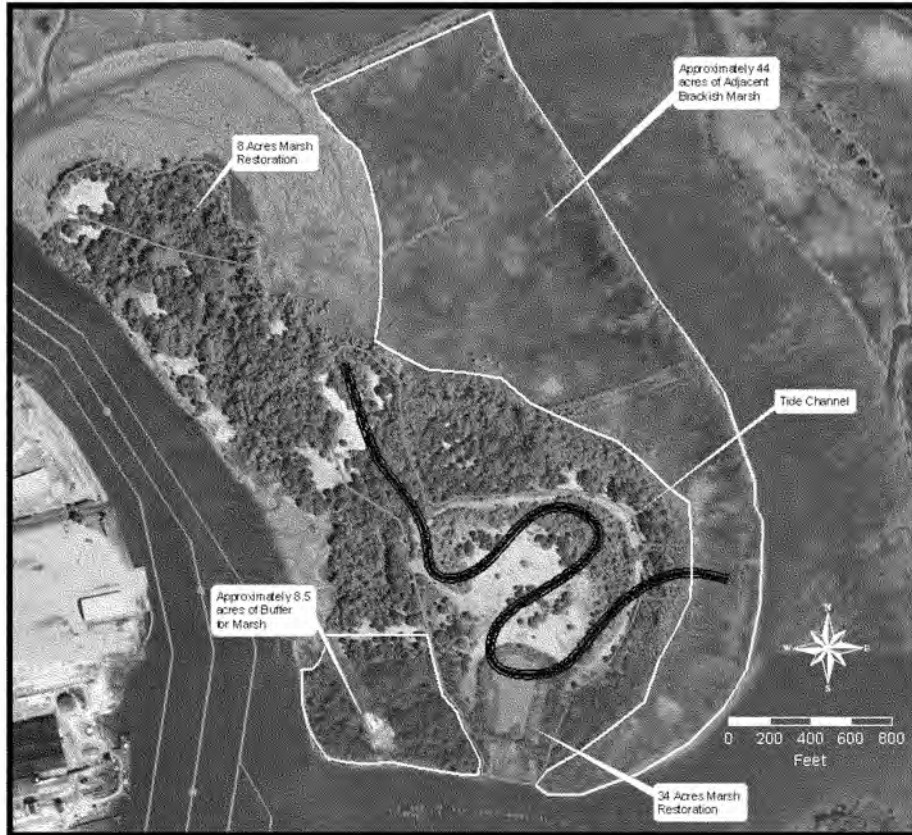


Figure 5-4. Restoration area at Disposal Area 1S.

5.01.2 Indirect Impacts to Wetlands

5.01.2.1 Procedures. Since tidal freshwater marshes were identified by the USFWS as the single most critical natural resource in the harbor, the Corps focused on identifying project impacts to that resource. The other natural resource agencies concurred with this priority. The majority of the tidal freshwater marshes presently occur between the Houlihan Bridge (GA 25) and the I-95 Bridge. Salinity is the primary determining factor in the conversion of tidal freshwater marshes, so that parameter was identified as the focus of the mitigation modeling efforts.

The Corps used a state-of-the-art hydrodynamic model to identify impacts to wetlands and floodplains from the proposed project alternatives. The project initially attempted to apply a boundary-fitted hydrodynamic model (BFHYDRO) and a similar water quality model (WQMAP) to the Savannah estuary. GPA began this effort in Tier I with an extensive data collection effort in 1997. They supplemented that with a more extensive hydrodynamic and water quality data collection effort in 1999. After several years of effort to develop reliable and accurate models, the Federal Cooperating Agencies decided in 2004 that the BFHYDRO and BFWASP models did not meet the desired performance criteria. The agencies then decided that instead of investing further effort into improving those models, the project should consider using models that EPA had recently developed for its TMDL analyses. EPA had used the same field data that GPA had collected in 1997 and 1999 and applied it in a different set of computer models (EFDC and WASP). After a technical review of the structure and performance of the EPA TMDL models, EPA, USFWS, NMFS, SC DHEC, and GA DNR-EPD concluded that the EPA models would likely provide acceptable impact prediction tools, and the SHEP should pursue refinement of those models. The project then funded efforts to enhance the capabilities and accuracies of these EPA models.

The Water Quality Interagency Coordination Team assisted in the application of EPA's model on this project. EPA, USFWS, NMFS, USGS, SC DHEC, GA DNR-EPD and the Corps agreed in 2006 that the enhanced model was suitable for use in evaluating potential impacts from this proposed harbor deepening project. ERDC performed an Independent Technical Review (ITR) of the model, focusing on the model grid representation, input parameters, and existing conditions calibration. The reviewer stated that the model was acceptable for impact evaluation purposes on this project. The ERDC ITR did not include analysis of the model programming but rather the application of the model to Savannah Harbor. The EFDC and WASP models are on a Corps' "allowed for use" list of approved engineering models.

The Wetlands Interagency Coordination Team defined the conditions under which the hydrodynamic model should be used to identify project impacts to wetlands. This consisted of the use of average river flows (1997) during the months of March through October for the basic evaluation. Additional runs would be performed to evaluate the sensitivity of the results to different input conditions. Those sensitivity analyses include low river flows (2001 conditions) and sea level rise of 25 cm (9.84 inches) and 50 cm (19.69 inches). The results of those sensitivity analyses are included in the GRR Engineering Appendix. As a summary, the project would produce fewer impacts to wetlands under both drought flows with higher sea levels

because those conditions would reduce the amount of tidal freshwater marshes that are available for impact by a harbor deepening project.

As part of the impact and mitigation modeling process, the Corps attempted to develop and use Marsh Succession Models. These models were intended to use salinity information from the hydrodynamic model as input and produce information on the wetland species or vegetative community expected at a given location. Two versions of a Marsh Succession Model were developed -- one by a consulting firm called Applied Technology and Management (ATM), and the other by the USGS Fish and Wildlife Cooperative Research Unit in Gainesville, Florida (USGS Coop Unit). Those two groups collected field data in the Savannah tidal marshes and surrounding estuarine wetlands. ATM collected its field data from 1999 to 2002, while the USGS extended their sampling period to cover from 1999 to 2005. These two organizations used different data collection techniques and different site locations. Using the information they collected, each developed relationships between observed parameters and wetland vegetation and community types occurring at a given site.

Both versions of the MSM used salinity information from the hydrodynamic model that had been processed by a Model-To-Marsh linkage (M2M) as input. That linkage was developed by the USGS office in Columbia, SC. The M2M took salinity values from the tidal creeks, distributed them across the marsh surface, and produced salinity values expected in the marsh root zone. The relationships between salinity levels in the creeks, marsh surface, and marsh root zone were developed from data collected by the USGS Coop Unit in the Savannah estuary. The USGS produced a report titled "Simulation of Water Levels and Salinity in the Rivers and Tidal Marshes in the Vicinity of the Savannah National Wildlife Refuge, Coastal South Carolina and Georgia" in 2006 (Conrad et al, 2006) that described their M2M linkage and the report received an independent technical review within USGS. The report can be found as USGS Scientific Investigations Report 2006-5187.

ATM produced a report describing the Marsh Succession Model they developed. The Corps' Mobile District produced a report describing the MSM that the USGS Coop Unit developed. Each report explained how its model was developed and its accuracy and reliability. An External Peer Review was conducted in 2007 by a three-member panel on both model reports. The reviewers generally found both models to be acceptable.

Problems appeared when the Corps applied the Marsh Succession Models to some of the mitigation plans. The models produced unreliable results when they were used to evaluate mitigation plans that substantially altered flows in the tidal creeks. Changes in salinity were predicted by the hydrodynamic model in certain areas, but corresponding changes were not forecast by the Marsh Succession Models. The problems were traced to the way in which the Model-To-Marsh linkage extrapolates salinity values from the rivers and distributes them across the surface of the marsh. The limited number of points from which the M2M makes its extrapolations results in the linkage not being sensitive to changes in salinity in localized portions of the estuary. Salinity changes predicted to occur in the river produced no corresponding change in salinity levels in adjacent marshes. In March 2007, the Federal Cooperating Agencies discussed a USGS proposal to revise the linkage to increase its usefulness for evaluating potential mitigation measures. The agencies did not believe the effort to revise the

linkage would necessarily be successful or that the predicted improvements would be sufficient for the needs of the project. Therefore, the Federal Cooperating Agencies decided to abandon the planned use of the Marsh Succession Models to evaluate the mitigation proposals. The Marsh Succession Models (MSM) could still be used to check the predictions of wetland vegetation distribution resulting from use of the hydrodynamic model. The following paragraphs discuss that comparison.

To compare the results of the USGS MSM to the EFDC hydrodynamic models, one needs to compare similar thresholds or categories. According to the USFWS, the most important impact criterion in the Savannah Estuary is a change from freshwater tidal marsh to non-freshwater marsh. A threshold of 0.5 ppt salinity is generally accepted as the differentiation between freshwater marsh and brackish marsh. Cowardin et al (1979) use the 0.5 ppt threshold to differentiate between estuarine and palustrine emergent wetlands. This criterion was adopted by the Wetlands Interagency Coordination Team and refined to be 0.5 ppt at 50% tile exceedance river flow.

In the USGS/USFWS MSM model, the most freshwater marsh category is "100% *Eleocharis montevidens*, *Galium tinctorum*, and *Sagittaria latifolia* (100% Elemo_Galti_Saglt)". It occurs in the range of salinity from 0 to <1.0 ppt salinity. This category is the closest to the EFDC Hydrodynamic model salinity outputs of 0.0 to 0.5 ppt. The following table shows the difference at various depths of the MSM model runs using the 100% Elemo_Galti_Saglt category and the EFDC Hydrodynamic model runs using the 0.0 to 0.5 ppt category at 50% exceedance river flow with NO MITIGATION.

**Table 5-3. Comparison of Salinity Impacts
of the USGS/USFWS MSM to the EFDC Hydrodynamic Models
with No Mitigation**

	USGS/USFWS MSM Model	EFDC Hydrodynamic Model
Channel Depth Alternative	Acres of 100% Elemo-Galti-Saglt Net Change at Average Flow	Acres of 0.0 to 0.5 ppt Net Change at 50% Exceedance Flow
42-foot (Baseline)	2,231	4,072
44-foot	- 280	- 469.2
45-foot	- 485	- 967
46-foot	- 720	- 1,057
48-foot	- 962	- 1,212

The comparison shows that wetland impacts identified by using the EFDC hydrodynamic model are higher than those identified by the Marsh Succession Model at all proposed project depths. This indicates that the Corps' use of the EFDC-derived impacts is a more conservative estimate than those produced by using the more technically-advanced Marsh Succession Model.

5.01.2.2 Impacts without Mitigation. Several studies were conducted during the SHEP to establish baseline conditions in regards to the amount of tidal freshwater marsh remaining in the estuary. Both ATM (March 2003) and USFWS (Welch and Kitchens 2006) conducted studies to classify the various wetland communities in the study area (I-95 Bridge to mouth of Back River). Using a marsh succession model, the USFWS identified the following marsh distribution (Welch and Kitchens 2006):

Table 5-4. Marsh Distribution From MSM Model

Marsh Type	Acreage
Freshwater	3,269
Brackish	3,082
Saltmarsh	2,506

As discussed in previous paragraphs, the EFDC model was used during the SHEP study to evaluate both existing stream salinity levels and salinity levels that would occur with the various channel deepening alternatives in place. However, the EFDC model does not directly predict marsh salinity. Consequently, determining the existing wetland species composition in the estuary as well as predicting how these species would change with the various channel deepening alternatives, was accomplished using a method where marsh salinity contour lines are extrapolated from the river into the adjacent marsh areas. This method creates contours that divide the marsh into 5 salinity categories: 0-0.5 ppt, which is considered freshwater, 0.6-1.0 ppt, 1.1-2.0 ppt, 2.1-4.0 ppt, and >4.0 ppt. Using this method and river salinities predicted by the EFDC model, Table 5-5 shows the distribution of wetlands that the Corps calculated for the estuary downstream of I-95.

Table 5-5. Marsh Distribution From EFDC Model for Average River Flows

Marsh Type	Acreage
Freshwater	4,072
Brackish	2,253
Saltmarsh	2,506

The Wetlands Interagency Coordination Team agreed that this marsh distribution acreage would be used as the baseline for the impact assessment of tidal freshwater marsh losses that could be caused by any of the harbor deepening alternatives under consideration.

All of the deepening alternatives would adversely impact tidal freshwater marsh. Model predictions indicate that deepening the harbor to 44, 45, 46, 47, or 48-feet without mitigation would result in the conversion of 551, 967, 1,057, 1,177, and 1,212 acres of tidal freshwater marsh, respectively (average flow, low sea level rise) to brackish marsh (Table 5-6). These numbers would increase with a rise in sea level.

Table 5-6. Summary of Project-Related Impacts without Mitigation

	DEPTH ALTERNATIVES				
	44-Foot	45-Foot	46-Foot	47-Foot	48-Foot
Freshwater Wetlands	-551 acres	-967 acres	-1,057 acres	-1,177 acres	-1,212 acres

5.01.2.3 Mitigation – Flow Rerouting. Since the Cooperating Agencies identified tidal freshwater marshes as the single most critical natural resource in the harbor, the Corps focused on reducing project impacts to that resource. The intent was to identify alterations that could be made in rivers and tidal creeks to reduce salinity levels in critical areas of the estuary. If such measures could be identified, those alterations would be expected to provide long term sustainable beneficial effects. The vertical extent of the tide (tidal range) is also important in determining the vitality of a tidal marsh system. This parameter became important during evaluation of some potential mitigation measures.

The Corps conducted an extensive investigation of potential ways to reduce the impacts that were projected to occur with just a channel deepening (no mitigation). The team evaluated numerous potential alterations to water flow in the estuary, as a means of reducing salinity impacts to freshwater marsh. It analyzed a total of 38 alterations at 7 locations. Those locations are shown in Figure 5-5. Natural resource agencies reviewed initial modeling results in July 2006, and the interagency team jointly identified alterations to pursue further. After some additional modeling work was performed, the Corps determined what design (size) would be most effective at each location.

That determination was based on the extent to which salinity would be decreased coupled with reductions in adverse effects which may appear in other portions of the estuary. Based on the effectiveness observed in the initial modeling and preliminary estimates of construction cost, the Corps ranked the 5 best stand-alone flow rerouting measures in their order of decreasing cost effectiveness, as shown below (Table 5-7).

Table 5-7. Flow Rerouting Measures

Mitigation Option	Component Added
C	Deepen McCoys Cut
D	Fill Sediment Basin
A	Close Middle River, Open New Cut, Close Houston Cut
E	Remove Tidegate
B	Reroute flow through Steamboat River

The Corps followed an incremental approach to evaluate how these measures could be combined. Since some measures result in similar effects, the order in which they are combined was found to be important. As a result of additional modeling performed after the interagency meeting and considering potential implementation difficulties, the Corps developed the dual approach shown below. The dual approach primarily resulted from uncertainties about the potential adverse effects of both (1) the filling of the Sediment Basin on harbor maintenance activities, and (2) relocating the downstream end of Middle River in Mitigation Option A. After additional modeling was performed, a decision would be made whether the path with Plans 1-2-3 or Plans 1-4-5 was more effective (Table 5-8). After making that determination, the Corps would then evaluate two other Mitigation Options, removing the Tidegate (Option E) and rerouting flow through Steamboat River (Option B). The natural resource agencies concurred in this approach in August 2006.

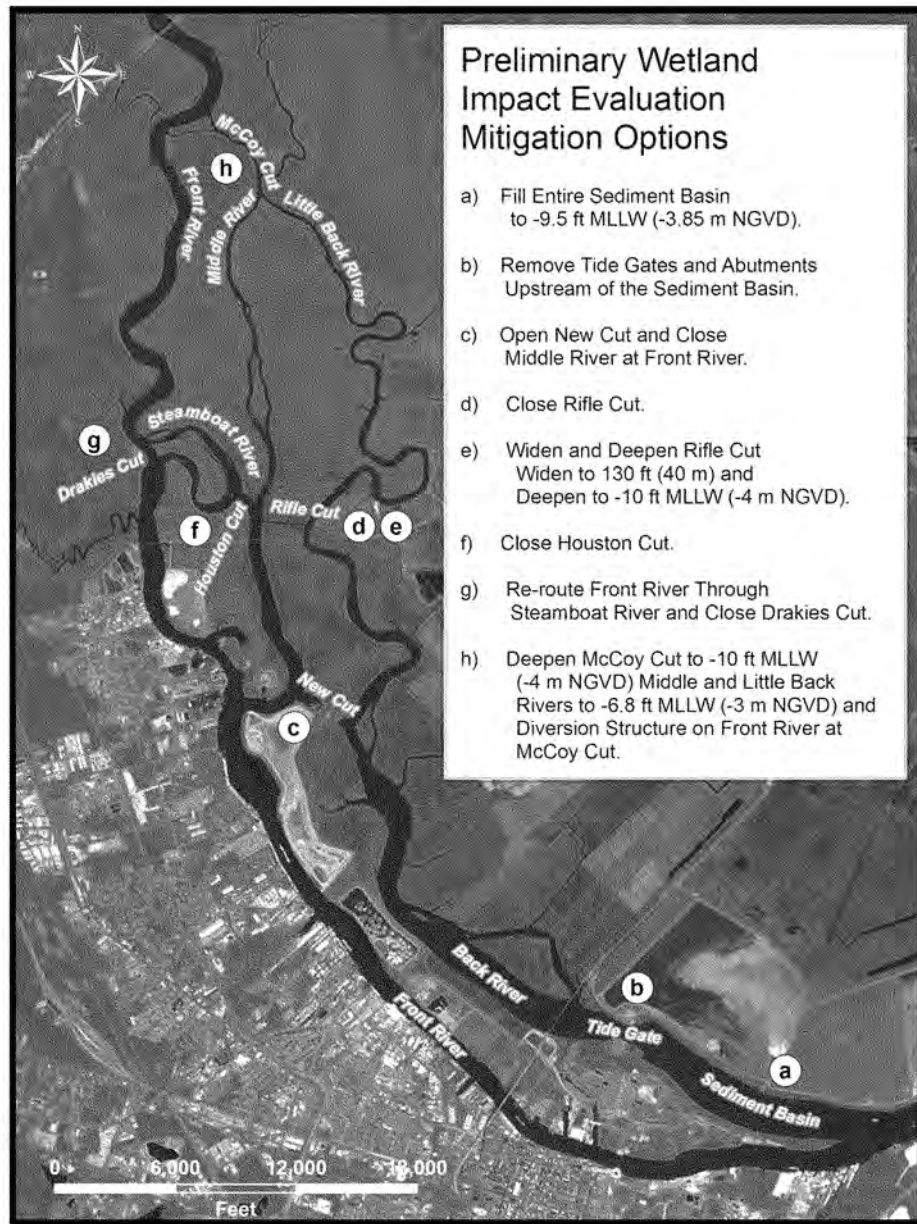


Figure 5-5. Potential flow-altering mitigation measures.

Table 5-8. Flow Rerouting Plans

Mitigation Plan	Mitigation Combination	Component Added
1	C	McCoys Cut
2	C + D	Sediment Basin
3	C + D + F	Rifle Cut
1	C	McCoys Cut
4	C + A	Middle River, New Cut, Houston Cut
5	C + A + D	Sediment Basin
6	3 or 5 + E	Tidegate
7	3 or 5 + B	Steamboat River

With the various channel depths considered, over 160 modeling runs were required to evaluate the effects of each mitigation plan. The modeling was conducted for each of the five depth alternatives. The results of the modeling are summarized in the following table prepared for the 6-foot deepening alternative (Table 5-9).

Table 5-9. Wetland/Marsh Mitigation Evaluation
48-foot Deepening Alternative
Average River Flows
50% Salinity Exceedance Values

	Marsh Acreage	Net Acres Adversely Impacted
Existing Conditions	4,072	-----
Deepening Only (No Mitigation)		1,932
Plan 1		988
Plan 2		988
Plan 3		834
Plan 4		1,334
Plan 5		325

Similar information was developed for the three alternative scenarios, which were considered as sensitivity analyses. One scenario used 2001 drought flows, rather than the average river flows. Two other scenarios included different amounts of sea level rise (25 or 50 cm) over the 50-year life of the project. The adverse impacts to freshwater wetlands were the same or less in two of the three sensitivity analyses. That trend did not hold up when 50-cm of sea level rise was considered. Under that scenario, the flow re-routing plans would not be as effective in reducing adverse impacts to freshwater wetlands. Some of those wetlands would have already been converted to brackish marshes as a result of the saltwater intrusion from the sea level rise, even without further harbor deepening. In general, the table above shows the largest amount of adverse impacts to tidal freshwater wetlands of the four scenarios that were considered.

The Corps then conducted additional modeling of the flow-altering components of the mitigation plans. The Corps' modelers developed additional plans to identify one that would be more effective in reducing wetland impacts. They developed the following variations to existing plans – Plans 3A, 3B, 3C, 6A, and 6B. While not a complete listing, Figures 5-6 to 5-13 show examples of how the flow-altering measures were combined into plans for analysis.

In September and October 2007, results became available on the effectiveness of the flow-altering features in reducing impacts to wetlands in the project area. The agencies suggested a slightly different methodology to graphically quantify impacts to the wetlands. The Corps used that alternate approach for the remainder of the study, so the numerical results of this iteration are not directly comparable with the initial impact quantification. The results for the second modeling iteration are discussed below.

After coordination of these modeling results, the USFWS proposed an additional plan, which was designated as Plan 8. That plan is shown in Figure 5-14. Initial modeling found that this plan would not be particularly effective at mitigating impacts to freshwater wetlands. It would result in a lower tidal range in the upper portion of Middle River, which would likely adversely affect wetlands located there. Therefore, this plan was not considered further.

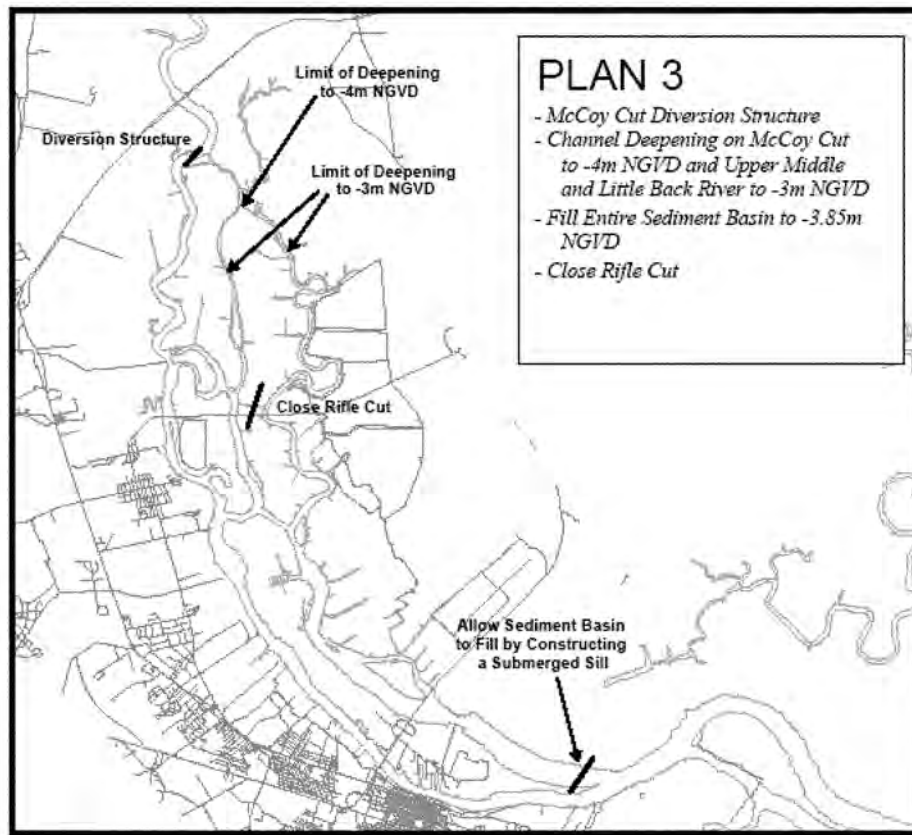


Figure 5-6. Potential flow rerouting Plan 3.

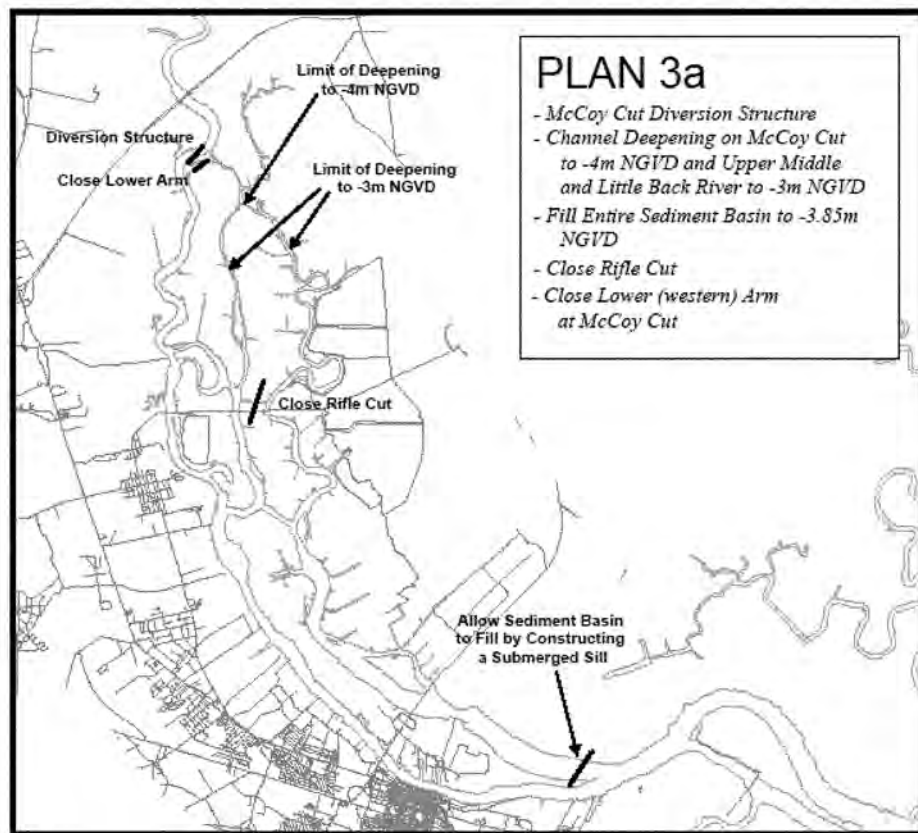


Figure 5-7. Potential flow rerouting Plan 3A.

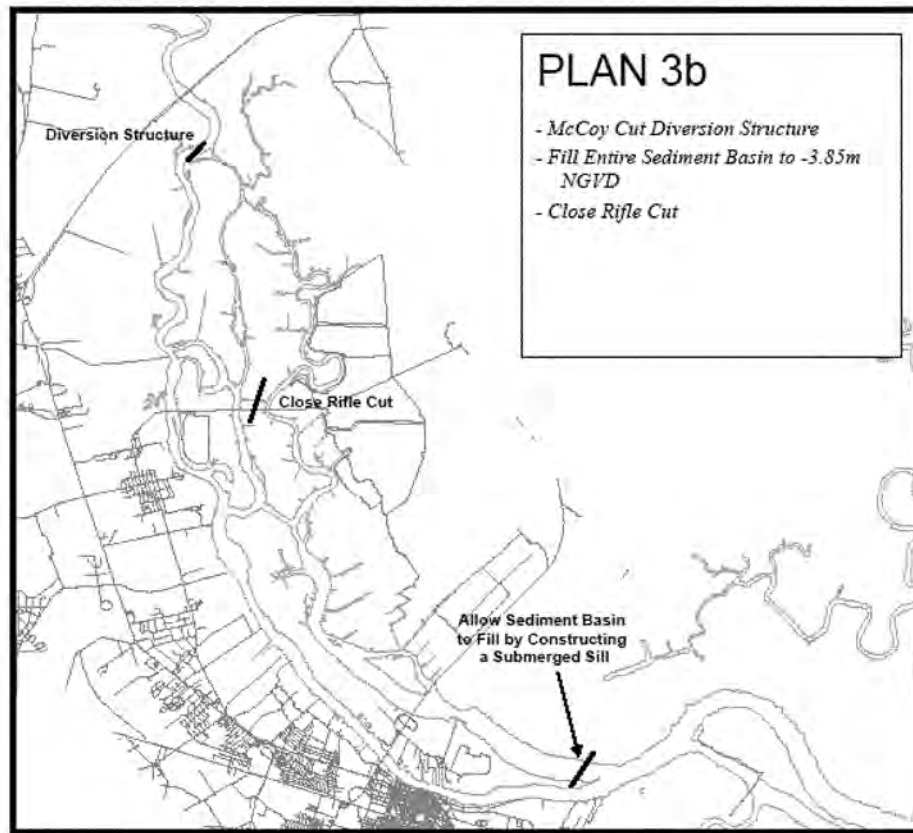


Figure 5-8. Potential flow rerouting Plan 3B.

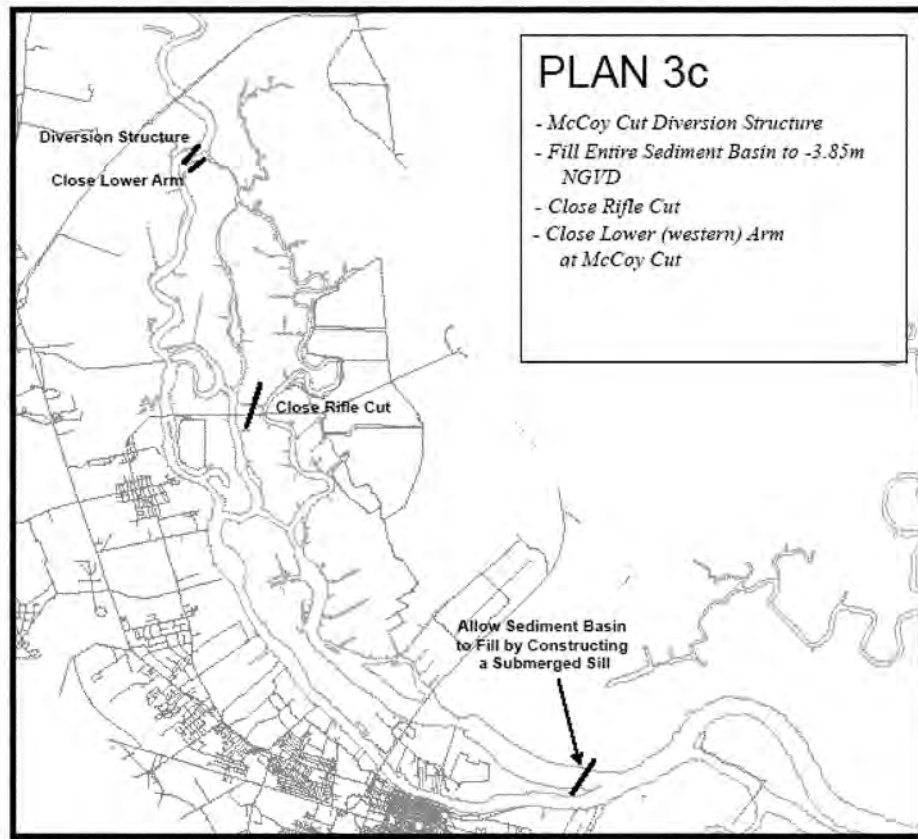


Figure 5-9. Potential flow rerouting Plan 3C.

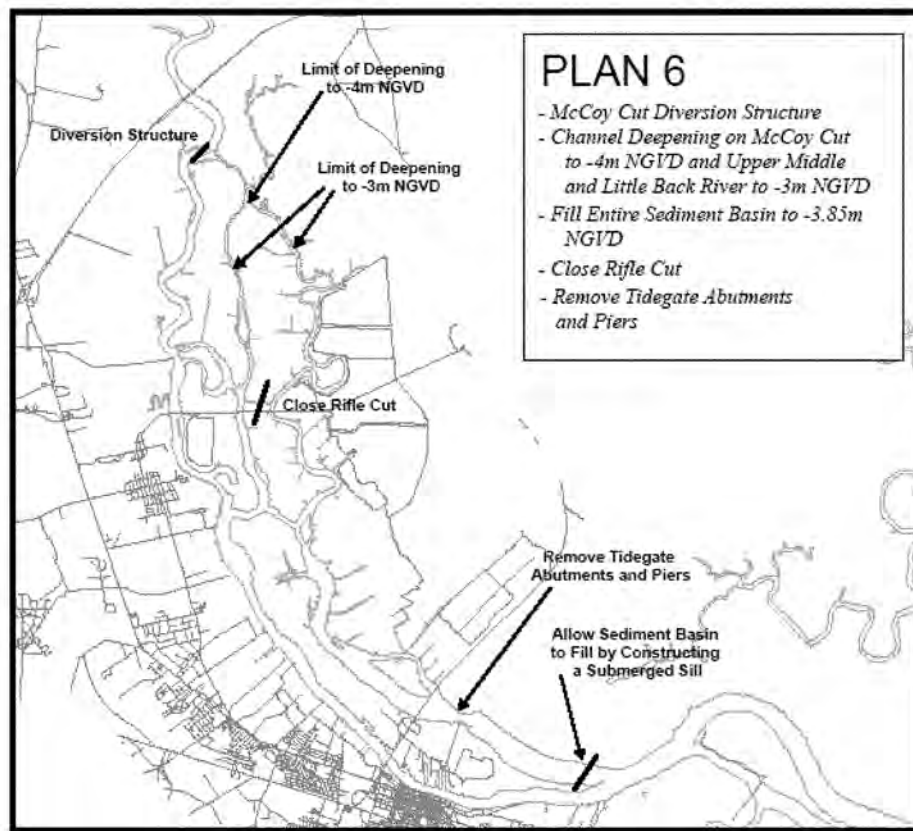


Figure 5-10. Potential flow rerouting Plan 6.

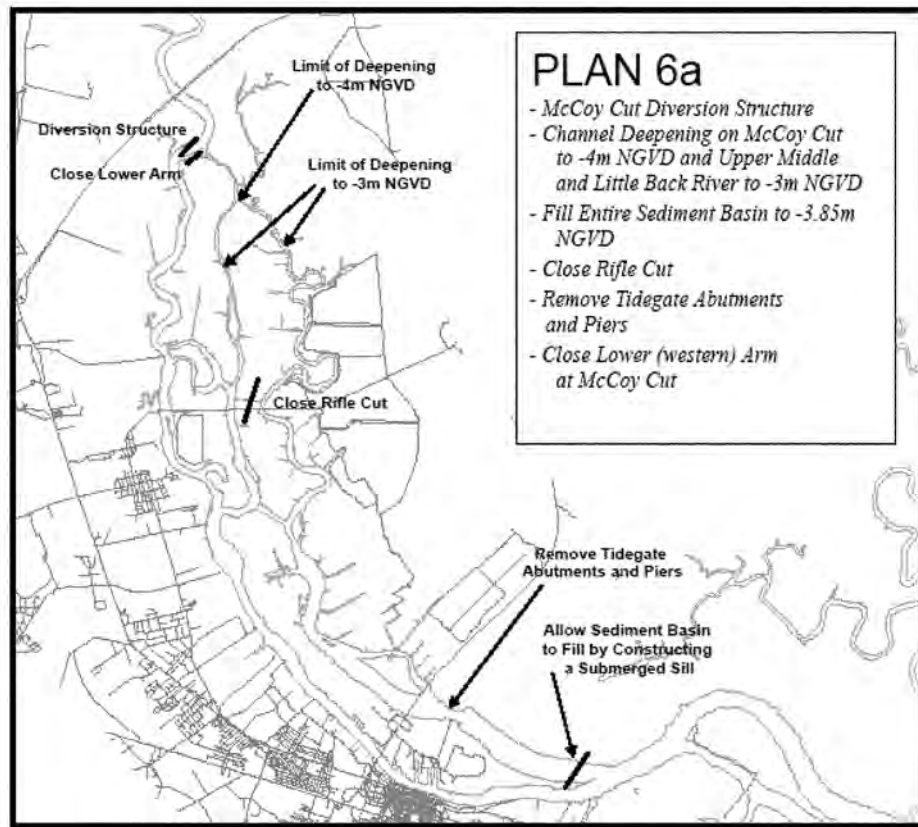


Figure 5-11. Potential flow rerouting Plan 6A.

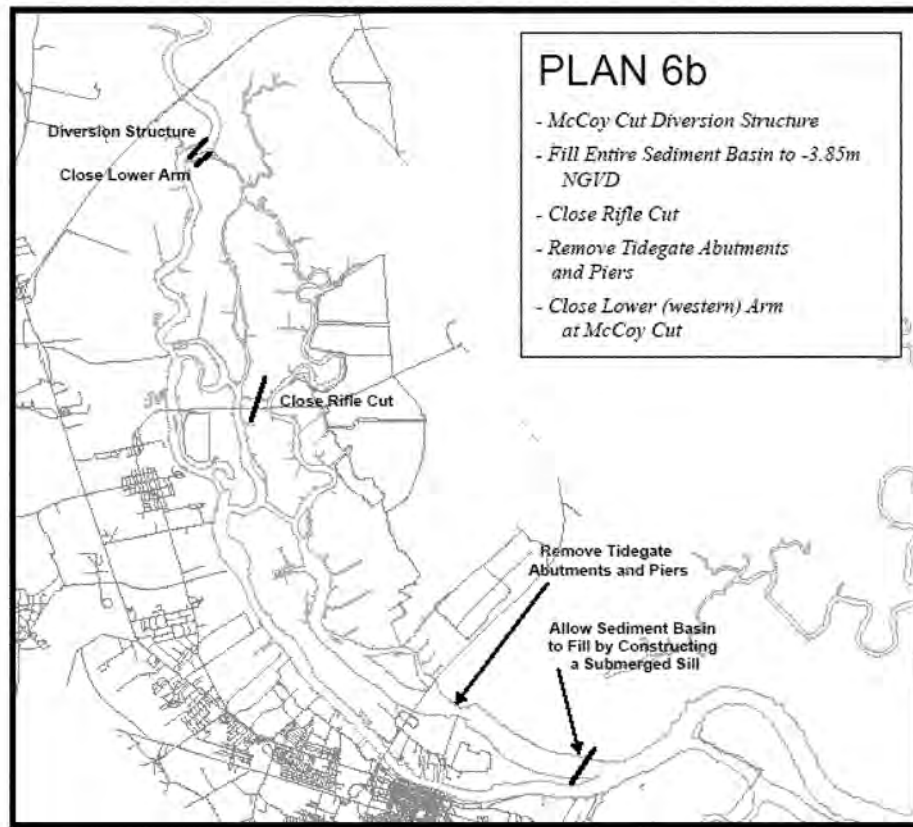


Figure 5-12. Potential flow rerouting Plan 6B.

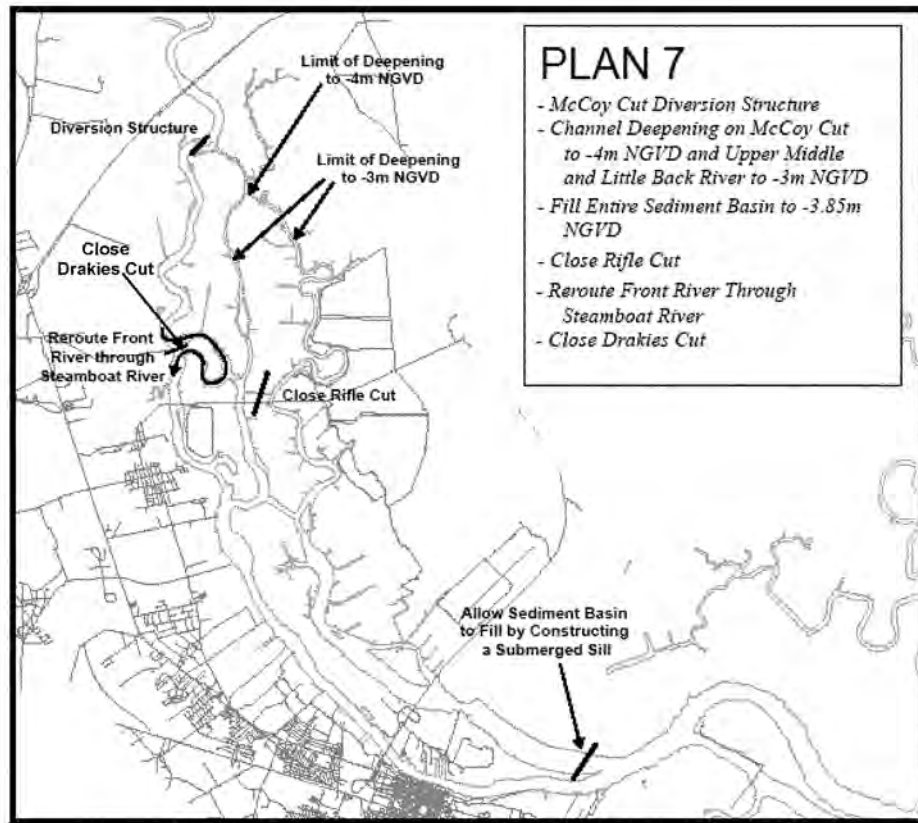


Figure 5-13. Potential flow rerouting Plan 7.

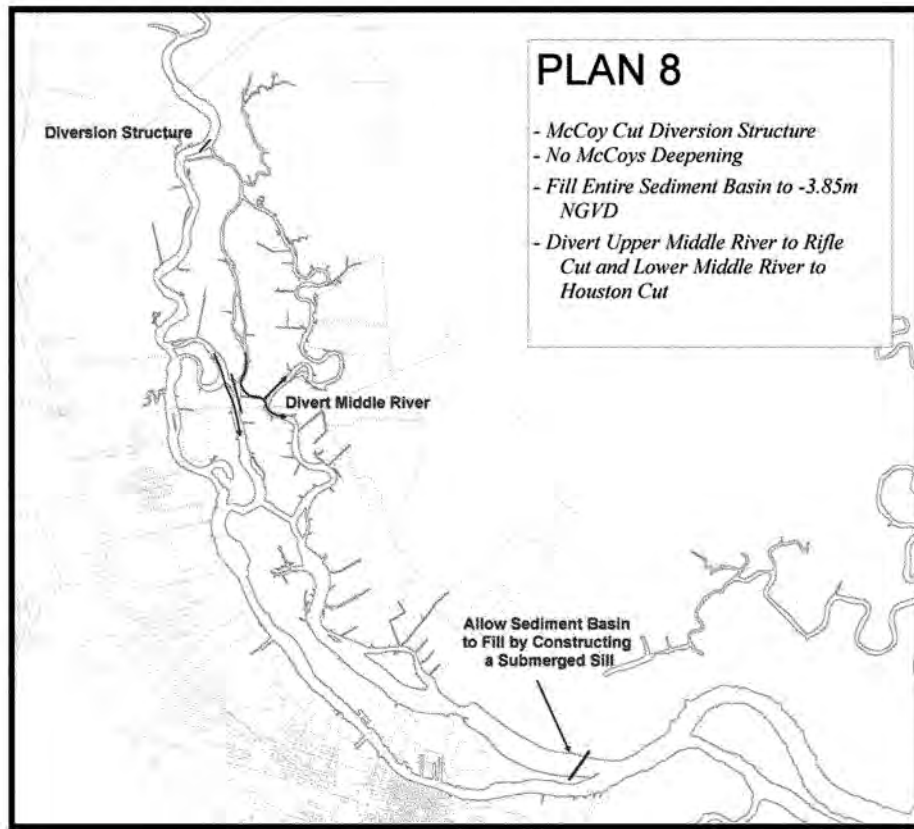


Figure 5-14. Potential flow rerouting Plan 8.

The effectiveness of these plans at reducing adverse impacts from the harbor deepening alternatives to freshwater marshes (<0.5 ppt) is displayed in the following tables (Tables 5-10 through 5-14) using average river flows and 50% salinity exceedance values. Based on the cost effectiveness of the flow rerouting plans at reducing adverse impacts to freshwater marshes, Savannah District selected flow rerouting Plan 6B for the 44-foot depth alternative and Plan 6A for all the other depth alternatives.

Table 5-10. Wetland/Marsh Mitigation Evaluation - 44-foot Depth Alternative

	Marsh Acreage	Net Acres Adversely Impacted
Existing Conditions	4,072	-----
Deepening Only (No Mitigation)	3,521	551
Plan 3	4,093	-21
Plan 3A	3,973	99
Plan 3B	3,821	251
Plan 3C	3,872	200
Plan 6	4,792	-720
Plan 6A	4,844	-772
Plan 6B	4,394	-322

NOTE: Negative adverse impact numbers means that the plan would result in positive effects of freshwater marshes.

Table 5-11. Wetland/Marsh Mitigation Evaluation - 45-foot Depth Alternative

	Marsh Acreage	Net Acres Adversely Impacted
Existing Conditions	4,072	-----
Deepening Only (No Mitigation)	3,105	967
Plan 3	3,718	354
Plan 3A	3,798	274
Plan 3B	3,572	500
Plan 3C	3,626	446
Plan 6	4,038	34
Plan 6A	4,040	32
Plan 6B	3,865	207

Table 5-12. Wetland/Marsh Mitigation Evaluation - 46-foot Depth Alternative

	Marsh Acreage	Net Acres Adversely Impacted
Existing Conditions	4,072	-----
Deepening Only (No Mitigation)	3,015	1,057
Plan 3	3,753	319
Plan 3A	3,840	232
Plan 3B	3,521	551
Plan 3C	3,599	473
Plan 6	3,817	255
Plan 6A	3,871	201
Plan 6B	3,610	462
Plan 7	4,285	-213

Table 5-13. Wetland/Marsh Mitigation Evaluation - 47-foot Depth Alternative

	Marsh Acreage	Net Acres Adversely Impacted
Existing Conditions	4,072	-----
Deepening Only (No Mitigation)	2,895	1,177
Plan 6A	3,849	223

Table 5-14. Wetland/Marsh Mitigation Evaluation - 48-foot Depth Alternative

	Marsh Acreage	Net Acres Adversely Impacted
Existing Conditions	4,072	-----
Deepening Only (No Mitigation)	2,860	1,212
Plan 3	3,584	488
Plan 3A	3,531	541
Plan 3B	3,406	666
Plan 3C	3,383	689
Plan 6	3,715	357
Plan 6A	3,735	337
Plan 6B	3,610	462
Plan 7	3,772	300

The regional agency-coordinated preferred level of mitigation for the selected plan (47-foot depth alternative) is based on a base year impact of 223 acres. Corps policy requires calculation of project impacts on an average annual basis throughout the period of analysis. The District, however, requested a waiver to deviate from Section 5, paragraph E-36.c.(1) of ER 1105-2-100 regarding how environmental impacts are computed. The Assistant Secretary of the Army (Civil Works) has granted the request for the policy waiver, allowing mitigation to be based on impacts expected to occur at the time of construction versus annualized impacts over the life of the project.

5.01.2.4 Additional Wetland Mitigation. As discussed in the previous paragraphs, indirect impacts associated with the proposed deepening would result in a vegetative shift in 223 acres of tidal freshwater marsh to brackish marsh with implementation of the selected plan (47-foot channel depth alternative) even with the flow rerouting. Approximately 740 acres of saltmarsh would also be impacted by the flow rerouting since more freshwater would be introduced into Little Back and Middle Rivers which could cause some areas of saltmarsh to shift to more brackish species. As previously discussed, the Corps used the EFDC model to evaluate both existing stream salinity levels and salinity levels that would occur with the various channel deepening alternatives in place. However, the EFDC model does not directly predict marsh salinity. Consequently, determining the existing wetland species composition in the estuary, as well as predicting how these species would change with the various channel deepening alternatives was accomplished using a method where riverine surface salinity levels are extrapolated across the adjacent marshes. This method creates contours that divide the marsh into 5 salinity categories: 0-0.5 ppt, which is considered freshwater, 0.6-1.0 ppt, 1.1-2.0 ppt, 2.1-4.0 ppt, and >4.0 ppt. In turn, distinctions between marsh types and acreage were defined based on the following salinity ranges: (0-0.5 ppt) Freshwater Marsh, (0.5-4 ppt) Brackish Marsh, and (>4ppt) Saltmarsh, as recommended by the Wetland Interagency Coordination Team.

The results of the functional assessment concluded that the differentiation between saltmarsh and brackish marsh recommended by the Wetland Interagency Coordination Team and used in the DEIS was constrained. The salinity range used in the SHEP to differentiate between brackish marsh (0.6-4 ppt) and saltmarsh (> 4ppt) was restrictive, given that brackish marsh salinities have been reported with a range from 0.5-10 ppt (NOAA, 2010) and in other estuarine systems from 0.5-17 ppt (Judd and Lonard, 2004). An earlier assessment of wetland vegetation coinciding with the salinity range reported for brackish marsh systems (i.e., 5-10 ppt) which occur within the area of potential effect, also supports those findings. The EFDC value for saltmarsh (> 4.0 ppt) is approximately 2.5 times less than that reported by NOAA (2010). Additionally, the NOAA (2010) range for brackish marsh includes areas determined by the EFDC model to be saltmarsh. When considering values reported in the literature, the acreage of saltmarsh conversion (740 acres) which was calculated using the EFDC model is a very inclusive value and includes existing vegetative areas that may not transition to brackish marsh following deepening because these areas currently exist within the salinity range of a brackish marsh (0.5-10 ppt). Thus, the salinity range used to quantify saltmarsh in the area of potential effect (i.e., > 4 ppt) may over-estimate the amount of saltmarsh in the system and under-estimate the amount of brackish marsh. As such, the described conversion of saltmarsh to brackish marsh, which could occur as a result of harbor deepening, would likely be much less if one takes into account

vegetative characteristics for wetland environments with associated salinities that are more commonly associated with a brackish marsh (i.e., range between 0.5 and 10 ppt).

Given the wide range of salinity reported in literature for brackish marsh systems, the inherent variability in salinity that exists for all estuarine systems, and the modeling results that report post-deepening salinity concentrations consistent with the aforementioned range, Savannah District concludes that the 740-acre calculated conversion of saltmarsh to brackish marsh if the harbor is deepened to 47-feet is conservative, with actual vegetative shifts unlikely to be identifiable *in situ* in Savannah Harbor. That said, the District was inclusive in its assessment of the potential for project-related effects and elected to include the saltmarsh and brackish marsh conversion in its calculation of minor impacts.

The conversion of 223 acres of freshwater wetland to brackish marsh represents the only significant wetland conversion that is likely to be noticeable if the harbor is deepened to 47-feet as proposed. It is important to note that the ecological values of the impacted 223 acres of freshwater wetlands would not be completely lost. Instead, those acres would convert to brackish marsh. The Corps' calculation of the number of acres of freshwater wetland that have the potential to be converted to brackish marsh is based on a shift in the location of 0.5 ppt salinity, a traditional rule-of-thumb for differentiating between freshwater marsh and brackish marsh. However, data reported in the literature for Savannah Harbor suggest that a shift in vegetation (from freshwater marsh to brackish marsh) in this estuary does not occur until salinity concentrations approach 2.5 ppt (Latham et al., 1994). Even at oligohaline marsh sites with average salinity concentration of 2.1 ppt, a discriminant function (DF) analysis revealed that only 47% of cases resulted in the correct pairing of environmental variables with vegetative species composition and dominance. At those same oligohaline sites, 37% of the vegetative species composition and dominance were more closely aligned with a freshwater classification (Latham et al., 1994).

Deepening the harbor to a 47-foot depth would result in a conversion of the dominant vegetative species typically observed in approximately 223 acres of freshwater marsh (freshwater to brackish marsh scenario). It is important to note that many of the emergent plant species associated with freshwater marsh systems would still be readily observed in environments that have been defined as brackish marsh (Latham et al., 1994). Likewise, the 47-foot depth would result in a conversion of the dominant vegetative species typically observed in 740 acres of saltmarsh (saltmarsh to brackish marsh scenario), and dominant saltmarsh species like *Spartina alterniflora* would still be observed in areas which have salinities that define a brackish marsh. However, the overall basic wetland functions typically associated with these systems would not change. A comparison of potential changes in elements of wetland function for both conversion scenarios is provided in Table 5-15.

Table 5-15. Changes in Wetland Function as a Result of Wetland Conversion

Elements of Wetland Function	Freshwater to Brackish Marsh (Approximately 223 acres)	Saltmarsh to Brackish Marsh (Approximately 740 acres)
Water Purification	Negligible	Negligible
Flood Protection	Negligible	Negligible
Shoreline Stabilization	Negligible	Negligible
Groundwater Recharge	Negligible	Negligible
Streamflow Maintenance	Negligible	Negligible
Retention of Particles	Negligible	Negligible
Surface Water Storage	Negligible	Negligible
Subsurface Storage	Negligible	Negligible
Nutrient Cycling	Negligible	Negligible
Values to Society	Negligible	Negligible
Fish and Wildlife Habitat	Minor Adverse	Negligible

Negligible Effect – the effect on the resource would be at the lowest levels of detection, barely measurable, with no perceptible consequences, either adverse or beneficial, to the resource.

Minor Adverse Effect – the effect on the resource is measurable or perceptible, but it is slight.

Adverse Effect: the action is contrary to the interest or welfare of the resource; a harmful or unfavorable result

As illustrated in the table above, the only indirect effect the 47-foot project would have on the function of these wetlands systems would be associated with fish and wildlife habitat. All other elements of wetland function associated with predicted shifts in wetlands classification would be negligible as a result of the anticipated increase in salinity. It should be noted that areas of the Savannah Harbor identified as saltmarsh or brackish marsh support similar fish and wildlife species (Jennings and Weyers, 2003). Any anticipated conversion of saltmarsh to a brackish marsh system would have a negligible impact on the overall function of the wetland system. The Corps recognizes that a comparison of fish and wildlife habitat between freshwater and brackish marsh systems yields fewer similarities. However, the conversion in fish and wildlife habitat after deepening will still be minor when considering the total function of the wetland and continued existence of some freshwater vegetation in wetland areas that would be classified as brackish marsh. For additional information pertaining to the functional assessment, please see Appendix C, Section VII Consideration of 2008 USEPA/USACE Mitigation Rule.

5.01.2.5 Mitigation - Restoration of Wetlands. Since there would be minor adverse effects to the fish and wildlife habitat function in 223 acres of tidal freshwater wetlands if the selected plan is implemented, an assessment was conducted to determine how to best mitigate for that impact. Once the extent of the impacts to wetlands was known, the Corps consulted natural resource agencies, the Stakeholders Evaluation Group, and other NGOs in an attempt to identify sites where freshwater wetlands could be restored, enhanced or created.

Four sites were identified and inspected by the Corps (Figure 5-15). These sites are within the Savannah River estuary and near the impact area. The site labeled Site A is a borrow site that was used during construction of US Interstate 95. Soils were re-deposited at the site in the 1970s, and it has since revegetated. Although freshwater marshes no longer occur on the property, an inspection revealed the mixed site contains a considerable amount of wetland vegetation. Thus, a substantial increase in wetland functional values would not be obtained if the site was restored to a tidal freshwater marsh. Therefore, the site was deleted from further consideration.

The site labeled as Site B consists of forested lands along the SC boundary of the Savannah National Wildlife Refuge (SNWR). The Corps initially identified this as a potential site where tidal freshwater marsh could be created. The property is situated in the estuary where freshwater occurs both now and after a potential deepening project. The site is adjacent to existing freshwater marshes, and tidal creeks that could be extended to provide the water necessary to flood the lands. The Corps developed preliminary designs to excavate the site to marsh elevation, move those soils to an adjacent property, and enlarge a creek to bring tidal flows to the site. Roughly 1,000 acres of freshwater wetlands could be created if lands exceeding a 10-foot MSL elevation were graded down to a 0 MSL elevation. The Corps and USFWS personnel inspected the site in September 2007. One portion of the site had been logged within the past 5 years, while two other portions were in the process of being logged. The USFWS questioned if the Corps could reliably convert the primarily upland site into a high quality tidal freshwater marsh. USFWS stated that they preferred the Corps not attempt to create wetlands on that site.

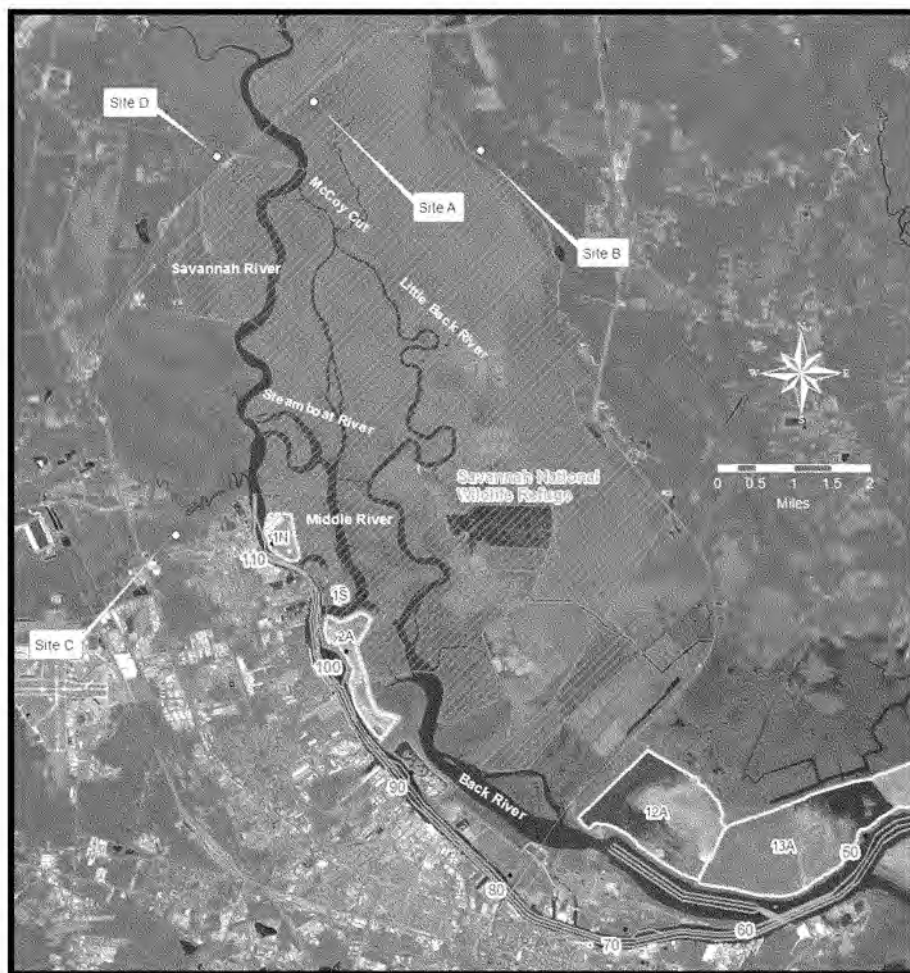


Figure 5-15. Potential wetland restoration and creation sites.

The USFWS acknowledged that the South Carolina lowcountry is rapidly developing, particularly with regard to large scale residential developments. Lands such as Tract B, with its road access and marsh views, seem to be particularly highly desired. Developers had surveyed this site and others along the SNWR boundary and were actively marketing the properties. The Corps consulted with the natural resource agencies about the value of acquiring this site and

preserving it to provide a buffer from development along one side of the Refuge. Before the Corps could complete its mitigation evaluation, the site sold for development and is no longer available to the non-Federal sponsor at a reasonable cost. Neither the Georgia Ports Authority nor the Georgia Department of Transportation has condemnation authority in South Carolina.

The site labeled as Site C is on the Georgia side of the river along St. Augustine Creek. The site had been identified by staff in Savannah District's Regulatory Division as having restoration potential. The site is a mixture of uplands and wetlands, with a breached dike bordering most of St. Augustine Creek. Corps' staff inspected the site in September 2007. They found sections of dikes to still be present, but several openings allow tidal flows to cover portions of the area. It was not apparent the extent to which the dike segments are still reducing tidal flows to the site. A drainage ditch from GA Highway 21 crosses the site, likely reducing water levels on some of the tract. Active use of the ditch to drain the highway may limit the ability to block the ditch to raise adjacent water levels. The restoration potential may well be limited to removing the dike segments and restoring marsh vegetation within the footprint of the dikes. That seemed to present a limited opportunity, and the site was dropped from further consideration for this project.

The site labeled Site D is located approximately 1 mile NW of the I-95 bridge over the Savannah River and is approximately 1 mile WSW of the Savannah River at its closest approach. The tract encompasses approximately 260 acres at the head of Knoxboro Creek, a tributary of the Savannah River on the Georgia side. After conducting a site visit in November of 2010, Corps' staff determined that the tract represents a very limited possibility for use as a wetland mitigation site for creation of tidal freshwater marsh. The site is surrounded on 3 sides by intact bottomland hardwood-cypress wetlands and the nearest existing freshwater tidal marshes are 2.5 miles ESE of the site. It may be that tidal freshwater marsh would not normally exist on the tract and could require extensive management to prevent succession to the forested wetlands that would normally occur there. Furthermore, if tidal freshwater marsh were created on the tract, and Knoxboro Creek would not provide sufficient water ebb and flow, the next nearest water source is the Savannah River, approximately 1 mile away. Establishing and maintaining a constructed tidal freshwater marsh on the site would require expensive construction and maintenance costs, and once established, would require constant intervention to prevent the site from reverting to forested wetlands. As such, the site was removed from consideration for this project.

The Corps consulted the natural resources agencies, the Stakeholders Evaluation Group, and NGOs in an attempt to identify other sites in the Savannah River estuary that could potentially be used for restoration or creation of tidal freshwater marsh. No one could identify other suitable sites.

The USFWS stated that mitigation actions must be performed within the basin for those actions to be acceptable to them and adequately compensate for wetland impacts within the Savannah National Wildlife Refuge. The Service also confirmed that restoration, enhancement or creation of saltmarsh would not be acceptable as mitigation for losses to tidal freshwater marsh.

5.01.2.6 Preservation of Wetlands. After pursuing ways to avoid and minimize project impacts, and then restore or enhance existing environmental functions, one looks to preservation as a means of addressing expected project impacts. For impacts to freshwater wetlands, the Corps used the Standard Operating Procedure for Compensatory Mitigation (SOP), which has been adopted by the natural resources agencies in Georgia to evaluate impacts and calculate compensatory mitigation on projects requiring Section 404 permits. Although the SOP was developed by the interagency Mitigation Banking Review Team for actions permitted through the Corps' Regulatory Division, it can also serve as a framework to quantify impacts from civil works projects such as this. EPA Region 4 suggested the Corps consider use of the SOP for this project. In brief, the SOP uses several factors to quantify the ecological impacts and benefits expected from various project actions. For impacts, those factors include the type of impact, the duration of the impact, the type of vegetation being impacted, and the preventability of the impact. For restoration, the factors include: expected improvement in hydrology and vegetation, timing of the restoration, maintenance that is expected to be needed, monitoring which would be performed, and control over the land to reduce future impacts. For preservation, the factors include: degree of threat to the identified lands, type of vegetation occurring on the lands, and control over the land to prevent future impacts.

The Corps took the impact data produced by the approved hydrodynamic model as the starting point for the SOP. The model output was used to characterize and quantify 3 classifications of wetlands – Freshwater (<0.5 ppt), Brackish (0.5 to 4.0 ppt), and Saltmarsh (>4.0 ppt). The team used the model salinity information and wetland classification to determine the acreage for wetlands of different types. The Corps then evaluated the output both before and after the flow-altering features are included in the project. Wetland types that would experience a net loss in acreage were identified as ones that would experience an adverse impact. In a similar manner, wetlands that would experience an increase in net acreage would benefit from and be restored by the project.

Using the previously described approach, adverse impacts were evaluated with respect to wetlands classified as Freshwater, Brackish and/or Saltmarsh. Model results documented that restoration could occur in either Freshwater or Brackish marsh. The flow-altering features were the primary means through which the net acreage in Freshwater and Brackish marsh would increase. In the 44-foot depth alternative, the flow-altering features of Plan 6B would result in net increases in both Freshwater and Brackish marsh acreage, with a corresponding decrease in Saltmarsh acreage. The natural resource agencies had previously identified Freshwater and Brackish marshes as being more valuable than Saltmarsh in the evaluation of this project. Since the 44-foot depth alternative with the Plan 6B flow-altering features would result in net increases in Freshwater and Brackish marsh acreage, the plan would fully mitigate that alternative's indirect adverse impacts to wetlands.

The SOP considers many factors in its calculations of the ecological extent of a project's impact, and the value of the restoration and/or preservation features. Those factors are summarized in Table 5-16.

Table 5-16. Regulatory SOP Factors

Factors	Factors Included		
	Adverse Impacts	Restoration	Preservation
Type of Impact	X		
Duration of Impact	X		
Existing Condition	X		
Type of Habitat	X		
Preventability	X		
Rarity of Habitat	X		
Improvement in Vegetation		X	
Improvement in Hydrology		X	
Timing of Restoration		X	
In-Kind vs. Out-Of-Kind Mitigation		X	X
Maintenance Requirements		X	
Monitoring Plan		X	
Type of Control		X	X
Degree of Threat			X

One of the factors considered in the SOP is the degree of protection to be provided over the lands to be acquired and preserved. That is the issue addressed in the factor titled "Type of Control". Lands that are owned in fee or by a government agency are considered more protected from future adverse impacts than are lands protected only by a restrictive covenant or conservation easement. A conservation easement can sometimes be obtained from a private owner without the government needing to resort to condemnation. However, more lands under easement would be needed to provide the same SOP-derived value as would fewer lands under government ownership. The Corps consulted the natural resource agencies to determine the type of real estate interest that the agencies believed would be most appropriate in this situation. The USFWS stated that fee ownership would be required.

The Corps applied the SOP to this project using the acreage outputs from the hydrodynamic model at various salinity levels. The Corps also evaluated the extent of impact that would occur to existing marshes (i.e., conversion of one intertidal marsh type to another) and the benefit that would occur to marshes as a result of the flow-altering features. The Corps also considered development pressures that are on waterfront properties in this estuary. Using the SOP, the 48-foot alternative would result in 7,705 units of adverse indirect impacts to wetlands (SOP calculation sheets can be found at the end of Appendix C). The impacts must be mitigated by at least an equal number of restoration and preservation units. In Georgia, the resource agencies' policy is that acceptable mitigation should consist of at least 50 percent restoration. For this project, restoration through the flow-altering features would comprise 58 percent of the total

wetland mitigation for the 48-foot alternative, 60 percent for the 47-foot and 46-foot alternatives, and 65 percent for the 45-foot alternative. Using the SOP, the Corps calculated the minimum number of acres that need to be acquired and preserved to acceptably mitigate for wetland impacts. For the project, those numbers are shown in Table 5-17.

Table 5-17. Preservation Needs for Wetland Impacts as Determined by SOP Calculations

Depth Alternative	Minimum Acres Needed
44-FOOT	0
45-FOOT	1,643
46-FOOT	2,188
47-FOOT	2,245
48-FOOT	2,683

Table 5-18 summarizes the results of the SOP calculations for the 47-foot alternative with flow altering plan 6A. The details of the SOP application for each depth alternative are shown in Appendix C. The units shown in the table are calculated through use of the SOP to quantify the amount of mitigation required and the counter-balancing environmental value of various mitigation actions.

Table 5-18. Summary of SOP Calculations for the 47-Foot Depth Alternative

	Freshwater	Brackish	Saltmarsh	Total
Impacted Wetlands				
Acres	223		740	
Units	2007		4736	6743
Restoration				
Acres		964		
Units		4048.8		4048.8 (60.0%)
Preservation				
Acres		2245		
Units		2694.2		2694.2 (40.0%)

Savannah District consulted the Corps' Center of Expertise for Ecosystem Restoration to confirm that the Regulatory SOP was a technically sufficient method of determining the amount of acres that the Project would need to acquire and preserve in order to compensate for adverse impacts to wetlands. The Center concurred that the SOP was a technically sound technique. They noted that – as with other techniques – the results depend heavily on the values assigned to specific parameters in the analysis. They also noted that with the approach followed in this application, much of the mitigation requirement was being driven by conversion of saltmarsh to brackish marsh, an activity which was reportedly a goal of the natural resource agencies for this estuary.

Table 5-19. Proposed Land Acquisition Acreage

Channel Depth Alternative	Freshwater Wetland Impacts (Acres)	Required Wetland Acquisition (Acres)
44-FOOT	+322*	N/A
45-FOOT	-32	1,643
46-FOOT	-201	2,188
47-FOOT	-223	2,245
48-FOOT	-337	2,683

* Denotes an increase in freshwater wetlands in conjunction with mitigation plan

Identification of lands to be acquired. The USFWS and the Savannah National Wildlife Refuge have identified properties within the estuary that they believe are ecologically valuable and provide positive contributions to the goals of the Refuge and enhance the area's fish and wildlife resources. The latest version of the Refuge's Acquisition Plan is dated July 2007 and is included in the document titled "Final Environmental Assessment and Land Protection Plan; Proposed Expansion of Savannah National Wildlife Refuge." This plan is being updated, and the USFWS has provided the Corps a Draft Map which reflects the latest approved expansion plan for the SNWR. The Corps proposes to acquire lands from the SNWR Acquisition Plan and provide them to the USFWS to manage as additions to the Savannah National Wildlife Refuge, to mitigate for the remaining wetland impacts from this project. The USFWS previously identified the ecological value of those properties and believes they would be valuable additions to, and advance the goals of, the Savannah Refuge. The SNWR has the authority to accept these lands, since the lands are already included in their approved Acquisition Plan. The USFWS would manage these properties using funds obtained through the Department of Interior's normal budget process. Although there are 45,836 acres in the approved Acquisition Plan, not all of those properties would provide the type of habitat that is desired as mitigation for this project. The location of these tracts is shown in Figure 5-16. The project would acquire properties from the approved SNWR Acquisition Plan that best meet the needs of the project. Those needs would be met by properties that are dominated by freshwater wetlands. The Corps has consulted with the Savannah National Wildlife Refuge and will lean heavily on their identified priorities.

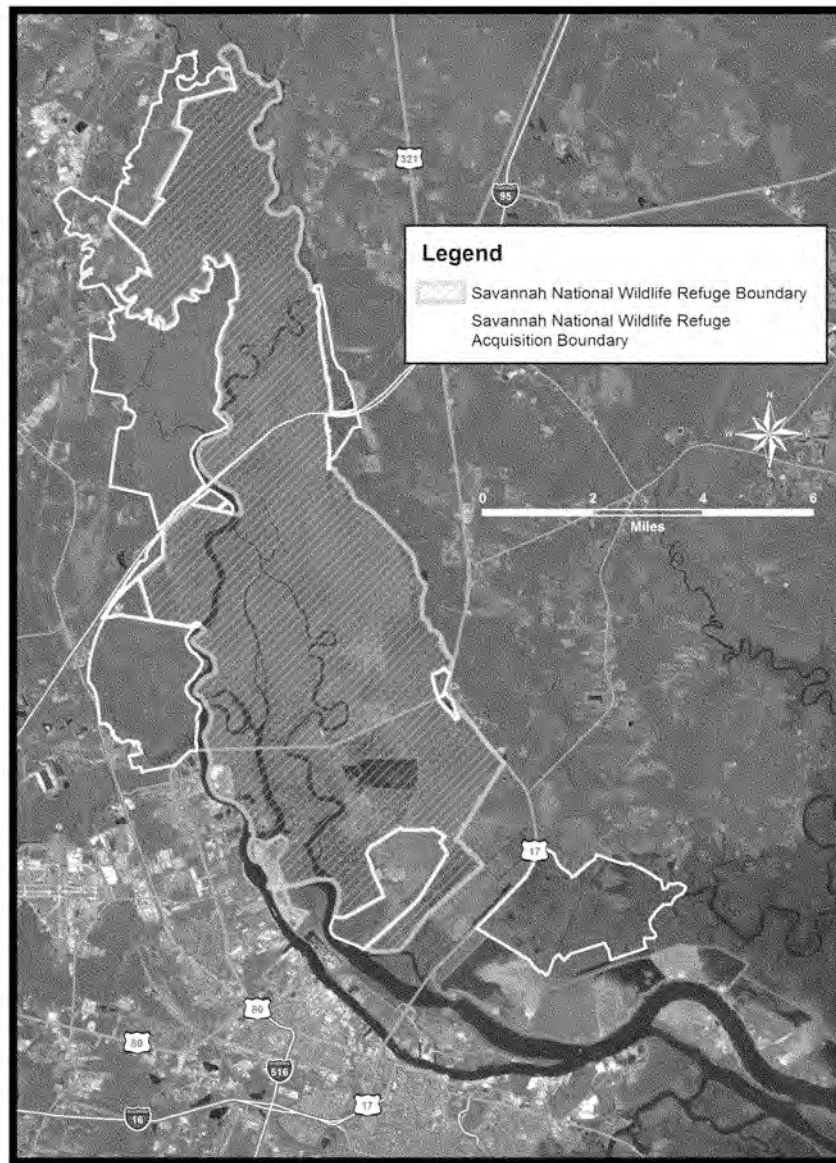


Figure 5-16. Approved refuge acquisition areas.

The Corps assessed the properties in the SNWR's Acquisition Plan to identify potential properties that could meet the wetland mitigation needs of the SHEP. This assessment (Consideration of 2008 USEPA/USACE Mitigation Rule) is in Appendix C. The lands proposed for preservation consist of bottomland hardwoods, maritime forest and uplands dominated by deciduous forest and regrowth. The bottomland hardwoods are classified as palustrine, forested, broad-leaved deciduous wetland systems that are both temporarily and seasonally flooded. Preserving these areas would ensure wildlife habitat is protected in perpetuity. Moreover, the additional lands would buffer the SNWR from future threats of development such that changes in land use would not occur immediately adjacent to existing areas of the Refuge that do contain estuarine emergent wetland characteristics. Thus, the acquisition and preservation of 2,245 acres of wetland and upland buffer would provide a functional replacement for the minor conversion of the only wetland function (i.e., fish and wildlife habitat) that would be expected as a result of the 223 acre freshwater to brackish marsh conversion.

5.01.2.7 Monitoring and Adaptive Management. Due to the unique nature of the impact (i.e., vegetative conversion), the Corps would also monitor to quantify the magnitude of the marsh conversion that does occur. If impacts to tidal freshwater marsh exceed those expected, funds would be available to purchase additional lands for preservation (Adaptive Management Plan). A monitoring plan has been developed (See Appendix D) that would establish 12 marsh monitoring sites in transitional areas that are predicted to most likely experience a vegetative shift as a result of the SHEP. Figure 5-17 shows the location of these 12 marsh monitoring sites. The green line illustrates the existing 0.5 ppt salinity contour within the harbor. The pink line illustrates the 0.5 ppt contour with the 47-foot project and implementation of Flow Diversion Plan 6A.

Seven of the marsh monitoring sites have already been established and were monitored by the USGS Florida Fish and Wildlife Cooperative Research Unit. The five new monitoring locations were chosen to expand monitoring in highly sensitive marshes, in other areas of marsh 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 versus exterior). One of the upriver sites and downriver sites would be used as a freshwater marsh and a brackish marsh reference site, respectively. The data collected from this monitoring would be used along with the hydrodynamic and water quality models to quantify indirect impacts to freshwater marsh and saltmarsh. These sites would be monitored during the one year of Pre-Construction monitoring, during construction and for ten additional years of Post-Construction Monitoring. The marsh sites would be characterized with respect to vegetation composition and compared to the reference marsh site. Tidal sample stations would also be installed at the sites which would record water surface elevation, specific conductance of surface waters that flood the marsh, specific conductance of waters in the root zone, and water depth every 30 minutes.

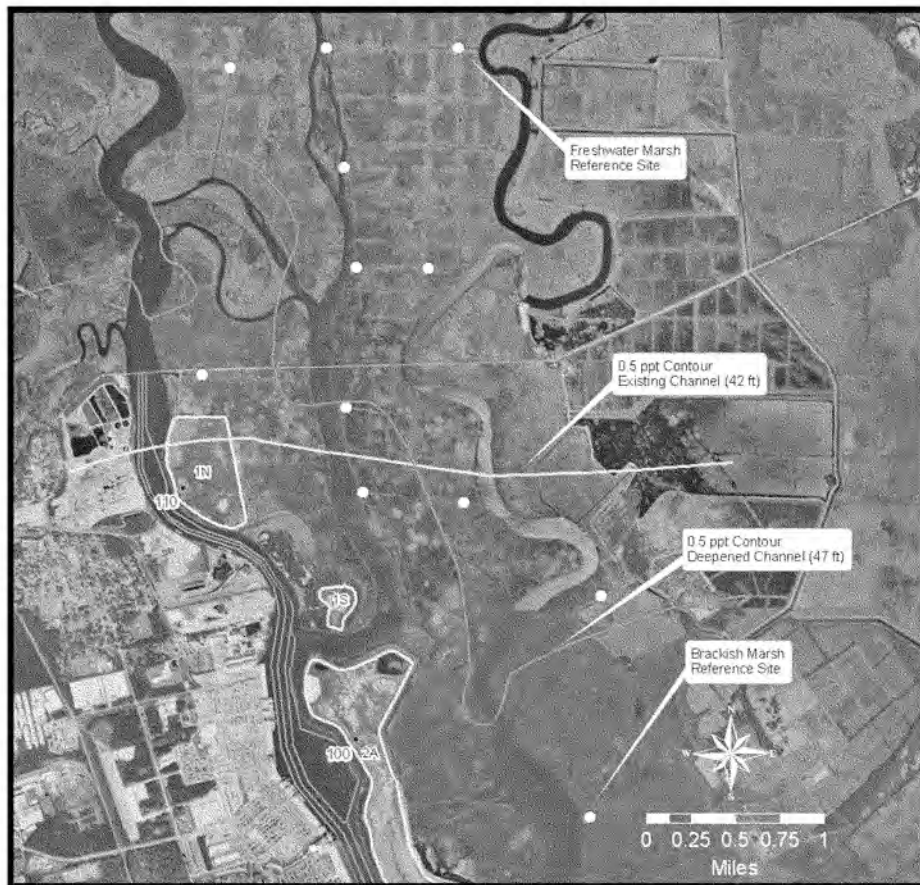


Figure 5-17. Proposed wetlands monitoring sites.

5.02 Water Quality

5.02.1 Dissolved Oxygen

Dissolved oxygen (D.O.) concerns relating to harbor deepening can be divided into three issues: (1) as the channel depth increases, the ability of oxygen to reach the river bottom decreases, causing lower average levels of dissolved oxygen at the bottom, and (2) as the channel prism enlarges, additional saltwater is moved to the upper portions of the harbor and into the estuary, decreasing the ability of those waters to accept oxygen from the air, and (3) as the channel prism enlarges, the average velocity decreases, reducing the mixing of oxygen throughout the water column. If dissolved oxygen concentrations decrease to unacceptable levels, it could have deleterious effects on fish and other aquatic organisms. Lower dissolved oxygen levels also reduce the ability of the estuary to handle the point- and non-point source loads of pollutants entering the estuary.

Another critical factor influencing dissolved oxygen levels in the estuary is the interaction of physical and biological processes. A decrease in dissolved oxygen levels typically occurs during summer months at the upper end of tidal rivers in Georgia and South Carolina. This is the combined effect of the reduced diffusion of oxygen into warm waters and the higher rate of uptake of oxygen from biologic organisms. The combination results in a drop in dissolved oxygen levels both during the summer and particularly during periods of slack tide. This condition is accentuated at the upper end of the navigation channel, where summer dissolved oxygen levels are generally low in the Front River between the Houlihan Bridge (Mile 21.5) and the junction with Back River (Mile 11.2).

The primary area of concern for dissolved oxygen is the Savannah River estuary. More specifically, it is the portion of the Savannah River between Fort Pulaski (River Mile 0.0) and the Seaboard Coastline Railroad Bridge (Mile 27.4). This section of the Savannah River estuary is the area that would be directly affected by the SHEP. Evaluation of impacts to the dissolved oxygen regime is critical, because this segment of the river is on the State of Georgia's Section 303(d) list as impaired for dissolved oxygen.

Model studies conducted by EPA as part of its 2006 TMDL assessment for Savannah Harbor indicate that construction of the existing project (42 foot channel, turning basins, Sediment Basin, etc.) has impacted the dissolved oxygen regime. The model estimates that the dissolved oxygen concentration in Savannah Harbor is 1 mg/l lower because of project improvements that have been made since the baseline year and condition (i.e., 1854 and a 12-foot controlling depth). Model predictions from the SHEP studies indicate that further deepening will have additional impacts on the dissolved oxygen regime in Savannah Harbor.

Two models were used during the SHEP to evaluate the impacts of the deepening alternatives on the dissolved oxygen regime in Savannah Harbor. The Environmental Fluid Dynamics Code (EFDC) model was used to develop the hydrodynamic data and then linked to the Water Quality Analysis Simulation Program Version 7.0 (WASP7) to obtain the dissolved oxygen data predictions.

The study evaluated 26 spatial zones that extend from Clio, Georgia (61 miles above Fort Pulaski) to the Atlantic Ocean (17 miles offshore from Fort Pulaski). Figure 5-18 shows the 26 zones which included 11 zones for Front River (FR), 6 zones for Middle River (MR), 3 zones for Back River (BR), 3 zones for Little Back River (LBR), 2 zones for South Channel (SC), and 1 zone for the Savannah River (SR). The South Carolina standards for dissolved oxygen were used to evaluate severity of impacts, because they were the most restrictive at the time of the study (daily average of 5 mg/l, with an instantaneous minimum of 4.0 mg/l, applied throughout the water column).

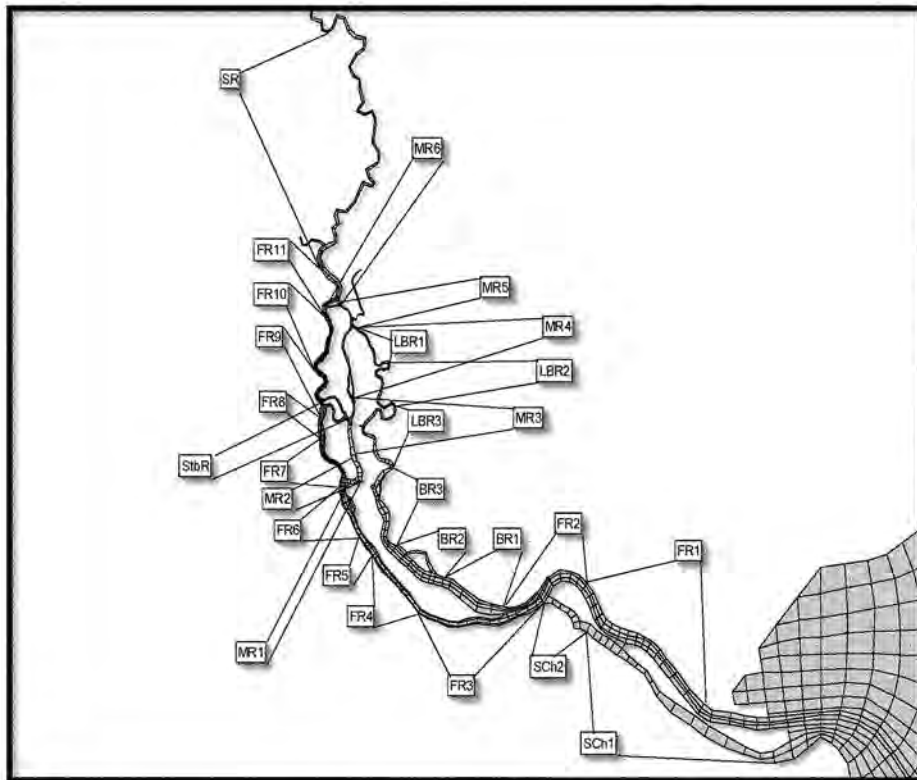


Figure 5-18. Spatial zones in dissolved oxygen study.

As specified by the Water Quality Interagency Coordination Team, the Corps conducted its basic dissolved oxygen impact analyses using average summer drought river flow conditions (August 1999). The interagency team also requested the Corps to evaluate the project's potential effects under other conditions, as sensitivity tests for the input conditions. These additional analyses included average flows in the river (August 1997), natural conditions (i.e., river depths prior to any harbor deepening), 2004 point source loads, and full permitted point source loads. The results of those analyses can be found in the GRR Engineering Appendix. However, as a summary, project impacts to dissolved oxygen were found to be higher under droughts than during average flow conditions.

The following two tables provide a summary of existing dissolved oxygen conditions for the estuary. The first table shows the average dissolved oxygen levels in each of the 26 zones that were modeled (Table 5-20). The second table shows the dissolved oxygen regime for the model grid cell with the lowest dissolved oxygen within each zone (Table 5-21). These data reflect dissolved oxygen levels in the bottom half of the water column, which should be lower than those for the entire water column.

Table 5-20. Average Dissolved Oxygen Levels under Existing Conditions

Zone Name	D.O. Concentration Percentiles (mg/L)								
	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	4.09	4.16	4.21	4.32	4.44	4.55	4.68	4.76	4.82
FR2	3.86	3.91	3.95	4.15	4.28	4.41	4.51	4.58	4.62
FR3	3.58	3.66	3.72	3.88	4.06	4.25	4.52	4.60	4.81
FR4	3.52	3.57	3.61	3.82	3.96	4.18	4.75	5.15	5.41
FR5	3.53	3.62	3.69	3.91	4.08	4.58	5.26	5.53	5.69
FR6	3.79	3.83	3.92	4.13	4.36	5.04	5.69	5.86	5.97
FR7	4.25	4.36	4.52	4.92	5.78	6.15	6.38	6.53	6.68
FR8	4.71	4.92	5.13	5.57	6.13	6.42	6.67	6.79	6.96
FR9	5.60	5.87	5.99	6.24	6.53	6.80	7.05	7.21	7.33
FR10	5.71	5.85	6.01	6.30	6.57	6.81	7.16	7.23	7.32
FR11	4.88	5.10	5.28	5.59	5.88	6.18	6.45	6.55	6.68
MR1	4.29	4.41	4.55	4.79	5.06	5.47	5.77	5.89	5.99
MR2	4.17	4.29	4.47	4.73	5.05	5.40	5.73	5.84	5.98
MR3	3.84	4.02	4.09	4.36	4.71	5.19	5.55	5.67	5.79
MR4	4.38	4.50	4.60	4.77	5.04	5.23	5.43	5.53	5.69
MR5	2.31	2.55	2.96	3.46	5.33	6.16	6.53	6.82	7.01
MR6	2.15	2.53	3.05	3.58	5.69	6.32	6.80	6.94	7.27
LBR1	4.29	4.49	4.58	4.79	4.98	5.18	5.29	5.44	5.56
LBR2	3.69	3.80	3.95	4.13	4.35	4.55	4.70	4.76	4.89
LBR3	3.52	3.56	3.63	3.77	3.93	4.08	4.22	4.31	4.42
BR1	3.42	3.47	3.52	3.77	3.90	4.06	4.24	4.32	4.42
BR2	3.17	3.25	3.34	3.47	3.65	3.83	3.96	4.11	4.19
BR3	3.36	3.41	3.46	3.52	3.63	3.74	3.84	3.87	3.90
SCh1	3.40	3.46	3.53	3.61	3.72	3.87	3.95	4.02	4.08
SCh2	3.84	3.94	3.99	4.11	4.26	4.38	4.48	4.53	4.63
SR	4.90	4.95	5.18	5.52	5.84	6.17	6.35	6.41	6.48
SibR	4.73	4.91	5.07	5.39	5.75	6.06	6.25	6.38	6.54

Table 5-21. Lowest Dissolved Oxygen in Each Zone under Existing Conditions

Zone Name	D.O. Concentration Percentiles (mg/L)								
	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	3.86	3.93	3.99	4.13	4.3	4.43	4.56	4.62	4.69
FR2	3.56	3.66	3.74	3.91	4.1	4.28	4.46	4.52	4.91
FR3	3.36	3.47	3.5	3.71	3.9	4.14	4.59	4.9	5.48
FR4	3.34	3.43	3.49	3.74	3.91	4.23	4.78	5.14	5.36
FR5	3.45	3.55	3.68	3.88	4.1	4.7	5.26	5.51	5.68
FR6	3.55	3.66	3.78	3.95	4.19	4.8	5.55	5.78	5.95
FR7	3.98	4.06	4.14	4.4	4.86	5.93	6.22	6.34	6.48
FR8	4.48	4.62	4.9	5.41	6.09	6.43	6.71	6.83	7.11
FR9	4.72	4.87	5.22	5.62	6.24	6.57	6.83	6.99	7.18
FR10	4.31	4.78	4.95	5.32	5.91	6.43	6.68	7.01	7.21
FR11	4.17	4.7	4.93	5.24	5.66	6.14	6.49	6.64	7.13
MR1	4.22	4.34	4.47	4.72	5.05	5.51	5.81	5.93	6.19
MR2	4.01	4.13	4.3	4.6	5.02	5.47	5.73	5.84	5.98
MR3	3.68	3.88	3.94	4.16	4.47	4.95	5.66	5.93	6.28
MR4	3.87	4.02	4.11	4.37	4.59	4.87	5.04	5.15	5.39
MR5	1.49	2.04	2.41	3.05	4.97	6.23	6.56	6.89	7.11
MR6	2.11	2.49	3.01	3.51	5.61	6.35	6.8	7.06	7.32
LBR1	3.57	4.35	4.74	5.12	5.42	5.64	5.97	6.15	6.47
LBR2	3.68	3.86	3.97	4.15	4.38	4.59	4.77	4.86	5.24
LBR3	2.88	3.28	3.46	3.67	3.92	4.31	4.7	4.95	5.18
BR1	3.15	3.28	3.44	3.59	3.82	4.05	4.26	4.34	4.45
BR2	2.43	2.72	2.86	3.11	3.3	3.54	3.67	3.74	3.82
BR3	2.87	3.12	3.32	3.48	3.65	3.8	3.93	4	4.13
SCh1	2.25	2.41	2.53	2.68	2.88	3.3	3.69	3.8	4.08
SCh2	3.62	3.78	3.88	4.02	4.19	4.35	4.48	4.56	4.7
SR	4.69	4.74	4.97	5.31	5.62	5.97	6.11	6.16	6.23
StbR	3.83	4.19	4.53	5.01	5.66	6.16	6.47	6.62	6.81

From a general perspective, the model shows that harbor deepening without mitigation would result in insignificant (1-2%) increases in the percentage of the harbor's waters with violations of existing dissolved oxygen standards. There would be upstream shifts of lower dissolved oxygen zones in bottom and surface layers of the estuary as the channel deepening increases in magnitude. The studies also indicate that deteriorations of the lowest dissolved oxygen values along critical cells (the cell with the lowest dissolved oxygen concentrations during specified simulation period) of major parts of the estuary increase proportionately to the amount of deepening.

NOTE: The following data show dissolved oxygen levels without mitigation for D.O. but with the flow re-routing components of the harbor deepening alternatives. These data also reflect conditions in the bottom half of the water column (i.e., bottom 3 layers of the 6-layer model), where dissolved oxygen levels are lower. For the data shown in Tables 5-22 to 5-26, the Corps identified a decrease in dissolved oxygen as substantial when values reported in the 10th percentile Project-Baseline Difference category were reduced by 0.25 mg/l.

Table 5-22 shows the predictions for the dissolved oxygen regime deterioration for the 48-foot channel project (1999 drought conditions). The most dissolved oxygen deterioration would occur with the 48-foot channel project. Critical cells of Front River Zones FR6-FR8, and FR11, Middle River Zone MR1, Lower Back River Zone LB3, as well as critical cells in Back River Zones BR1-BR3 show a substantial decrease in dissolved oxygen levels, while dissolved oxygen would increase in Front River Zones FR2-FR5, FR9, FR10, Middle River Zones MR2-MR6, and Lower Back River Zones LBR1 and LBR2.

Table 5-22. Predicted Dissolved Oxygen Decreases - 48-foot Depth Alternative (No D.O. Mitigation)

Zone Name	Relative Percent Difference from Existing Condition								
	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	0.8	0.5	0.0	0.0	-0.7	-0.9	-2.2	-2.4	-3.0
FR2	-0.8	8.5	8.8	7.4	5.6	4.4	3.4	3.5	-2.2
FR3	4.5	2.6	2.9	2.2	-0.5	-2.9	-5.7	-2.9	-4.7
FR4	5.1	3.8	2.9	1.1	-0.8	-5.0	-9.6	-8.0	-1.9
FR5	4.6	4.2	2.7	0.8	-1.2	-8.1	-13.9	-11.6	-10.0
FR6	1.7	1.1	-0.5	-0.3	-3.3	-10.8	-14.1	-11.6	-9.7
FR7	-4.5	-3.2	-3.1	-6.6	-11.9	-21.4	-11.7	-5.5	-3.1
FR8	-7.4	-8.0	-11.0	-15.0	-11.5	-7.2	-5.4	-4.2	-5.8
FR9	6.4	11.3	6.5	5.2	1.3	0.6	1.0	2.0	4.2
FR10	8.8	5.4	5.9	4.3	-0.2	-1.6	-1.3	-2.3	-0.8
FR11	0.2	-2.6	-2.4	-2.3	-0.2	0.0	-1.4	0.3	-2.8
MR1	-5.5	-5.3	-5.6	-5.9	-5.5	-9.1	-8.6	-8.1	-4.2
MR2	4.2	4.4	3.0	0.9	-2.4	-6.8	-5.2	-4.8	-4.8
MR3	12.8	10.6	11.9	10.6	9.2	3.0	-6.0	-7.3	-9.1
MR4	11.6	10.2	10.5	8.5	9.6	9.0	10.9	10.7	11.1
MR5	47.7	35.8	29.5	26.6	7.8	-0.6	-0.8	-1.6	-1.3
MR6	191.0	153.0	114.0	89.2	23.0	13.9	9.1	6.4	4.0
LBR1	14.0	10.8	7.6	7.2	7.0	8.2	5.9	6.2	3.6
LBR2	16.3	18.1	18.1	18.6	17.4	17.4	16.4	17.1	10.9
LBR3	-13.5	-19.5	-19.4	-18.0	-15.8	-16.0	-18.9	-21.2	-21.8
BR1	-43.5	-35.4	-23.3	-7.0	3.4	12.3	12.0	11.3	10.8
BR2	-40.7	-33.1	-29.7	-23.2	-13.9	-3.1	2.2	3.2	4.2
BR3	-41.8	-38.1	-38.9	-36.8	-32.9	-24.5	-15.5	-13.5	-11.1
SCh1	-7.1	-0.8	1.2	1.9	4.5	17.9	13.6	14.7	11.5
SCh2	-0.8	-2.6	-2.1	-1.0	-0.7	-1.1	-1.3	-1.5	-2.3
SR	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
StbR	-4.7	2.1	-0.9	0.4	-1.8	-3.1	-3.2	-3.9	-3.2

Table 5-23 shows the predictions for the dissolved oxygen regime deterioration of the 47-foot channel project. For the 47-foot channel, a substantial decrease in dissolved oxygen would occur in the critical cells of Front River Zones FR7, FR8, and FR11, and Middle River Zone MR1, Lower Back River Cell LB3, as well as Back River Zones BR1, BR2 and BR3. Dissolved oxygen would increase in Front River Zones FR1-FR5, FR9, FR10, Middle River Zones MR2, MR3, MR4, MR5, MR6, and Lower Back River Zones LBR1 and LBR2.

Table 5-23. Predicted Dissolved Oxygen Decreases - 47-foot Depth Alternative (No D.O. Mitigation)

Zone Name	Relative Percent Difference from Existing Condition								
	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	0.5	0.5	0.3	0.2	-0.7	-0.9	-1.8	-1.9	-1.9
FR2	-2.8	7.9	8.6	6.9	5.6	4.4	3.6	3.8	-2.4
FR3	4.5	2.3	2.6	1.9	-0.3	-2.4	-4.6	-0.2	-2.9
FR4	5.1	3.5	2.6	0.8	-0.5	-4.5	-8.2	-6.0	0.6
FR5	4.6	3.1	1.4	0.0	-2.2	-11.3	-12.2	-11.8	-10.4
FR6	2.0	1.6	0.0	0.3	-2.9	-9.2	-11.7	-9.9	-8.1
FR7	-4.3	-2.7	-2.9	-6.4	-11.3	-18.7	-7.7	-4.3	-2.8
FR8	-6.5	-6.9	-10.2	-14.0	-9.0	-5.8	-4.9	-4.0	-5.6
FR9	1.1	6.2	2.9	5.5	1.9	1.7	2.5	3.0	2.5
FR10	8.8	5.4	5.7	4.3	-0.3	-1.7	-1.3	-2.3	-0.8
FR11	0.2	-2.3	-2.4	-2.5	-0.2	0.0	-1.4	0.3	-2.7
MR1	-4.7	-4.6	-5.4	-5.1	-5.0	-8.3	-7.6	-6.7	-3.7
MR2	4.5	5.1	3.5	0.0	-4.2	-7.5	-5.9	-5.5	-1.7
MR3	12.8	11.1	12.2	11.1	9.6	3.8	-5.5	-6.6	-8.1
MR4	12.1	10.2	11.2	8.7	9.8	8.8	10.5	10.5	11.1
MR5	47.7	36.3	29.5	26.6	7.8	-0.6	-0.5	-1.6	-1.1
MR6	191.0	153.4	114.3	89.2	23.0	13.9	9.0	6.4	4.0
LBR1	13.7	10.8	7.8	7.2	6.8	8.0	5.9	6.2	3.4
LBR2	21.5	18.4	18.1	18.3	17.4	17.2	16.4	16.7	10.7
LBR3	-12.2	-18.9	-18.5	-17.4	-15.3	-16.0	-18.7	-21.6	-22.6
BR1	-46.3	-38.7	-26.5	-8.1	2.9	11.9	12.4	11.8	11.0
BR2	-43.6	-36.8	-32.5	-25.4	-15.2	-4.2	0.8	2.4	4.5
BR3	-44.6	-41.3	-41.9	-39.4	-35.3	-27.4	-17.3	-15.5	-13.1
SCh1	-4.0	-2.9	0.8	3.4	1.7	-4.5	-3.8	-3.2	-5.9
SCh2	-1.4	-2.6	-2.1	-1.0	-0.7	-1.1	-0.7	-1.3	-1.3
SR	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
StbR	-2.6	1.9	0.2	1.2	-0.5	-2.4	-2.6	-2.9	-2.8

Table 5-24 shows the predictions for the dissolved oxygen regime deterioration of the 46-foot channel project. For the 46-foot channel, a substantial decrease in dissolved oxygen would occur in the critical cells of Front River Zone FR1, FR8, FR9, FR11, Middle River Zone MR1, Lower Back River Zone LBR3, as well as Back River Zones BR1, BR2 and BR3. Dissolved oxygen would increase in Front River Zones FR2-FR7, FR10, Middle River Zones MR2, MR3, MR4, MR5, MR6, and Lower Back River Zones LBR1 and LBR2.

**Table 5-24. Predicted Dissolved Oxygen Decreases - 46-foot Depth Alternative
(No D.O. Mitigation)**

Zone Name	Relative Percent Difference from Existing Condition								
	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	0.5	-0.3	-0.5	0.0	-0.7	-0.5	-1.5	-1.5	-2.1
FR2	-5.1	7.4	7.8	6.9	5.6	4.7	3.6	3.8	-2.0
FR3	3.9	1.7	2.3	1.9	0.0	-1.7	-2.8	2.0	-2.0
FR4	3.6	2.9	2.3	0.8	-0.5	-4.0	-6.9	-3.7	2.1
FR5	4.1	3.1	2.2	0.8	-1.0	-6.4	-9.9	-6.9	-5.8
FR6	2.3	1.6	0.3	0.8	-2.1	-7.5	-8.1	-6.7	-5.2
FR7	6.0	7.4	8.7	8.2	10.5	-0.3	1.0	1.7	9.4
FR8	-5.1	-6.3	-9.0	-12.4	-7.4	-4.5	-3.7	-3.2	-4.6
FR9	-6.1	-7.4	-10.2	-11.9	-6.9	-3.2	-2.8	-3.6	-2.5
FR10	8.8	5.4	5.5	4.5	-0.2	-1.9	-1.2	-2.3	-1.0
FR11	0.2	-2.8	-2.4	-2.5	0.0	0.0	-1.4	0.3	-2.8
MR1	-4.0	-4.1	-4.3	-4.2	-4.0	-7.8	-5.9	-5.4	-2.1
MR2	5.2	5.3	3.5	1.5	-1.4	-5.3	-3.7	-2.9	-3.3
MR3	14.1	10.3	11.4	11.5	9.2	3.2	-6.2	-8.4	-9.6
MR4	12.4	10.4	11.2	9.2	9.8	9.2	10.5	10.3	10.9
MR5	47.7	36.3	29.0	26.6	7.6	-0.6	-0.5	-1.6	-1.1
MR6	191.0	153.4	114.3	89.2	23.0	13.9	9.0	6.4	4.0
LBR1	12.6	10.6	8.0	7.0	6.8	8.0	5.9	6.3	3.2
LBR2	0.0	17.9	17.9	18.6	17.4	17.0	16.4	16.9	10.7
LBR3	-10.8	-18.9	-18.2	-16.9	-15.3	-16.0	-19.1	-21.4	-22.2
BR1	-48.6	-42.7	-29.9	-10.0	1.8	11.4	12.4	12.0	11.0
BR2	-48.6	-40.4	-36.4	-27.7	-16.1	-5.1	0.3	2.1	4.2
BR3	-47.7	-44.2	-43.7	-40.8	-36.4	-29.5	-19.1	-16.5	-14.8
SCh1	-5.3	-3.7	1.6	3.0	1.0	-4.2	-4.9	-2.6	-4.2
SCh2	-0.6	-1.1	-1.3	-1.2	-1.0	-1.1	-1.1	-0.9	-0.9
SR	-0.2	0.0	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
StbR	-0.8	2.6	1.3	2.0	-0.5	-1.3	-2.0	-2.4	-2.8

Table 5-25 shows the predictions for the dissolved oxygen regime deterioration of the 45-foot channel project. For the 45-foot channel, a substantial decrease in dissolved oxygen would occur in the critical cells of Front River Zones FR7, FR8, FR9, and FR11, Middle River Zone MR1, Lower Back River Zone LBR 3 as well as Back River Zones BR1, BR2 and BR3. Dissolved oxygen would increase in Front River Zones FR2-FR6 and FR10, Middle River Zones MR3, MR4, MR5, MR6 and Lower Back River Zones LBR1 and LBR2.

**Table 5-25. Predicted Dissolved Oxygen Decreases - 45-foot Depth Alternative
(No D.O. Mitigation)**

Zone Name	Relative Percent Difference from Existing Condition								
	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	0.8	0.0	0.0	0.2	-0.5	-0.5	-0.9	-1.1	-1.5
FR2	-7.9	7.9	8.3	6.9	5.9	4.7	4.0	4.0	-1.8
FR3	3.9	1.7	2.3	3.0	0.5	-0.7	-2.0	2.4	-1.3
FR4	3.6	2.3	2.3	2.1	0.8	-1.9	-3.6	0.8	3.0
FR5	4.1	2.5	0.8	0.0	-1.7	-11.5	-8.4	-7.6	-6.7
FR6	2.3	2.2	0.8	1.5	-1.0	-4.8	-4.5	-4.3	-2.4
FR7	-3.0	-1.7	-2.4	-4.5	-8.2	-11.8	-3.4	-2.5	-1.9
FR8	-4.5	-5.4	-7.6	-10.2	-5.1	-3.6	-3.6	-2.5	-3.5
FR9	-5.3	-6.4	-8.8	-9.8	-5.4	-2.4	-2.3	-3.6	-2.5
FR10	8.8	5.4	5.5	4.3	-0.2	-1.9	-1.2	-2.3	-1.0
FR11	0.2	-2.3	-2.4	-2.5	0.0	0.0	-1.4	0.2	-2.7
MR1	-3.1	-3.2	-3.4	-3.4	-3.0	-6.4	-4.3	-3.5	-1.3
MR2	5.2	5.6	4.0	1.7	-0.8	-4.2	-2.8	-1.9	-2.8
MR3	13.9	12.1	12.4	11.5	10.3	4.6	-4.1	-4.9	-7.2
MR4	13.2	10.4	11.7	9.2	9.8	8.8	10.5	10.3	10.8
MR5	48.3	37.3	29.0	25.9	7.6	-0.6	-0.6	-1.6	-1.1
MR6	191.0	153.8	114.6	89.2	23.0	13.7	9.0	6.4	4.0
LBR1	12.3	10.8	8.2	7.0	6.6	7.8	5.7	6.2	3.1
LBR2	21.5	18.7	18.1	18.6	17.1	17.2	16.4	17.3	23.5
LBR3	-10.1	-17.7	-17.6	-16.9	-14.8	-15.5	-18.7	-21.4	-22.2
BR1	-53.0	-46.3	-33.7	-11.4	1.6	10.9	12.9	12.0	11.7
BR2	-51.4	-41.5	-38.1	-30.5	-17.6	-5.9	-0.3	1.6	3.1
BR3	-52.6	-47.1	-46.4	-42.5	-38.6	-31.6	-20.6	-18.5	-15.5
SCh1	-7.1	1.2	0.0	2.2	7.3	19.7	16.0	15.5	12.0
SCh2	0.0	-1.1	-0.5	-0.7	-0.5	-0.9	-0.9	-0.9	-0.4
SR	-0.2	-0.2	-0.2	-0.2	0.0	-0.2	-0.2	-0.2	-0.2
StbR	2.3	3.8	2.4	2.4	-0.2	-1.0	-1.7	-2.0	-1.6

Table 5-26 shows the predictions for the dissolved oxygen regime deterioration of the 44-foot channel project. For the 44-foot channel, a substantial decrease in dissolved oxygen would occur in the critical cells of Front River Zones FR1, FR5-FR8, and FR11, Middle River Zones MR1, and MR5, Lower Back River Zone LBR 3 as well as Back River Zones BR1, BR2 and BR3. Dissolved oxygen would increase in Front River Zones FR2-FR4, FR9, and FR10, Middle River Zones MR2-MR4, and MR6 and Lower Back River Zones LBR1 and LBR2. The changes in dissolved oxygen profiles for the 44-foot depth alternative are considerably different from the other alternatives since the flow rerouting components are different with this channel depth alternative.

**Table 5-26. Predicted Dissolved Oxygen Decreases - 44-foot Alternative
(No D.O. Mitigation)**

Zone Name	Relative Percent Difference from Existing Condition								
	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	-0.3	-0.8	-1.0	-0.5	-0.7	-0.2	-0.9	-0.4	-1.3
FR2	-9.0	7.4	7.0	6.4	5.9	4.9	4.0	4.4	-1.8
FR3	3.0	0.9	1.4	2.4	0.8	0.0	1.3	3.9	-0.2
FR4	3.3	1.7	2.0	1.3	0.5	-1.9	-2.9	-1.8	0.9
FR5	3.2	1.7	-0.5	-0.8	-2.7	-11.1	-7.0	-6.0	-4.9
FR6	1.4	0.3	-1.1	0.5	-1.9	-6.0	-4.0	-2.9	-1.7
FR7	-2.5	-1.7	-1.9	-3.9	-7.2	-6.7	-2.6	-2.2	-1.5
FR8	-3.6	-4.1	-6.3	-8.5	-3.1	-2.0	-2.8	-2.5	-3.5
FR9	7.0	14.0	10.0	9.1	3.4	2.4	3.2	2.7	2.4
FR10	7.0	4.8	4.0	3.0	-1.0	-2.6	-1.6	-3.6	-1.1
FR11	-13.9	-12.8	-11.6	-9.0	-0.7	-1.1	-2.2	-1.7	-4.1
MR1	-2.6	-2.5	-2.5	-2.8	-2.6	-6.0	-2.6	-1.9	-0.6
MR2	3.7	4.1	2.1	0.4	-2.6	-4.2	-1.6	-1.0	-1.5
MR3	11.4	7.7	9.6	8.2	6.7	1.6	-7.4	-8.4	-9.6
MR4	-0.8	16.2	19.5	19.0	19.0	18.3	20.2	21.4	24.7
MR5	-6.0	-23.5	-24.5	-16.4	0.8	-1.9	-1.7	-2.5	-2.0
MR6	157.3	134.9	104.7	86.0	21.2	12.4	8.4	5.8	3.4
LBR1	-10.9	-3.4	1.7	2.3	1.5	2.7	1.8	2.3	0.6
LBR2	3.8	6.5	6.0	6.0	5.9	5.9	5.0	6.4	8.4
LBR3	-39.6	-41.2	-40.8	-35.1	-30.4	-28.8	-29.8	-30.7	-32.0
BR1	-70.5	-57.6	-49.1	-32.9	-19.1	-3.7	-3.3	-3.5	-3.1
BR2	-79.0	-72.1	-64.3	-46.9	-33.3	-29.1	-24.0	-21.4	-19.1
BR3	-75.6	-68.3	-66.6	-60.3	-54.8	-41.6	-28.8	-24.8	-22.3
SCh1	-3.1	-1.7	0.4	0.7	1.0	-3.0	-3.5	-1.6	-3.9
SCh2	0.0	-1.1	-0.8	-0.7	-0.5	-0.9	-0.9	-0.9	0.0
SR	-0.2	-0.2	-0.2	-0.2	0.0	-0.2	-0.2	-0.2	-0.2
StbR	5.7	5.7	3.5	3.2	0.4	-0.6	-1.4	-1.1	-0.9

5.02.2 Mitigation for Impacts to Dissolved Oxygen

Deepening the navigation channel would adversely impact dissolved oxygen levels in the harbor without mitigation. Since this is a critical resource in the harbor, the Corps has included a feature in the mitigation plan for each depth alternative to minimize that adverse effect.

The Corps' studies indicate that oxygen injection is the most cost-effective method for raising dissolved oxygen levels in the harbor. Additional information about other alternatives that were considered is addressed in the MACTEC Report *Screening Level Evaluation of Measures to Improve Dissolved Oxygen in the Savannah River Estuary, Savannah Harbor Expansion Project and Savannah Harbor Ecosystem Restoration Study*, which is included in Attachment 3 of the Engineering Appendix of the GRR. Due to site-specific requirements, a land-based oxygen injection system was determined to be the most effective solution. The studies identified the use of Speece cones as the specific technique to inject oxygen into the water, although another land-based technique might be found later that could be more cost-effective. A different injection technique could be substituted at the time of construction without further NEPA coordination if impacts to wetlands, water quality or fisheries remain the same as with the Speece cones. The hydrodynamic and water quality modeling indicate that a system of injection locations would be needed, as summarized in Table 5-27. These systems would remove the incremental effects of the channel deepening alternatives.

Table 5-27. Oxygen Injection Comparison

Depth Alternative	Number of Injection Locations	Number of Cones Operated	Number of Cones Installed	Capacity to Increase D.O. (lbs/day)
44-foot	3	9	11	36,000
45-foot	3	8	10	32,000
46-foot	3	9	11	36,000
47-foot	3	10	12	40,000
48-foot	3	11	13	44,000

The general locations identified for these systems are shown in Figure 5-19. All three injection locations (near Georgia Power's Plant McIntosh, Hutchinson Island – west, Hutchinson Island – east) would be needed for each channel depth alternative. The systems would be land-based, with water being withdrawn from the river through pipes, then super-saturated with oxygen and returned to the river. The water intake structure would include screens to reduce the intake of trash and other suspended solids. The screens would be sized to keep flow velocities from exceeding 0.5 foot per second to minimize entrainment of fish larvae. The intake and discharge would be located along the side of the river and not extend into the authorized navigation channel. Figure 5-20 shows a typical layout for the oxygen injection facility. The systems would be operated to provide the needed amount of oxygen for that depth alternative during the months of July, August, and September. The Corps would begin to operate the systems on 15 June to allow the dissolved oxygen to be fully distributed throughout the estuary by 1 July.

With all oxygen injection designs, dissolved oxygen levels are higher near the injection site and taper off to lower levels as distance from the injection site increases. Removing the incremental adverse project effect at a great distance from an injection site requires large amounts of oxygen. This becomes a tradeoff between the amount of oxygen required (operating expense) and the number of injection locations (capital expense). As the number of injection locations increases, the complexity (and cost) of maintaining numerous systems also increases. The oxygen injection system configuration is designed to remove the incremental effect of a deeper channel in 97 percent of the cells in the hydrodynamic model. The minor impact at distances away from the injection location is balanced by the higher dissolved oxygen levels that would occur close to where the oxygen is added. The Corps believes the 97 percent level of performance recognizes both the higher dissolved oxygen levels close to the injection sites and the limitations of the model at distinguishing small differences between different run conditions.

Staff from natural resource agencies initially expressed concern about the potential for fish toxicity from the super-saturated discharge of the oxygen injection systems. To address those concerns and others, GPA conducted a Demonstration Project in 2008 of the Speece Cone technology in Savannah Harbor. They contracted for operation of two cones for roughly 6 weeks during the peak of the summer DO season. The systems was designed and operated for temporary operation (from a floating barge rather than a permanent landside facility). Extensive monitoring was performed to identify and document the effects of the system operation. Resource agency staff made several visits to view the operation themselves. The data collected during the demonstration was compiled by MACTEC included in a 2008 report titled *Savannah Harbor Reoxygenation Demonstration Project*. In response to questions from the resource agencies, MACTEC provided an additional report in 2009 titled *Savannah Harbor Reoxygenation Demonstration Project, Supplemental Data Evaluation Report*. This report is included in the GRR Engineering Appendix Supplemental Materials #49. Page 4-1 states "Nearfield mixing zone monitoring indicated that the supersaturated water injected by the ReOx system quickly mixed with the river water reducing DO plume concentrations by almost two orders of magnitude within 5 seconds ..." Page 281-343 discusses "Total Dissolved Gases and Dissolved Oxygen / Dissolved Nitrogen Ratios in Preventing Fish Mortality". Dissolved nitrogen is identified as being the major component in gas bubble disease. However, since the proposed system will oxygenate water with pure oxygen, dissolved nitrogen levels will not increase. Therefore, the traditional fish mortality that occurs with deep injection would not be a problem with the D.O. system design envisioned for Savannah Harbor.

MACTEC also provided the results of additional water quality modeling in a 2009 report titled *Modeling of GPA's Oxygen Injection Demonstration Project, Savannah, Georgia*. This report is included in the GRR Engineering Appendix Supplemental Materials #50. The near-field plume was modeled and described in Section 4.2 of that report. As shown in Figure 4-4, the modeling indicated that the discharge plume diluted from its initial concentration of 140 mg/l to about 10 mg/l within about 15 feet. Since there are large tidal flows in the Savannah River, fish moving with the current would only spend only a few seconds in the dilution plume. Fish could selectively choose to hold their position in the plume, but they would be choosing to concentrate in a small area within a 100-foot wide river.

The visual inspections that MACTEC and resource agency staff performed during the Demonstration Project did not observe any fish mortality or fish in distress. On the contrary, abundant wildlife was observed in the vicinity of the injection site. After observing the Speece cone system in operation, State and Federal environmental agency staff did not express any further concerns about fish mortality. The state water quality certifications require installation and operation of the D.O. systems as a condition of the Water Quality Certification. NOAA Fisheries also requires installation and operation of the D.O. systems as a condition of their Biological Opinion.

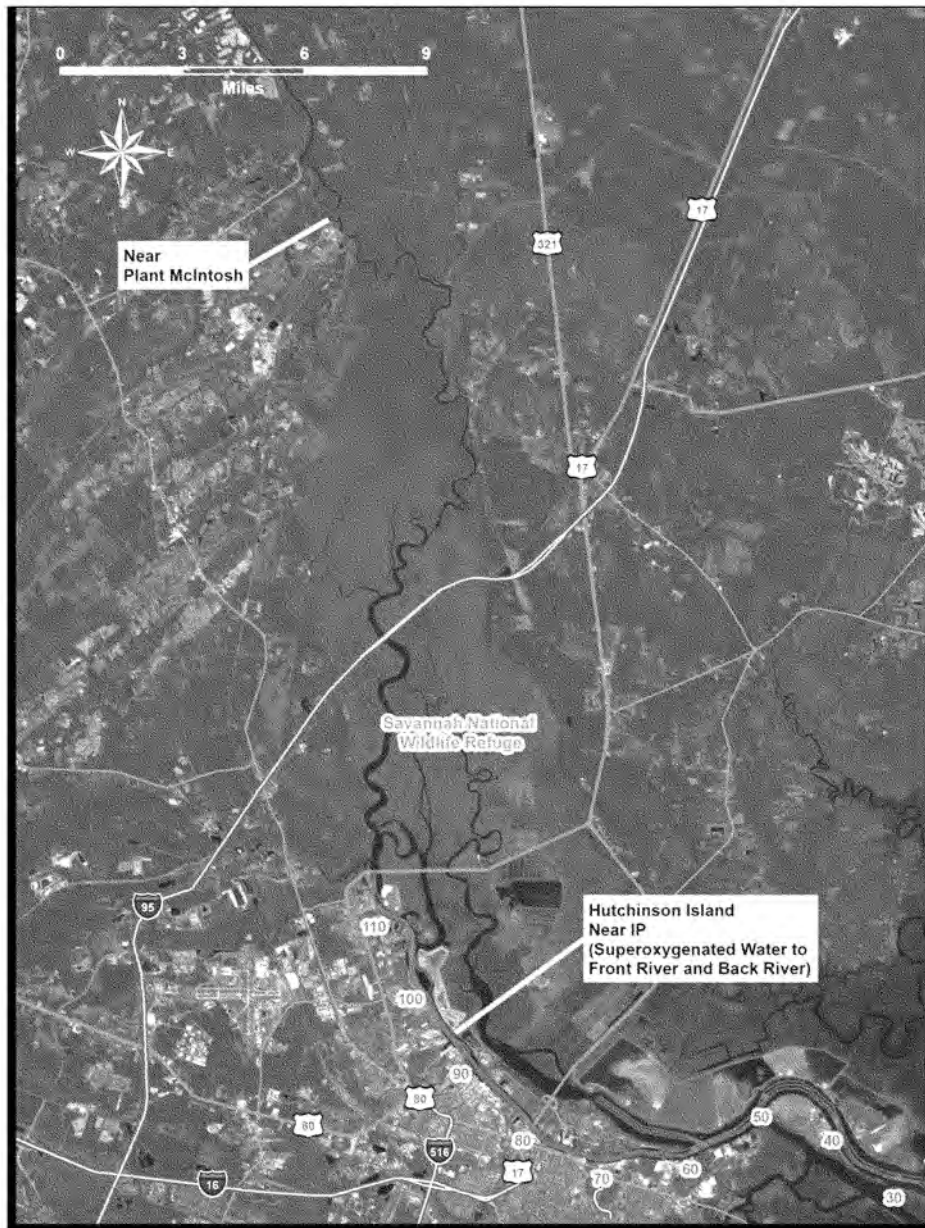


Figure 5-19. Locations for oxygen injection systems.

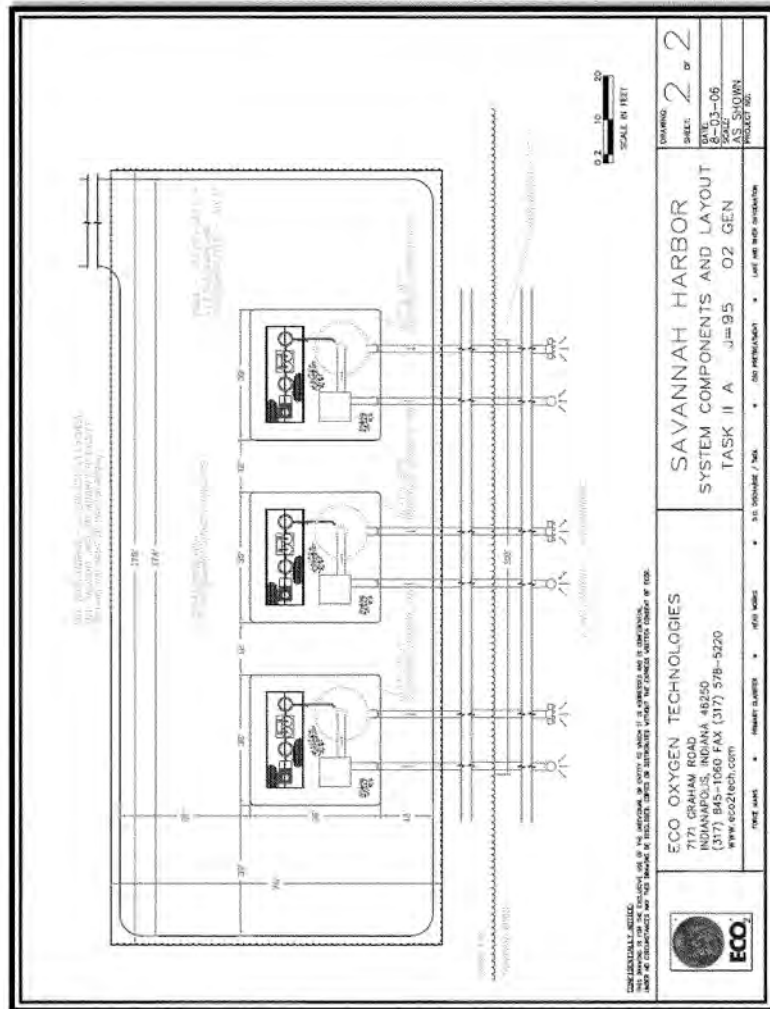


Figure 5-20. Layout of oxygen injection systems.
5-57

Since dissolved oxygen levels would be higher near the injection site and taper off away from the site, the Corps analyzed the model outputs and found that the systems would incidentally increase dissolved oxygen levels above their present levels over much of the harbor. Such improvements are a secondary incidental benefit of a system that is designed to remove the incremental effect of a deeper channel in 97 percent of the bottom half of the water column. The following information in Table 5-28 shows the extent of the improvements that would occur:

Table 5-28. Percent of Cells with Improvement in D.O. Levels Over Existing Conditions with the D.O. Improvement Systems

	Vertical Layer	44 ft depth	45 ft depth	46 ft depth	47 ft depth	48 ft depth
5th percentile	Surface	99.9	99.7	99.9	99.9	99.9
	Mid-Depth	94.4	98.3	98.1	98.7	98.5
	Bottom	97.2	97.4	97.8	98.1	97.2
	Water Column	98.3	99.9	99.9	99.9	99.9
10th percentile	Surface	99.9	99.9	99.8	99.9	99.9
	Mid-Depth	95.3	99.2	99.1	99	99.1
	Bottom	97.5	97.5	97.9	98.4	97.1
	Water Column	98.4	99.9	99.9	99.9	99.9
25th percentile	Surface	99.9	99.9	99.9	99.9	99.9
	Mid-Depth	95.5	99.4	99.3	99.1	99.2
	Bottom	97.9	97.7	98.0	98.1	97.7
	Water Column	98.7	99.9	99.9	99.9	99.9
50th percentile	Surface	99.9	99.9	99.9	99.9	99.9
	Mid-Depth	96.3	97.7	97.7	98.1	97.8
	Bottom	98.0	98.4	97.8	97.2	97.1
	Water Column	99.1	99.9	99.8	99.8	99.9

The proposed system designs provide the best balance of system spacing, size and effectiveness, when the issues of operating complexity, existing land uses, and over-compensation of impacts are considered. The systems are also scalable so that it could be expanded in the future if desired to produce net improvements in harbor dissolved oxygen levels.

5.02.3 Chloride Concentrations - Abercorn Creek

The City of Savannah has a water intake on Abercorn Creek to obtain surface water for its 62.5 million gallon per day (MGD) capacity municipal and industrial (M&I) water treatment plant (Figure 5-21). The intake is located in Effingham County, Georgia about two miles from the confluence of Abercorn Creek and the Savannah River and about 11 miles upstream of the SHEP deepening limits. The City presently operates the plant at around 30 MGD. That rate has been increasing substantially in recent years as the western part of the County has grown rapidly.

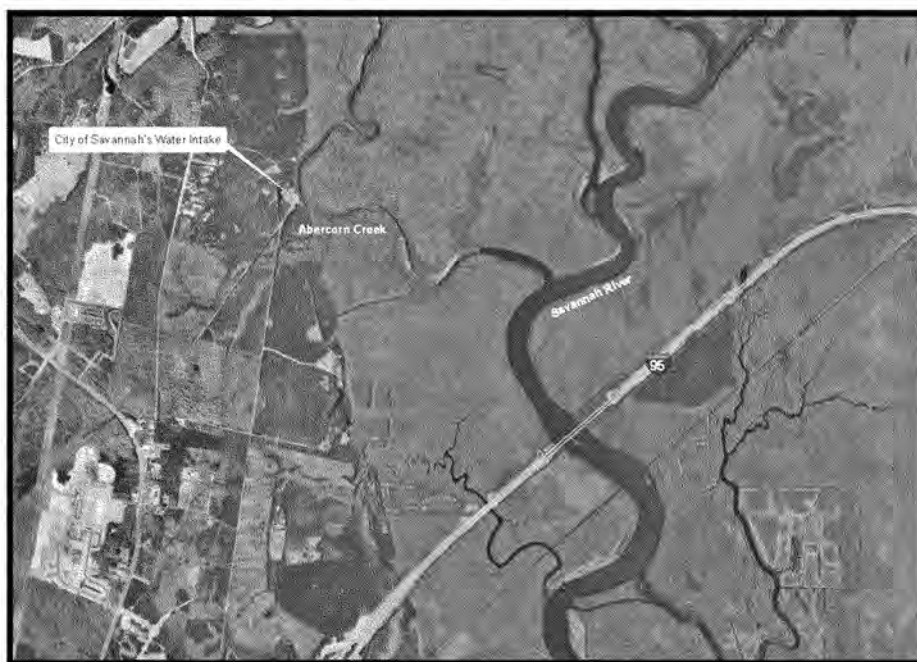


Figure 5-21. City of Savannah municipal and industrial water intake on Abercorn Creek.

The City withdraws water from Abercorn Creek for both municipal and industrial uses. In the past, the City's contracts with its industrial customers included a provision that the water provided must possess a chloride concentration not greater than 12 mg/l (or 12 ppm). That criterion is not included in the present contracts, but the industries still require water with very little chloride.

Although most of the water supply from this intake is used primarily by industrial users, it also serves residences in west Savannah, Pooler and south Effingham County. In addition to this surface water supply, the City of Savannah operates a number of groundwater wells at other locations. The City of Savannah is under directive from the State of Georgia to decrease

groundwater usage, which may increase demand for surface water from the Abercorn Creek intake.

Municipal water requires that chlorides be within the 250 mg/l (or 250 ppm) secondary drinking-water standard established by the EPA. This level is specified as a threshold of taste and odor detection and not as a health hazard. Distribution pipeline corrosion, including lead and copper in residential plumbing, and certain industrial processes are sensitive to chloride concentrations much lower than the drinking water standard.

Chloride levels at the City's intake vary over time with changes in river flow and tidal conditions. Based on data collected by the City of Savannah, the level of chlorides at the water intake on Abercorn Creek has historically averaged 10 to 12 mg/l. The City presently experiences times when the chloride concentration at the raw water intake at Abercorn Creek exceeds the 12 ppm threshold. Drought conditions allow estuarine water to move further upstream, increasing the number of days that the City experiences chloride levels at or above their threshold. Field observations at I-95 show that upriver salinity intrusion occurs only at river flows less than 6,000 cfs. Flows greater than 6,000 cfs keep the higher saline waters lower in the estuary and do not allow them to move far upstream. During the extremely dry 2001-2010 period, the flow was below 6,000 cfs 42% of the time. The number of low flow occurrences (less than 6,000 cfs) approximately doubled during 2001-2010, when compared to what would normally be expected. The lunar cycle also affects the extent to which tidal waters move up the estuary, with larger incursions occurring during the week surrounding a new moon. It appears that those incursions sometimes affect chloride levels at the City's intake.

The City expressed concerns during the Tier I phase of the project about whether additional harbor deepening would allow salinity to move upriver to the extent that chloride concentrations would increase to unacceptable levels at the City's water intake. Industrial users need the water to be relatively free of chlorides (12 ppm is a general threshold of acceptability) or they experience additional corrosion of their industrial boilers and subsequent higher maintenance costs.

The City's Water Treatment Plant does not treat for chlorides, and the industries bear the economic burden of increased maintenance costs at each of their facilities. The proposed harbor deepening could cause the City and/or its industrial customers additional water treatment costs, which would be considered an adverse project impact.

As part of the Savannah Harbor Expansion Project, Savannah District conducted a study to evaluate impacts to the City of Savannah's raw water intake on Abercorn Creek. An impact prediction tool was developed. The details of the development are outlined in the report titled *Savannah Harbor Expansion Project- Chloride Data Analysis and Model Development* dated November 15, 2006 which is included in the Engineering Investigations Supplemental Materials.

The objectives of that study were to develop a statistical correlation between chloride levels at the City's intake, chloride levels at a nearby downstream station, and upstream flows; determine the likelihood of increased chloride levels at the City's intake; identify potential point and non-

point sources of chlorides within the watershed; and develop a chloride model to predict changes in concentrations at the City's intake.

Development of a statistical correlation was largely based on chloride data collected and analyzed by the City over the period 1988 to 2004. This is an extensive dataset with numerous chloride data points between 5 and 20 mg/l. The statistical correlation (equation) was developed to represent the data points. The correlation has a high level of accuracy predicting within the bounds of the data collected, however, for chlorides predicted outside of this range the equation is less representative and has a greater margin of uncertainty.

Projection of chloride impacts due to harbor deepening and wetland mitigation using this method are documented in two reports *Chloride Impact Evaluation Impacts of Harbor Deepening Only* dated February 2007 and *Savannah Harbor Expansion Project Evaluation of Chloride Impacts with Proposed Mitigation Plan* dated December 2007 which are both included in the Engineering Investigations Supplemental Materials.

Study findings projected only negligible changes to the chloride concentrations from harbor deepening. The projected impacts were less than 1 mg/l and occurred only during low river flows (less than 6,000 cfs measured at Clyo, GA).

During the review process, concerns were expressed by the independent technical reviewer (USGS) and the City of Savannah about the methodology used to identify potential project impacts and the uncertainties due to lack of chloride data. The Corps reviewed the comments and confirmed that the statistical equation used to predict project impacts was the best that could be developed with the available data. The impact analysis concluded that the impacts to chloride levels on Abercorn Creek from a harbor deepening would not be significant. That conclusion was reported in the November 2010 Draft GRR and EIS documents. Those documents also stated that, as a result of concerns expressed by the City of Savannah about the technical reliability of the impact prediction tool, the Corps would further evaluate this issue.

The District and GPA began an intensive campaign to collect additional chloride data. The additional data was used to improve the accuracy and reliability of the chloride predictive tool, thereby providing a more technically robust evaluation of potential chloride impacts on Abercorn Creek due to harbor deepening.

5.02.4 Recent Data Collection

The Corps decided to collect additional data which could be used to refine the predictive model. The Corps consulted with the City of Savannah to develop a scope of work for collection of additional chloride data that it could use to refine its tool to predict chloride levels with a harbor deepening. USGS and GPA also participated in development of the SOW. Data collection was performed from early 2009 through summer 2010. The SOW included collection of data using several techniques at multiple sources and locations, shown in Figure 5-22 including:

- A. Abercorn Creek (flows, water surface, chloride, temperature, and conductivity)

- B. Bear Creek (flow, water surface, flow splits for Abercorn and Little Collis Creeks)
- C. I-95 Bridge (water surface, chloride, temperature, and conductivity)
- D. Houlihan Bridge (flow, water surface, chloride, temperature, and conductivity)
- E. Plant McIntosh (water surface, chloride, temperature, and conductivity)
- F. City Intake on Abercorn Creek (chloride)

Considerable effort was expended by Savannah District, USGS and ERDC to collect additional data. Automated collection of samples at various locations followed by laboratory analysis of the samples proved successful. Field instruments intended to record real-time chloride data were not successful, and that data was not used in the analysis. In addition to chloride data, velocity measurements and flow data were collected at Three Mouths, which is the confluence of Abercorn, Bear and Little Collis Creeks, to better calibrate the flow split in the hydrodynamic model at that location.

The Corps used this new data, the City's original chloride data, and subsequent daily chloride measurements collected by the City of Savannah, to refine the modeling methodology.

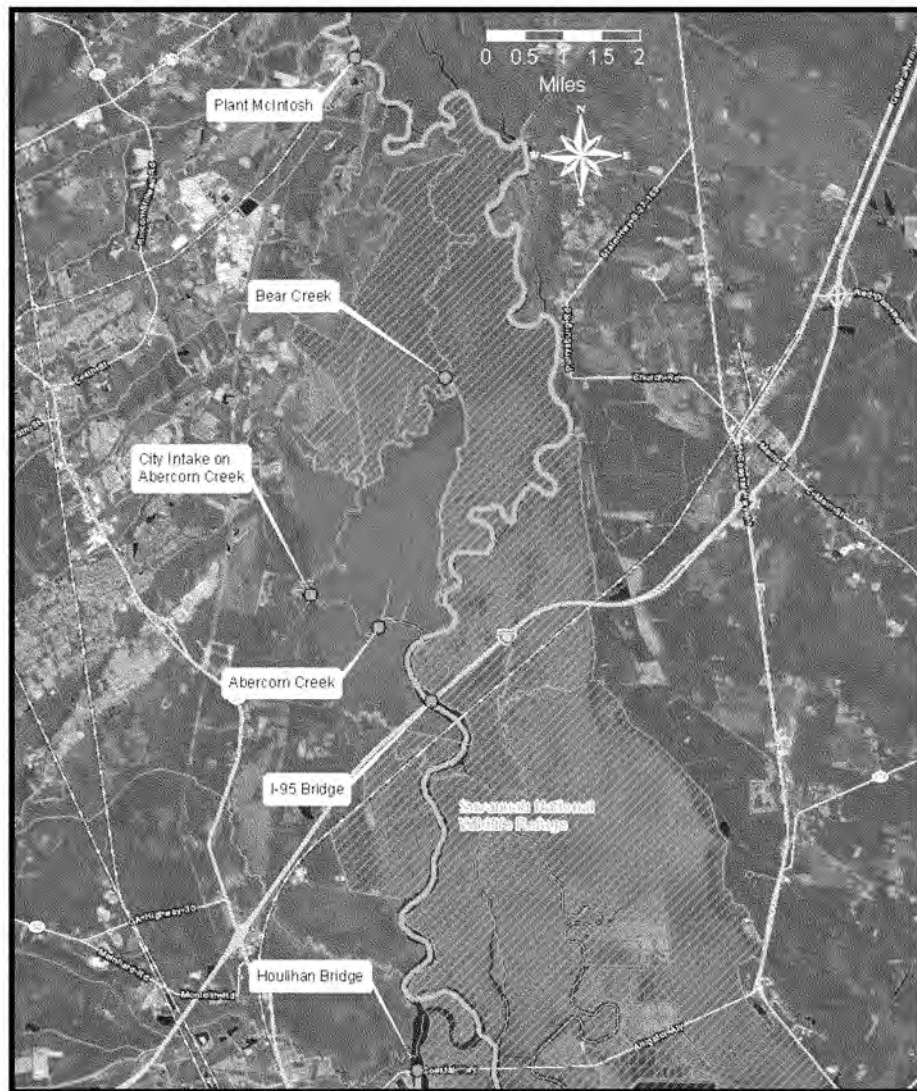


Figure 5-22. Chloride data collection 2009-2010.

5.02.5 Updated Modeling Methodology

The new modeling methodology, development and calibration, is described in the report titled *Chloride Modeling Savannah Harbor Expansion Project Savannah, Georgia* prepared by Tetra Tech and Advanced Data Mining Services dated December 31, 2010, and is included in the GRR Engineering Appendix Supplemental Materials. The new model methodology has two parts: (1) an updated version of the EFDC model using an enhanced hydrodynamic grid to include the complicated distributary system of Abercorn Creek, and (2) an Artificial Neural Network (ANN) which uses data mining techniques. The two-pronged modeling approach provided both a mechanistic and empirical approach for predicting chloride concentrations at the City's intake and allows one to present the findings in "bands" to better represent the uncertainty associated with the data and the models. The two independent methodologies provided reasonably close agreement on chloride projections and is the best possible evidence of accuracy in the projections.

5.02.6 Technical Review

A Corps Agency Technical Review (ATR) was performed on the updated model methodology and the report titled *Chloride Modeling Savannah Harbor Expansion Project Savannah, Georgia* prepared by Tetra Tech and Advanced Data Mining Services. A South Atlantic Division Regional Technical Expert for Water Resources Engineering performed an ATR of the EFDC component, and ERDC staff experienced with neural networks performed an ATR of the ANN component of the chloride model.

An Independent External Peer Review (IEPR) was conducted by Battelle, Inc on the chloride analysis. Comments from these rigorous reviews were incorporated into the modeling and analysis for SHEP impacts determination, and the reviewers concluded that the models were applied appropriately for this purpose.

5.02.7 Analysis of Daily Average and Maximum Chloride Concentrations

Table 5-29 summarizes the findings of the updated modeling effort. The results represent findings over two simulation periods. The first period is from 2003 to 2009 for both the EFDC and ANN models. This period was flood-free and included several prolonged drought periods, including the drought-of-record for the Savannah River Basin. This period represents impacts that could be expected during periods of extreme drought. The second period is from 1987-2009 which was simulated with EFDC only and corresponds to the magnitude and duration of impacts over a more representative period of time and river flow conditions.

Analysis of Table 5-29 shows that project effects vary depending on the parameter considered and the duration of the analysis. Average chloride concentrations at the City's water intake would increase with all deepening alternatives, but the increase would be small, ranging from 0.2 to 2.9 mg/l (from the existing 10.6/10.8 mg/l). The maximum daily average chloride concentrations would also increase with all deepening alternatives, ranging from 22 to 55 mg/l (from the existing 18 mg/l). All maximum values occurred during simulation of the drought of record (2008).

Table 5-29. Daily Average and Maximum Daily Average Predicted Chloride Levels

	1987-2009 Typical River Flow	2003-2009 Drought Flow	2008 Drought of Record ⁴
Project Depth Alternative	Average Daily Chloride Level, mg/l	Average Daily Chloride ³ Level, mg/l	Maximum Daily Average Chloride Level, mg/l
Existing ¹	10.6	10.8	18.3
44 ft Project	10.8	11.6	40.9
45 ft Project	11.1	12.0	48.6
46 ft Project	11.4	12.5	53.6
47 ft Project ²	11.7	13.1	62.2
48 ft Project	12.2	13.7	73.6

¹Existing chloride value obtained from measurements observed by the City of Savannah.

²NED Plan

³Chloride values are averages of the ANN and EFDC approaches.

⁴All maximum values occurred during simulation of the drought of record. There are 80+ years of flow data in the record and the drought of record occurred in 2008.

As the daily laboratory testing of chlorides is performed on a 24-composite schedule, so too are the daily chloride model projections presented above a composite of modeled hourly chloride values.

5.02.8 Analysis of Daily Chloride Durations

The maximum number of days that the chloride levels would be above a specified level for the 1987-2009 and 2003-2009 simulation periods are summarized in Table 5-30. Data shown for the existing channel condition is from daily sampling and laboratory analyses performed by the City of Savannah at their Port Wentworth water treatment plant. The high chloride spikes would be caused by a combination of low flow and spring high tides.

Table 5-30. Duration of Chloride Concentrations

Project Depth Alternative	Days Greater Than ... % of Days Greater Than...									
	2003-2009 Drought Flow					1987-2009 Typical River Flow				
	> 5 mg/l*	> 15 mg/l	> 25 mg/l	> 40 mg/l	> 50 mg/l	> 5 mg/l	> 15 mg/l	> 25 mg/l	> 40 mg/l	> 50 mg/l
Existing (Observed)	2483 100%	26 1.0%	0 -	0 -	0 -	6705 100%	111 1.7%	1 0.0%	0 -	0 -
44 ft Project	2483 100%	252 10.1%	39 1.6%	1 0.0%	0 -	8374 100%	457 5.5%	52 0.6%	1 0.0%	0 -
45 ft Project	2483 100%	331 13.3%	72 2.9%	11 0.4%	0 -	8374 100%	669 8.0%	91 1.1%	10 0.1%	0 -
46 ft Project	2483 100%	413 16.6%	112 4.5%	14 0.6%	4 0.2%	8374 100%	853 10.2%	142 1.7%	19 0.2%	4 0.0%
47 ft Project**	2483 100%	483 19.5%	156 6.3%	31 1.2%	10 0.4%	8374 100%	1051 12.6%	219 2.6%	41 0.5%	11 0.1%
48 ft Project	2483 100%	549 22.1%	206 8.3%	54 2.2%	18 0.7%	8374 100%	1301 15.5%	330 3.9%	68 0.8%	23 0.3%

*Background levels of chlorides are greater than 5 mg/l under all channel conditions.

**NED Plan

Table 5-31 shows the percentage of time that chloride levels are projected to be above 25 mg/l and 50 mg/l for the existing 42-foot channel depth and the proposed 47-foot depth for each year from 2001-2009. This period is not typical, as discussed previously and includes 2 prolonged droughts, including the drought of record occurring in 2008.

Table 5-31. Percentage of Days that Daily Average Chlorides are > 25 mg/l and 50 mg/l

Year	Chlorides > 25 mg/l		Chlorides > 50 mg/l	
	Existing 42 ft Depth	47 ft Project Depth	Existing 42 ft Depth	47 ft Project Depth
2001	0%	6%	0%	0.0%
2002	0%	5%	0%	0.0%
2003	0%	0%	0%	0.0%
2004	0%	2%	0%	0.0%
2005	0%	0%	0%	0.0%
2006	0%	0.2%	0%	0.0%
2007	0%	9%	0%	0.5%
2008	0%	17%	0%	2.2%
2009	0%	9%	0%	0.0%

5.02.9 Analysis of Hourly Chloride Concentrations and Durations

The City indicated that it is necessary to adjust some of its treatment processes on an hourly basis, and as a result, is concerned about hourly fluctuations in the chloride concentration at their raw water intake. Because there is limited mixing of water as it moves through the Savannah M&I Water Plant process and the distribution pipelines, these hourly chloride projections are critical to the operation of the water plant and the quality of the water that it produces.

The EFDC model used daily chloride concentrations in its calibration process, which used data from 2001-2009. Since 2003, the City has analyzed the chloride content of its intake water on a daily basis using a composite of samples taken hourly. Therefore, the chloride values upon which the updated EFDC model was calibrated represent a daily composite/average of hourly samples.

The District consulted with Tetra Tech, the developer of the updated EFDC model for chlorides about the potential reliability of the EFDC calculations for hourly chloride values at the City's water intake. Tetra Tech stated that although the daily average chloride value projections were derived from the hourly computed values, the model was not calibrated with the intent of generating hourly data. They believe that the 90th percentile predicted chloride value is a more reasonable representation of maximum short-duration chloride level likely to be experienced with the proposed harbor deepening project.

As a result, the District used the EFDC model to predict hourly chloride values at the City's water intake. In Figure 5-23, the blue line indicates the hourly maximum predicted for the day, the green line is the daily average, and the red line is the minimum hourly value predicted for the day. The predicted hourly peak of 185 mg/l is substantially higher than the maximum daily average of 62 mg/l. However, the predicted daily minimum remains at about 15 mg/l on that peak day. The peak 90th percentile chloride value is about 150 mg/l. The average being less than half the peak indicates that the lower chloride values have a longer duration than the higher chloride values. It also indicates that the high chloride levels are tidally dependent. When the tide ebbs, chloride levels are predicted to return to normal levels.

Model projections indicate for the period 1987-2009, there would be 41 days where the average daily chloride concentration exceeds a threshold of 40 mg/l; however, hourly exceedances of 40 mg/l are projected to occur 445 days during this same period. Hourly exceedances of 40 mg/l typically occur 3 to 6 hours per day, with a maximum of 12 hours per day. Although there is little measured hourly chloride data for comparison, the model projects that the 40 mg/l threshold has never been exceeded for even 1 hour under existing conditions.

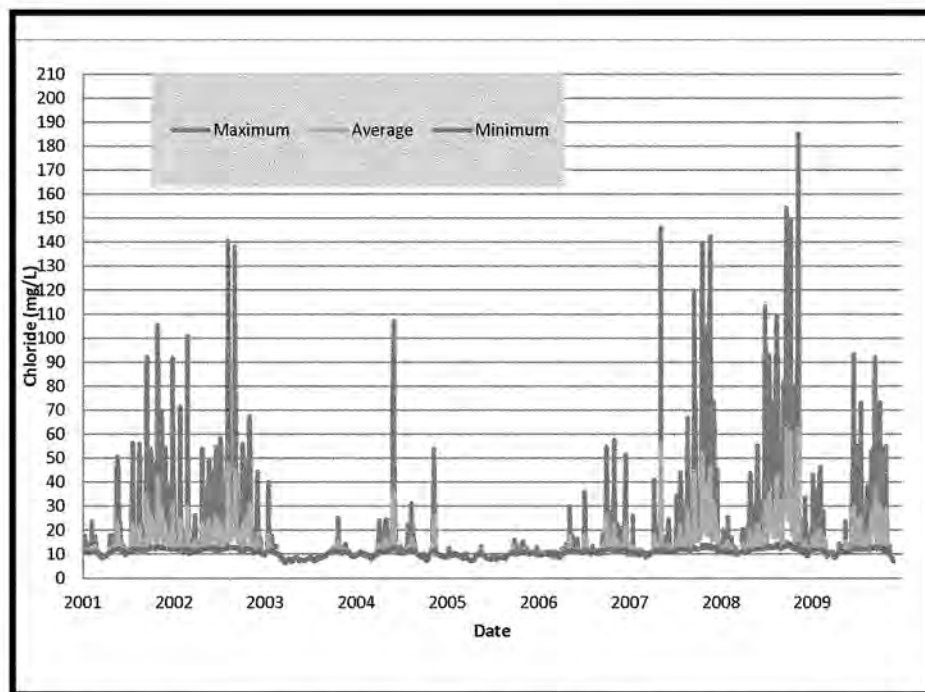


Figure 5-23. Hourly output from EFDC model for the 47 ft NED Plan.

5.02.10 Drinking Water Concerns-Chloride Levels

The City of Savannah's M&I water intake on Abercorn Creek presently supplies its Port Wentworth treatment facility with about 30 MGD, although the plant's design capacity is 62.5 MGD and its withdrawal permit from GA DNR-EPD is for 55 MGD. The updated impact analysis indicates that the proposed harbor deepening would increase chloride levels at the water intake under drought conditions during high tide. Under those conditions, maximum daily average chloride levels are predicted to be 62 mg/l with a maximum hourly chloride level projected as 185 mg/l for the 47-foot project. However, the long-term average chloride level is only predicted to increase from 11 to 13 mg/l.

The drinking water standard for chloride is 250 mg/l as a Secondary Maximum Contaminant Level (MCL) by USEPA. This level is established as a threshold of taste and odor detection, not as a health hazard. The predicted chloride concentrations with harbor deepening do not approach that threshold, even under the worst-case drought conditions (drought-of-record).

5.02.11 Corrosion Concerns

The City also expressed concern with the impact that increased chloride concentrations could have on the corrosion of the steel water distribution pipes – resulting in increased life-cycle costs for the pipe distribution networks – and corrosion of lead and copper – which could lead to unsafe levels of copper and lead ions in the water. In their February 2011 comment letter to the Corps, the City presented model results that show that corrosion rates of steel double for a chloride increase from 18 mg/l to 70 mg/l, on average, neglecting the influence of temperature. The City owns and maintains about 750 miles of water distribution pipeline, 60% of which is steel. They computed that a 12% decrease in life expectancy of pipelines, corresponded to an increased replacement cost of \$22 million.

Consequently, an investigation and analysis of water system chloride concerns was conducted. That report, completed April 29, 2011 is titled *Assessment of Chloride Impact from Savannah Harbor Deepening* and is included in the Engineering Supplemental Materials. The investigation included computer simulations (WatSim), which indicated that raising pH was a potential remedy for increased corrosion rate. The report recommended laboratory testing to confirm the model study. The conclusion of the analysis was that copper and lead corrosion were likely not an issue and that steel corrosion could be controlled by raising the pH of the treated water supplied to the distribution system. The study also recognized that increasing pH to reduce corrosivity could result in the formation of disinfection byproducts (DBPs), such as trihalomethanes and bromates, which are suspected carcinogens and regulated by the National Primary Drinking Water Standards.

The above report suggested additional laboratory analyses to confirm its conclusions. Consequently, more detailed laboratory analyses were performed at the water treatment plant to replicate the City's current water treatment process and evaluate the impact of increasing chlorides on the plant water and treatment process, including analysis of DBP formation. The report titled *City of Savannah Seawater Effects Study* dated November 2011 which is included in the GRR Engineering Appendix Supplemental Materials addressed concerns of the City's requirement for simultaneous drinking water standard compliance. It also presented evidence that there are two significant impacts to drinking water quality from increased chlorides – increased lead corrosion and formation of disinfectant byproducts (DBPs).

5.02.12 Lead Corrosion

Based on the laboratory analyses performed, lead corrosion is projected to increase considerably with increased chlorides, while copper and iron concentrations would not. While copper and iron concentrations were not shown to increase with increasing chlorides, lead concentrations in the water samples were shown to increase 2-4 times compared to the existing conditions as chloride concentrations increased from 10 mg/l to 50 mg/l.

Whether those increased levels would exceed regulatory action limits as defined by the USEPA's Safe Drinking Water Act (SDWA) Lead and Copper Rule, 40 CFR Part 141, as adopted in Georgia, cannot be determined with certainty due to the fact that regulatory sampling for lead is performed at the customer's tap, and is highly dependent upon the customer's piping and the

residence time in that piping. Although the SDWA action level for lead is 0.015 mg/l, the ideal concentration of lead in drinking water is zero. The Corps has determined that for this project, it is not acceptable to increase lead concentration in drinking water even though the regulatory threshold is not exceeded. An increase in lead concentration is considered an increase in health risk.

5.02.13 Disinfection Byproduct Formation

The City of Savannah uses free chlorine as a disinfectant against pathogens in their water treatment process, as do many water suppliers. It is an effective disinfectant and is available at a relatively low cost. However, free chlorine can react with dissolved natural organic matter present in the water to form byproducts. These disinfection byproducts (DBPs) can be classified as trihalomethanes (THMs) and haloacetic acids (HAAs) which are regulated under the SDWA Disinfectants and Disinfection Byproducts Rule (D/DBPR). The D/DBPR is a Federal regulation adopted in Georgia that limits the concentration of DBPs water suppliers can allow in public drinking water. Stage 1 of the D/DBPR was issued by the USEPA in December 1998 and Stage 2 was issued in 2006. Potential cancer, reproductive and developmental health risks can result from exposure to DBPs. Through Stage 1 of the D/DBPR, the USEPA MCL for total trihalomethanes is 80 µg/l and the five haloacetic acids are 60 µg/l. Stage 2 of the D/DBPR requires compliance with the THM and HAA MCLs at all sample points in the water distribution system. These are Primary Drinking Water Standards, and violations require notifying the public and reporting to the State.

The lab analysis previously referenced showed that DBPs are affected by increasing chlorides in two ways.

- Increasing chloride concentrations due to the SHEP causes an increase in chlorine required to treat the water. The additional disinfectant required to achieve treatment goals causes the formation of additional byproducts.
- As chlorides are pushed further upstream with harbor deepening, bromides, which are another component of seawater, are pushed further upstream as well. Brominated compounds can react with chlorine to form bromine-containing THMs, HAAs and other byproducts. The rate of DBP formation is also affected by the presence of bromide in the source water.

Under both of these circumstances expected to occur during low flow and high tide conditions with the SHEP, total THMs are projected to increase above the permitted level when chlorides exceed about 60 mg/l. HAAs are not projected to increase above regulatory limits, however the regulated species may be expanded in the future to include brominated HAAs, at which time the chloride impacts could affect compliance.

5.02.14 Industrial Water Supply Concerns

In 2008, the City of Savannah provided a letter with estimates of costs to industrial users if chlorides were increased to 50 mg/l. The costs were very high, but not considered to be representative since the increases to 50 mg/l are only projected to be occasional, not continuous.

5.02.14.1 Weyerhaeuser. Weyerhaeuser is the single largest user of the City's surface water supply; their demand is currently 12-13 MGD. Usage was higher, 15-16 MGD, before they installed process water cooling towers. The plant does not operate any groundwater wells. They use water supplied by the City supplemented by an intake they operate on-site near the Houlihan Bridge that draws 12-15 MGD of estuary water into the plant.

The on-site intake water is used (1) in a large plant fire protection system and (2) to cool the black liquor surface condenser which operates with once-through cooling water. The intake is designed to draw water from near the surface, therefore, surface water model results most closely represent the water used at the Weyerhaeuser intake. The EFDC modeling predicts that the increase in surface water chlorides at the Houlihan Bridge is about 50% (See Table 5-32). The principal concern for the Weyerhaeuser surface water intake is a reduction in the lifespan of the water distribution system. Their water distribution system for water purchased from the City is entirely separated from their surface water withdrawal system.

Table 5-32. Predicted Daily Average Chlorides at Houlihan Bridge

Model Projected Daily Average Chloride (mg/L)				
	Surface Layer		Bottom Layer	
	Existing	47' Plan	Existing	47' Plan
10th Percentile	287	569	1,444	7,203
50th Percentile	1,763	2,457	5,843	11,757
90th Percentile	2,965	3,887	10,174	15,456

Weyerhaeuser uses the water they purchase from the City of Savannah for boiler water, industrial process water, and cooling water. Boiler water must be demineralized before use. The demineralizer system currently runs at 50 to 60% of capacity. Additional chlorides, as well as any lime or phosphate introduced to reduce corrosion, will increase the load on the demineralizer and slow the output. Mill cooling water is cooled in cooling towers and returned to the mill circuit, however, the amount of recycling is governed by the impurity concentration. An increase in chloride will result in fewer cycles of usage for the cooling water, thus requiring an increase in the supply from the City I&D plant. The major process use of City water is in the bleaching process. Chlorides interfere with the bleaching, so increases in chloride levels could create a serious problem. The plant has an on-site storage tank for about 11 hours usage of demineralized

water. If the water supply quality does not meet their requirements for more than 11 hours, a plant shutdown would likely be needed. The hourly variation in chlorides indicates that the on-site storage of demineralized water may be sufficient if they are able to refill the storage tank between chloride spikes.

5.02.14.2 International Paper. International Paper (IP) uses water purchased from the City of Savannah and water from on-site wells that produce about 15 MGD. In the next 5 to 10 years, IP expects the GA DNR-EPD to require them to replace their ground water supplies with surface water. The ground water has a high level of silica, which provides a natural corrosion protection in their process water distribution system, but which also must be removed by a demineralizer prior to being used in the boilers. Since the surface water does not have high silica content, this would enable IP to have sufficient capacity to demineralize higher levels of chloride from the City water. However, IP is concerned about the integrity of their process water distribution system. Increased chlorides may result in an increased corrosion rate which could threaten the distribution system. Replacement of the piping system would likely be very costly due to the size of the system and the numerous facilities built above the pipelines after they were originally installed. Therefore, the potential impact at IP is limited to a potentially reduced lifespan for the water distribution system.

5.02.14.3 Other Industrial Users. IP and Weyerhaeuser are the two largest water users that the City supplies. However, firms located in downtown Savannah, Garden City, Port Wentworth, Pooler and Effingham County are also fed by the City of Savannah's Plant. No data is available on these other users, but their chloride concerns can be expected to be similar, but on a smaller scale.

5.02.15 Mitigation Techniques for Chloride Concentrations

Several mitigation options were identified early in the study process, in the event that mitigation due to harbor deepening would be warranted. These include:

5.02.15.1 Increasing Freshwater Supply through Bear Creek. The Bear Creek diversion structure allows a portion of freshwater from the Savannah River to be diverted down Bear Creek to Abercorn Creek providing improved water quality at the raw water intake. Bear Creek flows through a heavily wooded area which is part of the Savannah National Wildlife Refuge. Flow in Bear Creek is currently impeded by numerous fallen trees. Clearing and snagging would remove these trees and improve freshwater flow from the river. This option was shown to be effective when the Corps constructed a diversion structure at the mouth of Bear Creek in 2002 as part of the Lower Savannah River Basin Environmental Restoration Project. Clearing and snagging more of Bear Creek (than was included in the authorized Environmental Restoration Project) would be required for this measure to work effectively. Since the creek flows through the Savannah National Wildlife Refuge, approval from US Fish and Wildlife Service would be required. This option would also require a high level of periodic maintenance (removal of fallen trees) to perform as intended.

5.02.15.2 Construction of Freshwater Storage Impoundments. Water could be stored for use as a supplement when chloride concentrations on Abercorn Creek are higher than usual.

Implementation could be triggered by an early warning gaging system or the City's daily chloride monitoring program. However, constructing water storage impoundments ranges in cost from \$38 – \$85 million for a full 7-day supply (210 MG). A smaller storage volume would be needed if the water is mixed to dilute water from Abercorn Creek during periods of higher chloride. There is also risk involved to whether the volume of the supply will be sufficient for the duration the supplement is needed. Use of storage impoundments for blending water during intrusion events was not initially examined in detail. However, this alternative was retained for consideration should further analysis be required.

5.02.15.3 Desalinization. A conceptual cost estimate for desalinization treatment at the location of the four largest industrial users was developed using the methodology published by the U.S. Department of the Interior. That estimated cost was \$135 million and was determined to be cost prohibitive.

5.02.15.4 Groundwater Supplementation. Increasing the amount of groundwater withdrawal during times of potential chloride intrusion on Abercorn Creek. This would have to be offset by greater use of surface water during higher flow periods. The Georgia Department of Natural Resources Environmental Protection Division limits the amount of groundwater withdrawn by municipalities, complicating the use of an alternate source of water during times of drought with accompanying high chloride levels. Additionally, the City's current water supply distribution system does not have the capacity to move large quantities of water from wells currently in place in its network. Construction would likely require locating and installing new wells and modifying the distribution network.

5.02.15.5 Freshwater Flow Supplementation. Instituting a variable drought plan release from Thurmond Dam. Corps analyses indicate that a large amount of water would be required to restore salinity levels to their present location in the estuary over a long period of time (such as in a multi-year drought). Substantial changes would also be required to the operation of those reservoirs, resulting in potentially large-scale adverse effects to existing users and environmental resources. Lower impacts would occur if those flows only occurred during a portion of the month to target the effects of the spring tides. This approach would also be difficult for water users such as the City of Augusta, Savannah River Site, and Plant Vogtle. As a result, the Corps dropped this measure from further consideration.

5.02.15.6 A combination of increased groundwater withdrawal and greater releases from Thurmond Dam, as described above.

5.02.15.7 Construction of a sill at the mouth of Abercorn Creek to prevent chloride intrusion. Modeling results have shown, and field sampling has confirmed, that the Savannah River is well mixed (not stratified) at the mouth of Abercorn Creek. Therefore, a partial sill would not be effective in halting chloride intrusion. A mechanical gated structure that fully blocks inflow from the Savannah River during chloride incursion events would be required. Environmental impacts to wetlands would be excessive, and access to the gate location would be an issue. This option was not recommended for detailed study.

5.02.15.8 Replacement of individual plumbing fittings that are the source of lead contamination. It is very difficult to estimate the total number of homes and businesses that would require modification. Costs would vary significantly, with much higher costs to repair slab foundation homes. Real estate easement administration would also be very costly. Costs are conservatively estimated at \$100 million, and this alternative would not address the DBP issue.

5.02.15.9 Use of barges to store water for supplemental use. It would require approximately 160 water tanker barges to provide the necessary volume. The logistics of storing and maneuvering these barges on Abercorn Creek make this alternative unfeasible.

5.02.15.10 Construction of a Supplemental Water Intake Pipeline. Constructing a new intake pipeline would permit fresh water to be taken from the Savannah River more than 10 miles further upstream from the current location on Abercorn Creek where chloride levels remain relatively constant at around 8 mg/l. The proposed pipeline route is 8.7 miles long through Chatham and Effingham County to the intake site located near Plant McIntosh. This alternative is estimated to cost \$35.9 million.

5.02.15.11 Modified Water Treatment Process. Conceptual cost estimates for modified treatment process options were developed. The report (*Assessment of Chloride Impact from Savannah Harbor Deepening*) is included in the GRR Engineering Appendix Supplemental Materials. Potential modifications include a lime storage and feed system (\$2.8 million), a granular activated carbon system (\$47.2 million), and an ozonation system (\$35.4 million), all at the City M&I plant. The analysis in this report was based on water quality modeling and preliminary lab analysis. While results of this study are useful, they are not definitive and as a result, the report recommended further analysis be conducted regarding the corrosion of copper and lead resembling a larger on-site pilot scale study.

A primary objective of the subsequent testing was to identify a chemical process that would reduce the increased seawater corrosivity to existing levels that would work well with the City of Savannah's existing treatment plant, their water supply demands and the site specific water chemistry of the source water in Abercorn Creek. Various treatment options were explored as well as additional options. The results of the bench-scale study indicate that neither the existing corrosion inhibitor nor pH adjustment will consistently control lead corrosion. While there are chemical treatments that could potentially address the issue of DBP formation, they would not fully mitigate for increasing chlorides as lead corrosion would remain a problem. The only treatment solution that would address both lead and DBP formation issues is advanced treatment. Under advanced treatment, the conventional treatment process is amended to incorporate a range of sophisticated membrane technologies such as nanofiltration or reverse osmosis. Both of these options would remove the precursors relating to corrosion and DBP formation prior to treatment. However, either option would be very costly both in capital costs and operation and maintenance costs. Capital costs have been estimated to exceed \$60 million.

Based on extensive updated modeling efforts to predict chloride increases by frequency, concentration and duration along with multi-variable bench-scale laboratory analysis on-site at the City's treatment plant, the best solution to mitigate for impacts due to chloride increases with

harbor deepening is to remove the influence of the increased seawater intrusion. This can be accomplished most cost-effectively by storage impoundments (construct an impoundment that will store acceptable raw water for use during chloride spikes predicted to occur during very low river flow and high tides) or construction of a supplemental intake and pipeline that could draw water above the area impacted by salinity and chloride intrusion predicted with harbor deepening.

While impact studies were underway, the Corps studied these potential mitigation techniques, including constructing either a raw water storage impoundment or holding tank for treated water. The City Water Department staff expressed disapproval of holding tanks for treated water, identifying potential problems with residual chlorine byproducts when treated water is held for long periods before distribution and use. Therefore, the Corps focused on designing a storage impoundment for raw water. The preliminary design was for an impoundment capable of holding 1 week's supply of raw water ($7 \times 30 \text{ MGD} = 210 \text{ MGD}$). [NOTE: According to the City, the production volume of their plant is roughly 30 MGD and the plant's capacity has been 62.5 MGD since its expansion in 1998.] The Corps believes that a 1-week duration is sufficient to allow higher chloride levels associated with the new moon to recede, so that the City could resume withdrawing water directly from Abercorn Creek.

The Corps identified six potential locations between the City's water intake and its treatment plant for siting a raw water storage impoundment. Those sites are shown on Figures 5-24 and 5-25. The District provided its initial assessment of the locations to the City for comment and inspected each site. As a result of those assessments, the Corps eliminated 4 of the sites. The City of Savannah expressed concerns about the future availability of specific tracts in this rapidly-developing portion of the County. The Corps identified a nearby property that is already owned by the Georgia Ports Authority. It was Parcel 3 of the Savannah International Trade Park, located near Mulberry Grove, shown in Figure 5-26. Use of that parcel would ensure the site is available when needed. The Corps focused the final design and cost estimating work on that seventh potential location – the one owned by the GPA.

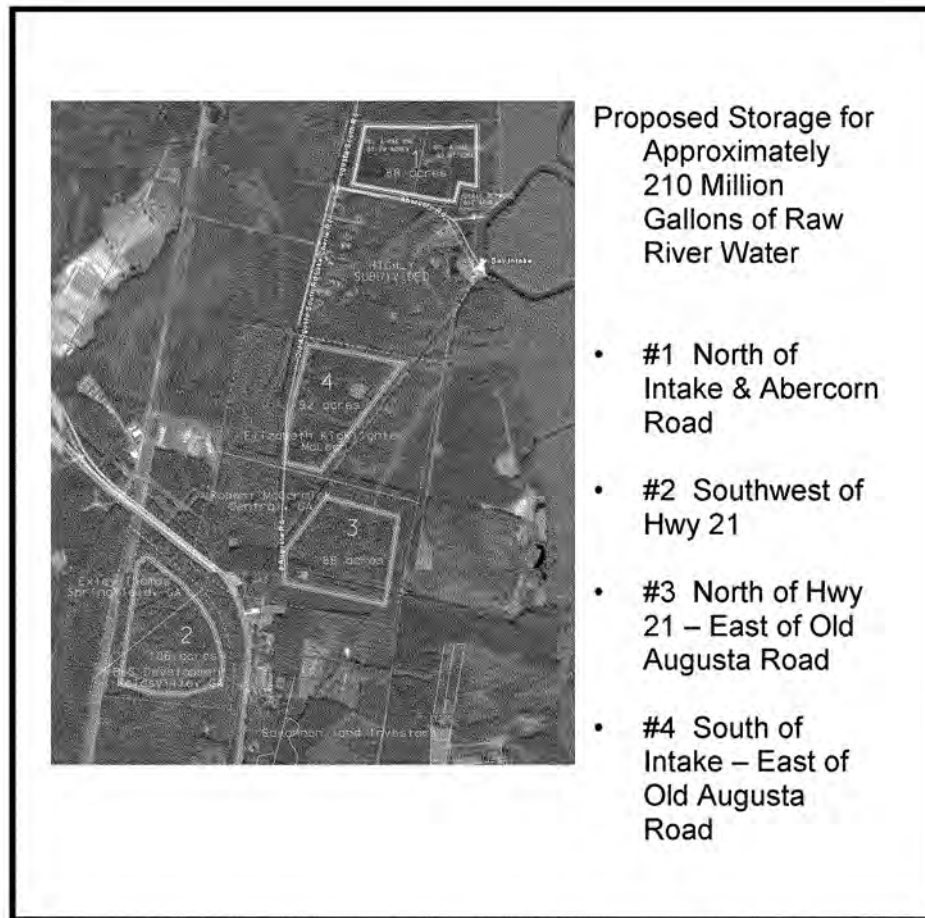


Figure 5-24. Potential water storage impoundment locations (#1-4).



- #5 Northwest of I-95 along Pipeline



- #6 Adjacent to and North of City's Water Treatment Plant

Figure 5-25. Potential water storage impoundment locations (#5-6).

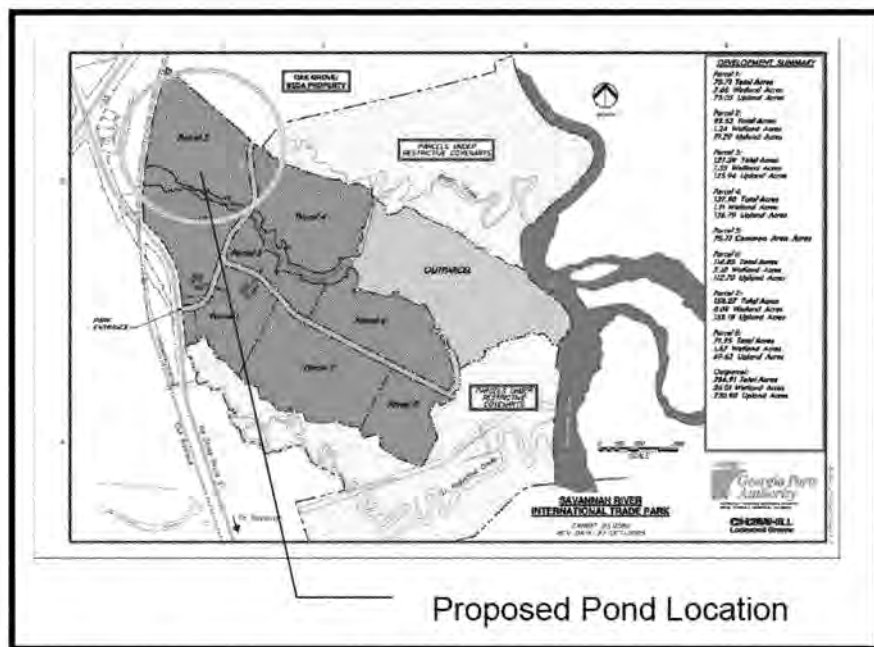


Figure 5-26. Potential water storage impoundment location (#7).

The Corps also evaluated locating a secondary (supplemental) intake point for the City's M&I water supply further upriver. The USFWS had stated that it would not allow a new water line to cross the Savannah National Wildlife Refuge. That reduced the number of routes that a new line could take. The Corps developed two conceptual designs for a supplemental intake line. Both were intended to provide water for a short duration (1 month) during droughts when chloride levels would be high in Abercorn Creek.

The first conceptual design was to install a pipe down Abercorn Creek and then up the Savannah River above Interstate 95 to near Purrysburg Landing. The total distance for the pipe was estimated to be 6 miles. This would relocate the intake point further upstream and remove it from salinity influences from the harbor. The PDT determined that construction and maintenance difficulties would make this approach unacceptable.

The second design was for an 8.7-mile pipeline up a power line right-of-way to near Plant McIntosh (upstream on the Savannah River), an electrical generating facility operated by Georgia Power (Figure 5-27). An initial layout was provided to the City, who expressed concerns about the intake being located too close to the Plant's upstream discharge. The Corps developed a second layout, with the intake located slightly downstream. The second layout had a slightly shorter total length of 8.1 miles. Those layouts are shown below.

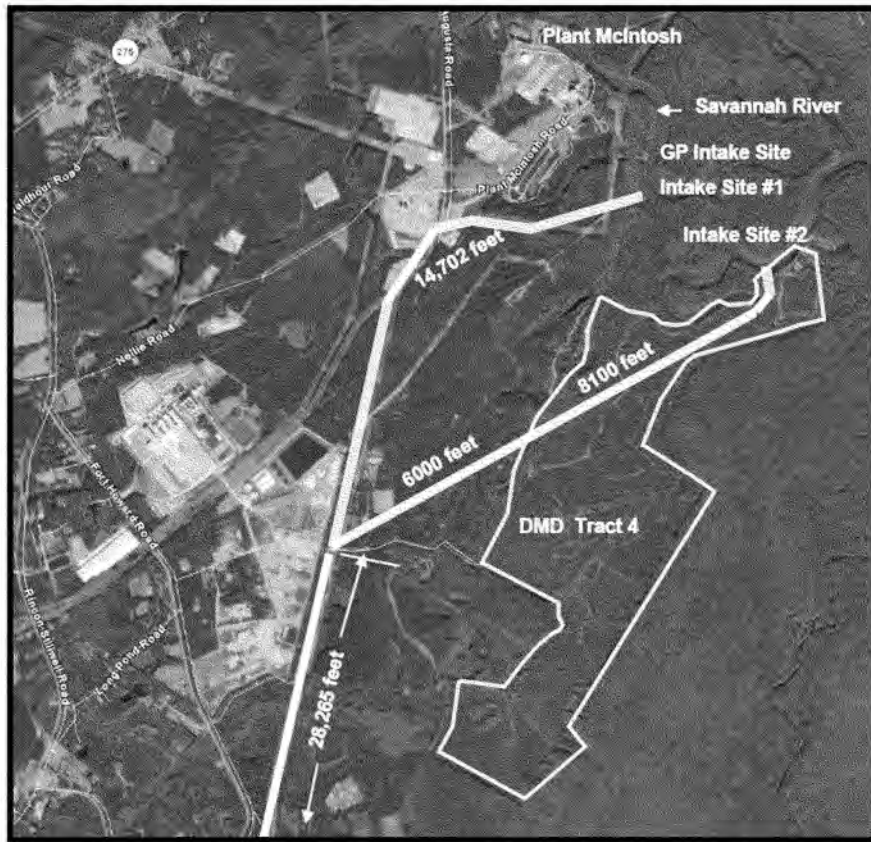


Figure 5-27. Potential pipeline locations.

Based on recent analyses, the storage alternative was determined to be the most cost-effective option to mitigate against both the increasing lead corrosion and the increasing DBP formation predicted with harbor deepening.

Design considerations for the raw water storage impoundment are:

A. The GA DNR-EPD, in the Section 401 Water Quality Certification for Savannah Harbor Expansion, stated that any mitigation remedy selected shall be based on the maximum plant capacity of 62.5 mgd. They also stated that any mitigation remedy shall be constructed in conjunction with the channel deepening.

B. A firm raw water pumping capacity of 75 mgd at the existing Abercorn Creek intake. Design constraints based on firm pumping capacity as opposed to the actual pumping capacity of 100 mgd is standard engineering practice and is required by the GA DNR-EPD's *Minimum Standards for Public Water Systems* published in May of 2000.

C. 20% of the storage volume will be unusable due to access limitations and sedimentation.

D. A performance goal of limiting the chloride concentration at the treatment plant to 40 mg/l during the model predicted worst-case scenario and to 25 mg/l 99 percent of the time. As shown in the lab analysis, 40 mg/l is the chloride concentration at which THMs in the distribution system can be expected to reach the MCL and potentially trigger a regulatory violation. Also shown in the analysis is that chloride concentrations as low as 25 mg/l have an adverse impact on lead corrosion.

A series of statistical analyses were used to determine the appropriate size for a raw water impoundment for use at the City's drinking water supply plant for all project depths under the design considerations noted previously. Results of the analysis for an impoundment volume for each project depth are shown in Table 5-33.

Table 5-33. Proposed Raw Water Storage Impoundment Volumes Required for Each Project Depth Alternative

Project Depth	Recommended Usable Impoundment Volume, MG	Required Total Impoundment Volume, MG
44 feet	22.5	28.0
45 feet	30.0	38.0
46 feet	46.5	58.0
47 feet	77.5	97.0
48 feet	120.0	150.0

A conceptual site layout for the 47 foot depth alternative is shown in Figure 5-28. The raw water storage impoundment would be about 35 acres in size and cost about \$25.2 million. The preliminary layout and conceptual site plan includes the following. Details of the design can be found in the CDM report titled *City of Savannah Seawater Effects Study* included in the GRR Engineering Appendix Supplemental Materials.

A. Dual 36" influent and effluent pipes to connect the impoundment to the existing raw water pipeline (to provide redundancy at the tie in points and allow for maintenance to occur during times when the impoundment is in use).

B. A pump station containing four vertical turbine pumps to convey flow out of the impoundment and back into the raw water lines.

- C. A mechanical mixer in the center of the impoundment to help maintain oxygen levels throughout the impoundment's depth, reducing the likelihood of algae growth and the associated taste and odor issues.
- D. A powdered activated carbon silo and feed system to be used on an intermittent basis during severe taste and odor episodes.
- E. A 24" drain pipe to be used to empty the impoundment during periodic maintenance cleaning.
- F. One or more in-situ chloride meters to be installed in Abercorn Creek to provide data for operational decision making.

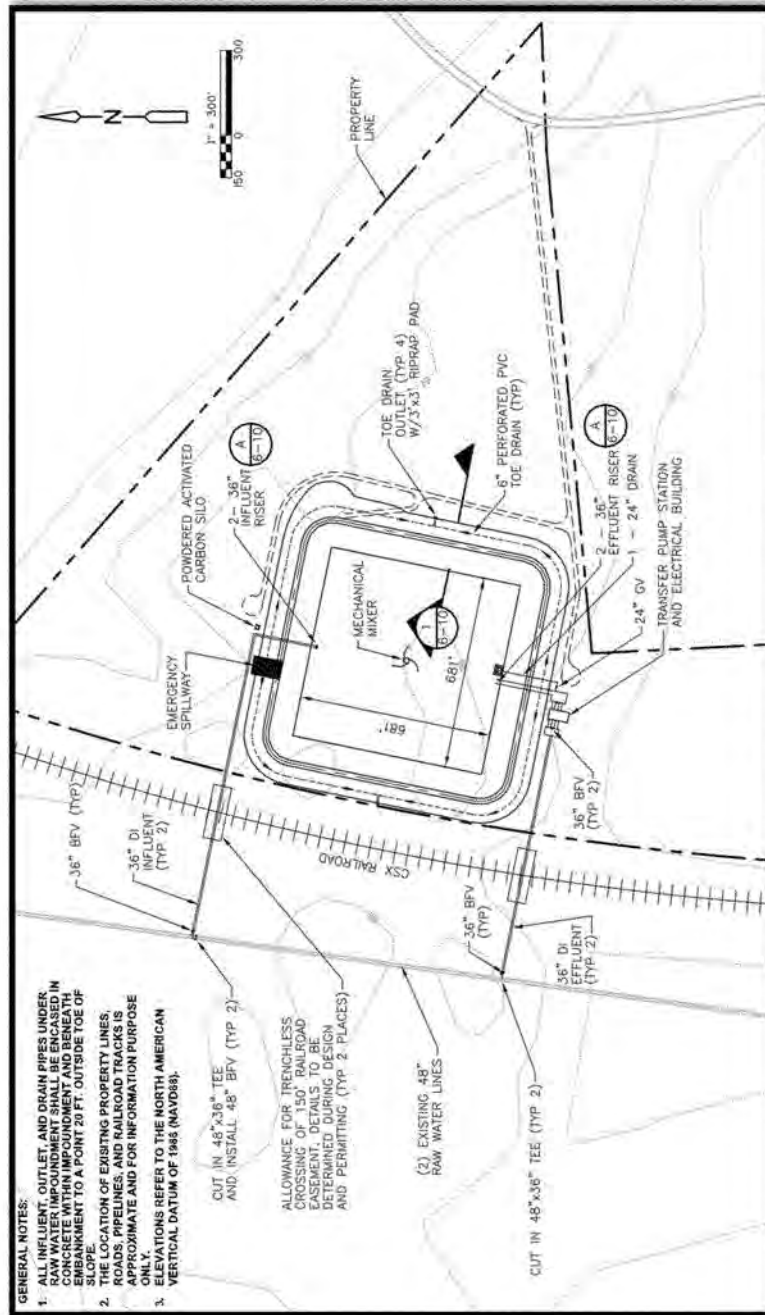


Figure 5-28. Raw water storage impoundment conceptual site layout.

Model predictions indicate that high chloride levels will occur diurnally, coincident with high tide.

An early warning system on Abercorn Creek would be required to provide data to the operator in a timely manner to know when valve and pump changes are needed.

Operation of the feature would require that water from the existing Abercorn Creek intake be used for treatment and pumped to the storage impoundment during occurrences of low chlorides. During occurrences of high chlorides, water from the impoundment will be pumped to the City's existing water treatment plant via the proposed pump station. During high chloride events at the intake, the intake pumps will be stopped and the plant will draw water from the storage impoundment, thereby avoiding the high chlorides occurring in Abercorn Creek. When chloride concentrations on Abercorn Creek return to acceptable levels during low tide, the storage impoundment can be refilled and made ready for use during the next high tide.

Based upon flow conditions experienced in November 2008, the worst-case event would require use of storage for 14 consecutive days. The total proposed storage volume represents only about 32 hours usage at plant capacity, but the chloride content of Abercorn Creek will rise and fall with each tidal cycle; therefore the impoundment will be partially refilled during low tide twice each day.

Operation and maintenance activities associates with this mitigation feature would be the responsibility of the City of Savannah.

5.03 Fisheries

5.03.1 Impacts to Fishery Resources

5.03.1.1 Overall approach. For potential impacts to fishery resources, Savannah District used the agency-approved hydrodynamic and water quality models coupled with definitions of acceptable habitat for critical and representative estuarine fish species. The District and the Cooperating Agencies followed this approach to produce the best information that could reasonably be developed to identify changes that could be expected from the project. The development and approval of the hydrodynamic and water quality models took from 1999 through 2005 and is described in detail in the Engineering Appendix that accompanies the GRR.

As those models were being developed, the Corps consulted with natural resource agencies to determine which estuarine fish species are critical in the estuary, which may be representative of a guild or group of similar species, and which may be sensitive to the physical changes expected to result from deepening the harbor. The Fishery Interagency Coordination Team identified the following species as being appropriate to identify potential project-induced impacts to fishery resources in the harbor:

- A. Striped bass
- B. Shortnose sturgeon

- C. Southern flounder
- D. American shad

The Team also requested the Corps evaluate project impacts on the following life stages:

- A. Striped bass – spawning, eggs, and larvae
- B. Shortnose sturgeon – adult winter, adult summer, and juvenile winter
- C. Southern flounder – adult
- D. American shad – adult

The habitat suitability criteria used in the model runs were defined and agreed upon by the Cooperating Agencies and the Fisheries Interagency Coordination Team, of which NMFS was a participating member. The criteria that the interagency team developed to define acceptable habitat for each of these species and life stages can be found in Appendix N.

The interagency team then defined the conditions under which the hydrodynamic and water quality models should be run to identify potential project impacts. The conditions consisted of river flow rates and time of year. Average river flows were determined to be most representative of conditions experienced over the long term. For some species, additional runs would also be performed with high (80% exceedance) and low (20% exceedance) river flows to ensure unusual impacts would not develop during those less-typical years.

The hydrodynamic and water quality models identified changes in salinity, dissolved oxygen, and velocity that would be expected throughout the harbor. Model cells that would change from acceptable to unacceptable habitat were identified as being adversely impacted by the project alternative. Tables were developed to quantify those changes and maps were prepared to show the location of the changes. This information was shared with the Fishery Interagency Coordination Team and is summarized in the following pages.

5.03.1.2 Impacts without Mitigation. The following table shows the impacts that would occur to fishery resources if no mitigation were included in the project. The values shown below are based on average river flows and use the 50%-tile salinity recorded for each model grid cell:

Table 5-34. Summary of Project-Related Fishery Impacts without Mitigation

	DEPTH ALTERNATIVES				
	44-Foot	45-Foot	46-Foot	47-Foot	48-Foot
Fisheries	Loss (-) of Acceptable Habitat				
- Striped bass spawning	- 8.0 % (-83.0 acres)	- 12.2 % (-127.0 acres)	- 13.0 % (-135.0 acres)	-18.1 % (-188.0 acres)	- 19.7 % (-205.0 acres)
- Striped bass eggs	-9.7 % (-163.0 acres)	- 11.2 % (-188.0 acres)	- 15.9 % (-266.0 acres)	-20.5 % (-344.0 acres)	-24.5 % (-411.0 acres)
- Striped bass larvae	-13.5% (-76.0 acres)	- 18.6 % (-105.0 acres)	- 21.0 % (-119.0 acres)	-13.8 % (-78.0 acres)	- 13.8 % (-78.0 acres)
- American shad (Jan)	0 %	0 %	0 %	0%	0 %
- American shad (May)	0 %	0 %	0 %	0%	0 %
- American shad (Aug)	0 %	0 %	0 %	0 %	0 %
- Shortnose sturgeon adult (January)	- 0.5% (-20.0 acres)	- 0.5 % (-20.0 acres)	-0.8 % (-32.0 acres)	-0.8% (-32.0 acres)	-1.1 % (-44.0 acres)
- Shortnose sturgeon adult (August)	- 3.2 % (- 45.0 acres)	- 6.4 % (- 89.0 acres)	- 9.5 % (- 132.0 acres)	-13.3 % (-185.0 acres)	- 15.80 % (- 220.0 acres)
- Shortnose sturgeon juvenile (January)	-5.0 % (-86.0 acres)	-10.4 % (-179.0 acres)	-15.9 % (-274.0 acres)	- 19.0 % (-328.0 acres)	- 21.6 % (-373.0 acres)
- Southern flounder	- 0.3 % (-6.0 acres)	- 2.4 % (-45.0 acres)	- 2.4 % (-45.0 acres)	-7.8 % (-146.0 acres)	0.0 %

5.03.1.3 Measures to Reduce Impacts. After the expected impacts to these resources were identified, the Corps used the hydrodynamic and water quality models to evaluate ways to reduce those impacts. The flow re-routing plans previously described in Section 5.01 would reduce the predicted increase in upstream salinity levels that would occur with the SHEP which, in turn, would minimize adverse impacts to fishery habitat. The proposed mitigation plans also include the injection of oxygen at three locations which would also reduce adverse impacts to upstream fishery habitat. However, even with implementation of these two mitigation features, adverse effects to fishery habitat could not be totally removed.

The following table summarizes the impacts of the depth alternatives that would remain even with the flow re-routing plans and oxygen injection:

Table 5-35. Summary of Project-Related Fishery Impacts with Mitigation

	DEPTH ALTERNATIVES				
	44-Foot	45-Foot	46-Foot	47-Foot	48-Foot
Fisheries	Loss (-) or Gain (+) of Acceptable Habitat				
- Striped bass spawning	- 2.9 % (-30.0 acres)	- 9.2 % (-96.0 acres)	- 10.0 % (-104.0 acres)	-13.5 % (-140.0 acres)	- 16.1 % (-167.0 acres)
- Striped bass eggs	- 9.4 % (-157.0 acres)	+5.2 % (+87.0 acres)	0 %	-11.1 % (-186.0 acres)	-10.8 % (-181.0 acres)
- Striped bass larvae	-5.6 % (-32.0 acres)	+ 1.7 % (+9.0 acres)	+ 5.6 % (+32.0 acres)	-5.0 % (-28.0 acres)	-3.5 % (-20.0 acres)
- American shad (Jan)	-0.2 % (- 9.0 acres)	-0.2 % (-9.0 acres)	- 0.2 % (-9.0 acres)	-0.2 % (-9.0 acres)	- 0.2 % (-9.0 acres)
- American shad (May)	- 0.2 % (-12.0 acres)	- 0.2 % (-11.0 acres)	- 0.2 % (-11.0 acres)	-0.2 % (-11.0 acres)	- 0.2 % (-11.0 acres)
- American shad (Aug)	-0.3 % (-16.0 acres)	-0.3 % (-15.0 acres)	-0.2 % (-11.0 acres)	-0.2 % (-11.0 acres)	-0.2 % (-11.0 acres)
- Shortnose sturgeon adult (January)	-3.9% (-153.0 acres)	- 4.6 % (-179.0 acres)	-6.2% (-240.0 acres)	-6.9 % (-266.0 acres)	- 8.4 % (-326.0 acres)
- Shortnose sturgeon adult (August)	+ 19.0 % (+ 260.0 acres)	+ 9.8 % (+ 134.0 acres)	+ 7.3 % (+ 100.0 acres)	+6.5 % (+ 89.0 acres)	+ 2.8 % (+ 39.0 acres)
- Shortnose sturgeon juvenile (January)	-6.7 % (-220.0 acres)	- 7.0 % (-231.0 acres)	-7.3 % (-238.0 acres)	-7.6 % (-251.0 acres)	-11.5 % (-376.0 acres)
- Southern flounder	+74.1 % (+1387.0 acres)	+ 54.2 % (+1014.0 acres)	+ 57.3 % (+1072.0 acres)	+57.3 % (+1072.0 acres)	+ 52.9 % (+989.0 acres)

This fishery impact information is shown in more detail in the tables on this and the following three pages.

Table 5-36. Impacts to Shortnose Sturgeon Habitat

WITHOUT MITIGATION						
	JUVENILES		ADULTS			
	January 50% flows		January 50% flows		August Avg flows	
	IMPACTS (%)	IMPACTS (acres)	IMPACTS (%)	IMPACTS (acres)	IMPACTS (%)	IMPACTS (acres)
44 ft depth	-5.0%	-86	-0.5%	-20	-3.2%	-45
45 ft depth	-10.4%	-179	-0.5%	-20	-6.4%	-89
46 ft depth	-15.9%	-274	-0.8%	-32	-9.5%	-132
47 ft depth	-19.0%	-328	-0.8%	-32	-13.3%	-185
48 ft depth	-21.6%	-373	-1.1%	-44	-15.8%	-220

WITH MITIGATION						
	JUVENILES		ADULTS			
	January		January		August *	
	IMPACTS (%)	IMPACTS (acres)	IMPACTS (%)	IMPACTS (acres)	IMPACTS (%)	IMPACTS (acres)
44 ft depth	-6.7%	-220	-3.9%	-153	19.0%	260
45 ft depth	-7.0%	-231	-4.6%	-179	9.8%	134
46 ft depth	-7.3%	-238	-6.2%	-240	7.3%	100
47 ft depth	-7.6%	-251	-6.9%	-266	6.5%	89
48 ft depth	-11.5%	-376	-8.4%	-326	2.8%	39

Table 5-37. Impacts to Striped Bass Habitat – Eggs

WITHOUT MITIGATION						
	EGGS					
	April 20%flows		April 50%flows		April 80%flows	
	IMPACTS (%)	IMPACTS (acres)	IMPACTS (%)	IMPACTS (acres)	IMPACTS (%)	IMPACTS (acres)
44 ft depth	-10.4%	-100	-9.7%	-163	-2.2%	-50
45 ft depth	-12.3%	-118	-11.2%	-188	-4.9%	-111
46 ft depth	-14.0%	-135	-15.9%	-266	-4.8%	-108
47 ft depth	-17.8%	-171	-20.5%	-344	-6.4%	-144
48 ft depth	-19.4%	-187	-24.5%	-411	-7.2%	-162

WITH MITIGATION						
	April 20%flows		April 50%flows		April 80%flows	
	IMPACTS (%)	IMPACTS (acres)	IMPACTS (%)	IMPACTS (acres)	IMPACTS (%)	IMPACTS (acres)
44 ft depth	-22.3%	-215	-9.4%	-157	7.6%	171
45 ft depth	-17.6%	-169	5.2%	87	8.0%	181
46 ft depth	-7.8%	-75	0.0%	0	6.9%	155
47 ft depth	-12.1%	-117	-11.1%	-186	5.0%	113
48 ft depth	-4.6%	-44	-10.8%	-181	3.4%	76

Table 5-38. Impacts to Striped Bass Habitat – Larvae

WITHOUT MITIGATION						
	LARVAE					
	May20%flows		May50%flows		May80%flows	
	IMPACTS (%)	IMPACTS (acres)	IMPACTS (%)	IMPACTS (acres)	IMPACTS (%)	IMPACTS (acres)
44 ft depth	38.0%	76	-13.5%	-76	-1.1%	-11
45 ft depth	56.4%	113	-18.6%	-105	-7.1%	-71
46 ft depth	99.5%	199	-21.0%	-119	-4.8%	-48
47 ft depth	105.8%	211	-13.8%	-78	6.6%	66
48 ft depth	104.6%	209	-13.8%	-78	6.0%	60

WITH MITIGATION						
	May 20%flows		May 50%flows		May 80%flows	
	IMPACTS (%)	IMPACTS (acres)	IMPACTS (%)	IMPACTS (acres)	IMPACTS (%)	IMPACTS (acres)
44 ft depth	174.6%	348	-5.6%	-32	-13.7%	-136
45 ft depth	187.4%	374	1.7%	9	7.6%	75
46 ft depth	191.4%	382	5.6%	32	10.1%	100
47 ft depth	178.7%	356	-5.0%	-28	26.4%	262
48 ft depth	154.6%	308	-3.5%	-20	30.0%	298

Table 5-39. Impacts to Striped Bass Habitat – Spawning

WITHOUT MITIGATION						
	SPAWNING					
	April 20%flows		April 50%flows		April 80%flows	
	IMPACTS (%)	IMPACTS (acres)	IMPACTS (%)	IMPACTS (acres)	IMPACTS (%)	IMPACTS (acres)
44 ft depth	-7.6%	-49	-8.0%	-83	-6.2%	-114
45 ft depth	-10.9%	-70	-12.2%	-127	-6.6%	-121
46 ft depth	-12.7%	-81	-13.0%	-135	-12.8%	-236
47 ft depth	-14.3%	-91	-18.1%	-188	14.7%	271
48 ft depth	-16.9%	-108	-19.7%	-205	-17.3%	-318

WITH MITIGATION						
	April 20%flows		April 50%flows		April 80%flows	
	IMPACTS (%)	IMPACTS (acres)	IMPACTS (%)	IMPACTS (acres)	IMPACTS (%)	IMPACTS (acres)
44 ft depth	-15.2%	-97	-2.9%	-30	-2.9%	-53
45 ft depth	-13.9%	-89	-9.2%	-96	-8.5%	-156
46 ft depth	-18.7%	-120	-10.0%	-104	-10.8%	-199
47 ft depth	-21.1%	-135	-13.5%	-140	-12.7%	-234
48 ft depth	-23.9%	-153	-16.1%	-167	-13.2%	-242

Table 5-40. Impacts to Southern Flounder Habitat

WITHOUT MITIGATION		
	August Average flows	
	IMPACTS (%)	IMPACTS (acres)
44 foot depth	-0.3%	-6
45 foot depth	-2.4%	-45
46 foot depth	-2.4%	-45
47 foot depth	-7.8%	-146
48 foot depth	0.0%	0

WITH MITIGATION		
	August Average flows	
	IMPACTS (%)	IMPACTS (acres)
44 foot depth	74.1%	1387
45 foot depth	54.2%	1014
46 foot depth	57.3%	1072
47 foot depth	57.3%	1072
48 foot depth	52.9%	989

Table 5-41. Impacts to American Shad Habitat

WITHOUT MITIGATION						
	May20%flows		May50%flows		May80%flows	
	IMPACTS (%)	IMPACTS (acres)	IMPACTS (%)	IMPACTS (acres)	IMPACTS (%)	IMPACTS (acres)
44 foot depth	0.0%	0	0.0%	0	0.0%	0
45 foot depth	0.0%	0	0.0%	0	0.0%	0
46 foot depth	0.0%	0	0.0%	0	0.0%	0
47 foot depth	0.0%	0	0.0%	0	0.0%	0
48 foot depth	0.0%	0	0.0%	0	0.0%	0

	January50%flows		August Average flows	
	IMPACTS (%)	IMPACTS (acres)	IMPACTS (%)	IMPACTS (acres)
44 foot depth	0.0%	0	0.0%	0
45 foot depth	0.0%	0	0.0%	0
46 foot depth	0.0%	0	0.0%	0
47 foot depth	0.0%	0	0.0%	0
48 foot depth	0.0%	0	0.0%	0

WITH MITIGATION						
	May 20% flows		May 50% flows		May 80% flows	
	IMPACTS (%)	IMPACTS (acres)	IMPACTS (%)	IMPACTS (acres)	IMPACTS (%)	IMPACTS (acres)
44 foot depth	-0.2%	-12	-0.2%	-12	-0.2%	-12
45 foot depth	-0.2%	-11	-0.2%	-11	-0.2%	-11
46 foot depth	-0.2%	-11	-0.2%	-11	-0.2%	-11
47 foot depth	-0.2%	-11	-0.2%	-11	-0.2%	-11
48 foot depth	-0.2%	-11	-0.2%	-11	-0.2%	-11

	January 50% flows		August Average flows	
	IMPACTS (%)	IMPACTS (acres)	IMPACTS (%)	IMPACTS (acres)
44 foot depth	-0.2%	-9	-0.3%	-16
45 foot depth	-0.2%	-9	-0.3%	-15
46 foot depth	-0.2%	-9	-0.2%	-11
47 foot depth	-0.2%	-9	-0.2%	-11
48 foot depth	-0.2%	-9	-0.2%	-11

Maps that show the locations of acceptable and unacceptable fishery habitats for these four representative species are shown on the following pages. Fishery habitat maps, except for American shad, are provided for the 42-foot channel (existing conditions), the 47-foot channel (Selected plan), and other alternative depths to show the range of impacts that would occur with a harbor deepening. Appendix P provides the fishery habitat maps for all four species and all alternatives considered.

The proposed harbor deepening alternatives would produce minimal adverse effects on habitat of American shad. Construction of the SHEP, regardless of depth and implementation of its associated mitigation plan, would have negligible impact on American shad habitat, ranging from -0.2 to -0.3 percent. These losses are within the accuracy of the models, so no further mitigation is warranted. Figures 5-29 and 5-30 show the locations of acceptable habitat for this species for existing conditions (August) and with deepening and implementation of the 47-foot channel, flow diversion, and oxygen injection. As impacts were shown to be negligible, these maps are representative of all three months simulated. Maps for all other scenarios are included in Appendix P.

Adverse impacts to Southern flounder would range between -0.3 and -7.8 percent without mitigation, with greater impacts predicted for the deeper depths. When the flow-altering and oxygen injection components of the mitigation plan are included, significant positive impacts would result to Southern flounder habitat. Improvements would range from 53 to 74 percent, with larger gains predicted for the 44- and 46-foot depth alternatives. The dissolved oxygen improvement systems would increase the portion of the harbor that is suitable as flounder habitat by up to 1,100 acres – a substantial increase and improvement. Figures 5-31 through 5-33 show the location of acceptable habitat for existing conditions, the 47-foot depth (Selected plan) and mitigation, and the 48-foot depth with its associated mitigation plan.

Substantial adverse impacts would remain to both Striped bass and Shortnose sturgeon habitat after the flow-altering and dissolved oxygen improvement components of the mitigation plan are included. The amount of habitat acceptable to Striped bass varies greatly with the amount of freshwater flow coming down the river. Suitable spawning habitat presently varies from 640 to 1,841 acres. Suitable egg habitat ranges from 961 to 2,256 acres, and suitable larval habitat ranges from 200 to 993 acres. When the flow-altering and oxygen injection components of the mitigation plan are included, adverse impacts to spawning habitat would range from -3 to -16 percent, with the impacts increasing with channel depth. Impacts to egg habitat were more varied, ranging from -11 to +5 percent. Impacts to larval habitat would range from -6 to +6 percent. Those impacts are based on average river flows. Mitigation for these remaining impacts is described in Section 5.03.2. Figures 5-34 through 5-42 show the locations of acceptable habitat for these various life stages.

Substantial impacts to Shortnose sturgeon would also remain after the flow-altering and dissolved oxygen improvement components of the mitigation plan are included. Impacts to juveniles would range from -7 to -12 percent. Impacts to winter adult habitat would range from -4 to -8 percent, with the adverse impacts increasing with channel depth. Impacts to summer adult habitat would range from +3 to +19 percent, with decreasing gains at deeper channel

depths. Figures 5-43 through 5-48 show locations of Shortnose sturgeon habitat for adults and juveniles.

The adverse impacts that would remain to Shortnose sturgeon and Striped bass after the flow-altering and dissolved oxygen components of the mitigation plan are included are at the level that warrants further mitigation. The Fishery Interagency Coordination Team was queried about potential ways that habitats within the harbor could be improved for these two species. For Striped bass, structural modifications, such as timber or rock flow diverters, were discussed. The agency fishery experts could not identify any measure that they believed would improve habitats over the range of river flow conditions that are experienced. For Shortnose sturgeon, no measures could be identified within the estuary that would improve habitats.

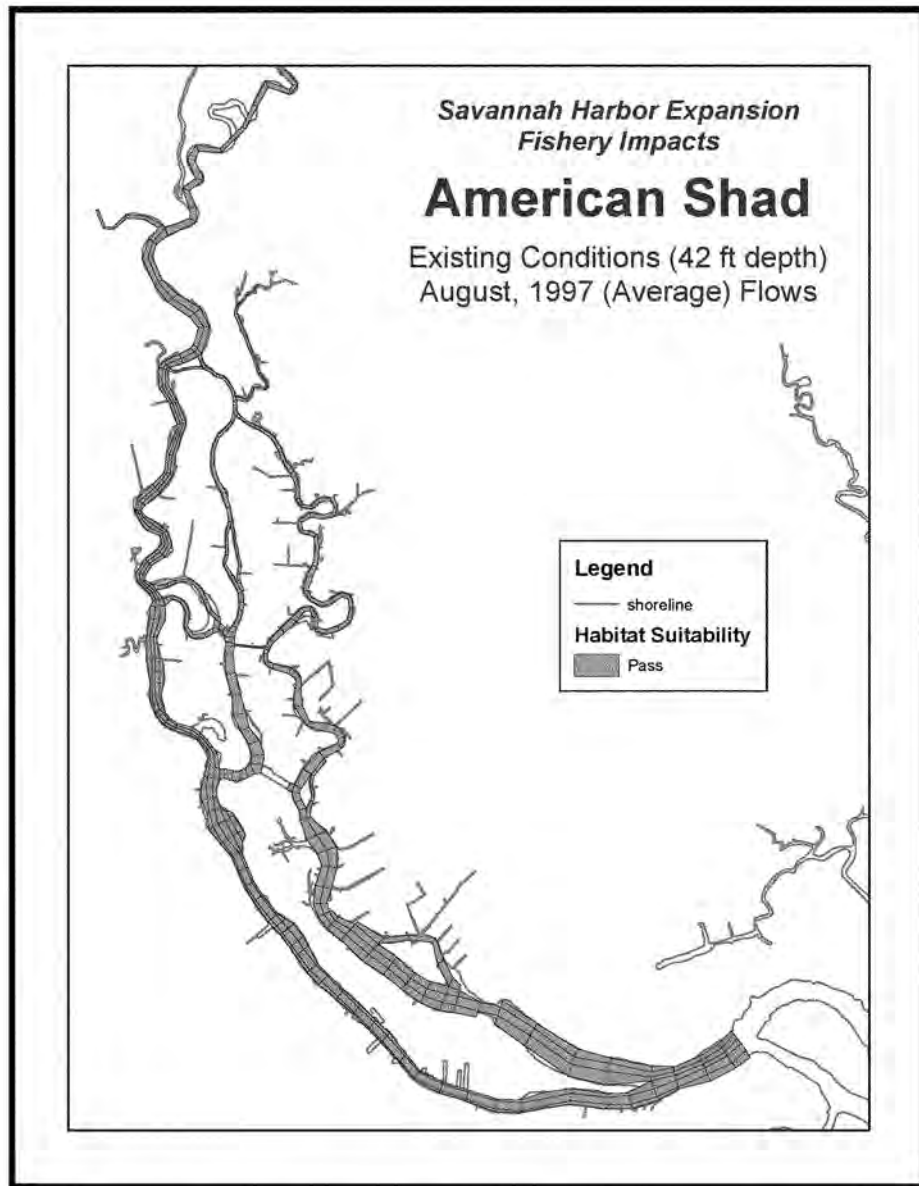


Figure 5-29. American shad habitat for existing conditions (42-foot channel).

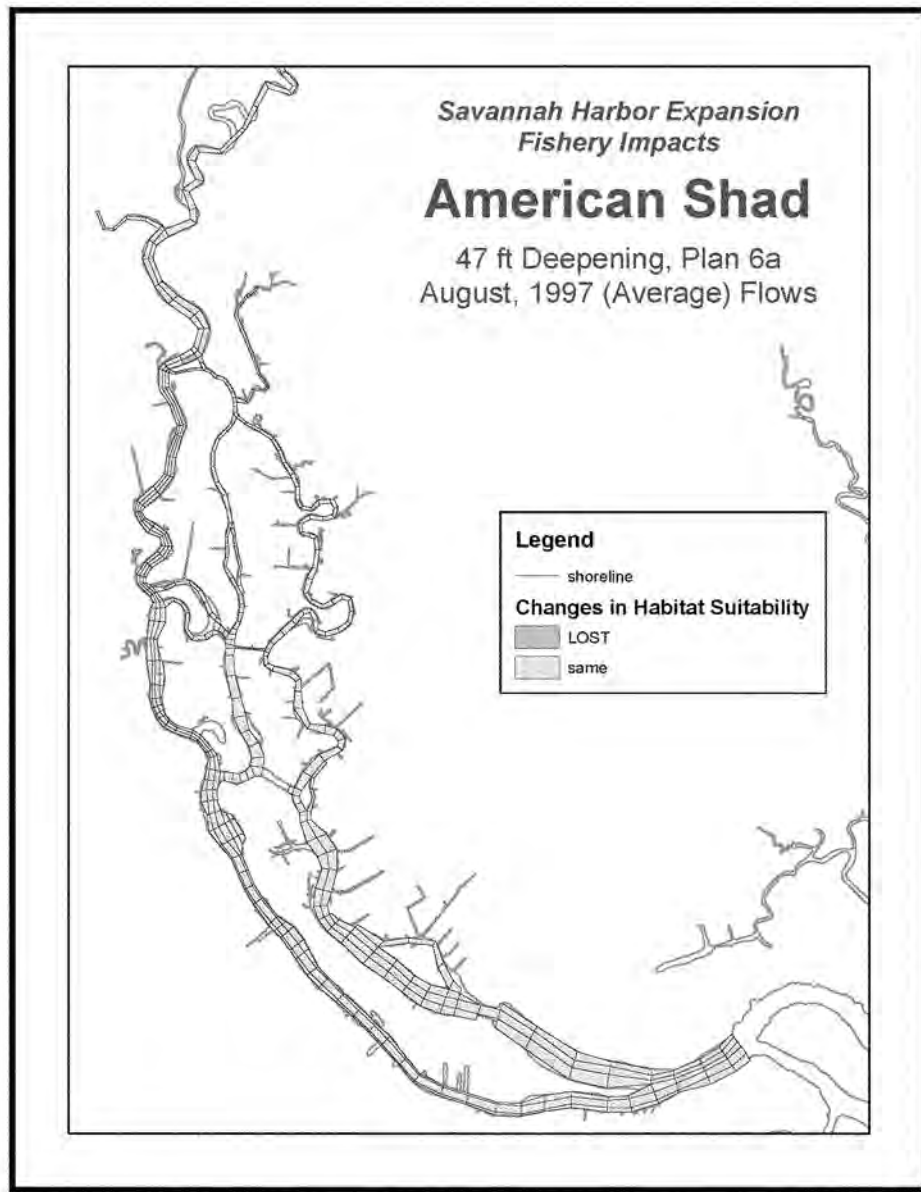


Figure 5-30. American shad habitat for the Selected Plan (47-foot depth alternative).

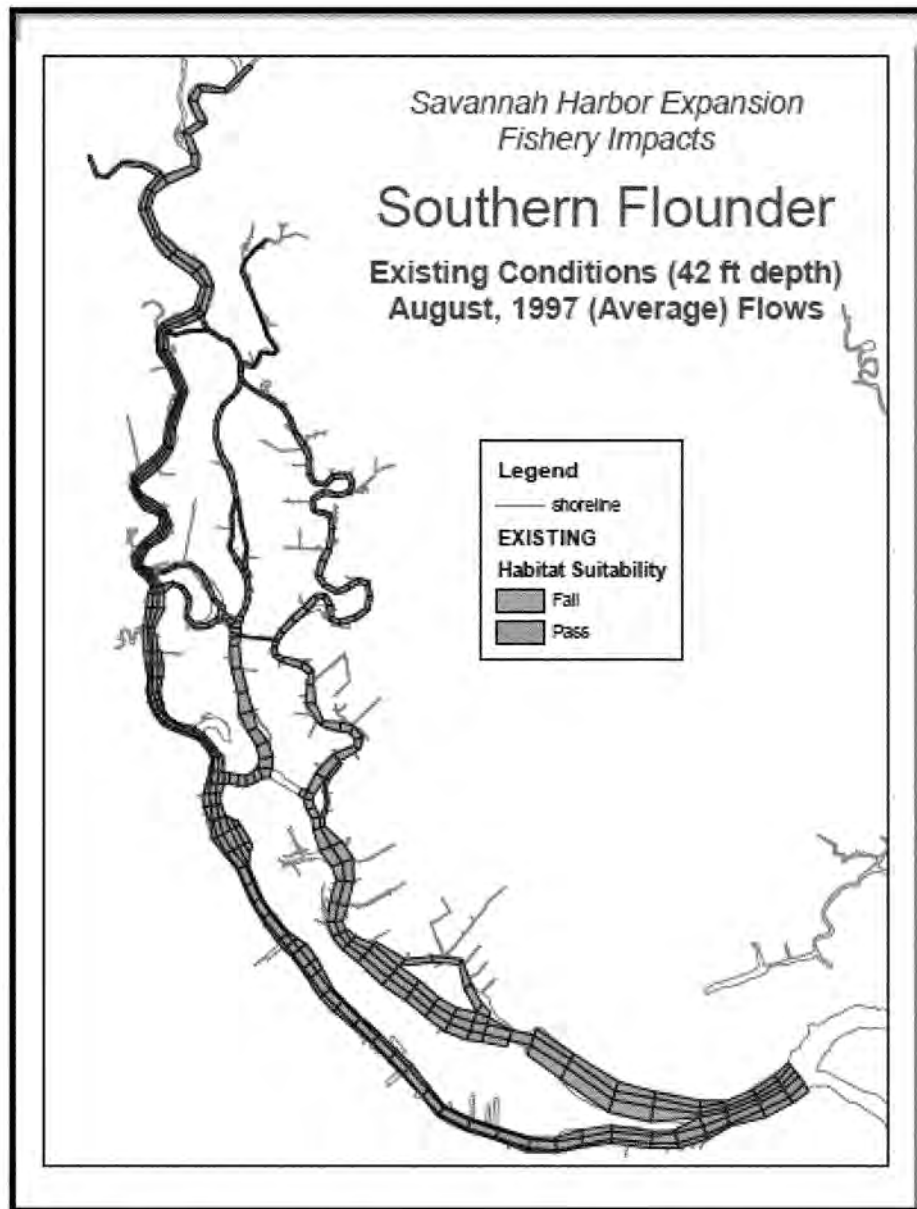


Figure 5-31. Southern flounder habitat for existing conditions (42-foot channel).

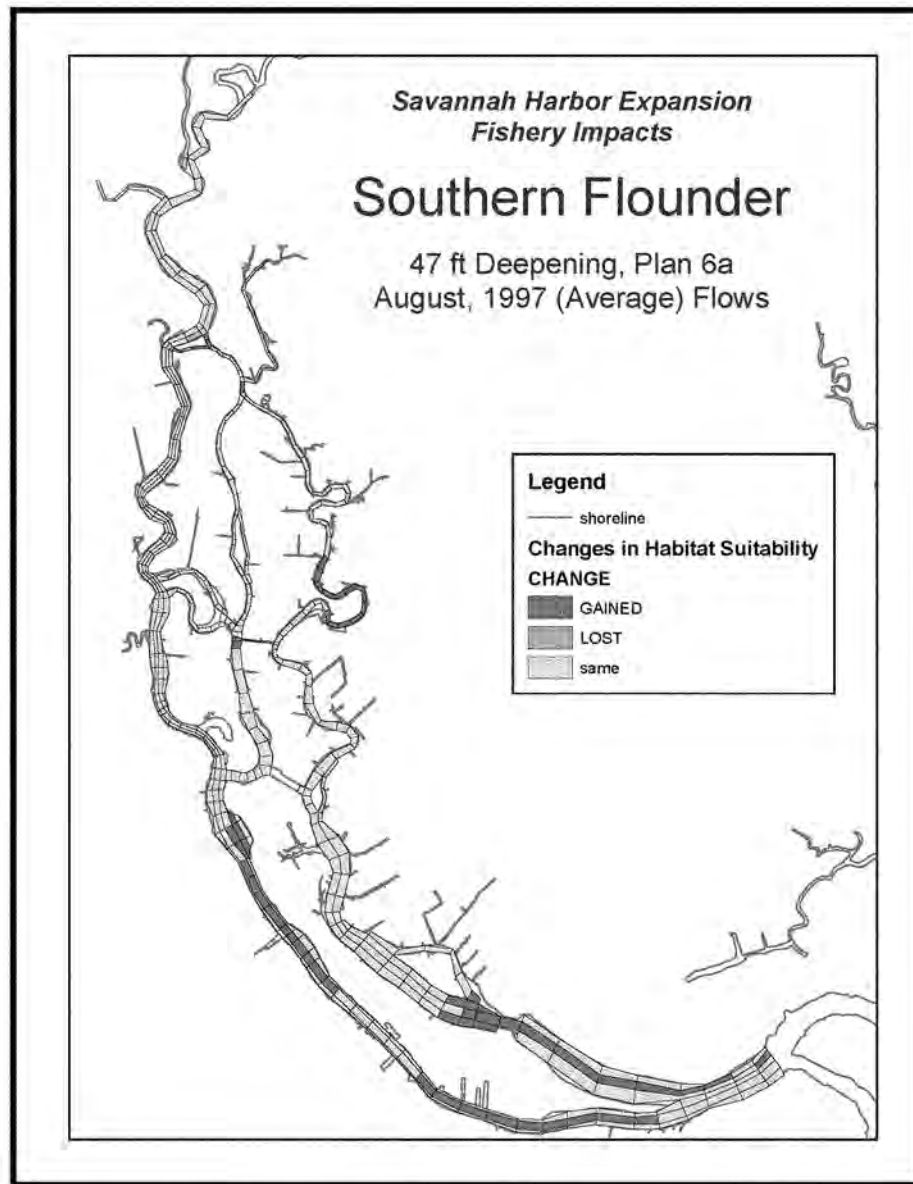


Figure 5-32. Southern flounder habitat for the Selected Plan (47-foot depth alternative).

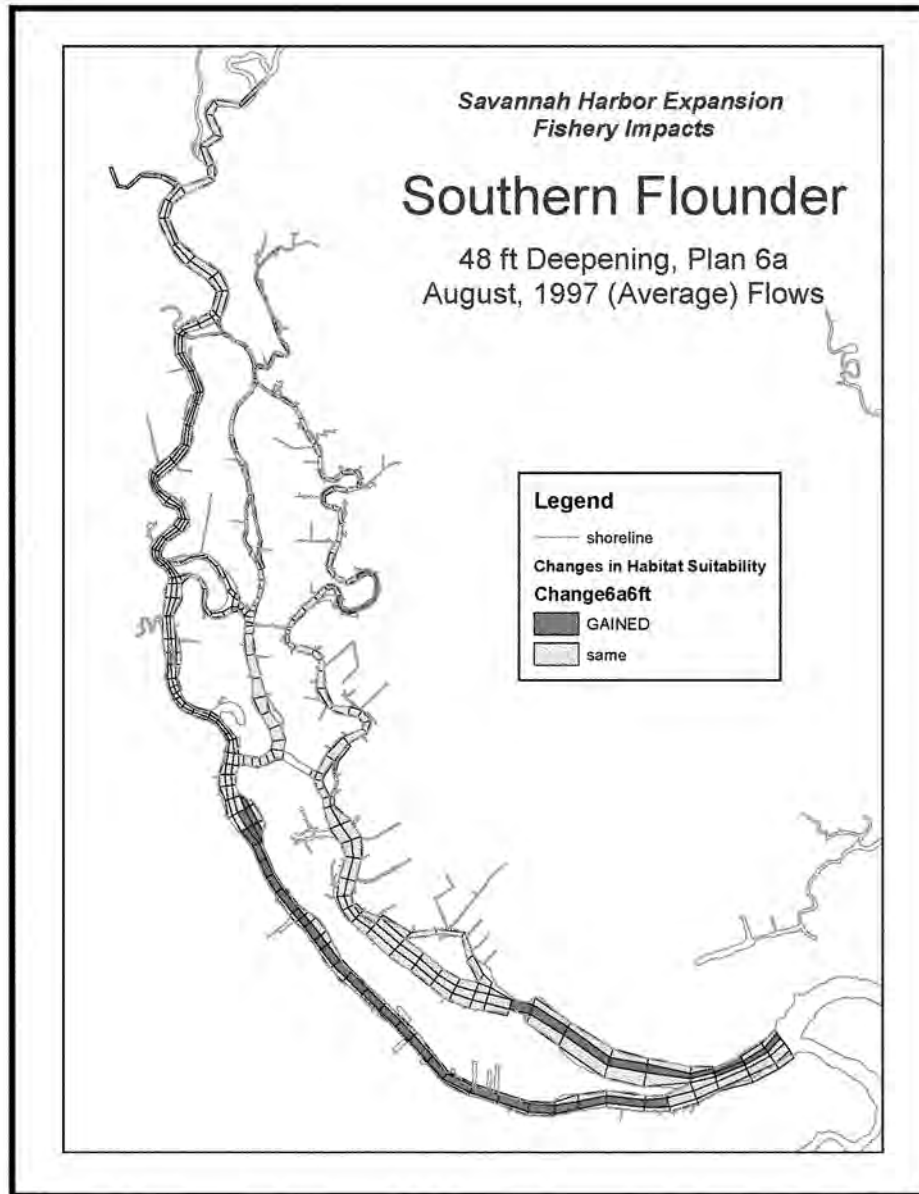


Figure 5-33. Southern flounder habitat for the 48-foot depth alternative.

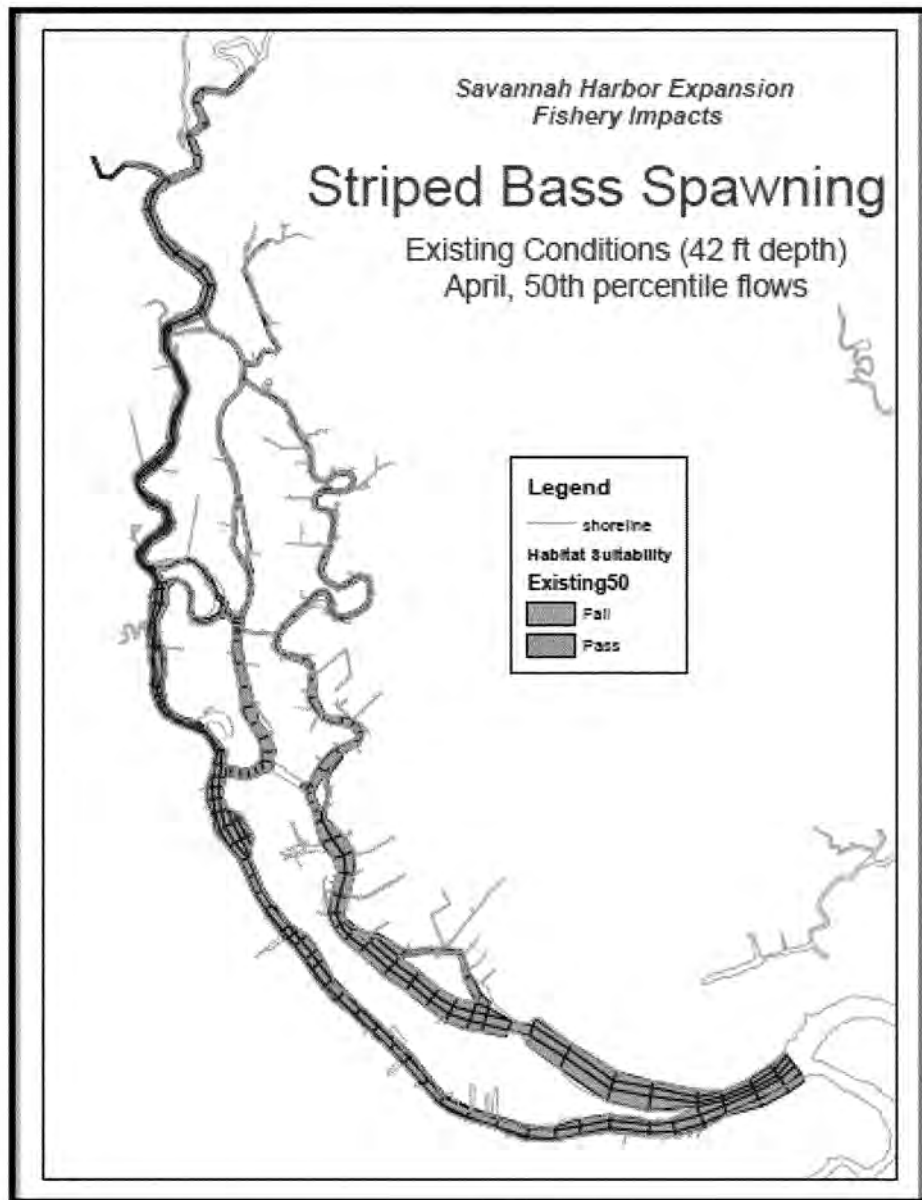


Figure 5-34. Striped bass spawning habitat for existing conditions (42-foot channel).

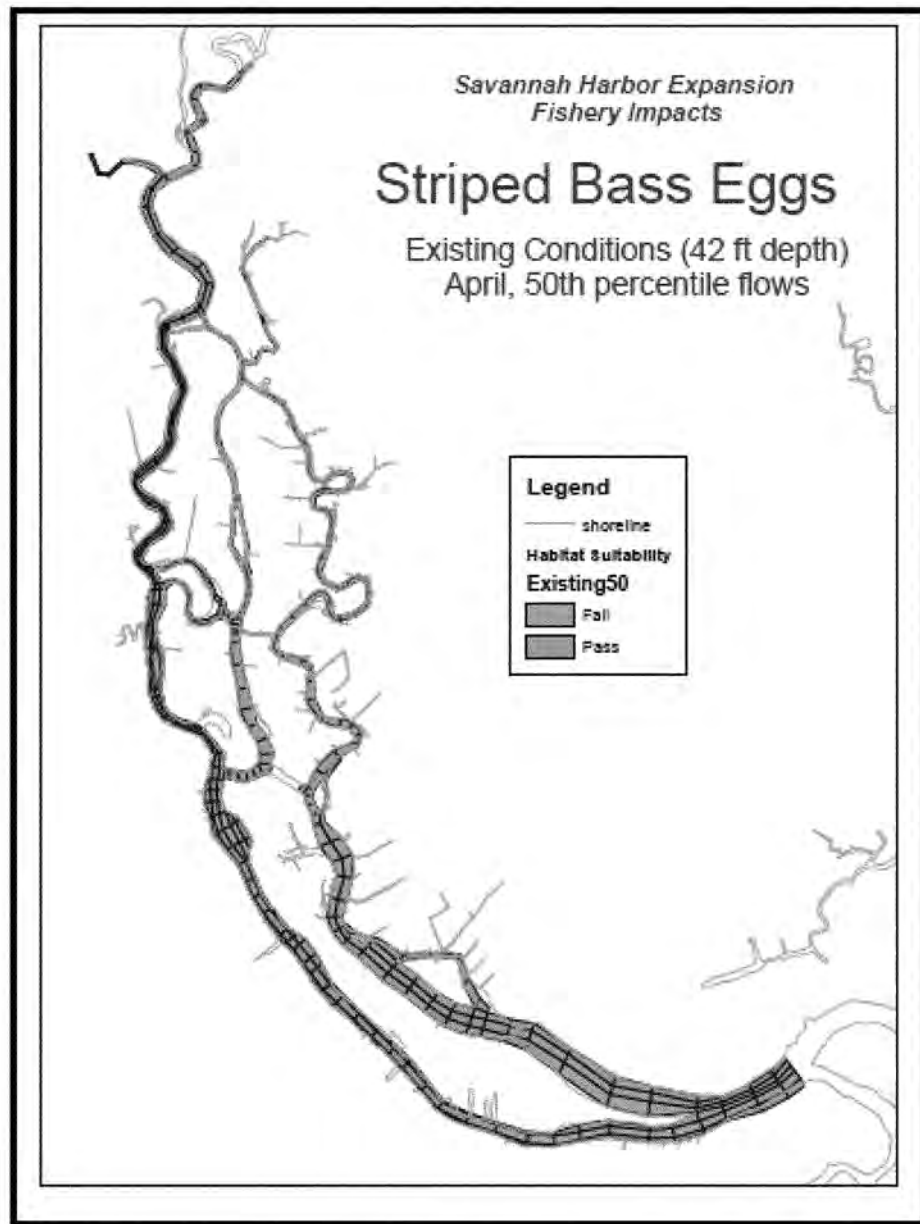


Figure 5-35. Striped bass egg habitat for existing conditions (42-foot channel).

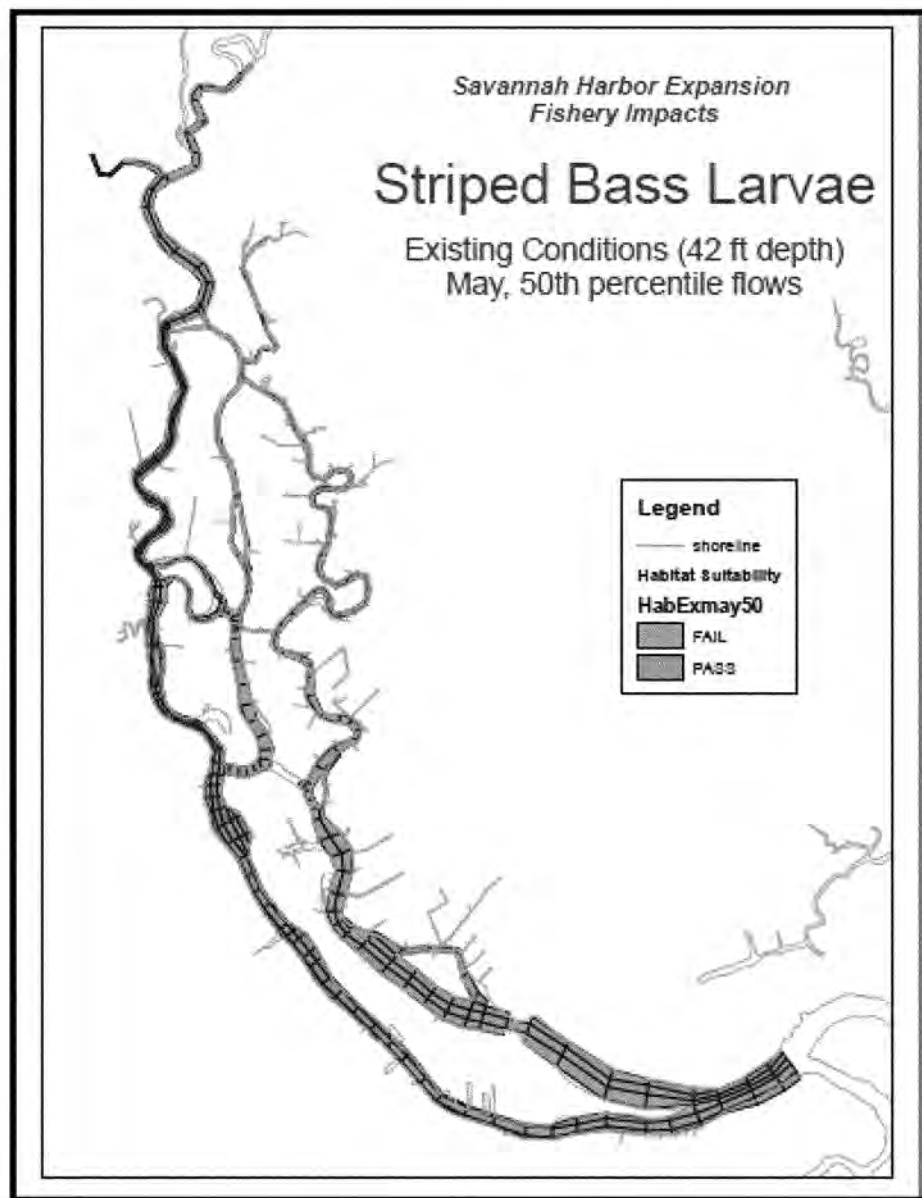


Figure 5-36. Striped bass larvae habitat for existing conditions (42-foot channel).

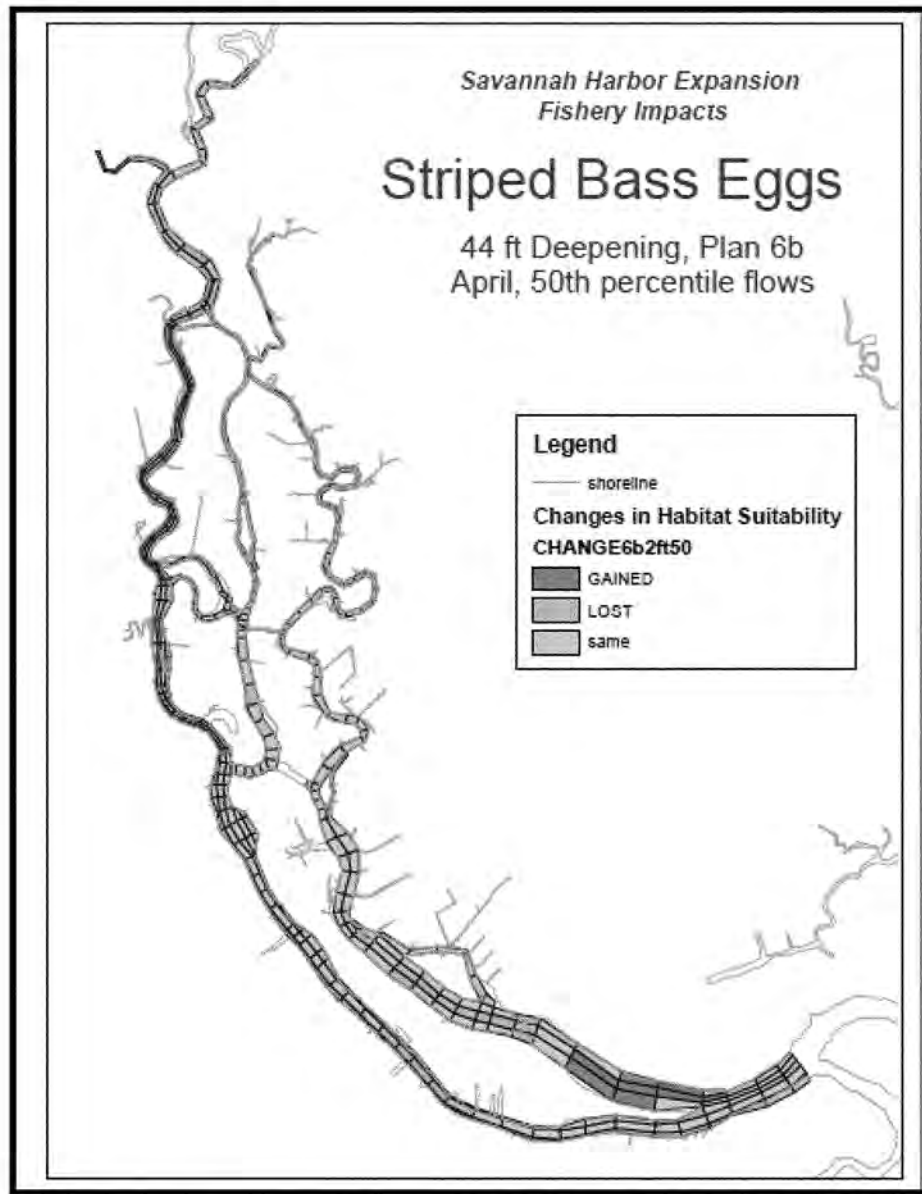


Figure 5-37. Striped bass egg habitat for the 44-foot depth alternative.

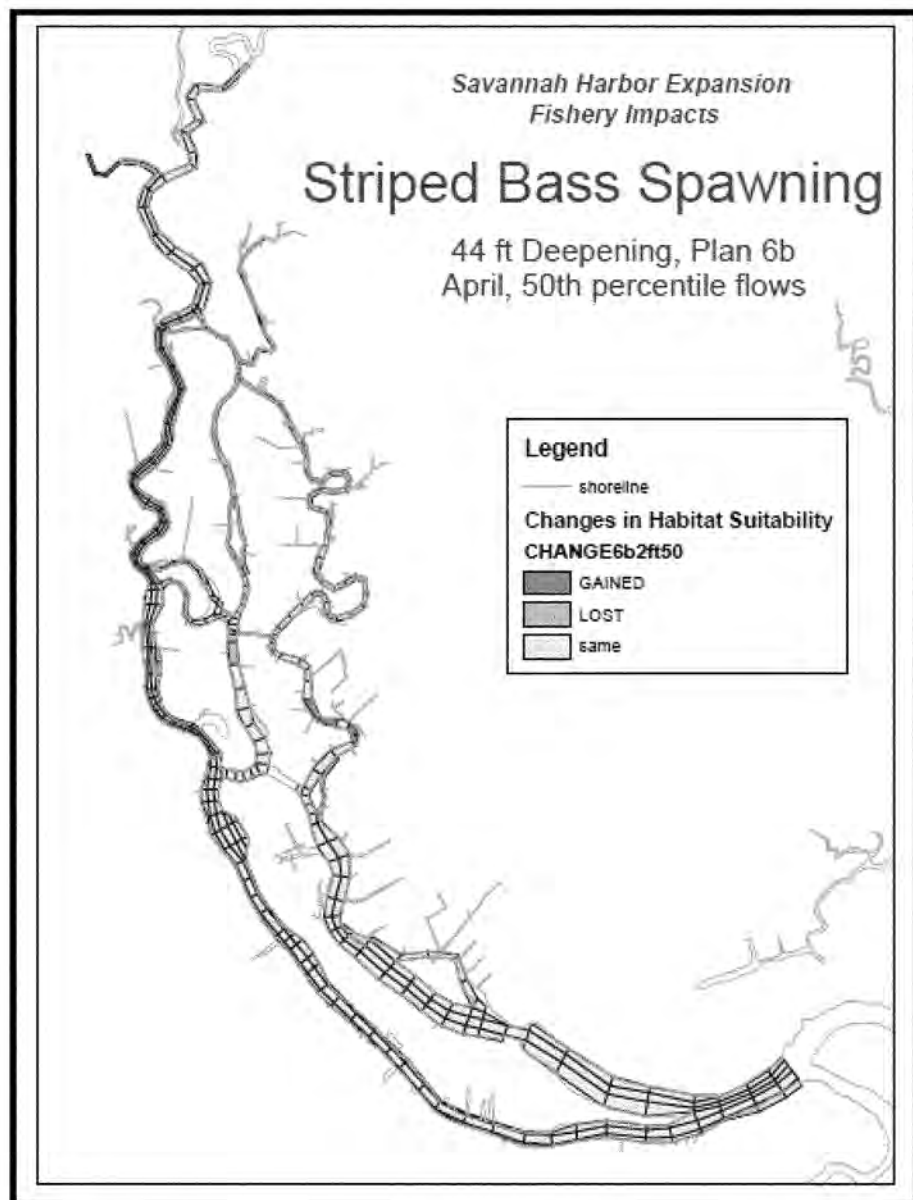


Figure 5-38. Striped bass spawning habitat for the 44-foot depth alternative.

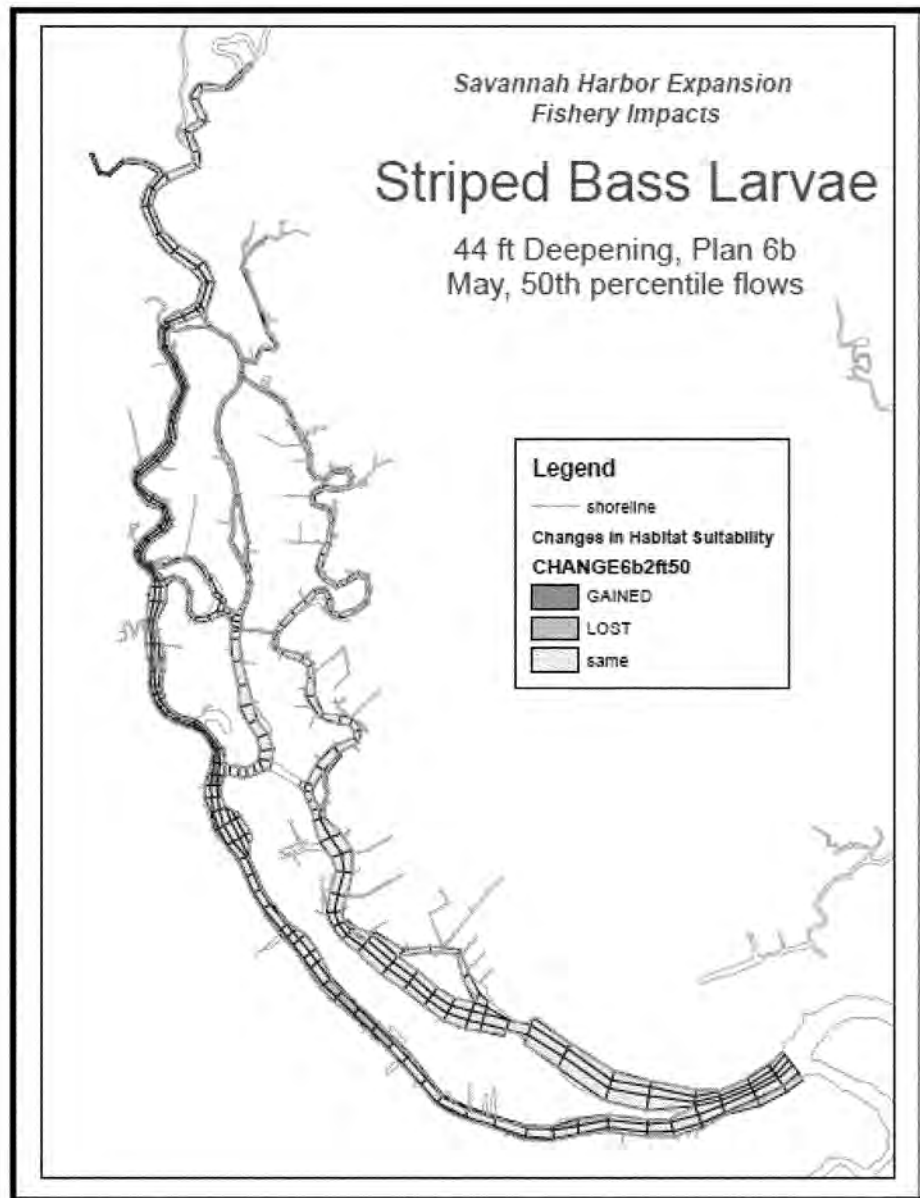


Figure 5-39. Striped bass larvae habitat for the 44-foot depth alternative.

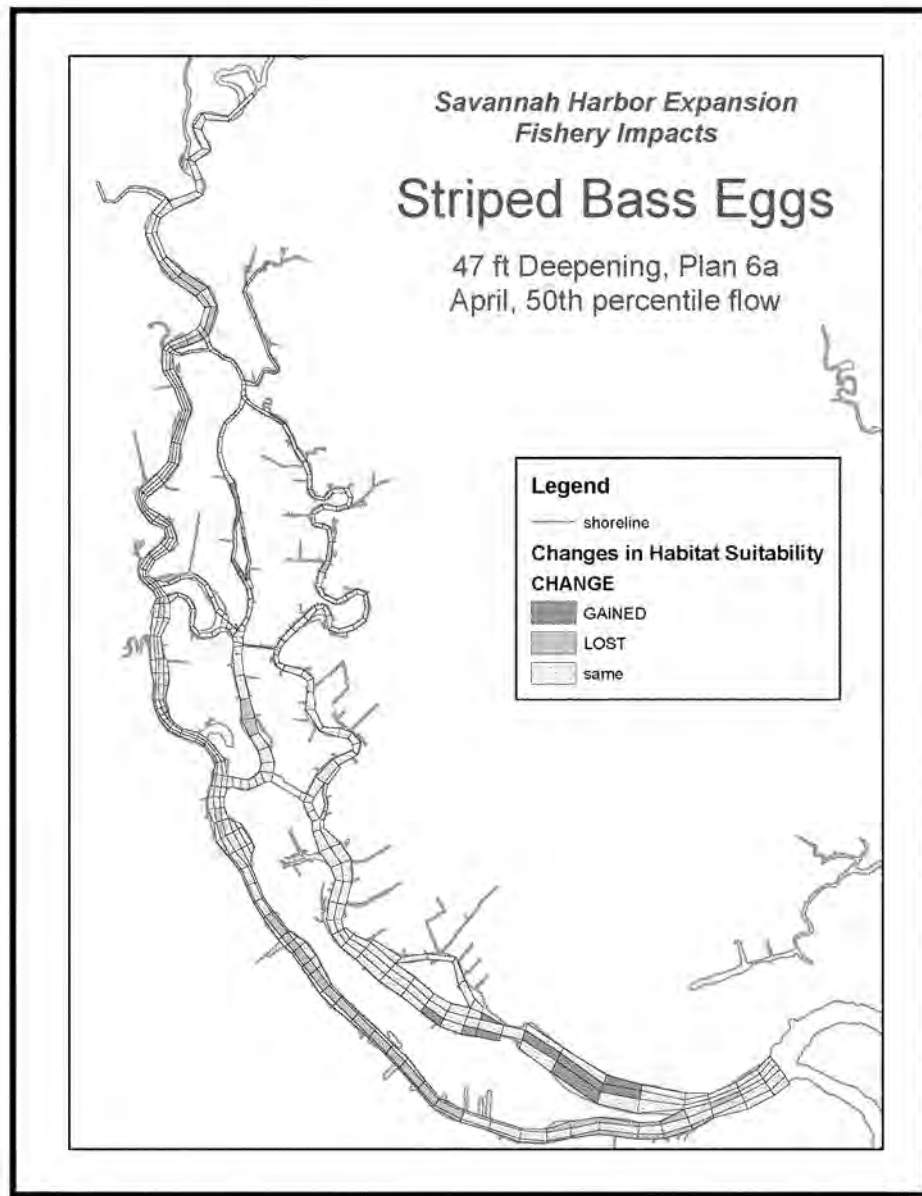


Figure 5-40. Striped bass egg habitat for the Selected Plan (47-foot depth alternative).

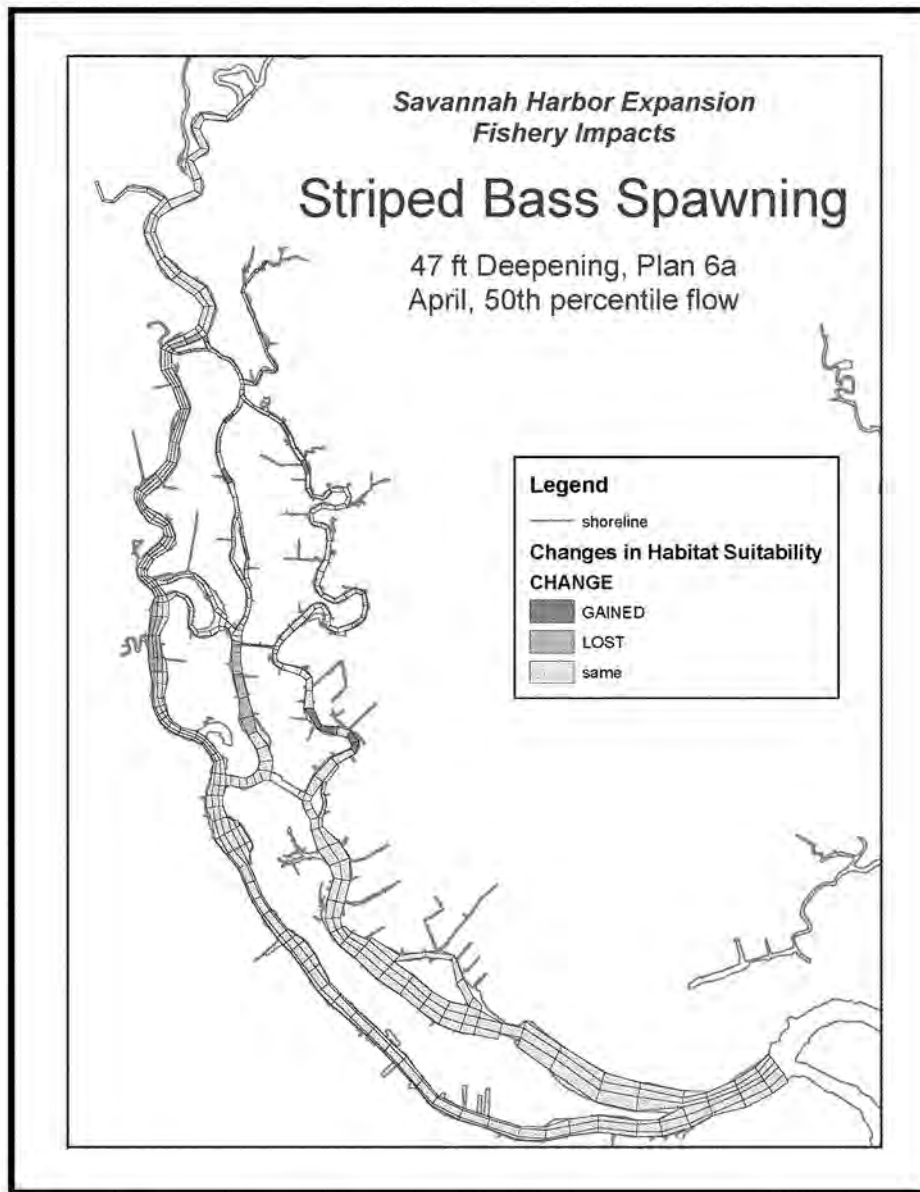


Figure 5-41. Striped bass spawning habitat for the Selected Plan (47-foot depth alternative).

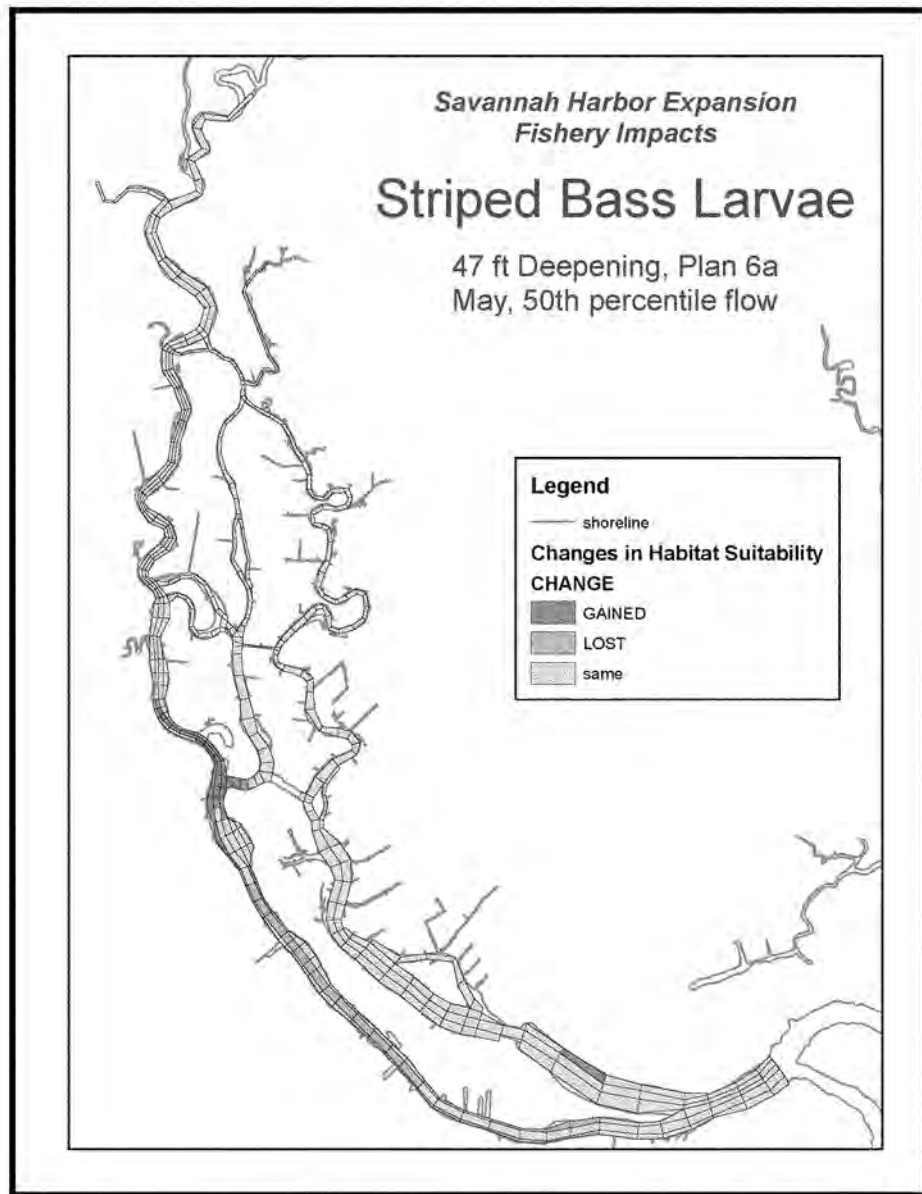


Figure 5-42. Striped bass larvae habitat for the Selected Plan (47-foot depth alternative).

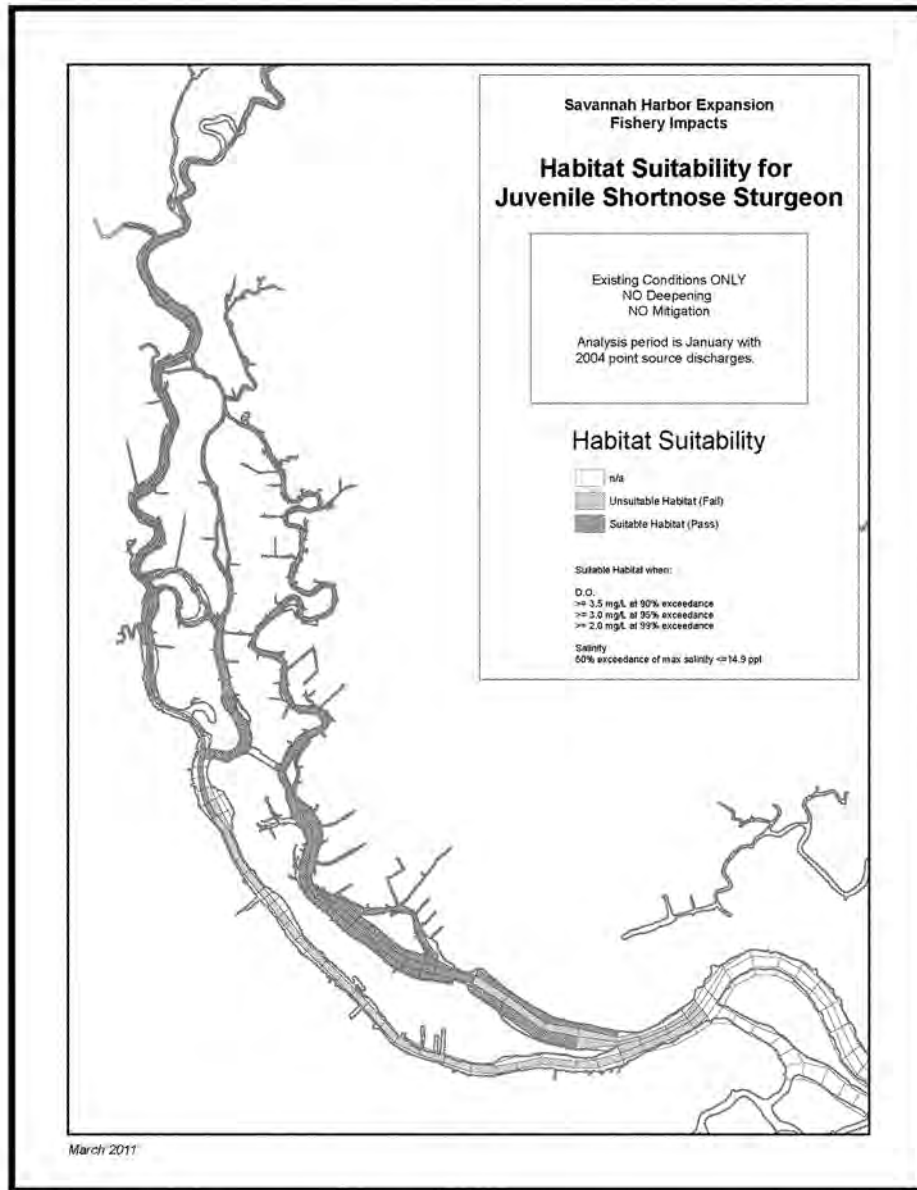


Figure 5-43. Shortnose sturgeon juvenile habitat for existing conditions (42-foot channel).

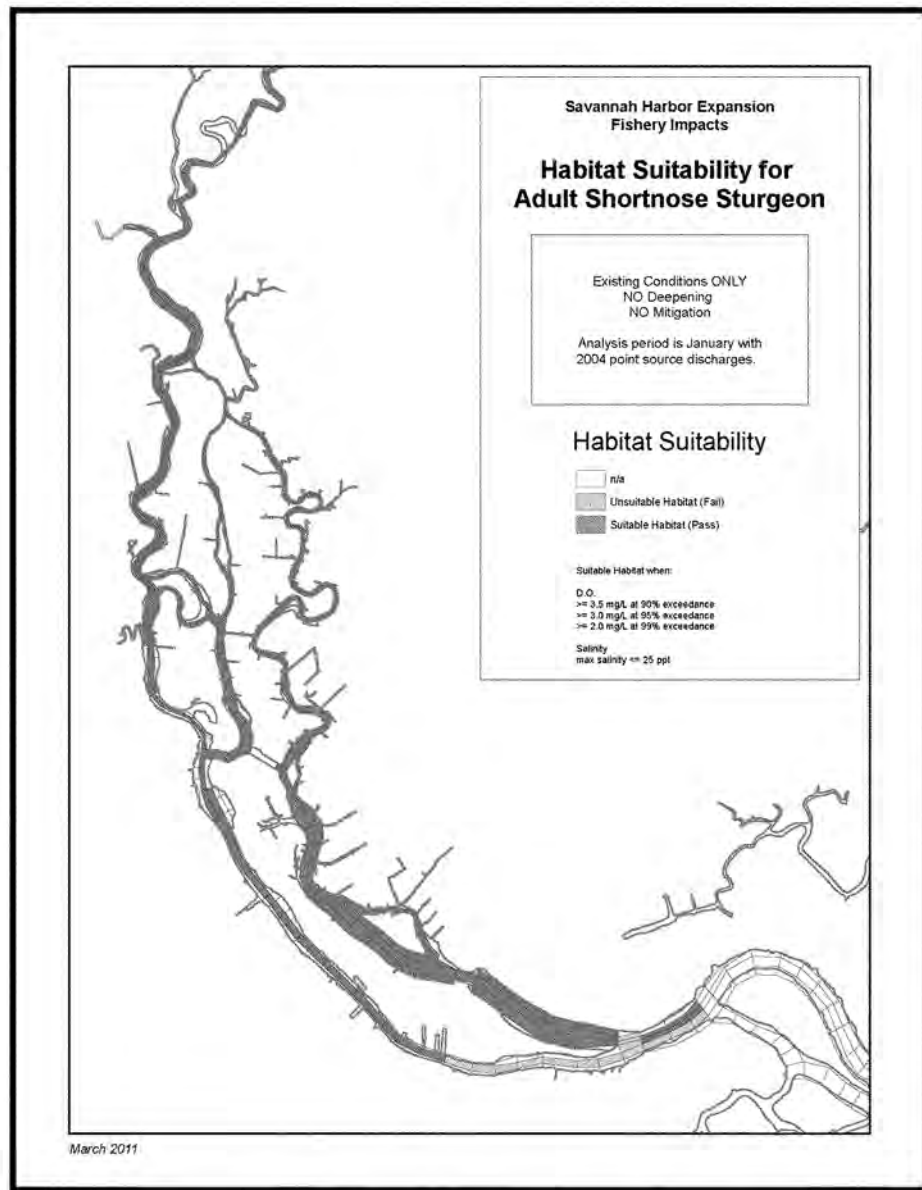


Figure 5-44. Shortnose sturgeon adult habitat for existing conditions (42-foot channel).

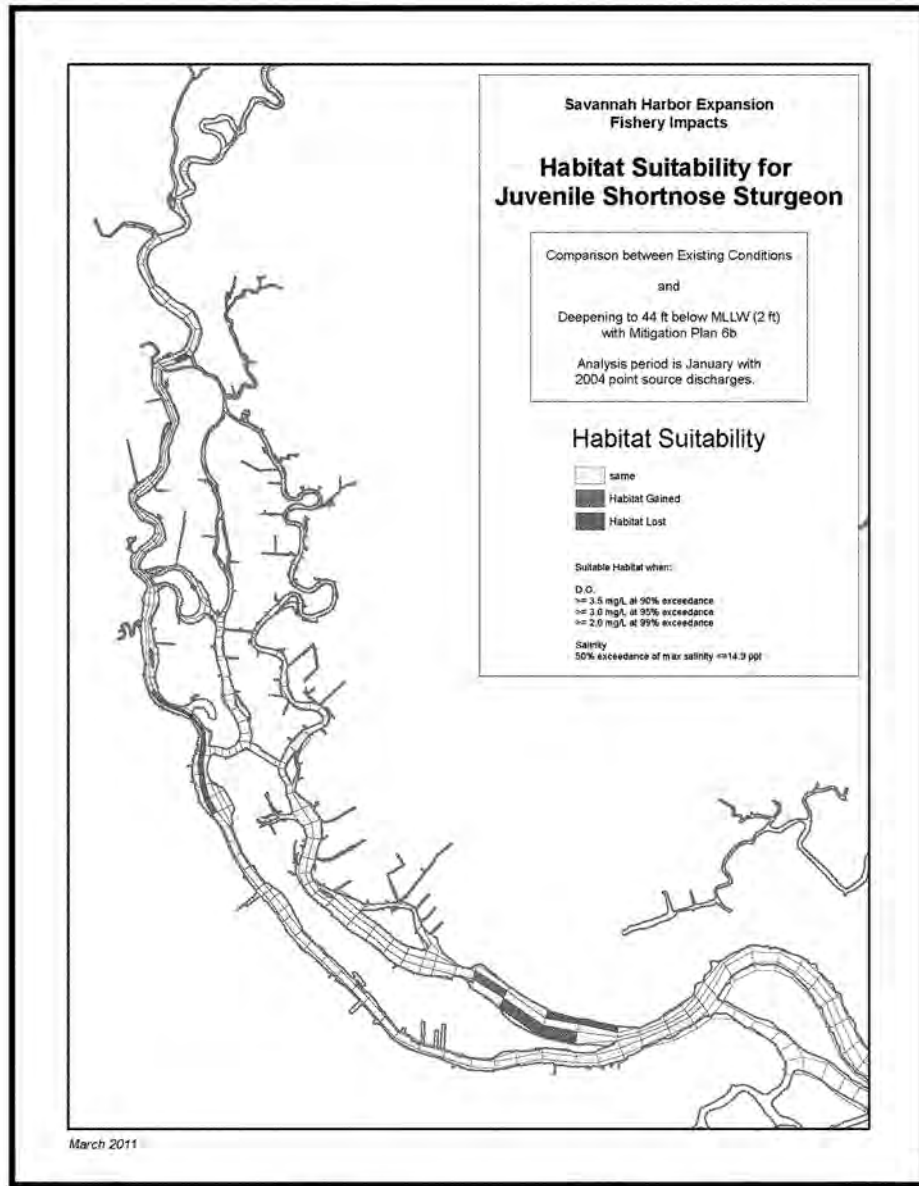


Figure 5-45. Shortnose sturgeon juvenile habitat for the 44-foot depth alternative.

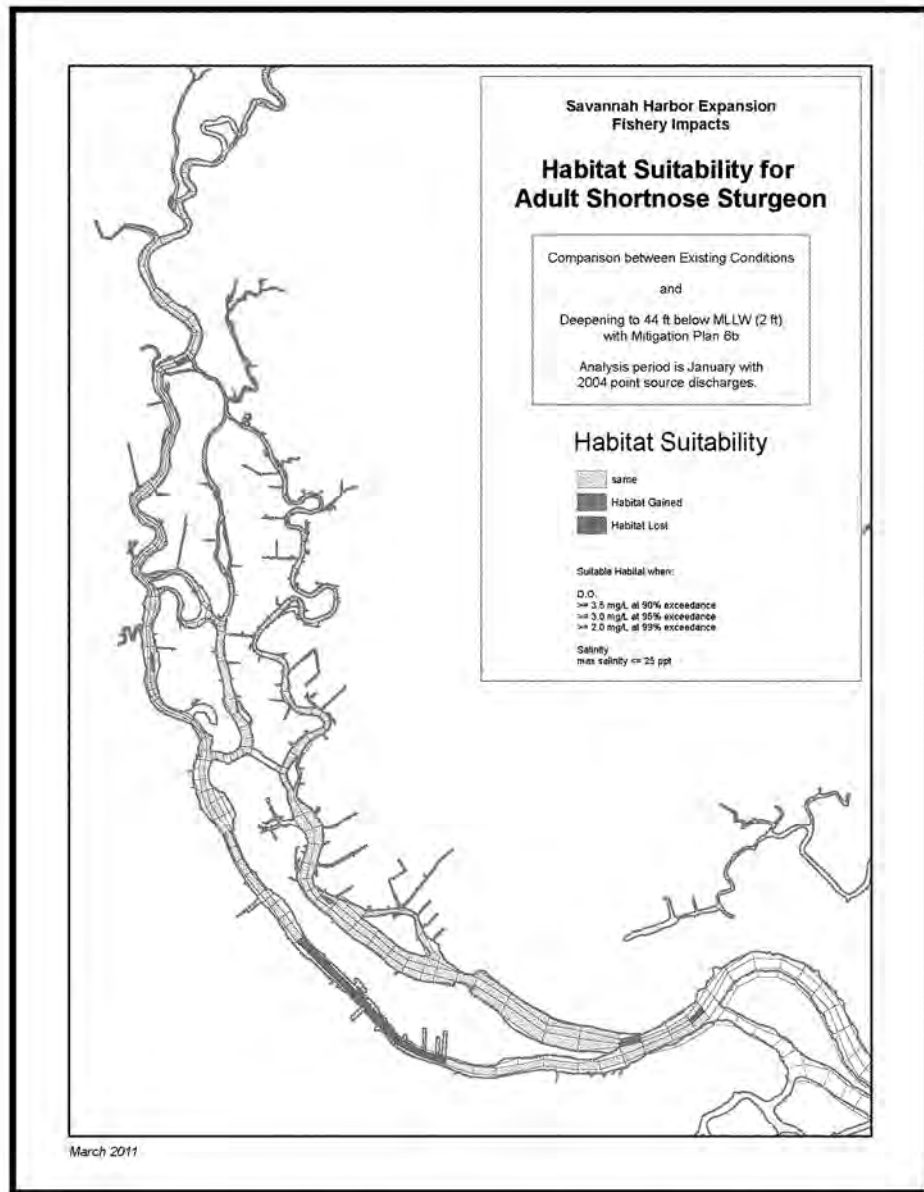


Figure 5-46. Shortnose sturgeon adult habitat for the 44-foot depth alternative.

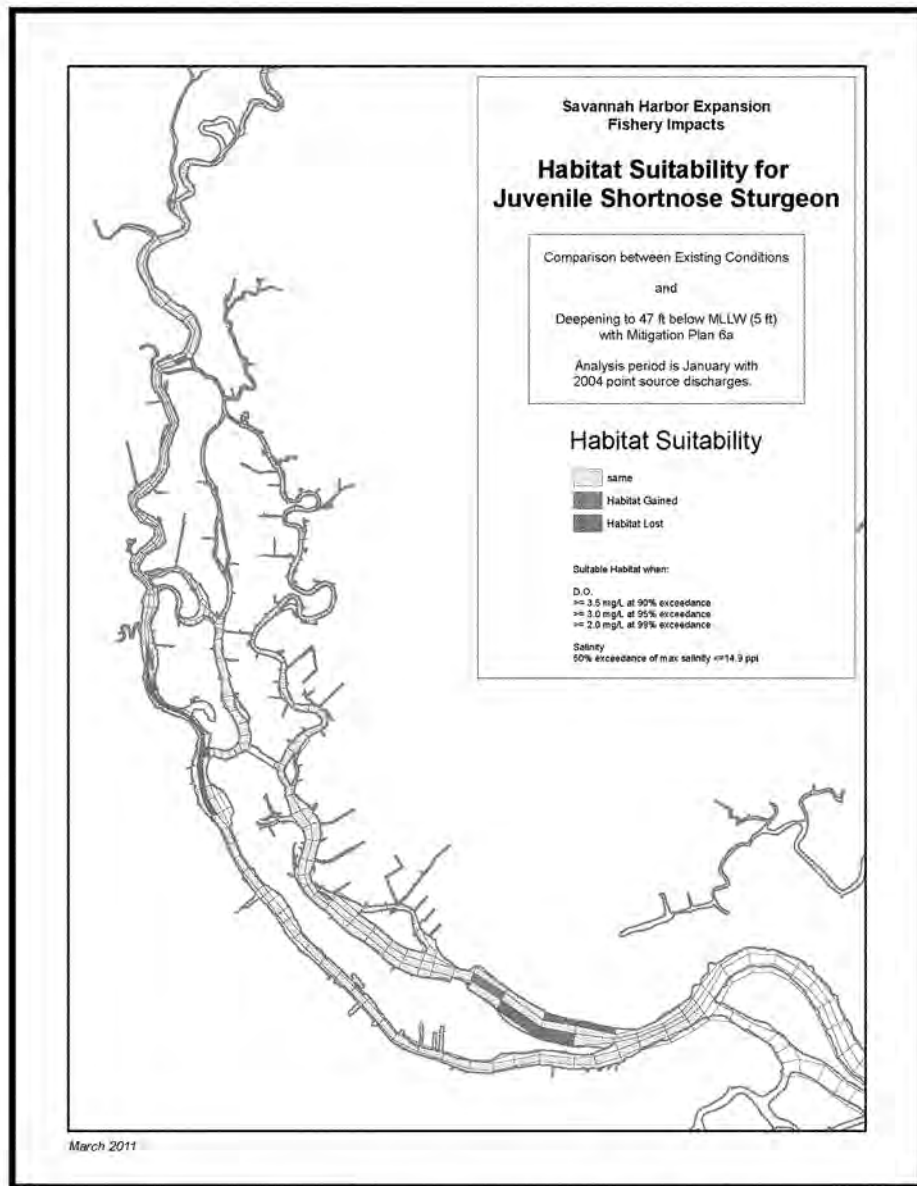
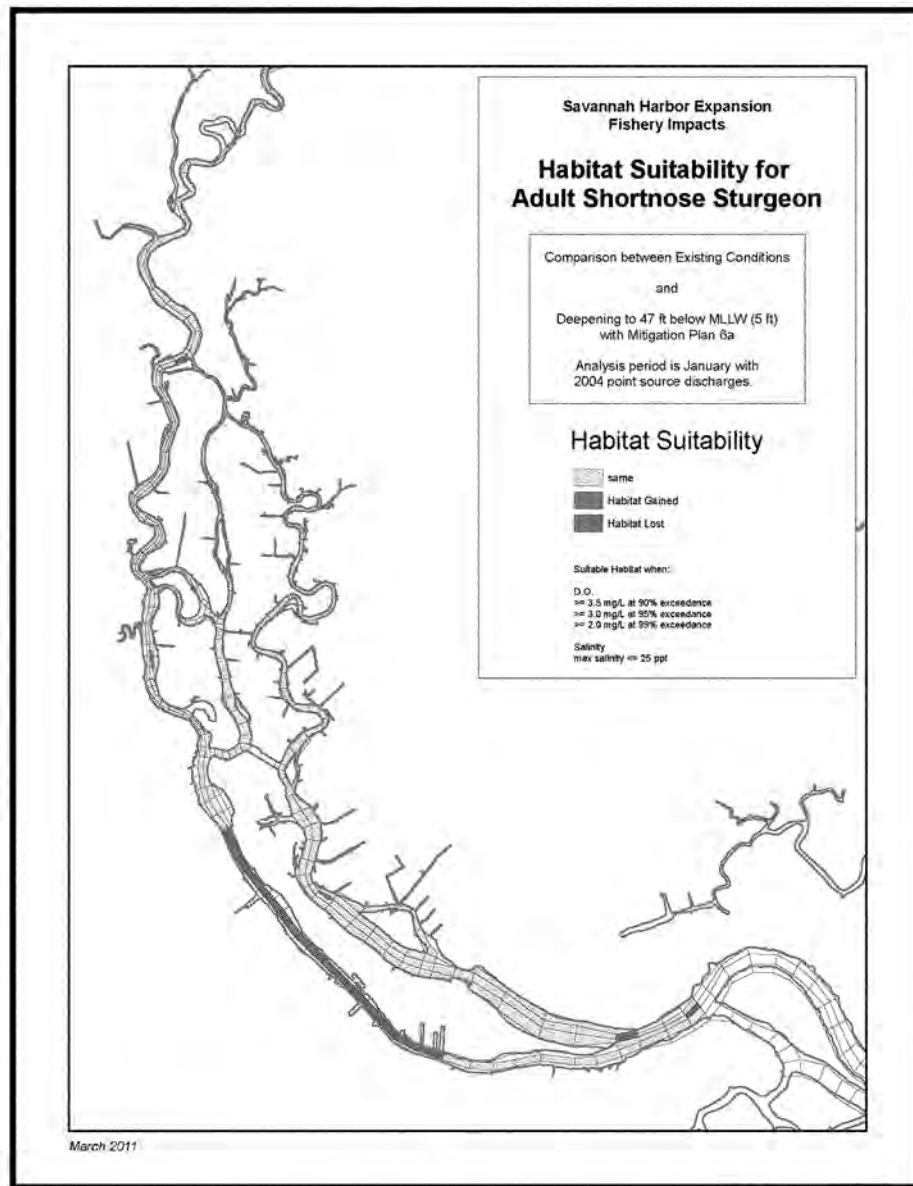


Figure 5-47. Shortnose sturgeon juvenile habitat for the Selected Plan (47-foot depth alternative).



**Figure 5-48. Shortnose sturgeon adult habitat for the Selected Plan
(47-foot depth alternative).**

5.03.2 Mitigation for Impacts to Fisheries

5.03.2.1 Shortnose Sturgeon. The Corps consulted natural resource agencies about potential ways to address remaining adverse impacts to Shortnose sturgeon. Neither the Corps nor the agencies could identify any measures that could be implemented in the estuary that would restore Shortnose sturgeon habitat or enhance existing habitats.

Consequently, the Corps began to evaluate other means to improve Shortnose sturgeon habitat including upstream spawning habitat. The Corps acknowledged that removal of the lowest dam on the river, the New Savannah Bluff Lock and Dam (NSBL&D) at Augusta, Georgia, would be the biologically-preferred method to allow sturgeon and other anadromous fish to access upstream habitat. The Corps also acknowledged that removal of the lock and dam would benefit the ecosystem. The Corps had proposed such an action in 1999, but local governments opposed it, citing adverse impacts to recreational uses of the pool upstream of the dam. In response, the Corps proposed rehabilitating the structure and adding a fishway to allow fish to move past the structure. In 2000, Congress authorized construction and operation of a fishway at NSBL&D as part of a lock and dam rehabilitation project. That project has not been funded. Coordination with local governments indicates they continue to oppose removal of the structure. Consequently, removal of the New Savannah Bluff Lock and Dam is not a feasible mitigation alternative for the following reasons:

- A. The lock and dam is a Congressionally-authorized project; therefore, the Corps is obligated to maintain the project as Congress provides funding for such actions.
- B. The current authorization language (WRDA 2000), amended in Omnibus Act 2001, calls for repair and rehabilitation of the lock and dam structure, construction of a fish passage, and conveyance of the Lock and Dam to the City of North Augusta.
- C. Removal of the structure would adversely impact the freshwater supply of eight major users.

Since removal of the NSBL&D is not feasible, the Corps suggested that a fish passage structure at NSBL&D be considered as mitigation feature for the SHEP impacts to Shortnose sturgeon habitat. A fishway around the structure would allow migrating fish to move past the dam and allow Shortnose sturgeon to access upstream historic spawning areas at the Augusta Shoals. The structure would also open up the river to American shad and other anadromous fish species, thereby helping those populations. There is also evidence that some of the Savannah Harbor Striped bass population spawn in upstream areas near the fall line, which could also benefit from the fishway.

The previously-approved horseshoe rock ramp design was proposed as a means of allowing Shortnose sturgeon and other anadromous species of fish to move past the NSBL&D during spawning season. The fishway would be located around the South Carolina abutment of the dam. This is the wooded area on the bank opposite the lock in Figure 5-49 below. It would be designed to operate continuously and pass 600 cubic feet per second (CFS) during low flow conditions (95% exceedance). The 600 CFS minimum attraction flow is 5% of the mean river flow during upstream spawning migration period of February through June. Higher attraction flows are probably better, but Parasiewicz et al. 1998 indicated that 5% of the river flow should

be an adequate attraction flow for most fish. The fishway would pass higher flows when the river flows are higher. Flows in the fishway are designed to be self-regulating over a two-foot headwater variation, including a range of river flows from 3,600 to 20,000 CFS. The horseshoe rock ramp would have roughly a 75-foot width across the base and use boulder weirs at approximately a 25-foot spacing. There would be roughly a 9-inch drop per weir along the length of the fishway. The water depth would range between 3.5 and 5.5 feet in the fishway. The horseshoe rock ramp bypass design would also allow fish to move downstream, thereby ensuring young fish spawned upriver could access other habitats needed in later life stages. Figures 5-50 and 5-51 show the rock ramp fishway design.



Figure 5-49. Aerial view of New Savannah Bluff Lock and Dam.

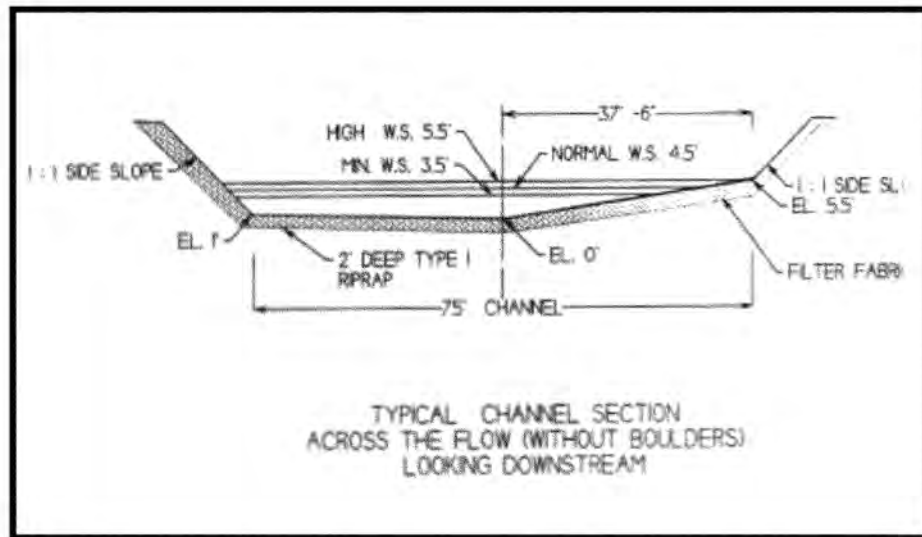


Figure 5-50. Typical cross-section of rock weir.

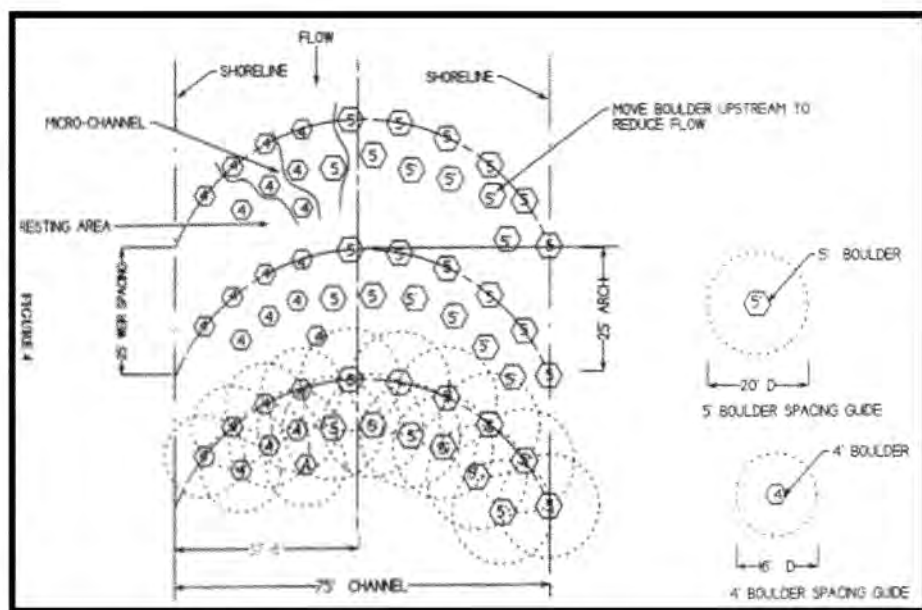


Figure 5-51. Plan view of boulder layout for rock weirs.

In June 2007, representatives of the resource agencies confirmed that the fishway appeared to be the only measure within the basin to effectively compensate for the predicted loss in Shortnose sturgeon habitats. The Corps conducted a preliminary review of the 2001 fishway design and confirmed that conditions had not changed that would reduce its effectiveness or ability to be implemented. In 2010, the Corps consulted the Federal and State regional natural resource agencies to determine if the state-of-the-art had advanced substantially since the design was completed for the fish passage structure at the NSBL&D. No fishery experts in the regional natural resource agencies identified any specific change to the proposed design that should be made as a result of recent documented fish passage research. The rock ramp design was provided to the cost estimators, who updated the cost for constructing the fishway. That fishway was added as a feature of the mitigation plan at an estimated ROM cost of \$4.3 million.

The horseshoe rock ramp bypass design as described above was presented in the DEIS. In their comments on the DEIS, some agencies believed the horseshoe rock ramp bypass would need to carry more than 5% of the river flow to successfully pass Shortnose sturgeon. Consequently, the Corps convened an interagency workshop on April 25-27, 2011 to discuss and evaluate mitigation options available. Numerous options were evaluated for fish passage at the NSBL&D. Using the input from the agencies at the workshop, the Corps screened the potential fish passage options and prepared preliminary designs for three new fish passage alternatives: (1) Full River Rock Ramp, (2) Off-Channel Rock Ramp, and (3) a Hybrid Rock Ramp. Although not specifically considered at the interagency workshop, the Corps considers the Off-Channel Rock Ramp to be a variation of the Full River and Hybrid Rock Ramp designs since they would all transport roughly the same amount of water for Shortnose sturgeon to use while moving through that location of the river. These alternatives differ by their location across the channel's cross-section. Once upstream passage occurs, successful downstream passage is critical to ensure that the adult breeding population as well as juvenile fish can return to traditional foraging habitats in the estuary. For all three alternatives, a rock ramp would be constructed to allow Shortnose sturgeon to swim to the upstream pool. In each design, large boulders would be used to create pools with local areas of lower velocities. All three designs would also accommodate the larger Atlantic sturgeon and readily pass other anadromous species such as American shad and Striped bass.

Table 5-42 shows a comparison of the three designs. The Full River Rock Ramp would capture all of the river flow (up to 10,000 cfs) 73% of the time from February-June which is the Shortnose sturgeon spawning season. Flows over 10,000 cfs would flow through the flood bypass channel and the ramp. The Off-Channel Rock Ramp Design would capture all of the river flow (up to 8,000 cfs) 64% of the time from February-June while the Hybrid Rock Ramp Design would capture all of the river flow (up to 9,000 cfs) 70% of the time. Since all three designs would achieve the objective of Shortnose sturgeon passage at the NSBL&D, the Off-Channel Rock Ramp Design was selected as the preferred design because it is the most cost effective. Figure 5-52 shows the most recent design for the Off-Channel Rock Ramp. A complete discussion of the analysis of fish passage alternatives at NSBL&D can be found in Appendix C.

Table 5-42. Comparisons of Potential Fishway Designs at NSBL&D

Parameter	Full River Rock Ramp	Off-Channel Rock Ramp	Hybrid Rock Ramp
100% of flow through ramp up to X cfs	10,000 cfs	8,000 cfs	9,000 cfs
Crest elevation of Rock Ramp	109 ft	109 ft	109.5 ft
Number of gates operational	0	5	3
Modification to existing Lock & Dam structure	Major	Minor	Moderate
Modification to existing Lock & Dam project	Major	Minor	Moderate
Percent of time ramp captures all of river flow (February - June)	73%	64%	70%
Effectiveness in fish passage (Upstream)	90%	75%	80%
Effectiveness in fish passage (Downstream)	100%	85%	90%
Effectiveness in fish passage (Overall)	Acceptable	Acceptable	Acceptable
ROM cost	\$100 mil	\$32 mil	\$41 mil
Cost Effectiveness (Cost /% SNS passage effectiveness)	\$1,050,000	\$325,000	\$480,000



Figure 5-52. Conceptual design of off-channel rock ramp.

The project's Monitoring Plan includes studies to evaluate Shortnose sturgeon distribution at the NSBL&D as well as the success of the fish passage structure. During the pre-construction

monitoring, the movement of fish at the NSBL&D would be monitored for one year. This monitoring would include capturing, tagging and tracking Shortnose sturgeon and possibly other representative species of fish indigenous to that area (Striped bass, Robust redhorse, and American shad). Fish would be collected and implanted with combined radio and acoustic transmitters. If possible, fish would be collected within one km of the dam. The fish would be monitored continuously in the vicinity of the dam using a fixed station radio receiver. In addition, the river would be searched weekly during migration season between NSBL&D and Jackson, SC Landing and between NSBL&D and the Augusta Diversion Dam. The Savannah River would also be searched from the Kings Island Turning Basin to the NSBL&D and above to the Augusta Diversion Dam on a monthly basis. When located, species, identification number and location would be recorded. Temperature would be recorded several times daily at locations above and below the dam. Dissolved oxygen, turbidity, and river stage at the dam would be recorded at least weekly and dam discharge recorded daily.

This study would be continued during the Post-Construction monitoring for the project during years 1-5 and 9 of the post-construction monitoring program. The original scope of the study would be supplemented with additional tasks that would concentrate on Shortnose sturgeon passage at NSBL&D. The results of this study would help the Corps determine if changes to the fish passage structure are warranted. If so, adaptive management funds would be available to make any required modifications as outlined in Appendix D.

It should be noted that construction of the off-channel rock ramp fish passage facility at NSBL&D would have a potential indirect, adverse impact on any future plans to generate hydropower at this facility should some entity desire to do that in the future. With the proposed bypass design, most of the flow would pass around the dam through the bypass, resulting in little flow being available to generate power by passing through the dam.

5.03.2.2 Striped Bass. The natural resource agencies could not identify any physical measures that could be implemented in the estuary to restore or enhance Striped bass habitats. See Tables 3-7 and 3-8 in Section 3 for a summary of impacts and Appendix C of the EIS for more details on the impacts analysis. The loss of 10 percent of spawning, egg development or larvae habitats could limit the size of the Savannah River population of Striped bass. The agency representatives concluded that the only means of addressing that impact would be through a stocking program. Through such a program, the project would provide additional fish to the population to compensate for the limiting nature of the reduced spawning and early development habitats. The Wildlife Resources Division (WRD) of the Georgia Department of Natural Resources conducted a Striped bass stocking program in this river in the late 1990s and continues to stock Striped bass on an annual basis. The Corps coordinated with GA DNR-WRD and confirmed that expanding their ongoing stocking program could compensate for the impacts identified to Striped bass. The type of stocking program was then discussed that would be appropriate for the level of impacts identified.

GA DNR defined the requirements of a full-scale stocking program, assuming there is no natural recruitment in the system. In that case, all young would have to be introduced into the system through stocking. When the Fishery Interagency Coordination Team discussed the impact evaluation approach, they were most concerned about salinity during spawning and early life-

stage habitats before the fish could orient themselves and find nursery habitats with suitable salinities. Since the young are able to select their habitats within 2 months, stocking young-of-the-year (Phase II fish) would be sufficient to get the population past the higher-salinity bottleneck caused by a harbor deepening. Development of a stocking program where young must be grown for a full year or more would not be needed to compensate for impacts from this project.

The costs for a full stocking program to replace 100 percent of the young would be appropriate mitigation if the project were expected to adversely impact 100 percent of the existing acceptable spawning or early life stage habitat in the estuary. However, since the alternatives being considered are not predicted to result in impacts which are that severe, the extent of the stocking needed could be reduced to the amount of habitat predicted to be impacted by the project. Thus, the percentage of habitat loss could be multiplied by the cost for a full-scale stocking program to determine the amount that would be sufficient to compensate for the habitat loss that is expected.

Using that approach, the adverse impacts expected for each life stage of Striped bass were combined to generate the cumulative adverse impact shown in the following table.

Table 5-43. Summary of Impacts to Striped Bass Habitat

Channel Depth Alternative	Spawning 50% Flows	Eggs 50% Flows	Larvae 50% Flows	Combined Adverse Impact
44-FOOT	-2.9 %	-9.4 %	-5.6 %	17.0 %
45-FOOT	-9.2 %	5.2 %	1.7 %	2.9 %
46-FOOT	-10.0 %	-0.0 %	5.6 %	5.0 %
47-FOOT	-11.1 %	-5.0 %	-13.5 %	26.9 %
48-FOOT	-16.1 %	-10.8 %	-3.5 %	27.8 %

With that combined adverse impact value and the costs of a complete stocking program, one can calculate the compensation required to mitigate for each depth alternative. The GA DNR-WRD provided information on the costs to rehabilitate and operate some of GA DNR-WRD's facilities at their Richmond Hill hatchery to conduct a Striped bass stocking program capable of producing 40,000 Phase II fish each year. The costs included initial expenses of \$3.1 million, annual expenses of \$203,000 to operate the program, and recurring costs of between \$30,000 and \$50,000 for equipment replacement. The Corps used those values and calculated them to represent an annualized cost of roughly \$466,700 for a complete Striped bass stocking program. Based on that average annual value, the following compensation would be required as summarized below in Table 5-44.

Table 5-44. Annual Compensation Amounts for Striped Bass Mitigation

Channel Depth Alternative	Combined Adverse Impact	Annual Program Funding
44-FOOT	17.0 %	\$79,335
45-FOOT	2.9 %	\$13,534
46-FOOT	5.0 %	\$23,334
47-FOOT	26.9 %	\$125,536
48-FOOT	27.8 %	\$129,737

The Corps proposes to fund that compensation as a lump sum. Using an interest rate of 4.125 percent over 50 years to obtain the present worth of that annual funding stream, the following lump sum payment would be required:

Table 5-45. Lump Sum Compensation Amounts for Striped Bass Mitigation

Channel Depth Alternative	Annual Program Funding	Lump Sum Payment
44-FOOT	\$79,335	\$1,668,000
45-FOOT	\$13,534	\$285,000
46-FOOT	\$23,334	\$491,000
47-FOOT	\$125,536	\$2,640,000
48-FOOT	\$129,737	\$2,728,000

Using the FY12 discount rate of 4.0 percent, the lump sum payment for the 47-foot depth alternative would be \$2,672,000.

An evaluation of the impacts of the SHEP on Striped bass habitat would be conducted during years 2, 4, and 9 of the Post-Construction monitoring to ensure that impacts do not exceed what is expected. The field data collected during the monitoring would be used in conjunction with the hydrodynamic and water quality models to conduct this assessment. Adaptive management funds would be available to provide further mitigation for Striped bass habitat should the study show that is warranted.

5.04 Sediment Quality

5.04.1 Overview

The proposed deepening of the Federal navigation channel to -47 feet MLW would require excavation of approximately 23.6 million cubic yards of sediments. Estimated maintenance dredging of the new deeper Federal channel will require the yearly removal of about 7 million cubic yards of sediments from the river and entrance channels.

Sediments of the Savannah River and the nearshore ocean continental shelf are continually subject to movement by wind, tide and strong currents. Redistribution of sediments is, therefore, a natural and continuous phenomenon. New work sediments removed from the entrance channel would be deposited in the ODMDs or existing upland CDF. If a non-Federal source of funding is identified, suitable O&M sediments from the entrance channel could also be deposited in the nearshore sand sharing system or directly on the Tybee Island beach. Otherwise, the O&M sediments from the entrance channel would be deposited in the Savannah ODMDs or a CDF.

5.04.2 Sediment Quality Evaluation (Assessing Potential Contaminant Impacts)

Three rounds of new work sediment sampling and analysis were performed for the Savannah Harbor Expansion Project, with each round building upon the results of the previous work. The details of the entire evaluation are described in the Sediment Quality Evaluation contained in Appendix M. This section summarizes that information.

The initial round of sampling and analysis was performed during the Tier I studies. Sediment core samples were collected in 1997 and examined for sediment physical and chemical properties to identify whether any chemicals occur in the new work sediments at concentrations that present environmental concerns. The sampling area covered the entire area proposed for harbor deepening, extending from deep water in the ocean to the Kings Island Turning Basin (Station 103+000). Parameters investigated included metals, PCBs, PAHs, petroleum hydrocarbons, phenols, pesticides, dioxin congeners, cyanide, organotins, and nutrients.

The evaluation found that most of the sediments did not provide any concern for potential contaminant-related impacts associated with the proposed dredging and dredged sediment placement. However, three potential issues were identified.

One issue involved sediments near the old RACON Tower site located on the outer end of the entrance channel. Polycyclic aromatic hydrocarbons (PAHs) and cadmium were detected in a sample taken at about Station 75+000 near the old RACON Tower where a spill of fuel, batteries, and paint lacquer occurred in November 1996. Sampling conducted there in 2005 during the second round of analysis revealed that those sediments do not pose a potential for potential contaminant-related environmental impacts.

The second issue pertained mostly to whether the sediment chemistry data for pesticides, PAHs and phenols were adequate for comparison to screening criteria. This issue was addressed during the 2005 sampling. The confirmatory sampling within the channel revealed there are no potential sediment contaminant concerns related to pesticides, PAHs, phenols, or metals other than cadmium.

The final issue involved the concentration and distribution of cadmium within the new work sediments. Cadmium was found to occur naturally in unusually high levels within Miocene clays that would be excavated during the SHEP dredging. Again, sampling was conducted during the second round to address this issue.

Sediment samples from the harbor were examined for radionuclides. Both maintenance and new work sediments were examined. The examination found sediment samples with radioactivity ranging from 0.02 to 0.04 mRem/hr. These results are consistent with the background levels, with only a few samples exhibiting an increase of 0.01 mRem/hr over the background range. Such findings were anticipated, since these soils contain phosphatic and glauconite minerals, along with other clays, that exhibit naturally-occurring levels above background levels. These results are two orders of magnitude below acceptable action levels approved by OSHA and the US Environmental Protection Agency that range between 1 mRem/hr to 5 mRem/hr. Based on these results, the levels of gross radioactivity measured in the harbor sediments pose no reason for concern. Further information can be found in the GRR Engineering Appendix, Dredged Material Physical Analysis Report.

5.04.2.1 Cadmium-Laden Sediments. The second round of new work sampling was completed in 2006 and it concluded that the only sediment contaminant of concern for the proposed harbor deepening is naturally-occurring cadmium found in Miocene clays that would be dredged and/or exposed during construction. The highest concentrations of cadmium (average 21.45 mg/kg) are found between Stations 16+000 and 45+000 (River Mile 3.0 to 8.5) and medium concentrations (average 6.67 mg/kg) are found between Stations 45+000 to 94+000 (River Mile 8.5 to 17.8).

The answers to three questions influence the degree to which cadmium might move from channel bottom sediment to benthics to the aquatic food chain: (a) would clay sediment with elevated cadmium be exposed so that benthics growing in the clay could support an aquatic food chain, (b) can Miocene clays support benthic organisms, and (c) would cadmium in the bottom sediments be available to benthic organisms such that the organisms would accumulate cadmium and pass it through the food chain?

To help answer these questions, the Corps contracted with EA Engineering, Science, and Technology to perform additional detailed studies (third round of sampling). Those studies were performed in 2007 and included the following activities:

- A. Sediment Profile Imaging to locate/verify exposed Miocene clays and assess the potential existence of benthic communities in the clay;
- B. Side scan sonar survey to identify and map bottom characteristics in the channel;
- C. Benthic community assessment;
- D. Sediment sample collection (vibracoring 6 ft into Miocene clay at four locations in the navigation channel, reference sediment sampling, and upland reference soil sampling);
- E. Collection of dredging water from one location in the Federal navigation channel and one receiving water location in Fields Cut;
- F. Compositing and processing sediment cores to create "high cadmium" and "low cadmium" composite samples for further testing;
- G. Analytical testing of bulk sediment, standard elutriates, effluent elutriates, dredging water, and receiving water samples;
- H. Analytical testing of porewater and SLRP samples at the high cadmium locations only;
- I. Aquatic bioaccumulation studies and plant uptake studies using high and low cadmium composites; and

J. Risk evaluation and report preparation.

EA's findings are summarized in the following paragraphs. Their full report is available from Savannah District for review.

One of the investigations that EA conducted was of the benthic community of the river bottom, both inside and outside the navigation channel. They found a substantial benthic community within the channel bottom. In addition, they found that the coarse sand/gravel/clay substrate was used by benthic organisms, although they were unable to determine to what extent benthic organisms burrow into the clay. They found that the substantial presence of benthic organisms within the channel maintenance sediments indicates that the impact of maintenance dredging is temporary. However, the limited availability of exposed high cadmium sediments within the navigation channel, as discussed above, precludes more than minimal potential for clay dwelling benthic input to the riverine ecosystem. EA found that the clay substrate does support benthic organisms, but that this substrate comprises less than 28 percent of the channel bottom between Stations +16+000 and +60+000. This finding indicates that benthic organisms residing in exposed Miocene clays should present a relatively small fraction of the benthic organisms within the channel ecosystem. Because of the predicted small fraction of available habitat, potential impacts through bioaccumulation of cadmium by benthic organisms within the Miocene clays appear to be minor, but not zero. To be conservative, the potential for bioaccumulation of cadmium by benthic organisms was evaluated. Section 4.2.5 of the Sediment Quality Evaluation (Appendix M) contains that assessment. The bioaccumulation studies show bioaccumulation in high cadmium sediments to be well below potential levels of effect. Therefore, potential environmental impacts through bioaccumulation of cadmium by benthic organisms are expected to be minimal.

Laboratory testing revealed that cadmium within the exposed high cadmium sediments would be relatively unavailable to biota. The essentially anoxic state of the channel sediments should preclude significant movement of cadmium to the environment. In addition, exposure of the riverine environment to high cadmium clays would be restricted, since the majority of the exposed clays are expected to be covered by O&M sediments.

Discharges of sediment to the water column during hydraulic dredging, seen as increased turbidity in the water column, are normally considered *de minimis*. However, in this case, the dredged sediment could contain elevated levels of cadmium. The presence of sediments with elevated levels of cadmium raises the potential for environmental impact. However, the Miocene clays thought to contain elevated levels of cadmium are expected to remain relatively intact during the dredging process and remain relatively intact and form clay balls that would be deposited in CDFs 14A and 14B. Relatively minor amounts of clay would be expected to be released to the water column. Furthermore, standard elutriate analyses on the sediment composites found the dissolved fraction of only three parameters to be above water quality criteria. Cadmium was not one of the parameters.

Other potential impacts or exposure pathways include:

- A. The cadmium-laden sediments would also be pumped to an upland CDF.

- B. Once in a CDF, the cadmium-laden sediments could contaminate ground water (under the CDF).
- C. The dredge effluent from the CDF containing the cadmium could be discharged back into the Savannah River.
- D. Birds and other terrestrial animals living in the CDF could take up cadmium while feeding.
- E. Worker exposure during dredging of cadmium-laden sediment.

The Sediment Quality Evaluation (Appendix M) indicates the following about those issues:

1. Potential impacts associated with other pathways by which a contaminant might leave a CDF (leachate to groundwater, runoff, effluent, volatilization) were found to be minimal. A liner could be used to prevent cadmium movement to groundwater as leachate. Studies found cadmium to be tightly bound within wet sediments and clay porewater concentrations were found to be very low. Therefore, movement of cadmium through leachate (into the groundwater) is expected to be minor and of minimal environmental concern. Therefore, a liner to prevent cadmium movement to groundwater is not warranted.
2. A risk assessment was conducted for workers associated with dredging and sediment placement operations exposed to cadmium-laden enriched sediments. The conclusion was that exposure to the cadmium-laden dredged sediment does not pose a concern for adverse non-carcinogenic or carcinogenic health effects.
3. Birds and mammals feeding in the CDF would not be exposed to cadmium-laden sediments (from the Station +16+000 to +45+000 reach) if the sediments are isolated within a CDF and capped/covered with sediment from another reach. The high cadmium sediments would not be disturbed further and would not be allowed to be later excavated and placed in any exposed upland area.

5.04.2.2 Mitigating Exposure to Cadmium in Sediments. All cadmium-laden sediment from Stations 6+375 to 45+000, 51+000 to 57+000, and 80+125 to 90+000 would be placed in CDF 14A (if there is sufficient capacity) or CDFs 14A and 14B. The sediment would be deposited so that it remains covered with water until after placement of the cover is completed. This material would not be allowed to dewater and/or desiccate until after placement of the cover is completed and cadmium levels in the surface sediments of the CDF are less than 4 mg/kg. Samples would be taken of the inflow (head section of dredge discharge pipe) during placement and analyzed for cadmium. The Corps would perform monthly biological sampling (wildlife and avian use abundance surveys) in CDFs 14A and 14B. This monitoring would be performed during and after (for 3 years) sediment placement to provide a record of wildlife and bird use of these CDFs. The monitoring methodology that the Corps would perform is summarized below. Please see Appendix D for a more detailed description of the timing of each event. If conflict exists between the descriptions, then Appendix D takes precedent.

Following placement of cadmium-laden sediments within a CDF, grab samples would be collected to characterize the cadmium levels of the surficial sediments. This would occur prior

to placement of the sediment cap. Eighty-six (86 grab) samples would be collected from a depth of 15 cm. Samples would be evenly spaced across the CDF, and analyzed for cadmium concentration on a dry weight basis.

A cap/cover of sediments obtained from areas of the channel where concentrations of cadmium are believed to be 4 mg/kg or less would be placed on the sediments in the CDFs. Following placement of the cover, eighty-six (86) grab samples would be taken from a depth of 30 cm and analyzed for cadmium. If the analysis of the sediment samples taken from the cover indicates that concentrations of cadmium are less than 4 mg/kg, monitoring of the cover would be complete.

If the analysis of the sediment samples taken from the cap indicates that concentrations of cadmium are equal to or exceed 4mg/kg in a cumulative area of 25 acres or more of the capping/covering layer, then three actions would be initiated. First, the CDF would be kept flooded to keep the sediments wet/moist. Second, the CDF would receive a cover of O&M material at the earliest possible time. Once the layer of O&M material has been placed in the CDF, the surface sediments (to depth of 30 cm) would be sampled (86 grab samples) and analyzed for cadmium. The process of placing O&M material into the CDF and testing for cadmium would be repeated until cadmium concentrations in the surface sediments are less than 4mg/kg.

Third, biological monitoring would be conducted (monthly) to determine which avian and wildlife species are frequenting the CDFs. If there is concern about the number of birds or animals or a particular species using the CDFs, then some type of hazing may be appropriate. Vegetation sampling would be conducted on a quarterly basis, if required (if the surface sediment sampling in the CDF indicates that cadmium levels are 4 mg/kg or higher). Vegetation sampling would be conducted in defined "hot spots" to determine the potential for cadmium uptake by plants. Samples collected from CDFs 14A and 14 B would be compared to control samples from other, cadmium-free environments found in adjacent CDFs. If vegetation samples have significantly elevated cadmium concentrations, then efforts would be initiated to eradicate vegetation and/or place an additional capping layer in the CDF.

Independent of the concentrations of cadmium on the cap/cover, the Corps would perform monthly biological monitoring of birds that use CDFs 14A and 14B during and after sediment placement. Cadmium levels in blood samples would be evaluated before, during and after sediment placement. Appendix M describes the plan for bird sampling protocols which take into account the hydrologic condition of the CDFs (wet or dry) and the season since these conditions greatly influence the avian species that use the CDFs. A reference CDF would also be sampled as background. Samples would be obtained prior to the placement of material into the CDFs which would serve as baseline data. This sampling would continue during all dredged material placement activities and for 3 years after placement is completed. If the concentration of cadmium in the samples taken during and after construction is significantly higher than that observed in the baseline samples, tissue (liver) sampling would be conducted.

The effluent from all CDFs would be monitored during dredging operations. The effluent from CDFs 14A and 14B would specifically be monitored for cadmium. Sampling (weekly) would be

conducted to determine the cadmium concentrations in the effluent discharged from CDFs 14A and 14B. Monitoring of the effluent from CDFs 14A and 14B would continue as long as a discharge was present and until all sediments have been covered, dewatered, and stabilized. Following the installation of a clean cap, cadmium would be monitored in the effluent on a monthly basis for one year.

At the end of construction, sediment samples will be taken from the exposed channel bottom sediment surface and analyzed for grain size and metals (aluminum, iron, arsenic, beryllium, cadmium, chromium, copper, lead, manganese, mercury, nickel, selenium, silver, and zinc). Samples will be cores taken to a depth of 15 cm. Where both O&M and new work sediments appear in the core, each will be analyzed separately. Samples will be taken within the channel every 2,000 feet from Stations +100+000 to 0+000 (26 samples) randomly selecting either the center line of the green side or red side. Five stations will be randomly selected to have two adjacent samples collected, from both the red and green side (10 samples). These last samples would be used to define the variability in bottom sediment metal concentrations across the channel. In addition, 5 samples would be run in duplicate (lab duplicates). Analysis of the river bottom would provide an assessment of anticipated cadmium concentrations in sediment at the sediment water interface.

As requested by the GA DNR-EPD, sediment analysis would be required prior to maintenance dredging in channel reaches with cadmium-laden sediments. Samples would be taken and analyzed for cadmium from two locations for at least two maintenance dredging cycles and furnished to the GA DNR-EPD at least 45 days prior to dredging.

In light of the information summarized above, the dredging and the placement of cadmium-laden sediment in CDF 14A, CDF 14B is not anticipated to result in adverse impacts to the aquatic environment or biota found in the CDFs.

5.05 Groundwater

Since the 1880s, increasing withdrawals of water from the Upper Floridan aquifer has lowered the water levels in the aquifer under Savannah Harbor as much as 100 feet below MLW (USACE 2007). This lowering of the water level within the Upper Floridan aquifer has created a cone of depression centered beneath Savannah, extending 50 km or about 31 miles in all directions. The net effect of this lowering of the water level is the reversal of the movement of water within the aquifer to a downward flow of water through the confining layer toward the center of the area of greatest pumping from the aquifer (Savannah).

In recognition of concerns about potential impacts to the groundwater that were expressed during the NEPA scoping process and in other public forums (meetings of the Stakeholders Evaluation Group), the Corps conducted additional detailed evaluations of this issue.

Savannah District used input from various agencies including the USGS, GA DNR-EPD, SC DHEC, the Stakeholders Evaluation Group, and GPA to develop a scope of work for the supplemental studies. The activities included the tasks shown in the following table.

Table 5-46. Tasks Comprising Aquifer Effects Evaluation Supplemental Studies

Task	Subject	Description
1	Subbottom Seismic Survey	Conduct additional subbottom surveying with particular emphasis to better define paleochannel geometry and Miocene confining unit thickness. All seismic data will be acquired in digital format to facilitate analysis and storage in the GIS.
2	Marine Drilling	Conduct additional marine continuous core borings to further characterize in-filled sediments of paleochannels and Miocene confining unit below paleochannels.
3	Land Drilling	Conduct additional continuous core borings on land adjacent to navigation channel to top of Upper Floridan aquifer at three strategic locations where geologic or hydrogeologic data is sparse.
4	GIS	Combine existing geologic, hydrogeologic, seismic, and engineering data from previous studies into the harbor-wide GIS being constructed for Savannah Harbor. Add future supplemental data to the GIS to allow enhanced analysis and visualization.
5	3-D Numerical Hydraulic Model	Develop 3-D coupled flow and transport model of the hydrologic system focused on the navigation channel, and use model to compare before and after dredging results as related to projected chloride changes in the Upper Floridan aquifer.
6	Aquitard Test Feasibility	Conduct trial step-drawdown pumping test on two recently installed Upper Floridan wells located adjacent to river channel to determine feasibility of hydraulic testing of confining unit. If results indicate hydraulic testing of confining unit is feasible, estimate design parameters and assumptions for full aquitard testing.

The detailed study approach provided a greater understanding of the geologic and hydrogeologic framework underlying the navigation channel. Measured porewater data, hydraulic conductivity data, head data, seismic data, and confining layer thickness data were used to build upon a regional model built by USGS and refine it to address water quality issues specifically associated with dredging impacts. To ensure the groundwater model results were conservative, the dredging scenarios were run assuming an additional three feet of sediment would be removed below the proposed dredging depths. In addition, the model outputs used two values of hydraulic conductivity and provided two sets of results that bracketed true conditions, yielding a best-case and worst-case scenario for both dredging and no dredging conditions.

The overall study results are summarized as follows:

- A. The ground water simulation model results indicated that the head gradients (water withdrawals from the Upper Floridan aquifer) are the dominant force contributing to the downward movement of salt water through the Miocene confining unit.

B. The groundwater modeling simulations were run 200 years into the future with a constant pumping rate in the Savannah area. This rate of pumping would cause breakthrough of seawater to occur at some downstream locations in approximately 100 to 300 years regardless of the proposed harbor deepening.

C. The negative head gradient induced by pumping water from the Floridan aquifer in Savannah has caused limited breakthrough of chlorides to occur in the downstream reaches of the Savannah River. The porewater profiles and model results from this study (USACE 2007) indicate that increased salinity in the Savannah River and the reduced thickness of the confining layer due to the proposed deepening in the Savannah River will not significantly affect the timing of the breakthrough of chlorides along the navigation channel in the Upper Floridan aquifer. The proposed deepening would contribute a maximum of only about 3 to 4 percent of increased total downward flow through the confining layer into the Upper Floridan aquifer. However, modeling results show that chloride concentrations decrease significantly upon entering the Upper Floridan aquifer due to considerable horizontal flow of fresh water within the aquifer mixing with and diluting the relative low volume of salt water migrating downward from the navigation channel. Therefore, the proposed deepening of the Savannah River navigation channel would have minimal impacts on water quality in production wells that tap the Upper Floridan aquifer in and around the City of Savannah.

The proposed harbor deepening would have minimal adverse impacts on groundwater. The full results of the field work, groundwater modeling, and GIS analyses are described in Section 5 of the Engineering Appendix of the GRR. They are described in further detail in a document titled *"Supplemental Studies to Determine Potential Groundwater Impacts to the Upper Floridan Aquifer, Savannah Harbor Expansion Project, Final Report, June 2007"* (USACE 2007).

5.05.1 Paleochannels

Another groundwater-related issue is the possibility that chlorides could enter the aquifer through the removal of harbor sediments from paleochannels. These are former Pleistocene-age stream channels that eroded into the aquifer's confining Miocene cap and later became filled with less-dense and more transmissive sediments.

Savannah District conducted sub-bottom profiler surveys of the existing entrance channel area. The purpose of the survey was to identify the depth and character of the aquifer's Miocene-age cap and locate paleochannels that cut into the cap. No Pleistocene streams were found in the ocean end of the entrance channel that would be lengthened.

The groundwater modeling results indicate that any additional contribution of chloride by the paleochannels is negligible when compared to the total contribution from other adjacent saltwater sources outside paleochannels along the Savannah River bottom. GIS analyses indicated that the minimum thickness of Miocene confining material occurs where paleochannels have incised into the top of the unit, and that deepening of the Federal navigation channel to -48 feet MLW would not further impact the Miocene confining layer in these areas.

5.05.2 Fractures within the Miocene Confining Unit

A groundwater-related issue identified at the end of the Tier I EIS and scoping meetings for the current EIS was the possible existence of fractures or joints within the Miocene confining unit underlying the navigation channel. Fractures within the Miocene aquitard could provide an avenue for saltwater to more rapidly move through the Miocene layer into the Upper Floridan aquifer. The potential effects of such fractures were a specific target of the District's expanded groundwater investigations.

The geophysical sampling did not identify any fractures or joints in the Miocene clay. Based on the following reasons, the Corps concluded that fractures or joints are not a factor in the hydraulics of the confining layer in the Savannah area:

1. The in-situ conditions under which the confining layer exists. At a depth of -42 feet MLW, the Miocene clay exists at a considerable overburden or lithostatic pressure. If fractures or joints existed in the past, the in-situ conditions would not allow them to exist as open pathways for enhanced downward flow. Instead, the overburden or lithostatic pressure and the plastic nature of the clay found in the Miocene aquitard would cause any open fractures to heal.
2. The nature of the confining material (i.e., there is considerable amount of clay within the Miocene aquitard), and
3. The lack of any physical evidence (i.e., no fractures observed in core samples, no springs in the project area).

The proposed harbor deepening would not cause increased salinity to enter any fractures of the Miocene aquitard and, thereby, increase salinity into the Upper Floridan aquifer.

Although construction of the SHEP is expected to have very little effect on the downward migration of saltwater into the Upper Floridan aquifer, the Georgia DNR-EPD has required as a condition of its water quality certification that a monitoring plan be developed to detect any potential chloride migration into the aquifer that could be caused from channel deepening. Consequently, monitoring of chloride levels in the Upper Floridan aquifer would be conducted along critical groundwater flow paths to ensure that the SHEP does not result in the significant migration of chlorides downward through the confining layer that could move towards production wells in the Savannah area. The monitoring would involve the establishment of sentry wells along critical groundwater flow paths which would be installed near the top of the aquifer to monitor downward migration of chlorides through the confining unit and deeper in the aquifer to monitor how horizontal flow of freshwater mixes with and dilutes the chloride. Monitoring wells would be established upgradient of critical groundwater flow paths to provide information on the background chloride concentrations associated with groundwater withdrawals in the Savannah area independent of SHEP dredging activities. Annual monitoring of these wells would be conducted for the life of the project, and differences in the long-term trends of chloride concentrations in the sentry and background wells would be used to evaluate impacts of the SHEP from impacts of groundwater withdrawal on chloride concentrations in the aquifer.

Groundwater monitoring also includes the establishment of benchmark chloride concentrations for each sentry well. The benchmark chloride concentrations would be established to protect the Savannah area production wells. If it is determined that the rate of downward migration of chloride into the Upper Floridan aquifer through the confining unit beneath the Savannah River is increasing due to the project and is affecting Savannah area production wells, the Corps would be required, as indicated in the water quality certification, to develop a remediation and implementation plan.

5.06 Air Quality

The air quality in the harbor area is generally good. The area is designated by USEPA as in attainment for all National Ambient Air Quality Standards (NAAQS) for criteria pollutants, which means the area is under no Federal or State restrictions for the purpose of improving air quality to meet any air quality standard. For example, USEPA has designated both Chatham County, Georgia and Jasper County, South Carolina as attainment areas for the 8-hour ozone standard, as well as other NAAQS.

Local industries have implemented process improvements over the last 5 to 10 years which have significantly reduced the quantity of substances emitted to the air. Concerns do exist among some in the community about the quality of the air, and a community group has actively pursued improving air quality. In general, maritime industries are not major air emitters. However, some industries located along the river that move raw materials or processed goods through the harbor also produce large amounts of air emissions. Harbor maintenance activities do not generate significant amounts of air contaminants.

To identify potential impacts to air quality from the proposed harbor deepening, the Corps conducted an air quality analysis in 2006. The investigation quantified emissions from deep-draft containerships that call at the port, as well as those that are expected to call in the future, and considered how those emissions would change as a result of the proposed harbor deepening. The Corps provided its report to the U.S. Environmental Protection Agency (EPA) Region 4 office for review and comment. As a result of their review, EPA requested the analysis be expanded to include (1) the emissions from landside equipment that service these vessels, (2) the air toxics emitted by both the vessels and the landside equipment, and (3) similar analyses associated with the privately-owned terminals in the harbor. EPA recognized that the emissions associated from vessels calling at the privately-owned terminals were not likely to be affected by the proposed harbor deepening, but they desired the comprehensive air quality assessment of the harbor to be able to more accurately place any expected increase in emissions resulting from the proposed harbor deepening in its proper context.

In response to EPA Region 4's request, the Corps prepared an Air Emission Inventory for the Port of Savannah. The objective of the inventory was to expand the Corps' 2006 air quality analysis to the entire harbor to more completely assess air quality impacts from the proposed harbor deepening. This more detailed assessment evaluates the air emissions from all cargo-carrying vessels and landside cargo handling equipment at both the GPA and privately-operated terminals at the port. It also compares these emissions for both the "With" and "Without

Project" (No Action) alternatives. In addition to the criteria pollutants that are traditionally evaluated when one discusses air emissions, estimates of air toxics and greenhouse gases emitted at the Port were also calculated. The assessment does not include a detailed dispersion modeling assessment of these emissions or a risk-based assessment of the health effects associated with the proposed project. The primary focus of the work is a comparative assessment of the air emissions associated with the operation of the port before and after project implementation, in conjunction with consideration of the current status of air quality in the Savannah area.

Upon their review of the DEIS, EPA submitted additional comments on January 28, 2011 concerning the Air Emission Inventory. As a result, the Corps further revised the analysis to address those additional comments.

The Air Emission Inventory for the Port of Savannah, dated January 2012 can be found in Appendix K of this EIS. Air emission impacts are thoroughly discussed in the analysis section (Chapter 5) of the inventory and the conclusions are summarized as follows:

Five categories of activities in the Port of Savannah in 2008 were found to have relatively minor amounts of air emissions (Table 6-1 and Figures 6-1 and 6-2 in Appendix K). Those categories consist of (1) internal movement of vessels within the port (Shifts); (2) Maintenance dredging performed by the Corps; (3) Tourist boats (Chatham County's shuttle service and two large private tour boats); (4) hotelling of container vessels at Garden City Terminal, and (5) operations associated with Liquefied Natural Gas vessels. Those activities do not adversely affect the quality of air in Chatham County or at the Port. NO_x is the pollutant that is emitted in the largest quantities in the port (see Table 6-3 and Figures 6-1 and 6-2 in Appendix K). This pollutant comprises roughly 58 percent of the amount of emissions among the seven pollutants analyzed (HC, VOC, CO, NO_x, PM₁₀, PM_{2.5} and SO₂).

Container vessels are the source of most air emissions among the various types of vessels that call at the port. That is to be expected, as the port services more container vessels than any other vessel type.

Most of the air emissions at the Port result from the deep-draft vessels which call there. The tugs which guide those vessels and the land-based operations that handle their cargoes were found to contribute much less pollution than the vessels or their land-based support operations.

The Corps predicts a larger number of vessels would call on the Port of Savannah in years 2016, 2020, 2025, 2030, and 2066 with the existing channel depth of -42 feet (Without Project Condition) than with the proposed depth of -47 feet (see Table 4-3 I Appendix K). In 2030, for the -42 and -47 foot depths, the number of vessels predicted to call at Savannah would decrease from 4,092 to 3,601 respectively. In 2030, the Fleet Forecast estimates 14% more vessels would call in Savannah with the existing depth of - 42 feet than with the proposed depth of - 47 feet. More vessels calling on the Port with the existing -42 foot depth during

this projected time (i.e., 2016 to 2066) would result in a greater amount of criteria pollutants, air toxics and greenhouse gases being emitted in Chatham County. Those emissions would be reduced by a deeper harbor that would allow a fleet of larger vessels that each carries more cargo. With a deeper harbor, the same cargo quantities could be moved through the port with fewer container ships. Tables which provide a summary of all emissions (Appendix K) show this trend.

For the land-based operations at GPA's Garden City Terminal, toplifts were found to produce the most air emissions, followed by rubber-tired gantry cranes, jockey trucks, and aerial cranes. The trucks which bring containers to the port and take them to their US destination were found to be relatively small contributors to the total air emissions. Although trucks emitted more NO_x than other pollutants, they contributed a larger percentage of CO (8.8 percent) to the emissions from the terminal. Truck emissions comprise less than 5 percent of all air emissions produced by the port.

While containerships are docked and being serviced (referred to as hotelling) at Garden City Terminal, they contribute less than 12% of the total emissions of the total port emissions. The emissions while hotelling represent less than 12% of the emissions from the Garden City Terminal (vessels, tugs, and landside CHE). With the proposed future EPA reductions in both NO_x and sulfur emissions for containerships, this percentage would be further reduced. Therefore, hotelling is not a major contributor to the port's emissions.

New work dredging to deepen the harbor would be a substantial contributor (>29 percent) of the port's emissions of CO and NO_x during the four-year construction period. However, a large portion of those emissions would occur offshore while deepening the entrance channel and are not likely to contribute to air pollution in the City or County.

The Port of Savannah is a substantial contributor of NO_x (18.3 percent) emissions in Chatham County, when compared to the EPA 2002 NEI data. It only contributes minor amounts to emissions of SO₂ (5.4 percent), PM₁₀ (3.4 percent), PM_{2.5} (9.5 percent), HC (1.9 percent), VOC (1.9 percent), and CO (1.3 percent). When these same 2008 port emissions are compared to the Chatham County EPA 2005 NEI Data, NO_x is reduced to 13.5%, SO₂ is 5.1%, PM₁₀ is 3.1%, PM_{2.5} is 7.2%, HC is 2.0%, VOC is 2.0%, and CO is 1.6%. Lastly, when the 2008 Port of Savannah emissions are compared to combined Chatham County, Georgia and Jasper County, South Carolina, (EPA 2005 NEI data), NO_x is further reduced to 11.5%, SO₂ is 4.8%, PM₁₀ is 2.1%, PM_{2.5} is 4.9%, HC is 1.6%, VOC is 1.6%, and CO is 1.24%.

Emissions of NO_x, SO₂, and PM_{2.5} are likely to continue to decrease as the terminal operators replace their equipment with newer engines that do not emit as much pollution and use the lower sulfur fuels mandated by EPA. The port's contributions to SO₂ emissions are expected to decrease as a result of EPA's

requirements for use of cleaner fuels. These new standards should substantially reduce SO₂ emissions, as the SO₂ content in the fuels used by non-road diesel, locomotives, and marine diesel engines transitioned from 500 ppm sulfur in 2007 to ultra low sulfur diesel (ULSD) -- which is 15 ppm -- in 2010.

For ocean-going vessels (OGV), EPA issued new emission standards in late 2009 for Category 3 marine diesel engines which will require an 80 percent reduction in NO_x emissions beginning in 2016. EPA also adopted standards for engines covered by MARPOL Annex VI that require OGV within 200 miles of the US to use fuel with a maximum of 1% sulfur (10,000 ppm) beginning in 2012 and 0.10% (1,000 ppm) beginning in 2015. Again, the port's contributions of NO_x and SO₂ emissions in the County should substantially decrease as a result of these new requirements for cleaner fuels.

Comparing the calculated port air toxic emissions in 2008 to EPA's 2002 and 2005 county-wide air toxic emissions, the Port is not a significant contributor of any air toxics emitted in Chatham County. The Port contributes minor amounts (less than 4%) of the County's totals for the 28 air toxics that were calculated.

For the 50-year project life, the Port does not appear to be a significant source of greenhouse gases (primarily CO₂). Port operations contribute less than the one facility that is included in EPA's public database for Chatham County - the existing coal fired Kraft Steam Electric Plant in Port Wentworth, Georgia, which has emitted on average over 1.3 million tons per year of CO₂ into the atmosphere since 2002.

Moreover, EPA's Emissions data for the Kraft Steam Electric Plant in Port Wentworth show that it discharged about 7,705 tons of SO₂ in 2007. The Total Port Emissions (2008 values) show that the SO₂ emissions for all 22 terminals in the port was about 1,177 tons. This means that the Kraft Steam Electric Plant, which is adjacent to the Garden City Terminal, discharges more than 6 times (7,705 tons SO₂/1,177 tons SO₂) the amount of SO₂ than all 22 terminals in the harbor.

Future growth in cargo movements and accompanying air emissions are expected at Savannah. Those increases would be the result of increasing demand for the goods which move through the port and not a result of a harbor deepening. Those higher total emission levels in the future would be lessened if larger container vessels were enabled by deepening to regularly call at the port. The expected future growth in total emission levels will be substantially lessened by the recently-mandated use of cleaner fuels.

Any of the proposed harbor deepening alternatives would reduce air emission levels in the Port of Savannah from what they would be with the present 42-foot navigation channel. The beneficial effect increases with the amount of deepening.

Construction of a deeper channel would result in temporary increases in air emissions during new work dredging. However, those temporary increases would be distributed along the length of the channel -- roughly a third of which is in the ocean (the entrance channel). Future maintenance dredging emissions would likewise be temporary and very similar in type and quantity to emissions that occur now during maintenance dredging for the existing project.

Even though future ships calling at Savannah Harbor will be larger, there will be fewer numbers of them and their engines/fuels will be cleaner, so overall total emissions from ships, the main contributors to port emissions, would be reduced as explained in Appendix K. As a result, there would be a positive overall air emissions impact from a harbor deepening project that would not require mitigation.

5.06.1 Air Quality Standards

Chatham County is considered by EPA to be in an attainment area since it meets the National Ambient Air Quality Standards, which are shown below:

Table 5-47. Air Quality Standards

Pollutant	Primary Standard	Secondary Standard
PM ₁₀	150 ug/m3 (daily)	Same
PM _{2.5}	<u>15 ug/m3 (annual)</u> 35 ug/m3 (daily)	Same
NO _x	53 ppb (annual) <u>100 ppb (1-hour)</u>	<u>53 ppb (annual)</u>
SO ₂	<u>75 ppb (1-hour)</u>	0.5 ppm (3-hour)
CO	9 ppm (8-hour) 35 ppm (1-hour)	None
Lead	1.5 ug/m3 (<u>3-month average</u>)	Same
Ozone	<u>0.075 ppm (8-hour)</u>	Same

EPA published information in January 2008 about air quality in Chatham County in its "Latest Findings on National Air Quality, Status and Trends Through 2006". In that document, EPA stated that Savannah's 2006 Ozone level ranged from 0.065 to 0.084 ppm (4th highest daily maximum 8-hour concentration), below the standard of 0.08 ppm. Ground level ozone is formed when NO_x and VOC react in the presence of sunlight. That document also reported that ozone levels had improved in Savannah from 2000 to 2006. The summer daily maximum 8-hour ozone concentrations between 2000-2001 (average) and 2005-2006 (average) decreased by 0.002 ppm (from Figure 12 in EPA's document). For a number of years, EPA has indicated that they may promulgate a new ozone standard, but the Corps does not know if or when that may occur.

EPA also reported a small increase in PM 2.5 concentration from 2000-2006. Figure 14 of that document showed that PM 2.5 had decreased by -1 to 4 ug/m3 over that period. The average

annual PM 2.5 concentrations were in the range of 12.1 to 15 ug/m³, with 66 out of 895 measurements exceeding 15.1 ug/m³. The daily range of PM 2.5 was in the range of 16 to 35 ug/m³, with 126 out of 895 measurements (14%) exceeding 35 ug/m³ (Figure 15 of EPA's document).

EPA reported that PM 10 levels for Savannah ranged from 0 to 54 ug/m³ (Figure 21 in EPA's document), with 425 out of 904 measurements exceeding 54 ug/m³.

These values indicate that the air quality in the Savannah Harbor area is within the standards for ozone and PM2.5 and well within the standard for PM10.

The State Implementation Plan (SIP) identifies how the State will attain and maintain the primary and secondary NAAQS. Each State is required to have a SIP which contains control measures and strategies which demonstrate how each state will attain and maintain the NAAQS. Georgia and South Carolina each have a State Implementation Plan approved or promulgated under Section 110 of the CAA. Part D of title I of the Act specifies additional requirements applicable to nonattainment areas. Section 110 and part D describe the elements of a SIP and include, among other things, emission inventories, a monitoring network, an air quality analysis, modeling, attainment demonstrations, enforcement mechanisms, and regulations which have been adopted by the State to attain or maintain NAAQS. EPA has adopted regulatory requirements which spell out the procedures for preparing, adopting and submitting SIPs and SIP revisions that are codified in 40 CFR Part 51.

Under CAA Section 176(c), certain Federal actions must be analyzed to determine whether they conform with the applicable SIP(s). However, a Conformity Determination is not required for the SHEP under Section 176(c) because 40 CFR Section 93.153 (b) provides: "For Federal actions not covered by paragraph (a) of this section, a conformity determination is required for each pollutant where the total of direct and indirect emissions in a non-attainment or maintenance area (emphasis added by the writer) caused by a Federal action would equal or exceed any of the rates in paragraphs (b)(1) or (2) of this section." Since both Chatham and Jasper Counties have been designated by the States as attainment areas, a Conformity Determination is not required.

Table 5-78 in Appendix K, Summary of all Pollutants (Tons/Year) for all Vessels and all Land Based Emissions for the 22 Terminals, clearly shows that the air emissions (including greenhouse gases, primarily CO₂) at the existing (No Action Alternative) or baseline depth of -42 foot depth would be greater than the total air emissions for the -47/48 foot depth in all years from 2016 to 2066. The data also indicate that for the future project condition, air emissions for the No Action Alternative would be greater than the deepened harbor. Since air toxics are ratios of either VOC or PM10, that the amount of air toxics discharged by the 22 terminals would be greater for the No Action Alternative than a deepened harbor. There would be less emissions with a deepened harbor (comparing With and Without Project conditions) because fewer larger vessels (more heavily loaded) would be needed to transport the same number of containers than with the existing depth (No Action Alternative) of -42 foot. This does not mean that these larger vessels emit less air pollutants than smaller vessels; they do not. Fewer but larger vessels (more heavily loaded) would be needed to transport the 6.5 million TEUs in a deepened harbor than in

the No Action Alternative. This is also reflected in the Commodity and Fleet Forecasts found in the GRR Economic Appendix.

Since the proposed harbor deepening is not expected to increase the number of vessels or total cargo moving through the port, no changes to air quality would occur as a result of the project. Increases in air emissions at the port are expected over time as a result of growth in demand for goods that move through the port. Those increases would occur independent of a harbor deepening project.

Therefore, over the life of the project (from 2016 to 2066) the proposed deepening of the harbor will not interfere with the area remaining in attainment of the NAAQS under Section 110 of the Clean Air Act.

Since, (1) the calculated air emissions for the Future Without Project Condition (i.e., baseline or existing depth of -42 feet) would be greater than with the Proposed Action (i.e., 47-foot depth), and (2) both Chatham County, Georgia and Jasper County, South Carolina are designated as attainment areas, air quality modeling is not warranted to evaluate the effects of the Proposed Action (i.e., 47-foot depth).

5.07 Marine and Estuarine Resources

5.07.1 Dredging Impacts

Dredging has the potential to adversely affect animals and plants in a variety of ways. These include actions of the dredging equipment (i.e., cutting, suction, sediment removal, hydraulic pumping of water and sediment, and noise); physical contact with dredging equipment and vessels (i.e., impact); and physical barriers imposed by the presence of dredging equipment (i.e., pipelines). Potential impacts vary according to the type of equipment used, the time period in relation to life cycles of organisms that could be affected, and the nature of the interaction of a particular species with the dredging activities.

5.07.1.1 Entrainment. Pipeline dredging consists of mechanical action of a rotating cutterhead to loosen bottom material and hydraulic action by a pump to transport it to the placement site. The transported sediment consists of a slurry of approximately 15-20 percent solids and 80 percent water, depending on the characteristics of the bottom sediment. The suction-velocity field or entrainment field will extend over only a small area in the vicinity of the cutterhead at the river bottom.

The biological effect of hydraulic entrainment has been a subject of concern for more than a decade, and a number of studies have been conducted nationwide to assess its impact on early life stages of marine resources, including larval oysters (Carrier et al., 1986), post-larval brown shrimp (Van Dolah et al., 1994), striped bass eggs and larvae (Burton et al., 1992), juvenile salmonid fishes (Buell, 1992), and Dungeness crabs (Armstrong et al., 1982). These studies indicate that the primary organisms subject to entrainment by hydraulic dredges are bottom-oriented fishes and shellfishes. The significance of this impact depends upon the species present; the number of organisms entrained; the relationship of the number entrained to local, regional, and total population numbers; and the natural mortality rate for the various life stages of a species.

A hydraulic dredge with a discharge pipe no larger than 30-inch diameter would be capable of transporting about 40,000 cubic yards of sediment per day, pumped as a slurry containing about

15 percent sediment by volume. The volume of water discharged would, thus, be about 226,700 cubic yards per day, or about 70 cubic feet per second (cfs). In contrast, the average daily freshwater flow in the Savannah River at Clyo is about 11,290 cfs. Therefore, the amount of water intercepted by the operating dredge (70 cfs divided by 11,290 cfs) is estimated to be less than 6/10ths of one percent of the daily freshwater flow in the Savannah River. That small amount does not present a concern.

Assessment of the significance of entrainment is difficult, but it is believed that the impact is minimal. The reasons for the expected low levels of impact include: (1) the very small volumes of water pumped by dredges relative to the total amount of water in the vicinity, thereby impacting only a small proportion of organisms, and (2) the extremely large numbers of larvae produced by most estuarine-dependent species. Since natural larval mortalities may approach 99 percent (Dew and Hecht, 1994; Cushing, 1988), entrainment by hydraulic dredges operating in the harbor should not pose a significant additional risk in most circumstances. Neither direct quantification studies nor modeling efforts have demonstrated population-level impacts due to larval entrainment by hydraulic dredges (Memorandum dated 8 August 1995 from Douglas Clarke, Ph.D., Coastal Ecology Branch, Waterways Experiment Station, Corps of Engineers, DOTS Request for Assistance). It should be noted that hydraulic dredging in Savannah Harbor would not be conducted above Station 63 during the spawning season for the Striped bass (April 1-May 15). This restriction would also apply to the channel improvements proposed at McCoy's Cut, Little Back River and Middle River.

Phytoplankton and zooplankton could be impacted through entrainment into a dredge. Phytoplankton concentrate near the surface of the water. Dredges typically remove water from the bottom of the channel, so no adverse impacts to phytoplankton are expected from entrainment. Depending on the species, zooplankton are generally scattered throughout the water column. Since they are widely dispersed and not concentrated on the bottom of the river, no adverse impacts are expected to zooplankton from entrainment.

In light of these factors, the proposed harbor deepening is not expected to substantially adversely affect impact fish or shellfish through direct entrainment or impacts to their feeding areas.

5.07.1.2 Dredge Plume Turbidity. Studies performed by Dr. D.F. Hayes in 1986 on a hydraulic cutterhead dredge operating in Savannah Harbor indicated that average suspended sediment concentrations within 1,600 feet of the dredge were generally raised less than 200 mg/l in the lower water column and less than 100 mg/l and 50 mg/l in the middle and upper water column, respectively. More recent data indicate that present-day dredging operations are conducted in ways that do not increase suspended sediment concentrations to such an extent. (USACE 2006, USACE 2009, and USACE 2011). The Corps' 2006 EIS for the Long Term Management Strategy included information from new work dredging obtained from the 1989-1991 Savannah Harbor Widening Project and the 1993/1994 Savannah Harbor Deepening Project. TSS was measured at mid-channel and near the surface (3 feet below). In only 5 percent of the time did a mid-depth reading exceed 100 mg/L, while none of the near surface readings exceeded 100 mg/L. The Corps' 2011 report discussed the effects of O&M dredging on turbidity and dissolved oxygen. One analysis focused upon data collected in 2007 -2009 when turbidity data were consistently collected both up-current and down-current of the operating

dredge. The vast majority of data collected over those three years identified little net effect of the dredging on suspended sediments in the river. The Savannah River has a naturally high suspended sediment load which during storm events increases well beyond the 200 mg/l increase created by a hydraulic dredge. In addition, during storm events, the higher suspended sediment loads would likely be more uniform throughout the water column due to mixing as the plume proceeds downstream.

Hopper dredges would predominantly be used within the ocean bar channel (Stations 0+000 to -97+680B) of the harbor. Hopper dredge suction arms hydraulically remove sediment from the navigation channel and discharge the material into the storage hoppers on the dredge. During filling, fine sediments (primarily silt, clays, and fine-sands) are washed overboard to maximize the load of coarse sediments transported to the placement site. This washing and overflow process is a source of turbidity plumes and sedimentation generated by the hopper dredge. The distance that sediment plumes may extend is dependent upon the type of dredge, how it is operated, currents, and the nature of the sediments within the excavation area. Elevated sediment levels from hopper dredge operations have been recorded at about 1,100 feet from an excavation site (Blair *et al.* 1990). Furthermore, according to Neff (1981 and 1985), concentrations of 1000 ppm immediately after discharge decreased to 10 ppm within one hour. The minimal impact of settling particles from hopper dredge turbidity plumes was further supported by a study from Pooptech (1982), which found that the initial hopper dredge overflow concentrations of 3,500 mg/l were reduced to 500 mg/l within 50 meters. Another source of turbidity and sedimentation from hopper dredges is through the deposition of their sediment loads at the placement sites.

Mechanical dredges could be used throughout the proposed project length (Station 103+000 to -97+680B). Turbidity would be generated when the full bucket travels through the water column to the surface and is emptied into an adjacent barge. The magnitude of the river flows (i.e., the Savannah River has an average discharge of 11,290 cubic feet per second) indicate that rapid dilution of effects can be expected. Moreover, turbidity within the ocean bar would be quickly dissipated due to currents, wind and wave action.

Fish and shellfish species inhabiting the Savannah Harbor vicinity are adapted to, and highly tolerant of, naturally-elevated suspended sediment concentrations. In reviews of laboratory tests, Hirsch *et al.* (1978) and Stern and Stickle (1978) found marine and estuarine organisms to be very tolerant of the effects of sediment suspensions. Lethal or sub-lethal effects on larval or adult fish or shellfish occur after longer exposures to higher concentrations of suspended sediment than typically occur in the water column during dredging and sediment placement operations (Pedicord and McFarland 1978; Preist 1981).

The potential for interruption of the movement of estuarine fish and shellfish, particularly anadromous fishes, to and from nursery and spawning areas in the Savannah estuary by the physical presence of dredging equipment or by the physical-chemical water quality alterations associated with dredging is an issue of concern. However, river currents or flows upon which larval organisms depend for transport will not be interrupted or reduced. Dredge-induced water quality conditions will only be short-term and impact a small cross-sectional area of the Savannah River. Therefore, the potential for blockage of migration routes would be minimal.

The frequency of maintenance dredging should not be significantly different than what occurs now in the harbor.

In addition to entrainment, phytoplankton and zooplankton can be impacted by increases in suspended sediment concentrations and turbidity. Because of tidal currents, turbidity and suspended sediment caused by dredging will essentially be confined to the navigation channel down current of the dredge and will dissipate generally within 1,600 feet of the dredge (Payonk et al. 1988, Palermo et al. 1988, and McLellan 1989).

The existing navigation channel side slopes would not change with the proposed deepening and, therefore, any adjacent shellfish areas to the channel will not be impacted.

According to GA DNR-CRD, there are three shellfish harvesting areas near the project area – the Chatham County Recreational Shellfish Harvest Area and two commercial leases (Halfmoon and Wilmington). All three shellfish harvesting areas are located a sufficient distance from the dredging in the Savannah River channel that sedimentation and high turbidity would not adversely impact these resources. The closest area is located over 3,000 feet from the navigation channel. As such, turbidity caused during the new work dredging would not adversely impact shellfish areas.

In light of these factors, the proposed harbor deepening is not expected to result in more than minimal adverse impacts as a result of the dredge plume.

5.07.1.3 Dissolved Oxygen Concentrations During Dredging and Disposal Process. In addition to the factors outlined above, dissolved oxygen levels in Savannah Harbor are also of concern during the dredging and disposal process. The dissolved oxygen regime in Savannah Harbor is characterized by low levels of dissolved oxygen during the summer months, with much of the estuary typically dropping below state standards. The Corps is required to monitor dissolved oxygen levels in the effluent from its sediment disposal areas, as well as in the vicinity of its dredging operations. When dissolved oxygen levels fall to 3.0 mg/liter or less, the Corps is required to cease dredging operations unless a waiver is obtained. If the SHEP is approved and constructed, the terms of the new Section 401 Water Quality Certifications would be in effect. For both Georgia and South Carolina Georgia waters, that would include compliance with the 2009 dissolved oxygen standard. It may also require the Corps to cease dredging operations when dissolved oxygen levels in the river drop below a daily average of 5.0 mg/liter and an instantaneous average of 4.0 mg/l throughout the water column when natural conditions result in dissolved oxygen above those values. If it is determined that the natural condition in the waterbody is less than these values, the criteria will revert to the “natural condition” and the water quality standard allows for a 0.1 mg/l deficit from the “natural” dissolved oxygen value. Up to a 10% deficit is allowed if it can be demonstrated that resident aquatic species would not be adversely affected. Since the available dissolved oxygen deficit has already been allocated, the Corps would be 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 Harbor. Variances for maintenance dredging when dissolved oxygen levels are less than 3.0 mg/l may be granted under some circumstances, including if the Corps injects additional dissolved oxygen into the Savannah River.

5.07.1.4 Loss of Benthic Resources During Dredging. Removal of the bottom substrate within the dredging areas would eliminate all benthic resources in those locations. Those sites would be available for recolonization and use by benthic organisms once the dredging event ceases, so no irreversible loss of resources would occur. The populations that reestablish should be similar to those eliminated, since the species are substrate dependent and the sediments that create shoals in the channel and adjacent areas now will continue to do so after the proposed dredging. Maintenance will not limit the density and diversity of the benthic community that becomes reestablished any more so than existing maintenance activities. However, benthic populations in the navigation channel are in a state of flux due to the continual sedimentation and shoaling that creates the need for maintenance dredging. EA (2008) conducted a benthic community assessment of the river bottom both inside and outside the navigation channel. They found a substantial benthic community within the channel bottom. They observed that the coarse sand/gravel/clay substrate was used by benthic organisms, but they were unable to determine to what extent benthic organisms burrow into the exposed clay. They stated that the substantial presence of benthic organisms within the channel maintenance sediments indicates that the impact of maintenance dredging is temporary. The bottom substrate consists of exposed clay in roughly 28 percent of the channel bottom between Stations +16+000 and +60+000. EA found that the clay substrate supports a limited benthic community.

Although a temporary loss of benthic communities would result from the proposed excavation, the long-term effect on this resource would be minimal.

5.07.1.5 Noise Associated with Dredging. The noise generated from a hopper dredge is similar to a cutterhead suction dredge except there is no rotating cutterhead. The majority of the noise is generated from the dragarm sliding along the bottom, the pumps filling the hopper, and operation of the ship engine/propeller. Like the cutterhead suction dredge, the noise ranged from 70 to 1,000 Hz and peaked at 120 to 140 dB (Clarke et al 2002). These results from Clarke et al are preliminary and have not been published.

The noise generated from a mechanical dredge entails lowering the open bucket through the water column, closing the bucket after impact on the bottom, lifting the closed bucket up through the water column, and emptying the bucket into an adjacent barge. Once the barge is full, it would be towed by a tug offshore and emptied into the Savannah ODMDS or other approved placement sites. According to discussions with Doug Clarke and Charles Dickerson, US Army Engineer Research and Development Center the maximum noise spike with mechanical dredges is when the bucket hits the bottom. All other noises from this operation (i.e., winch motor, spuds, etc.) are insignificant. The sediment within Savannah Harbor is predominantly sand/silt/mud mixture. No rock, gravel, or cobbles are located within the portion of the navigation channel to be deepened. According to the Clarke et al (2002), the peak amplitude for the bucket hitting the rocky, gravel, cobble bottom at Cook Inlet, Alaska was about 120 dB. Both Doug Clarke and Charles Dickerson, US Army ERDC stated that this peak amplitude of the bucket hitting the existing sand/silt/mud substrate of Savannah Harbor would be significantly less than 120dB.

In light of these factors, the proposed harbor deepening is not expected to result in more than minimal adverse impacts as a result of noise.

5.07.1.6 Lighting During Construction. Dredge plants and associated tugs and barges are required to meet Corps, US Coast Guard, and OSHA lighting standards for safety. During the dredging process, if the dredge is within the vicinity of the nearshore area off Tybee Island, lighting from the dredge or other associated vessels may impact sensitive beach organisms (i.e. sea turtles). This impact would be of most concern during the nesting season for sea turtles.

The Biological Opinion for the project prepared by the NMFS contains reasonable and prudent measures to minimize potential effects of lights on sea turtles during the nesting season. All lighting aboard hopper dredges and hopper dredge pumpout barges operating within 3 nm of sea turtle nesting beaches shall be limited to the minimal lighting necessary to comply with the US Coast Guard and/or OSHA requirements. All non-essential lighting on the dredge and pumpout barge shall be minimized through reduction, shielding, lowering, and appropriate placement of lights to reduce potential disorientation effects on female sea turtles approaching the nesting beaches and sea turtle hatchlings making their way seaward from their natal beaches.

5.07.2 Sediment Placement Impacts

5.07.2.1 Nearshore Placement Areas. In the DEIS, the Corps proposed placement of new work and maintenance dredged material into nearshore sites off Tybee as a means of putting this material into the sand budget for the island. There is a potential for impacts to fish and other mobile aquatic life from placement of dredged sediments in the nearshore areas off Tybee Island. Impacts from placement operations could result from physical impacts from the dredge plume, as well as high suspended solids and increased turbidity.

The sediments that would have been deposited in the nearshore area consist primarily of sands; however, they are not considered “beach quality” material. The sand content of the sediments generally exceeds 70 percent and in most reaches exceeds 80 percent. The high sand content reduces the amount of fines that would be suspended in the water column and produce turbidity.

Since adult fish are mobile and the placement impacts are very localized (at the end of the dredge discharge pipeline), the potential for adult fish being harmed due to physical impacts from the dredge plume and attendant vessels traffic is quite low.

Eggs and larval fish are not as mobile as adults, so there is a higher potential for those early life stages to be physically damaged by sediment or materials in the dredge plume. However, the nearshore areas off Tybee Island have a very high sediment load since the Savannah River discharges at the north end of the island. Also the wind and wave climate in the nearshore area tends to have a naturally high sediment content and high turbidity. The placement activities would be very localized and therefore not impact a large area.

The benthic communities residing in the nearshore placement areas could be physically buried by the deposited sediment. After the sediment placement is complete, the site would be available for recolonization. The extent to which recolonization would occur would depend on the frequency and amount of maintenance sediment being placed in these nearshore areas. Literature dating back to the 1970’s along the southeastern coast of North Carolina indicate that opportunistic infauna species (ex: *Emerita* and polychaetes) found in beach nourished areas are

subject to direct mortality from burial. Recovery occurs in 1 to 3 years depending on the sediment compatibility and the relationship of the beach nourishment placement to recruitment timeframes (Hayden and Dolan, 1974; Saloman, 1984; Nelson, 1989; Van Dolah et al., 1992; Van Dolah et al., 1993; Hackney et al., 1996; P.C. Jutte et al., 1999)

Deposition in the nearshore placement sites would result in elevated turbidity and suspended solids. The Corps proposed to place sediments within the nearshore area that are a minimum of 70 percent or greater sand (averaging about 30 percent or less silt and clay). Due to the fairly low percentage of silt and clay content of the sediments that were proposed to be placed in the nearshore areas, the impact was not expected to be greater than the natural increase in turbidity and suspended material during storm events. Because of the quality of the sediment to be deposited (70 percent or greater sand), the sediment plumes generated from these activities in the marine environment were not expected to extend further than the general vicinity of the harbor entrance.

The GA DNR-CRD has designated and leased three locations for recreational and commercial shellfish harvesting. Those leased areas are located about 7 miles from the closest nearshore placement site (i.e., MLW 500) near Tybee Island. The Corps believes that the sediment plume (increased turbidity and suspended solids) generated from the proposed placement operations within the nearshore area off Tybee Island would not impact these shellfish harvesting areas.

The Corps believes that the placement of sediment in the nearshore areas off Tybee Island would not result in any long-term adverse impacts to the benthic communities or the recreational and commercial shellfish harvesting leases in the area.

However, based on concerns expressed by the GA DNR-CRD and the City of Tybee Island on the DEIS, the use of the nearshore placement areas for new work material from the SHEP has been removed from the project. All material removed from deepening and extending the entrance channel would be placed in the ODMDS or a CDF.

The nearshore placement sites at Tybee Island approved as part of the LTMS could be used for suitable future maintenance material from the entrance channel provided a non-Federal sponsor provided the additional funds to use that site.

Before sediment is initially placed in a nearshore site, Savannah District would perform confirmatory surveys to ensure that no hard-bottom communities and/or cultural resources are located at the proposed construction sites. If any hard-bottom areas are located, no maintenance sediments would be placed within these areas. Should any cultural resources be identified, the Georgia SHPO would be consulted. Deposition of dredged sediment on any unknown submerged cultural resource would not adversely affect it, but would instead provide additional protection from wave- or current-induced exposure and erosion.

5.07.2.2 Effluent Turbidity. The turbidity in effluent from diked sediment placement is controlled by adjustable spillways. The South Carolina standard for turbidity is that discharges are not to exceed 25 NTUs provided the existing uses of the water body are maintained. Savannah District imposes a 500 mg/l limit on suspended solids in the CDF discharges. This

limit is believed to be sufficient to reduce turbidity impacts in the receiving waters to acceptable levels.

Based on this factor, no significant adverse impacts from turbidity during sediment placement operations are expected from implementation of the harbor deepening alternatives.

5.07.2.3 Hardbottoms. Of special concern in the offshore area are hardbottoms, which are localized areas, not covered by unconsolidated sediments where the ocean floor is hard rock. Hardbottoms are also called “live bottoms” because they support a rich diversity of invertebrates such as corals, anemones and sponges, and are refuges for fish and other marine life. They provide valuable habitat for reef fish such as black sea bass, red porgy, and groupers. Hardbottoms are also attractive to pelagic species such as king mackerel, amberjack, and cobia. Hardbottoms are not abundant along the Georgia coast.

In June 2001 (Barry A. Vittor & Associates 2001), the Corps funded benthic sampling and analysis of about 2,500 acres south of the Savannah Harbor ocean bar channel. This benthic survey did not identify any hardbottom areas within or near the nearshore placement areas off Tybee Island or the ocean bar channel. That survey did not include all the nearshore areas that were proposed for sediment placement. Based on surveys of adjacent sites and the similarity of the bottom contours and substrate, no unique benthic communities are expected in those areas.

The Corps is not aware of any previous surveys that have been performed for hardbottoms on some of the nearshore placement sites that were proposed to be used for the SHEP. Based on surveys of adjacent sites and the similarity of the bottom contours and substrate, no hardbottoms are expected in those areas. No additional nearshore surveys are planned since the use of new nearshore placement sites at Tybee island has been removed from the project.

The proposed harbor deepening would occur within the existing channels of Savannah Harbor. There are no hardbottoms within these areas. Additional surveys will be conducted offshore in the area of the new bar channel extension. Although not expected, should the surveys indicate possible presence of hardbottoms, the Corps will coordinate with NMFS at that time.

Based on these factors, no significant adverse impacts to hardbottom communities are expected from implementation of the harbor deepening alternatives.

5.07.2.4 Artificial Fishing Reefs. The Georgia DNR, Coastal Resources Division lists one artificial reef in the project vicinity. Artificial Reef SAV is located about 6 nautical miles southeast of Tybee Island in an average water depth of 30 to 40 feet mean low water (Figure 5-53). No excavated sediments would be placed near Artificial Reef SAV. Therefore, the proposed action would not adversely impact Artificial Reef SAV.

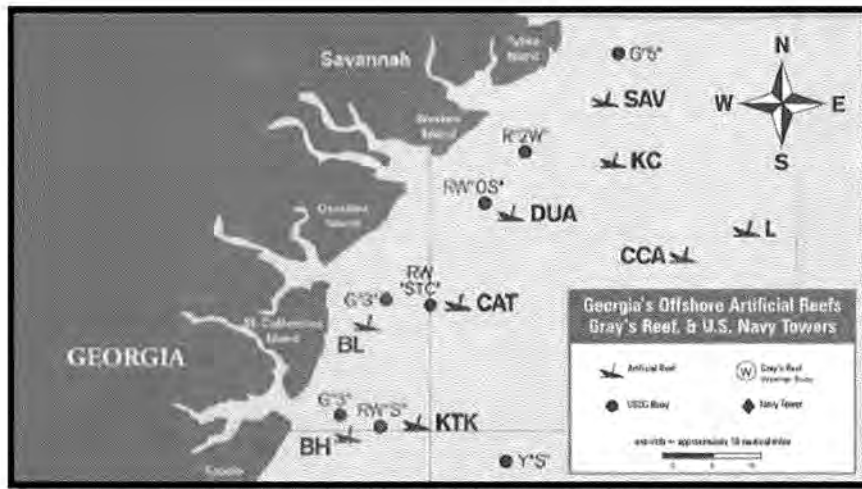


Figure 5-53. Georgia's artificial reefs.

5.08 Terrestrial Resources

Several environmental resources exist in the harbor which deserve special recognition and are special resources of concern as described in Section 4.07. Actions which could impact those areas may affect multiple resources, such as water quality, wetlands, aquatic species, benthic communities and wildlife. To ensure these areas receive the recognition and concern which they warrant, they are described and evaluated separately. The resources which warrant special concern include the Savannah National Wildlife Refuge, the Tybee National Wildlife Refuge, and the Turtle Island Wildlife Management Area.

5.08.1 Savannah National Wildlife Refuge

The proposed deepening of the existing Federal navigation channel to 47-foot depth would adversely impact tidal freshwater wetlands. Most of these types of estuarine emergent wetlands are located within the SNWR. Both marsh and uplands would be excavated to enlarge the Kings Island Turning Basin. The Corps will mitigate these adverse impacts (see Section 5.01 and Appendix C).

5.08.2 Tybee National Wildlife Refuge

The Tybee National Wildlife Refuge consists of 400-acres of wetlands and low diked islands. Some of the Jones/Oysterbed Island CDF is located within this Refuge. New work and/or O&M

sediments would be deposited within the CDF. The Jones/Oysterbed Island CDF is routinely used for the deposition of sediments dredged from Savannah Harbor. No adverse impacts are anticipated.

5.08.3 Turtle Island Wildlife Management Area

No impacts are anticipated because no work will take place within this site or adjacent to the site.

5.08.4 Confined Disposal Facilities (CDFs)

The proposed action would not adversely impact the useful life of the CDFs. Deposition of sediments within the CDFs would not adversely impact terrestrial habitats within the CDFs beyond what has received prior approval. Within the CDFs, expected impacts to flora and fauna are as follows:

5.08.4.1 Flora

As a result of dredged sediment deposition, the CDFs can be expected to continue to support mixed early-successional stage plant communities within diked areas. These communities will probably be dominated by the following species, which are common in the diked placement areas in the region today:

- A. *Baccharis halimifolia* (Grounseel-tree)
- B. Tamarisk (salt cedar)
- C. *Phragmites australis* (common reed)
- D. *Aster subulatus*
- E. *Xanthium strumarium* (cocklebur)
- F. *Heterotheca subaxillaris* (golden aster)

The impacts of dredge pipeline across marsh or other vegetation to reach the placement areas should be short-term and minor. The vegetation should quickly recover following pipeline removal.

When dikes are constructed or rebuilt, heavy equipment such as bulldozers, backhoes and draglines are used. The CDFs have upland access; therefore, temporary earth loading and unloading ramps from barges would not be needed to get the heavy equipment to the sites.

The Corps will use Best Management Practices as defined by the SC Department of Health and Environmental Control to control stormwater and erosion when dikes are raised.

Therefore, no long term adverse impacts to the flora on the CDFs are expected.

5.08.4.2 Fauna

The impacts associated with the proposed action on the fauna which inhabit the CDFs would be minimized to the maximum extent feasible. These CDFs are used in the regular maintenance of the harbor. Work on these CDFs take place on a recurring basis. The fauna should quickly

recover following any dike work or dredging activity. No adverse long-term impacts are anticipated.

Dredged sediment placement sites that receive a high percentage of fine materials (silts and clays), have the potential to become mosquito breeding habitat. As the sediment dries and compacts, it forms a network of cracks, extending from the surface down to a depth of nearly one foot. The sides of these cracks are used as attachment sites for mosquito eggs. In the past, there have been several instances of nuisance mosquito outbreaks from the CDF placement areas located along the northern bank of the Savannah River.

Management recommendations for mosquito surveillance and control on the CDFs was prepared by Chatham County Georgia and Jasper County, South Carolina, the Georgia Department of Transportation, and the Corps of Engineers (USACE 1996). The recommendations include surveillance, surface water management, and chemical and biological control measures. The Corps has funded mosquito control activities at the CDFs, and that funding is expected to continue in the future.

5.08.4.3 Migratory Birds

Many species of migratory birds use the harbor's confined upland placement sites. A variety of species of birds are regularly observed in the scrub/brush habitat that surrounds the CDFs. That habitat is present to some degree on other uplands throughout Chatham and Jasper Counties. However, the existing CDFs provide unique habitat in the Project area for certain species of migratory birds. These sites provide nesting habitat for a limited number of migratory bird species, but those species include some of special concern such as Least tern, Black-necked stilt, and Wilson's plover. Many other species of birds use the CDFs outside the breeding season, some in high numbers.

These birds using the CDFs for feeding, loafing, and nesting areas will continue to use them during the new work sediment placement for the harbor deepening. During construction activities, not all of the CDFs would be used at the same time. The work on these CDFs will be sequential (one or two at a time, out of the six) depending on the order of work. With the management approach that Savannah District has adopted, the CDFs are managed to provide bird habitat during sediment placement operations. Water is ponded in the CDFs to provide feeding and loafing areas. The ponded CDFs are used by shorebirds, waterfowl, herons, egrets, ibis, wood stork, gulls, and terns. The ponded water also isolates the bird nesting islands constructed within the CDFs. Once a CDF has temporarily ceased being used for sediment placement, it would be dried and the site would then provide terrestrial habitats for birds.

The Corps would continue to implement its protective measures to ensure its use of the CDFs do not adversely impact migratory birds. Based on these factors, no adverse impacts are anticipated to this resource.

5.08.4.4 Proposed Jasper County Marine Terminal

The proposed deepening of the Savannah Harbor navigation channel would occur prior to construction of a container terminal in Jasper County if the SHEP is constructed. The consulting firm that is presently managing studies that may lead to construction of a terminal have stated that a successful container terminal in Jasper County would require a navigation channel to the site with a depth greater than 42 feet MLW. Consequently, construction of the SHEP would provide a deepened entrance channel and inner harbor channel to the site of a proposed Jasper County Marine Terminal if the project is constructed.

New work sediments would be deposited on the property (currently CDFs 14A and 14B) last identified as the location for this proposed terminal. Deposition of those sediments would raise the elevation of the property, resulting in less fill being required in the future to raise the site to an elevation suitable for terminal operations.

The new work sediments identified for deposition on the site are primarily those that have been found to possess elevated levels of naturally-occurring cadmium. The presence of the cadmium should not substantially affect subsequent development of the site into a marine terminal, because a terminal would pave the surface of the site to allow ready movement of trucks and containers. Pilings could be driven through the new work sediments as needed for any future development of the site.

5.09 Existing Shorelines Adjacent to the Federal Navigation Channel

The proposed deepening of the Federal navigation channel could increase shoreline and/or beach erosion along the channel shoreline, from Savannah to Tybee Island. In light of that possibility, Savannah District conducted several investigations to identify and evaluate potential shore erosion impacts, including the following: Ship Wake Analysis, Bank Erosion Analysis, and Coastal Erosion Study at Tybee Island. Many areas are presently experiencing erosion and the vessel fleet continues to change, so determining the incremental effect of deepening the harbor is a technically difficult analysis.

The Ship Wake Analysis was conducted by the US Army Corps of Engineers, Engineer Research and Development Center (ERDC), Coastal and Hydraulics Lab. The report documenting that study was titled "*Ship Forces on the Shoreline of the Savannah Harbor Project*" and was completed in August 2006. This ERDC study and the GEC forecast of ship traffic were used by the Savannah District to complete the "*Savannah Harbor Expansion Bank Erosion Study*" dated November 2006. The 2006 *Bank Erosion Study* (updated in 2011) used aerial photographs taken between 1957 and 2006, site inspections made in 2003 and 2006, history of the Savannah River documents from 1850 through 2006, and previous erosion studies conducted for the Savannah River and Tybee Island. A revised fleet forecast resulted in the updated Bank Erosion Study.

The following were taken into account during the Bank Erosion Study:

- A. All shoreline areas of the river between Tybee and Station 103+500 at the Garden City Terminal were reviewed for potential project impacts.
- B. River Front erosion was not considered a factor during the study because the shoreline is already protected by bank protection and structures.
- C. Fort Jackson erosion was not considered a factor during the study because the shoreline was stabilized in 2003 (see Figures 5-54 and 5-55).
- D. Bight Area (from about Stations 40+000 to 50+000) erosion was not considered a factor since it is in the process of being stabilized.
- E. The North Tybee Island and Ft. Pulaski shorelines were considered within the study area.

The following conclusions were taken from the Bank Erosion Study and updates, copies of which can be found in the GRR Engineering Appendix.

A. The North Tybee shoreline studied indicates some degree of erosion from various causes (i.e., tide, Northeaster's, ship wake, etc.). However, the distance from the North Tybee Island shoreline to the shipping channel is roughly one mile and the site is separated from the shipping channel by the Cockspur Island Training Wall. Correlations to ship traffic and the proposed deepening work do not appear to be supported. All indications (including the ERDC study dated August 2006) suggest that deepening the shipping channel will reduce energies from ship wakes by approximately 2.3 to 5.9 percent. Therefore, the proposed harbor deepening will not have any measurable effect on the North Tybee shoreline.

B. The distance from the Fort Pulaski shoreline to the southernmost edge of the shipping channel varies from about 470 to 1,060 feet. The portion of Fort Pulaski that was evaluated is an unprotected area. It has three major drainage features and one ongoing scour depression on the upstream side immediately adjacent to the end of the rock slope protection. Aerial photographs from 1955 through 2006 were used to estimate the average yearly bank erosion along about 4,100 feet of shoreline. Photos indicate that a minimum of about 1.8 feet each year is lost toward the ends of the rock protection. The maximum erosion occurs in a bend area of this site with measurements indicating about 3 feet of shoreline per year lost to erosion in both the with and without project condition. Construction of the project would not cause substantial additional erosion to occur. Calculations indicate that in the worst case, up to 3.1 feet of shoreline erosion due to all causes could occur along Fort Pulaski's unprotected shoreline in any given year, of which only 0.1 foot (1.2 inches) of erosion is due to present-day ship traffic. The majority of the ongoing and expected future erosion at the site is due to tide, flows, river mechanics, shape and other causes unrelated to ship traffic through the channel. Given the current traffic predictions and forecasts, the bank erosion expected to result from harbor deepening at this site would be less than 1/2 inch at the end of the 50-year project life, an amount that would not be measureable in the field in light of the erosion caused by other factors.

The Savannah District recently constructed shore protection measures at CDFs 13A, 13B, 14A and 14B. Consequently, they are protected from long-term shoreline erosion. The District is constructing bank protection on Jones/Oysterbed Island, so it can be assumed to be protected in the without project condition. The revetment at Jones/Oysterbed Island is currently underway. The first of three phases was completed in December 2012, and the two remaining phases are scheduled to be completed by 2015, prior to completion of the proposed inner harbor dredging. With a deepened harbor, fewer ships are expected to call (when compared to without project condition). As a result, the proposed deepening is not expected to impact the shoreline of the confined disposal areas to any measurable degree.

In 2006, ERDC completed the "Coastal Erosion Report", which examined *"the impact of the Savannah Harbor navigation project on the regional morphology and to quantify the influence of the navigation project on increased shoreline recession rates along Tybee Island."* Those evaluations included a combination of quantitative shoreline change analysis, volume change calculations, and hydro/sediment modeling. Sediment volume change analysis and modeling results were integrated to assess the impact of the Savannah Harbor navigation channel on sediment transport pathways. The results of the circulation and wave modeling indicate very small changes associated with the proposed deepening on the beaches of Tybee Island. This report is included in GRR Engineering Appendix.

Based on these factors, the Corps believes that the proposed harbor deepening alternatives would not result in major or significant adverse impacts to ocean or river shorelines.

5.10 Floodplains

In 2005, Applied Technology and Management, Inc. (ATM) developed an EFDC model using data based on measured water surface elevations collected at the USGS Customs House gage located in Charleston, SC during Hurricane Hugo which made landfall on September 21, 1989 as a Category 4 storm. Hurricane Hugo was chosen because it was the largest hurricane in recent record with closest proximity to the Savannah River estuary. Moreover, the data sets recorded during this event were used to model a similar event in the Savannah River estuary because they are relevant and available.

The results from the ATM hurricane surge modeling indicate that the change in storm surge water surface elevation due to the proposed harbor deepening would not be significant. The existing depth is compared to the 48 foot deepening alternative (deepening an additional 6 feet) for all of the 6 storm events scenarios simulated. The maximum increase for the maximum 48-foot depth alternative in predicted surge height is 0.90 foot, which occurs during the 15 foot surge at the I-95 Bridge. The hurricane surge modeling shows no significant adverse impacts due to harbor deepening from a propagated storm surge as it travels upstream through the river system and navigation channel.

In December 2007, TetraTech also evaluated hurricane surge (see Savannah Harbor Expansion Project, Evaluation of Hurricane Surge Impacts with Proposed Mitigation Plan, December 2007). They analyzed surge heights within the estuary for each depth alternative with their mitigation plans. The results of the both the ATM and TetraTech evaluations are shown in the tables below.

Table 5-48. Increase in Water Surface Elevation due to Hurricane Surge for the 48-Foot Depth Alternative

Storm Surge Height	Increase in Water Surface Elevations	
	Ft. Jackson	I-95 Bridge
5 Foot		
Peak on peak	0.3 foot	0.7 foot
Offset peaks	0.3 foot	0.7 foot
10 Foot		
Peak on peak	0.3 foot	0.8 foot
Offset peaks	0.3 foot	0.8 foot
15 Foot		
Peak on peak	0.3 foot	0.9 foot
Offset peaks	0.3 foot	0.8 foot
Maximum Difference	0.3 foot	0.9 foot

Table 5-49. Increase in Water Surface Elevation for 15-Foot Hurricane Surge (Peak on Peak Condition)

Project Depth Alternatives	Increases in Water Surface Elevation	
	Ft. Jackson	I-95 Bridge
44 feet MLLW	0.1 foot	0.3 foot
45 feet MLLW	0.2 foot	0.5 foot
46 feet MLLW	0.2 foot	0.6 foot
47 feet MLLW	0.3 foot	0.8 foot
48 feet MLLW	0.3 foot	0.9 foot

In the most extreme case (i.e., with the peak 15-foot storm surge and at the 48-foot channel depth), both the ATM and Tetra Tech hurricane storm surge analyses predict less than a 0.9 foot increase at the I-95 bridge. The Corps consulted officials at the Chatham County Emergency Management Agency about these results. The County indicated that since the impact amount is less than the 1-foot contour interval available for the high ground areas, they would not be able to identify any locations that would be adversely impacted by the small increase in surge height. They also noted that the maximum predicted increase was in addition to a substantial surge height (15 feet), which would cause noticeable adverse impacts on its own.

No new dredged material placement areas are being planned for the proposed harbor deepening. All dredged material would be placed either in the existing upland CDFs or within the offshore EPA-approved ODMDs. The exception is the use of excavated sediments to construct the submerged broad berm at the lower end of Back River.

The proposed project would not adversely impact floodplains in the project area since the Corps is not planning to develop any area within the 100-year floodplain. The height of hurricane storm surges on the floodplains would also not be measurably affected.

Therefore, the Corps believes that proposed deepening alternatives would not significantly increase hurricane storm surges in the project area, including Tybee Island, Fort Jackson, or the City of Savannah and floodplains in the project area will not be adversely impacted.

5.11 Threatened and Endangered Species

A biological assessment (BATES) evaluating the potential impacts of the proposed action on endangered and threatened species was prepared. The biological assessment resulted in a determination that the project, as currently proposed, "may affect, but is not likely to adversely affect" Piping plover, Wood stork, West Indian manatee, Right whale and Humpback whales, sea turtles, and Shortnose sturgeon, and Atlantic sturgeon. The biological assessment appears in Appendix B, and discusses the relationship of the proposed action to these species. Project plans have been refined to minimize potential effects to the extent feasible.

5.11.1 US Fish and Wildlife Service Findings

The BATES was coordinated with the USFWS (jurisdiction over the West Indian manatee, Piping plover, Wood stork and nesting sea turtles) and NMFS (jurisdiction over whales, sea turtles, Atlantic sturgeon and Shortnose sturgeon) pursuant to Section 7 of the Endangered Species Act. The BATES includes a discussion of the impacts of the SHEP on the Atlantic sturgeon, even though the species was listed as endangered just prior to release of the Final EIS.

Based on their review of the project, the DEIS and the GRR, the USFWS submitted their views on the BATES by letter on April 28, 2011. The USFWS concurred with the findings in the BATES that the SHEP may affect but is not likely to adversely affect the Piping plover, Wood stork, West Indian manatee, and nesting sea turtles. Their report on the BATES is included in Appendix Z.

5.11.2 National Marine Fisheries Service Findings

The NMFS submitted their Biological Opinion (BO) for the SHEP by letter dated November 4, 2011. The BO concurred with the findings of the BATES that the SHEP may affect but would not likely adversely affect Leatherback sea turtles, Green sea turtles, Hawksbill sea turtles, North Atlantic Right whales, and Humpback whales. However, the BO determined that construction of the SHEP would likely adversely affect Kemp's ridley sea turtles, Loggerhead sea turtles, Shortnose sturgeon and Atlantic sturgeon. The NMFS BO is included in Appendix Z.

5.11.2.1 Sea Turtles. The “likely to adversely affect” determination for Loggerhead sea turtles and Kemp’s ridley sea turtles is primarily based on the incidental take of these species that would be expected to occur during hopper dredging operations over the 3-4 year construction period for the SHEP. To minimize impacts, hopper dredging would be conducted during the months of December through March, when sea turtles are least abundant. Despite the limited dredging window during winter months, use of deflector dragheads and relocation trawling (removing sea turtles from the entrance channel prior to dredging), the NMFS estimates that approximately 16 Loggerhead sea turtles and 11 Kemp’s ridley sea turtles would be taken during the entrance channel dredging required for the SHEP. Once the NMFS reaches a determination that a project will likely adversely affect a listed species, they must conduct a Jeopardy Analysis to determine whether the proposed action would likely jeopardize the recovery of that species. Based on information developed in the BO, the NMFS concluded that construction of the SHEP would not interfere with the recovery objectives for either the Northwest Atlantic DPS (distinct population segment) of the Loggerhead sea turtle or Kemp’s ridley sea turtle, or result in an appreciable reduction in the likelihood of their recovery in the wild. This determination is based on their knowledge of existing populations of these species and their anticipated future reproduction trends.

The determination by the NMFS that the SHEP is not likely to jeopardize the continued existence of the Northwest Atlantic DPS of the Loggerhead sea turtle or Kemp’s ridley sea turtle is also based on implementation of Reasonable and Prudent Measures (RPMs) outlined in the BO, and the Terms and Conditions which implement those measures. Section 9 of the Endangered Species Act prohibits the take of endangered or threatened species. NMFS believes that for the SHEP to comply with the provisions of Section 9, the Corps must adhere to the Reasonable and Prudent Measures and the Terms and Conditions that implement those measures provided in the BO. The BO includes three Reasonable and Prudent Measures to protect the Northwest Atlantic DPS of the Loggerhead sea turtle and Kemp’s ridley sea turtle. These three Reasonable and Prudent Measures and the Terms and Conditions to implement them are as follows:

A. Take Reporting

1. NMFS approved protected species observers must be on-board hopper dredges;
2. 100 percent inflow screening of dredged material is required and 100 percent overflow screening;
3. The hopper’s inflow screens should have 4-inch by 4-inch screening;
4. Flexible, graduated screens should be used; and
5. The dredging pump shall be disengaged by the operator when the draghead is not firmly on the bottom to prevent impingement or entrainment of sea turtles.

B. Deflector Dragheads

1. A state-of-the art rigid deflector draghead must be used on all hopper dredges at all times;
2. Observer reports of incidental take by hopper dredges must be reported by onboard NMFS approved protected species observers, the dredging company, or the COE within 24 hours of any sea turtle or other listed species take observed. A final report summarizing the results of the hopper dredging and any documented sea turtle or other

listed species take must be submitted to the NMFS within 30 working days of completion of the dredging project;

3. The Corps' representative shall notify the Sea Turtle Stranding and Salvage Network of the start-up and completion of hopper dredging operations and ask to be notified of any sea turtle strandings in the project area that bear signs of potential draghead impingement or entrainment, or interaction with a bed-leveling type dredge; information of such stranding shall be reported in writing within 30 days of project end to the NMFS' Southeast Regional Office; and

4. The COE shall provide NMFS' Southeast Regional Office with a report detailing instances, with photographs when available, of stranded sea turtles that bear indications of draghead impingement or entrainment and/or bed leveler interactions.

C. Relocation Trawling

1. Relocation trawling (RPM 3) (if applicable). Prior to turtle relocation trawling, the COE shall develop and submit to the NMFS detailed specifications on the final selected turtle relocation trawling gear sufficiently ahead of dredging activities for NMFS to review and comment on the plans. The use of relocation trawling will be required during all proposed hopper dredging during December 1 through March 31;

2. The COE shall provide the NMFS' Southeast Regional Office with an end-of-project report within 30 days of completion of relocation trawling; and

3. In the event that trawling does result in the capture of a sea turtle, the COE may employ a separate chase boat to relocate the turtle at a distance of no less than 3 miles from the centerline of the navigation channel at the capture site. The Corps shall be subject to the conditions outlined in the BO concerning handling, captured sea turtle holding conditions, scientific measurements and data collection, injuries, flipper tagging, PIT-Tag scanning, etc.

In addition to the requirements discussed above, the Corps shall follow the Terms and Conditions of the BO with respect to:

A. The BO provides the permitting authority for any NMFS-approved protected species observer to tissue-sample live or dead captured sea turtles. All live or dead sea turtles captured by relocation trawling and hopper dredging shall be tissue sampled prior to release in accordance with NMFS' procedures.

B. The COE must ensure that all contracted personnel involved in operating hopper dredges receive thorough training on measures of dredge operation that will minimize take of sea turtles.

C. All lighting aboard hopper dredges and hopper dredge pumpout barges operating within 3 nautical miles of sea turtle nesting beaches shall be limited to the minimal light necessary to comply with the U.S. Coast Guard and/or OSHA requirements. All non-essential lighting on the dredge and pumpout barge shall be minimized through reduction, shielding, lowering, and appropriate placement of lights to minimize illumination of the water to reduce potential disorientation effects on female sea turtles approaching the nesting beaches and sea turtle hatchlings making their way seaward from their natal beaches.

D. The COE will be required to conduct activities in compliance with NMFS' March 23, 2006, *Sea Turtle and Smalltooth Sawfish Construction Conditions*.

5.11.2.2 Shortnose and Atlantic Sturgeon. The "likely to adversely affect" determination for Shortnose sturgeon is primarily based on adverse effects (increase in salinity) to important estuarine winter foraging habitats for both juvenile and adult fish. While the NMFS expects these effects to be sub-lethal for individual sturgeon, these effects could reduce the Savannah River's overall carrying capacity and ability to provide optimal habitat for the Shortnose sturgeon to forage. The NMFS believes that both adults and juveniles will move to suitable habitats further upriver once the SHEP is constructed. However, the NMFS also points out that there may be a transitional period as the habitat adjusts to the new, higher salinity. They expect sturgeon to use these areas for foraging once their prey have colonized and stabilized to the new environmental conditions. The NMFS also determined that construction of the SHEP would not likely cause a long-term reduction in reproduction. NMFS expects that construction of the fish passage facility at the NSBL&D will result in access to historic spawning habitat upstream of the dam that increases spawning activity over the long-term. Based on these determinations, the NMFS concluded that construction of the SHEP is not likely to jeopardize the continued existence of Shortnose sturgeon. With implementation of the Reasonable and Prudent Measures NMFS identified to protect this species, NMFS concluded that the overall effect on the species would be acceptable.

The "likely to adversely affect" determination for Atlantic sturgeon is primarily based on NOAA's estimated incidental take of four Atlantic sturgeon during hopper dredging operations necessary to construct the SHEP and adverse effects (increase in salinity) to important estuarine foraging habitat for juveniles and adults. The estimated incidental take of four Atlantic sturgeon during entrance channel construction would not decrease the overall population of this species in the South Atlantic DPS (Distinct Population Segment) as there are significant numbers of fish found in the rivers comprising the South Atlantic DPS range of Atlantic sturgeon. The effects of SHEP on foraging habitat and spawning success of Atlantic sturgeon are similar to those for the Shortnose sturgeon. Based on these determinations, the NMFS was able to conclude that construction of the SHEP would not likely jeopardize the continued existence of the South Atlantic DPS of Atlantic sturgeon, and the project's overall effect on the species would be acceptable.

For sturgeon, the BO includes five Reasonable and Prudent Measures that must be implemented for the Corps to be exempt from the provisions of Section 9 of the ESA. These five Reasonable and Prudent Measures and the terms and conditions to implement those measures are as follows:

A. Implement Safe and Effective Fish Passage in a Timely Manner.

1. Develop a plan for safe and effective fish passage. Using the proposed off-channel rock ramp design as its basis, the COE will coordinate with the NMFS, USFWS, SCDNR, and GADNR to develop the final design details. The COE shall conduct a comparison analysis of the performance of existing rock ramps located in other parts of the country with similar characteristics to the proposed New Savannah Bluff Lock and Dam fish passage conditions to review information on the spatial variation of velocities

across the width of rock ramp designs. The COE will coordinate the results of that effort with the natural resource agencies within 6 months of receiving all of the environmental approvals to implement the project. NMFS has requested a minimum of 2 months to provide a review of the final fish passage design. The proposed final design shall require NMFS' final review to validate that the design meets the requirements specified in the BO. The goal of the fish passage alternative is to achieve at least 75 percent upstream passage effectiveness for both Shortnose and Atlantic sturgeon, at least 85 percent downstream passage effectiveness, and cause no serious injury to sturgeon that come into contact with the passage or dam structures. The fish passage would maintain velocities comparable to those found in the upstream habitat that the sturgeon are expected to access upon completion of the fish passage facility.

2. Fish passage construction shall commence prior to or concurrently with inner harbor dredging and be complete within two years.

3. The COE shall purchase any additional land necessary for the fish passage and for an access road to the site. The land acquisition process must be initiated prior to, or concurrent with, commencement of entrance channel dredging.

4. To protect spawning sturgeon and their offspring, no in-water fish passage construction downstream of the New Savannah Bluff Lock and Dam shall occur during the late winter/spring period and early summer larval period between February 1 and May 31 of any year.

5. The COE shall adhere to protective measures during construction of the fish passage including appropriate erosion and turbidity controls. Additionally, the Corps will ensure passage throughout the habitat. Adequate pathways must be provided at all times so that fish can migrate between foraging habitat and spawning habitat; no blocking of the channel is allowed. Normal water flows must be maintained throughout the construction areas. The COE shall not reduce flows during the spring/early summer to aid in the construction of the fish passage.

6. The COE shall develop a Monitoring and Adaptive Management Plan specifically for the fish passage that will, to the maximum extent practicable, ensure the performance criteria will be achieved. The plan will also identify triggers for passage modification. Post-construction monitoring shall be designed and conducted to assess the effectiveness of the fish passage in safely passing sturgeon upstream and downstream. The COE shall consult with the NMFS and the other natural resource agencies to complete the plan within 6 months of receiving all environmental approvals to implement the project. NMFS shall have final review of such plan. If it is determined that sturgeon are not safely and effectively passing upstream and downstream through the fish passage, measures shall be taken to rectify the problem.

B. Protective Measures for Sturgeon during Construction in the SHEP Project Area.

1. The construction of the diversion structure associated with the flow re-routing modifications shall be conducted between May 15 and November 1 while most sturgeon are congregated upstream of the construction area.
2. During construction of the various flow diversion measures, the COE will adhere to appropriate erosion and turbidity controls. No blocking of the channel is allowed, except where included as part of the flow re-routing modifications.

C. **Ensure Appropriate Monitoring and Adaptive Management Within the Lower Savannah River Project Area.** A comprehensive monitoring and adaptive management plan shall be developed for assessing project impacts associated with the deepening, the flow-re-routing modifications, the injection of oxygen, the fish passage and for implementing corrective actions. The plan shall identify success criteria and triggers. The COE shall consult with the NMFS and the other natural resource agencies to complete the plan within 6 months of receiving all environmental approvals to implement the project. NMFS shall have final review of such plan. The plan shall be completed within 6 months of receiving all environmental approvals to implement the project. The Plan shall include monitoring to determine whether the predicted amount of habitat loss is being exceeded. If the monitoring indicates habitat loss to any species within NMFS' ESA authority is being exceeded, this will trigger re-initiation of consultation with the NMFS.

D. **Ensure Appropriate Dissolved Oxygen Levels.** Monitoring and adaptive management for dissolved oxygen levels shall ensure that the dissolved oxygen systems perform as expected to offset harbor deepening impacts and ensure the amount of suitable habitat as predicted in the modeling of the three-level summer habitat suitability criteria for sturgeon are not reduced. If dissolved oxygen excursions below minimum levels in the modeled river cells are longer in duration than specified in the criteria, corrective action (increasing or adjusting the operation of the Speece cones, cessation of dredging in the area of concern, etc.) will be taken immediately. If short-term response is not practicable, solutions shall be implemented as soon as possible, and not later than July 1, following identification of the poor oxygen levels.

E. **Tissue Sampling, Tags and Reporting Take.** A tissue sample shall be taken of any sturgeon handled or stranded. All sturgeon encountered shall be scanned for a PIT tag. If a lethal take occurs, the COE shall arrange for containment analysis of the carcass. Sonic tags, or some other state-of-the-art tracing device shall be placed on sturgeon captured during relocation trawling, or alive by the hopper dredge by NMFS-approved personnel only. Observer reports of incidental take by hopper dredges and relocation trawls will be reported to the NMFS' Southeast Regional Office.

5.11.2.3 Corps Proposed Actions. The Corps will follow the Reasonable and Prudent Measures and the Terms and Conditions in the NMFS November 4, 2011 BO for construction of SHEP. If the NMFS updates the Regional Biological Opinion (RBO) for operation of hopper dredges, the Corps will follow that newer document for long term operation and maintenance of the SHEP. If the NMFS does not update the RBO for operation of hopper dredges, the Corps will follow the 1997 RBO for long term operation and maintenance of the SHEP.

5.12 Cultural Resources

Analysis of potential impacts to cultural resources considers both direct and indirect impacts. Direct impacts may be the result of physically altering, damaging, or destroying all or part of a resource, altering characteristics of the surrounding environment by introducing elements that are out of character for the period the resource represents, or neglecting the resource to the extent that it deteriorates or is destroyed. Indirect impacts are those that may occur as a result of a change in the wave action in the vicinity of the resource during dredging and other construction activities.

The APE has been defined as those areas listed in Section 4.10.1 where ground disturbing activities and placement of dredged material will occur. Previous cultural resource investigations as described in Section 4.10.2 have located several resources within and in the vicinity of the APE. These resources are displayed in Table 4-16. Table 5-50 lists the potential impact to those resources from the action and proposed mitigation, if required. Areas within the APE that require additional cultural resources investigation are discussed in Section 5.12.3.

Table 5-50. Known Cultural Resources within the APE Requiring Additional Investigation

Resource Name/Site Number	NRHP Status	Potential Impact	Proposed Mitigation
Fort Pulaski National Monument (GA)	Listed as National Monument	Negligible increase in erosion	None Required
Savannah National Historic Landmark District (GA)	Listed as National Historic Landmark	None	None Required
Fort James Jackson National Historic Landmark (GA)	Listed as National Historic Landmark	None	None Required
CSS <i>Georgia</i> (SC & GA waters)	Listed	Dredging Impacts	To be determined in consultation with GA, SC SHPO and US Navy
The Savannah and Ogeechee Canal (GA)	Listed	None	None Required
Pennyworth Island (GA)	Nomination Pending Approval	Increased shoreline erosion or accretion	To be determined in consultation with GA SHPO
Fig Island Channel Site (GA)	Determined Eligible	None	None Required
Mansfield/Shafsbury Plantation—09CH685	Recommended Eligible	Increased shoreline erosion or accretion	To be determined in consultation with the GA SHPO
Poplar Grove Plantation—38JA203	Recommended Eligible	Increased shoreline erosion or accretion	To be determined in consultation with the SC SHPO
Shubra Plantation – 38JA204	Recommended Eligible	Increased shoreline erosion or accretion	To be determined in consultation with the SC SHPO

5.12.1 Alternatives Considered During Project Design in Order to Reduce the Area of Potential Effect

The initial concept design for this project was to deepen the channel by up to 10 feet the full channel bottom width for the entire length of the navigation channel. This design would have resulted in side slope sloughing that would have impacted an area up to 50 to 80 feet wide on either side of the navigation channel. The design was subsequently modified to deepen the channel by no more than 6 feet and to dredge to a width that would not affect existing side slopes. The decision to maintain the existing side slopes and narrow the bottom width of the navigation channel greatly reduced potential impacts to cultural resources.

The initial project design also included a series of 16 bend wideners varying from 76 to 156 feet in width and with a total length of over 56,000 linear feet. The results of a ship simulation study resulted in a new design with three bend wideners with widths from 76 to 156 feet and a total length of less than 15,250 linear feet and nine areas to be dredged to the full existing channel width with a total length of less than 49,000 feet.

5.12.2 Cultural Resources Investigations for Specific Sites

As stated in Section 4.10 not all previously undisturbed areas within the APE have been investigated, nor have all resources that were previously identified been evaluated for the NRHP. The section below discusses previous cultural resources investigations, resources identified and any investigations and/or evaluation of resources that will be required.

5.12.2.1 Bar Channel Extension (Outside State Waters) –Stations –60+000 to –97,680-- Bottom and Side Slopes. The project, as originally proposed, included a 25,000-foot long channel extension, Savannah District archaeologists and hydrographic surveyors conducted side scan sonar and cesium magnetometer surveys of the proposed channel extension area. The survey area was 700 feet wide, sufficient to include the 600-foot proposed channel width and side slopes. In 2005, Savannah District contracted with Panamerican Consultants, Inc., to analyze the data, identify anomalies and/or targets for further evaluation, and conduct diver investigations of potentially significant anomalies and/or targets. The contractor has completed the analyses and has investigated one magnetic anomaly/sonar target. The anomaly/target was identified as modern debris.

As part of studies to identify potential impacts to the Floridan Aquifer, Savannah District conducted sub-bottom profiler surveys of the existing bar channel area, as well as areas on the bar considered for bend wideners and channel extension. The purpose of the survey was to identify the depth and character of the aquifer's Miocene-age cap and to locate former Pleistocene stream channels that cut into the cap. Since stream banks have a higher potential for containing prehistoric archaeological sites, the results of these surveys were also examined by District archaeologists. No Pleistocene streams were found in the extension area.

Due to changes in shoals, in 2009, the bar channel extension was redesigned to be a 38,600-foot-long by 600-foot-wide channel located on a different alignment. Savannah District is contracting for a side scan sonar, magnetometer, and sub-bottom profiler, and diver investigation of the new

location. In order to ensure that avoidance of impacts to potentially significant cultural resources is a viable alternative, the area being surveyed is 1100 feet wide. The survey is designed to locate shipwrecks and landforms likely to contain prehistoric sites.

5.12.2.2 Bend Wideners and Full-width Dredging Areas. The project includes dredging along the entire length of the existing navigation channel up to Garden City Terminal (Station 103+000) and construction of three bend wideners at critical turns. A summary of the cultural resources investigation conducted in these areas are summarized below.

Bend Widener (SC waters)—Stations -21+000 to -14+000, 76-foot bottom width plus side slope of 20 feet. Savannah District archaeologists and hydrographic surveyors conducted side scan sonar and magnetometer surveys of this area. The survey area was 300 feet wide. In 2005, the District contracted with Panamerican Consultants, Inc., to analyze the data, identify anomalies and/or targets for further evaluation, and conduct diver investigations of the anomalies. The contractor completed the analyses and recommended no anomalies and/or targets for evaluation.

Sub-bottom profiler surveys conducted as part of the aquifer impact studies identified a Pleistocene stream channel that bisected this area. Savannah District geologists and a contract geoarchaeologist with Brockington and Associates selected four areas from which to take core samples—three located along the banks of the stream and one located on a terrace that formed within the stream channel as sea level rose. Analysis of the cores revealed that the sediments within and adjacent to the stream channel date to the mid-Pleistocene Era and are not associated with human activity.

Full-channel-width Dredging Area (SC waters)—Stations +9+000 to +12+750—side slope impact area of ca. 20 feet. The easterly 1000 feet has been previously impacted by construction of a 36-foot-deep turning basin. The remaining area was surveyed in 2003 by Savannah District contractor Panamerican Consultants for a then-planned 76-foot-wide bend widener plus side slopes. Eight anomalies and/or targets were recommended as potentially significant. Due to project redesign, all are located over 200 feet from the revised area of potential effect. No further investigations are recommended.

Full-channel-width Dredging Area (GA waters)—Stations +9+500 to +11+500—side slope impact area of ca. 20 feet. This area was surveyed for a previous deepening project. No magnetic anomalies and/or targets were located. No further investigations are recommended.

Full-channel width Dredging Area (SC waters)—Stations +27+250 to +31+750—side slope impact area of ca. 20 feet. In 2003, an area 300 feet wide was surveyed by Savannah District contractor Panamerican Consultants, Inc., in order to identify potential impacts associated with a then-planned 76-foot-wide channel widener plus side slopes. Ten magnetic anomalies and/or targets were recommended as potentially significant. Due to project redesign, all are located over 100 feet from the revised area of potential effect.

Full-channel-width Dredging Area (SC waters)—Stations +41+500 to +49+500—side slope impact area of ca. 20 feet. This area was surveyed as part of a previous deepening project. The

survey identified four anomalies and/or targets for further evaluation. Two of the targets, SH-R15 and SH-R19N-1 were located within that project's area of potential of effect and were investigated. Both targets were found to be generated by modern debris. The remaining two anomalies/targets, SH-R16-2 and SH-R17N-1, have not been investigated. These targets will be relocated and assessed.

Full-channel-width Dredging (GA waters)—Stations +31+000 to +49+500—side slope impact area of ca. 20 feet. In 2003, an area 300 feet wide was surveyed by Savannah District contractor Panamerican Consultants, Inc., in order to identify potential impacts associated with a then-planned 76-foot-wide channel widener plus side slopes. Seven individual or clusters of anomalies and/or targets recommended as potentially significant are located within or near to the side slope impact area. Two anomalies and/or targets clusters (cluster 7C-1, 7C-9, 7C-10 and cluster 7E-6, 7E-14, 7E-18, 7E-34, 7E-53, 7E-55) were investigated by Panamerican Consultants, Inc., in 2005 and were found to be generated by modern debris. The remaining three potentially significant individual anomalies and one cluster are recommended for evaluation. Anomaly 7B-4 and anomaly cluster 7C-5, 7C-14 appear to extend into the area of potential effect and will be investigated.

Bend Widener (GA waters)—Stations +49+500 to +53+000—156-foot bottom width plus side slope of less than 75 feet. In 2003, an area 450 feet wide was surveyed by Savannah District contractor Panamerican Consultants, Inc., in order to identify potential impacts associated with this widener. In 2005, Panamerican Consultants considered diving on anomalies 7A-1 and 7A-8, but, further analysis of the fathometer data and additional remote sensing data gathered as part of that investigation found that the anomalies were located in the dredged channel bottom and were generated by modern debris. Anomaly 7A-9 would be located within the side slope of the proposed bend widener and, based on limited dated, anomalies 7A-26, 7A-28, 7A-31, and 7A-32 are located sufficiently near to the area of potential effect to warrant further investigation.

Bend Widener (SC waters)—Stations +52+250 to +55+000—76-foot bottom width plus side slope of less than 100 feet. In 2003, an area 350 feet wide was surveyed by Savannah District contractor Panamerican Consultants, Inc., in order to identify potential impacts associated with this widener. No anomalies and/or targets were recommended for further investigation. No further investigations are proposed for this bend widener.

Full-channel-width Dredging (GA waters)—Stations +63+250 to +69+000—side slope impact area of ca. 20 feet. The westernmost 1,750 feet of this area overlaps the Fig Island Turning Basin that has been previously dredged to 38 feet. The eastern portion of this area was surveyed as part of a previous deepening project. Five anomalies and/or targets were identified, none of which were recommended for additional investigation. No further investigations are recommended for this area.

Full-channel-width Dredging (GA waters)—Stations +69+000 to +71+000—side slope impact area of ca. 20 feet. In 2003, an area 500 feet wide was surveyed by Savannah District contractor Panamerican Consultants, Inc., in order to identify potential impacts associated with a then-planned 76-foot-wide channel widener plus side slopes. Four anomalies located within the

existing channel side slope (4-22, 4-24, 4-26, and 4-27) are recommended for further investigation.

Full-channel-width Dredging (GA waters)—Stations +76+000 to +77+500—side slope impact area of ca. 20 feet. In 2003, an area 150 feet wide (to the shoreline) was surveyed by Savannah District contractor Panamerican Consultants, Inc., in order to identify potential impacts associated with a then-planned 76-foot-wide channel widener plus side slopes. One anomaly (3-1) was recommended for additional investigation based on the characteristics of its magnetic signature, however, this anomaly is located at the toe of the side slope of the existing navigation channel in an area that has been dredged to 36 feet for commercial wharves. Based on the history of bottom disturbance in this area, no further investigations are recommended for this anomaly.

Full-channel-width Dredging (GA waters)—Stations +87+750 to +89+500—side slope impact area of ca. 20 feet. In 2003, an area 400 feet wide (to the shoreline) was surveyed by Savannah District contractor Panamerican Consultants, Inc., in order to identify potential impacts associated with a then-planned 76-foot-wide channel widener plus side slopes. No anomalies and/or targets located within the side slope impact area were recommended for further investigation. No further investigations are proposed for this area.

Bend Widener (GA waters)—Stations +101+000 to +103+000—128.6 feet plus side slope of less than 100 feet. This area was investigated by a Georgia Ports Authority archaeological contractor as part of studies conducted for proposed channel modifications associated with the construction of Container Berth 8. Section 106 compliance was completed as required by a Department of the Army Permit issued under the authority of Section 404 of the Clean Water Act of 1972. It has since been dredged. No further investigations are recommended for this area.

5.12.2.3 Kings Island Turning Basin Side Slopes (GA waters)—Stations 98+500 to 100+500—side slope impact area of ca. 20 feet. In 2003, an area 150 feet wide (to the shoreline) was surveyed by Savannah District contractor Panamerican Consultants, Inc., in order to identify potential impacts associated with side slope changes. No anomalies and/or targets were recommended for additional investigation. Two shoreline sites that had been identified by a previous survey and determined not to be eligible for inclusion in the National Register of Historic Places were relocated. No further investigations are recommended for this area.

5.12.2.4 Meeting Areas. The project includes construction of two meeting areas in the inner harbor. A summary of the cultural resources investigations conducted in these areas are summarized below.

GA and SC waters—Stations +55+000 to +68+500—100 feet wide plus side slope of less than 100 feet. In 2005, Savannah District contractor Panamerican Consultants, Inc., surveyed an area 400 feet wide to identify potential impacts associated with this passing lane. One previously identified resource, CSS *Georgia*, is located within this area and is discussed in the following section. The survey also identified a number of magnetic anomalies and sonar targets, six of which were selected for diver investigation. Three were found to be generated by modern harbor debris, one (GA waters) was generated by the remains of a steel-hulled sailing vessel

dating to the late nineteenth or early twentieth century, and two (SC waters) were generated by the remains of Confederate crib obstructions.

The sailing vessel has been tentatively identified as the pilot boat *Eclipse*, which burned in this general area in 1918. The vessel is potentially eligible for inclusion in the National Register of Historic Places. It is located behind (north of) the submerged remains of the original Fig Island jetty where historical documentation indicates that the bark *Undine* was also abandoned in 1893. *Undine* was built in 1867 as a clipper ship by William Pyle of Sunderland, England. Attempts were made to redesign the passing lane to avoid impacts to these resources, however, it was found that a shorter lane would not meet the needs of the larger vessels transiting the channel.

The Confederate crib obstructions, although severely degraded, are sufficiently intact for the site to be recommended as eligible for inclusion in the National Register of Historic Places at the local level for their archaeological research potential and association with significant events.

GA waters—Stations +16+000 to +20+000—100 feet wide plus side slopes of less than 100 feet. An area 100 feet wide was surveyed in 1994 for the previous channel deepening project. No potentially significant sonar targets or magnetic anomalies were located in this area. The remaining 100-foot-wide impact area associated with the construction of the proposed passing lane will be surveyed. Archival research has shown that this area of the harbor has the lowest potential for containing shipwreck remains.

5.12.2.5 Mitigation Features (GA and SC). The project includes construction of a number of mitigation features to compensate for predicted adverse environmental impacts. Construction of these features will affect wetlands, submerged river bottoms, and high ground. A summary of the cultural resource investigations in the areas proposed for construction of the various mitigation features is summarized below.

Flow Rerouting Plan 6A. This plan includes the following features, McCoy Cut diversion structure, channel deepening on McCoy Cut to -4m NGVD and Upper Middle and Little Back Rivers to -3m NGVD, allowing sediment basin to fill to -3.85M NGVD by constructing a submerged sill, close Rifle Cut, remove tide gate abutments and piers, close lower (western) arm of McCoy Cut. Because the proposed features are designed to change the hydraulics of the Middle, Little Back, and Back Rivers, the area of effect includes the construction areas as well as any areas that will be subjected to increased erosion or deposition. In order to determine the effect of the proposed plan upon historic properties, the construction areas, as well as the entire lengths of Middle, Little Back, and Back River channels and shorelines will need to be archaeologically surveyed. These surveys will include archival research, shoreline low water survey and testing, remote sensing (magnetometer and side scan sonar) surveys of submerged areas, and diver investigation of anomalies and/or targets.

One portion of Back River has been surveyed previously. In 1992, Tidewater Atlantic Research, Inc. conducted remote sensing and low water surveys of the Back River area as part of the studies required under the terms of the 1992 Programmatic Agreement (PA) for the closing of New Cut and the removal of the tide gate from operation. The survey area included the Back

River, from shore to shore, from the mouth of the sediment basin at its juncture with the Savannah Harbor navigation channel to lower end of Hog Island in Little Back River. The survey identified 31 archaeological sites. Sixteen were wrecked or abandoned vessels. One was a prehistoric archaeological site. The remaining sites were related to historic rice plantations (e.g. wharves, dikes, dams, bulkheads, canals, trunks, mills, etc.). The 1992 survey also identified 26 magnetic anomalies and/or sonar targets.

In 1993 and 1994 Savannah District archaeologists conducted archival research, archaeological survey, site monitoring, and diver investigations of sites, magnetic anomalies, and/or sonar targets in the portion of the 1992 survey area located above the tide gate. The purpose of the work was to determine the historical significance of the previously recorded resources and to assess the effect of the New Cut Closure Project upon these resources. A number of sites were determined eligible for inclusion in the National Register of Historic Places. The research concluded that the project had caused some erosion, the areas had stabilized and the extensive documentation conducted during the survey was sufficient to document the portions of the resources that were impacted. The potential impact of Plan 6a upon these resources will be evaluated.

Seven of the magnetic anomalies and/or sonar targets were located in the sediment basin area below the tide gate. More detailed evaluations of these anomalies/targets are needed to determine if they are located within the area of potential effect and their potential significance.

The remaining portions of the area of effect for Plan 6a are located within the Savannah National Wildlife Refuge. None of these areas have been previously surveyed for cultural resources.

Oxygen Injection Systems. Two areas have been proposed for construction of oxygen injection systems which would serve three oxygen injection locations. The area of effect for these systems includes the construction areas, as well as the submerged areas near the outlet pipes that would be subjected to larger increases in oxygen levels. Increases in oxygen result in increased degradation of submerged resources (e.g. wrecks, wharves, artifacts, etc.).

One system would be located on the Hutchinson Island. It would serve oxygen injection locations on both the west and east sides of Hutchinson Island. The terrestrial and submerged areas have been severely disturbed from construction of pipelines, infrastructure for existing aeration ponds, and disposal of dredged material. The second system would be above the harbor located near Georgia Power Company's Plant McIntosh. The terrestrial and submerged portions of the area of effect will be surveyed for historic properties.

Other Environmental Mitigation Features. Other proposed environmental features include: constructing a boat ramp on Hutchinson Island, constructing a fish passage at New Savannah Bluff Lock and Dam, stocking of striped bass, and restoring brackish marsh in existing Disposal Area 1S. Fish stocking will have no effect upon historic properties. The Hutchinson Island boat ramp would be located in Georgia within the area that was heavily disturbed during Tide Gate Construction and that has previously been determined to not contain historic properties. The fish passage structure would be located in South Carolina in an area believed to have been disturbed during original lock and dam construction. Savannah District will conduct archival research and an archaeological survey during the design process to verify that the entire area has been

disturbed. Disposal Area 1S (Georgia) was not surveyed prior to its use as a Savannah Harbor disposal area. While it is unlikely that any historic properties buried beneath the disposal sediments would retain sufficient integrity to be determined eligible for inclusion in the National Register of Historic Places, Savannah District will conduct archival research and coring investigations to investigate this possibility.

5.12.2.6 Fort James Jackson National Historic Landmark (Georgia)--Station 58+000 and 59+000. During the Tier I process, the public made extensive comments about potential impacts to the fort. In 2003, the fort was stabilized with sheet piling along the outside perimeter of the fort wall and along the adjacent shoreline with rock rip rap (see photographs on the following two pages). The proposed harbor deepening would have no effect upon this historic property.

5.12.2.7 CSS *Georgia* (South Carolina & Georgia waters)--Station 58+500 to 59+000. The wreck of the CSS *Georgia* is included in the National Register of Historic Places at the national level of significance for architecture, association with significant events, association with significant people, and archaeological research potential. The National Register boundary includes the channel side slope, the top of slope, and an area extending 50 feet into the authorized navigation channel. The boundary between South Carolina and Georgia runs through the wreck site. Since 1984, Savannah District has had an agreement with both states to avoid the site area during dredging by 50 horizontal feet for a distance of 1000 feet along the channel. No dredging has been conducted of any portion of the existing navigation channel located between stations +58+000 and +59+000 since 1992.

A 1992 Programmatic Agreement required Savannah District to determine past, present, and future effects of the existing Savannah Harbor Navigation Project upon this resource and to identify and evaluate alternatives to mitigate these effects. This evaluation study was conducted in 2003 in conjunction with studies to determine the incremental effect of the proposed expansion project. The studies demonstrated that past, present, and future operation and maintenance activities have, and will continue to have, an adverse effect upon the wreck site. In addition, the proposed meeting area that would be constructed as part of the expansion project would adversely affect the site. Impacts to the site would not differ with the various harbor deepening alternatives. The report of these investigations has been coordinated with the Georgia and South Carolina State Historic Preservation Offices.

The navigation channel could not be substantially deepened without crossing a major portion of the wreck site. As a result, evaluation of the deepening alternatives included an *in-situ* archeological assessment of the present condition of the CSS *Georgia*. An extensive analysis of the wreck site was performed.

Using the new information, Savannah District reviewed the status of CSS *Georgia* in 2006 and concluded that past operation and maintenance dredging had severely impacted the wreck site. The wreck had become exposed and largely destroyed by a combination of factors including different river flow patterns, new work (primarily construction of the 4-foot advance maintenance section in 1983), maintenance dredging practices, and marine organisms. The data indicated that action should be taken to ensure the remaining archaeological information possessed by the remains of the wreck is obtained before the site degrades further.

The 2007 report documenting the *in-situ* archeological evaluation included recommendations for future actions. The evaluation recommended a systematic archeological salvage operation, which would include partial and full excavation conducted by divers working from a fixed platform. In light of the condition of the wreck at that time, the best plan consists of removing the remaining wreck and conducting archeological data recovery, which includes excavating, conserving, and curating. As a result of the likely impacts of the deepening alternatives on the site, the project includes performance of an archeological salvage operation as mitigation.



Figure 5-54. Aerial view of Old Fort Jackson.



Figure 5-55. Upstream bank protection at Old Fort Jackson.

As a result of those findings, Savannah District will conduct archaeological data recovery of the *CSS Georgia* prior to or at the same time of the deepening of the navigation channel. The harbor deepening project would be responsible for final clearance of explosive ordnance prior to deepening the channel and constructing the meeting area.

Savannah District prepared a Programmatic Agreement in accordance with 36 CFR 800.14b(1)(ii) for the proposed Savannah Harbor Expansion Project, including activities at the *CSS Georgia*. Consulting parties include the Georgia and South Carolina State Historic Preservation Officers, Savannah District, and the Naval History and Heritage Command of the US Navy, the owner of the *CSS Georgia*. The Advisory Council on Historic Preservation decided it did not need to be a signatory party to the Agreement. The Catawba Nation is a concurring party. The Agreement has been signed by all parties and is included as Appendix G.

An Antiquities Permit would be required from the US Navy Naval History and Heritage Command.

5.12.3 Surveys to be Performed

The following surveys would be conducted prior to construction in compliance with all applicable cultural resources laws and regulations. The District will coordinate its findings with the SC or GA SHPO, whichever is applicable for that location in accordance with the stipulations of the PA, which is found in Appendix G.

5.12.3.1 Survey of Bar Channel Extension (Stations -75+000B to -97+680B) and Diver Investigation of Selected Anomalies/Targets in Bar Channel Extension Area and Inner Harbor. Proposed surveys include dual frequency side scan sonar, cesium magnetometer, and sub-bottom profiler survey of area 1100 feet wide and 39,000 feet long. Sonar lane spacing of 150 feet and scale of 75 meters would be required. Likewise, magnetometer lane spacing of 50 feet would also be needed. Two sub-bottom lines on full channel length plus short cross lines as needed. If needed, Phase II testing of submerged and terrestrial sites would occur in areas that cannot be avoided. Mitigation and/or protection of submerged sites would occur for sites identified as eligible for inclusion in the National Register.

5.12.3.2 Mitigation Features and Associated Lands (GA and SC). In compliance with requirements of the Clean Water Act, Savannah District is working with the US Fish and Wildlife Service, US Environmental Protection Agency, the Georgia Department of Natural Resources, the South Carolina Department of Natural Resources, and the South Carolina Department of Health and Environmental Control to mitigate for impacts to estuarine wetlands. The agencies identified properties to be used, and actions to be taken at those sites. Lands being considered include wetlands, submerged river bottoms, and high ground. Proposed surveys include dual frequency side scan sonar, cesium magnetometer, and sub-bottom profiler survey of Back River, Little Back River, and Middle River project areas. Sonar lane spacing of 100 feet and scale of 50 meters would be required. Likewise, magnetometer lane spacing of 30 feet would also be required. A sub-bottom profiler would be used as needed to define buried anomalies. Diving would also occur on selected anomalies/targets. If needed, Phase II testing of submerged and terrestrial sites would occur in areas that cannot be avoided. Mitigation and/or protection of submerged and/or terrestrial sites would occur for sites identified as eligible for inclusion in the National Register.

The mitigation plan includes the following features, McCoy Cut diversion structure, channel deepening on McCoy Cut to -4 m NGVD and Upper Middle and Little Back Rivers to -3m NGVD, constructing a submerged sill to -3.85 m NGVD at the Sediment Basin, close Rifle Cut, remove Tidegate abutments and piers, close lower (western) arm of McCoy Cut, constructing a boat ramp, and grading down a portion of Disposal Area 1S. Because the proposed features are designed to change the hydraulics of the Middle, Little Back, and Back Rivers, the area of effect includes the construction areas as well as any areas that will be subjected to increased erosion or deposition. To determine the effect of the proposed plan upon historic properties, the construction areas, as well as the entire lengths of Middle, Little Back, and Back River channels and shorelines will need to be archaeologically surveyed. These surveys will include archival

research, shoreline low water survey and testing, remote sensing (magnetometer and side scan sonar) surveys of submerged areas, and diver investigation of anomalies and/or targets.

One portion of Back River has been surveyed previously. In 1992, Tidewater Atlantic Research, Inc. conducted remote sensing and low water surveys of the Back River area as part of the studies required under the terms of the 1992 Programmatic Agreement for the closing of New Cut and the removal of the Tidegate from operation. The survey area included the Back River, from shore to shore, from the mouth of the sediment basin at its juncture with the Savannah Harbor navigation channel to lower end of Hog Island in Little Back River. The survey identified 31 archaeological sites. Sixteen were wrecked or abandoned vessels. One was a prehistoric archaeological site. The remaining sites were related to historic rice plantations (e.g. wharves, dikes, dams, bulkheads, canals, trunks, mills, etc.). The 1992 survey also identified 26 magnetic anomalies and/or sonar targets.

In 1993 and 1994, Savannah District archaeologists conducted archival research, archaeological survey, site monitoring, and diver investigations of sites, magnetic anomalies, and/or sonar targets in the portion of the 1992 survey area located above the Tidegate. The purpose of the work was to determine the historical significance of the previously recorded resources and to assess the effect of the New Cut Closure Project upon these resources. A number of sites were determined eligible for inclusion in the National Register of Historic Places, including the Pennyworth Plantation Site which is being nominated to the National Register of Historic Places. The research concluded that the project had caused some erosion, the areas had stabilized and the extensive documentation conducted during the survey was sufficient to document the portions of the resources that were impacted. The potential impact of Plan 6A upon these resources will be evaluated.

Seven of the magnetic anomalies and/or sonar targets were located in the Sediment Basin area below the Tidegate. More detailed evaluations of these anomalies/targets are needed to determine if they are located within the area of potential effect and their potential significance. Sonar lane spacing of 100 feet and scale of 50 meters would be required. Likewise, magnetometer lane spacing of 30 feet would also be required. A sub-bottom profiler would be used as needed to define buried anomalies. Diving would also occur on selected anomalies/targets. If needed, Phase II testing of submerged and terrestrial sites would occur in areas that cannot be avoided. Mitigation and/or protection of submerged and/or terrestrial sites would occur for sites identified as eligible for inclusion in the National Register.

Three injection locations (near Georgia Power's Plant McIntosh, Hutchinson Island – west, Hutchinson Island –east) have been proposed for construction of oxygenation systems. The area of effect for these systems includes the construction areas, as well as the submerged areas near the outlet pipes that would be subjected to larger increases in oxygen levels. Increases in oxygen result in increased degradation of submerged resources (e.g. wrecks, wharves, artifacts, etc.). The terrestrial and submerged portions of the area of effect will be surveyed for historic properties. Proposed surveys include dual frequency side scan sonar, cesium magnetometer, and sub-bottom profiler survey of Back River, Little Back River, and Middle River project areas. Sonar lane spacing of 100 feet and scale of 50 meters would be required. Likewise, magnetometer lane spacing of 30 feet would also be required. A sub-bottom profiler would be

used as needed to define buried anomalies. Diving would also occur on selected anomalies/targets. If needed, Phase II testing of submerged and terrestrial sites would occur in areas that cannot be avoided. Mitigation and/or protection of submerged and/or terrestrial sites would occur for sites identified as eligible for inclusion in the National Register.

5.12.3.3 Other Environmental Mitigation Features. A number of other environmental mitigation feature alternatives are being formulated. Archaeological investigations will be conducted of the selected alternatives. If any historical sites are found as a result of these additional cultural resource investigations, the Corps will avoid and/or comply with any restrictions proposed by the Georgia and South Carolina State Historic Preservation Offices

5.12.4 Consultation with Native American Tribes

The notice of availability for the 1998 draft Environmental Impact Statement for the expansion project was provided to a number of Native American Tribes. In March 2006 and November 2010, coordination letters were sent to the nineteen Federally recognized Native American Tribes who have an interest in the proposed project area informing them of the status of the project and inviting their comments. Several Tribes responded and requested that they be notified should sites with Native American components be encountered. Only the Catawba Nation requested to be added as a concurring party to the Programmatic Agreement.

5.12.5 Consultation with the Georgia and South Carolina Historic Preservation Offices

The draft Programmatic Agreement and preliminary project description were coordinated with the Georgia and South Carolina Historic Preservation Offices in March 2006. Shortly after both offices reviewed and approved the agreement, it was determined that project planning would proceed for an extended period and it was likely that large, new features would be added. It was decided to hold the document until more of the new features and their potential effect on historic properties could be identified. While the agreement document itself has not been changed, the attached supporting documentation report (this document) has been updated to reflect the final proposed project. The PA has been signed by both parties.

5.12.6 Consultation with the Advisory Council on Historic Preservation

The Advisory Council on Historic Preservation was contacted in May 2006 and asked if they wished to participate in the Programmatic Agreement. They indicated that they would not participate at that time.

5.12.7 Other Consulting Parties

In accordance with 36 CFR 800.2(c)(5), individuals or organizations with a demonstrated interest may participate as a consulting party due to the nature of their legal relation to the undertaking or affected properties. The US Navy is the owner of the CSS *Georgia*, a resource that will be adversely affected by the proposed project. The US Navy Naval History and Heritage Command reviewed the draft Programmatic Agreement and draft EIS in December 2010 and requested they be included as a consulting party to the Agreement. Their involvement is limited to advice and

comment pertaining to the mitigation of the CSS *Georgia* only. A copy of the signed agreement is found in Appendix G.

5.12.8 Public Involvement

A number of public involvement meetings have been held as part of the National Environmental Policy Act compliance activities. Two of these events included manned cultural resources information booths which informed the public about the cultural resources studies and potential impacts to these resources.

Savannah District conducted a media day and created brochures during studies of the CSS *Georgia*. A local television station ran a series of stories on the progress of the investigations, and one former reporter is creating a documentary about the vessel. District archaeologists made presentations to a large number of groups. Among them were the Society for Georgia Archaeology, local chapters of the Sons of Confederate Veterans and the United Daughters of the Confederacy, the Coastal Georgia Archaeological Society, an honors sorority, and other groups.

The 1998 draft environmental impact statement elicited 1,588 responses from individuals supporting archaeological recovery of the CSS *Georgia* and stabilization of Fort James Jackson (since completed).

5.12.9 Summary

With implementation of the Programmatic Agreement and the surveys and investigations described in the previous paragraphs, the Savannah Harbor Expansion Project would be in compliance with Section 106 of the National Historic Preservation Act, and no unacceptable adverse impacts to historic properties would occur.

5.13 Coastal Zone Management Consistency

The Corps performed an analysis of the proposed project with respect to resources under the purview of Georgia and South Carolina's programs concerning Coastal Zone Management Consistency. The analysis of Coastal Zone Management Consistency for Georgia and South Carolina can be found in Appendix I and Appendix J of the EIS, respectively. These Federal Consistency Determinations found that construction of the SHEP in conjunction with implementation of the various mitigation features was fully consistent with the Coastal Zone Management Programs of both states. The Federal Consistency Determinations were provided to each State for review during the comment period on the DEIS.

The Coastal Resources Division of the Georgia Department of Natural Resources submitted the results of their review of the Georgia Coastal Zone Management Consistency Determination by letter of January 25, 2011. The CRD of the GADNR found that in general, the proposal to deepen the Savannah Harbor is consistent with the enforceable policies of the Georgia Coastal

Zone Management Program. The CRD of the GADNR did express the following concerns/requests concerning the SHEP:

A. The CRD of the Georgia DNR supported the City of Tybee Island's concern that the new work material to be placed in the nearshore dredged material placement sites was not of beach quality and therefore unsuitable for placement in State waters. The Corps responded to this concern by eliminating the placement of new work dredged material into the nearshore sites off Tybee Island from the proposed project.

B. The CRD of the Georgia DNR expressed concern over the proposal to place dredged material into Sites 11 and 12 because of potential long-term impacts to marine habitat and commercial and recreational offshore fishing. The Corps responded to this concern by removing dredged material placement sites 11 and 12 from project plans.

C. The Georgia DNR-CRD also requested that material from the area of the entrance channel (Station -57+000B to Station -98+600B) be considered for nearshore placement or beach nourishment. While this material would be suitable for beach nourishment, such placement would require cost sharing. The Corps must use the least cost environmentally acceptable method of disposal. In this case, placement of the sediments from the entrance channel extension into the Savannah Harbor ODMDS is the least costly environmentally acceptable alternative. Placement of that sediment into nearshore areas or directly onto Tybee Beach would require a local sponsor to incur the extra costs of placing the material into those areas.

D. The Georgia DNR-CRD also requested that future maintenance dredging material from Stations -30+000B to -40+000B and Stations 28+000 to 0+000 be used for beach nourishment. These sediments would be placed in the ODMDS and the existing CDFs respectively using the least cost, environmentally acceptable method of disposal. Consequently, use of these maintenance sediments for beach nourishment would require a local sponsor who would be willing to pay the extra costs required to place the material on the beach.

The SC DHEC-OCRM provided the results of their initial review of the South Carolina Coastal Zone Management Consistency Determination by letter of January 25, 2011. The SC DHEC-OCRM did not concur that the SHEP was consistent with the South Carolina Coastal Management Plan (SCCMP). A summary of their concerns is as follows:

A. The project as proposed will not restore or enhance resources of the state but will result in a degradation of coastal resources.

B. The project as proposed will reduce dissolved oxygen, and depends on mechanical means in attempt to maintain current levels. This causes a net loss of degraded fisheries habitat.

C. The proposed dredging to deepen the Savannah Harbor as set forth in the National Economic Development (NED) Plan, 47-foot Depth Alternative, and the Locally Preferred (LP) Plan, 48-foot Depth Alternative, will reduce the dissolved oxygen levels in the Savannah River from the existing state in an area utilized for spawning of important fishery species including Striped bass and Shortnose sturgeon (SNS). Stocking of fingerlings does not eliminate impacts

to spawning and nursery areas for the Striped Bass, and the construction of a fishway does not assure the Shortnose Sturgeon will be able to use it. In the event low DO (Dissolved Oxygen) levels fall below current concentrations, as predicted in the EIS, the lower part of the river may not be passable by adult or juvenile sturgeon.

D. Models described in the EIS indicate impacts to large areas of freshwater marshlands including important habitat for fish, wading birds, and waterfowl. Mitigation for this impact is to preserve additional wetlands adjacent to the Savannah National Wildlife Refuge. Preservation does not replace the lost values and functions of the impaired freshwater marsh.

E. The project will result in a very large volume of spoils that will use significant areas within the existing spoils disposal sites, located mostly in Jasper County, resulting in a shorter life of the CDF. This may result in the need for additional wetland impacts for expansion of the CDF in Jasper County. The proposed disposal of spoils in the CDFs 14A/B will potentially eliminate the possibility of a new port in Jasper County.

F. The extent and significance of negative impacts on Geographic Areas of Concern (GAPCs). The proposed project will impact habitat for the federally endangered Shortnose sturgeon. Endangered species habitat is considered GAPC in the SCCMP. There is no certainty the sturgeon will use the proposed fishway at the New Savannah Bluff Lock and Dam or that it will have any effect on spawning or survival of this species.

G. Mitigation for impacts to Striped bass and Shortnose sturgeon is dependent on mechanical means (oxygen injection and release of fingerlings) that has not been adequately demonstrated to reduce or eliminate the impacts to water quality and fish survival.

H. The measures proposed to mitigate for the predicted increase in salinity are to close Rifle Cut and Little Back River. These alterations would result in a loss of navigable waters by the public in these two water bodies.

I. SC DHEC-OCRM policies require a demonstration of no feasible alternatives. The Federal Consistency Determination does not sufficiently demonstrate that there are no feasible alternatives.

The Corps met with SC DHEC staff and provided additional information to address their concerns. As a result of these meetings and the additional information the Corps provided, SC DHEC determined that the SHEP will comply with South Carolina water quality standards and is fully consistent with enforceable provisions of the SC CMP. The SC DHEC-OCRM removed their objection to the Corps' finding of Consistency for the SHEP. The approvals for both the South Carolina Water Quality Certification and Coastal Zone Consistency Determination are included in Appendix Z. These approvals include the following conditions:

A. The Record of Decision (ROD) will expressly recognize a binding commitment to install, operate, and maintain the DO system in accordance with the project mitigation plan, subject to Congressional appropriation of funds for the project. The Corps will make the DO system a top

priority for annual operation and maintenance (O&M) funds appropriated and received for the project, above normal maintenance requirements.

B. The Corps shall comply with all terms and conditions in the National Marine Fisheries Service Final Biological Opinion.

C. To ensure protection of cultural resources, the SC DHEC must receive an executed Programmatic Agreement for Cultural Resources signed by the COE and the South Carolina Historic Preservation Office.

D. To ensure that levels of environmental effects predicted in the EIS are not exceeded, COE will comply with the Monitoring and Adaptive Management Plan provided as Appendix D of the EIS. The Monitoring and Adaptive Management Plan will ensure the accuracy of the predicted environmental impacts, assess the effectiveness of the mitigation features, and provided for modification of the Project as needed.

5.14 Essential Fish Habitat

The Corps evaluated the project impacts on Essential Fish Habitat. The Corps believes that with the mitigation and monitoring plans in place, the proposed action is not expected to cause adverse impacts to Essential Fish Habitat or EFH species (see Section 5.07, above), including fish accessibility to habitat. Impacts are expected to be minor on an individual project and cumulative effects basis. The Essential Fish Habitat analysis is found in Appendix S of the EIS. The NMFS reviewed the SHEP EFH analysis and provided comments. The comments of the NMFS on the SHEP EFH evaluation and the Corps' responses are also included in Appendix S. The Corps intends to implement the EFH recommendations as outlined in the responses to comments contained in Appendix S.

5.15 Cumulative Impacts of the Proposed Action

The Corps performed a cumulative impacts analysis of the impacts of existing, proposed and potential projects in the Savannah area to place in better perspective the expected impacts from the Savannah Harbor Expansion Project. The cumulative impacts analysis is found in Appendix L of the EIS. A brief summary of the findings of this cumulative impact analysis is as follows:

The scoping process for the cumulative impact analysis resulted in the identification of six major resources or issues of concern in the Savannah Harbor estuary that should be evaluated in this analysis. These six resources were wetlands, fisheries, dissolved oxygen, groundwater, endangered species, and Tybee Island and the nearshore area. For each issue or resource, the cumulative impact analysis included a discussion of geographic scope, historical basis (baseline condition), past actions/stresses, present condition, present actions/stresses, capacity to withstand stress, future actions/stresses, incremental impacts, and alternatives to avoid, minimize, or mitigate cumulative effects.

The **first** major concern addressed in the SHEP cumulative impact assessment was wetlands. The wetlands analysis was divided into three parts: (1) the impounded wetlands in the Savannah National Wildlife Refuge, (2) tidal freshwater marsh, and (3) other wetland communities (brackish, salt marsh) in the Savannah Harbor estuary.

The SNWR manages about 5,700 acres of diked impoundments for waterfowl. These impoundments include about 3,000 acres of freshwater pools which include both draw down pools and permanently flooded pools. Freshwater (salinity of 0.5 ppt or less) is obtained from Lucknow Canal just off Little Back River and passed through a freshwater control system to the SNWR impoundments as well as several adjacent landowners.

The SNWR commenced operations in 1927 when the authorized depth of the Savannah Harbor Navigation Channel was 26 feet MLW. Since that time, four harbor deepening projects have occurred (1937, 1958, 1975 and 1994) which have increased the authorized depth of the project to 42 feet MLW. Additionally, the Tidegate and Sediment Basin Project was completed in 1977 which concentrated much of the sediment from the navigation channel in the Sediment Basin where it could be easily dredged and deposited into adjacent disposal areas. All of these improvements caused an upstream movement of saltwater. During the Planning stages of the Tidegate and Sediment Basin Project, it became apparent that construction of the project would increase upstream salinity levels to the point that the SNWR would not have a dependable source of freshwater. Consequently, the project included construction of a freshwater control system for the SNWR which is in use today. The authorized freshwater control system was not fully constructed, and salinity levels in the vicinity of the SNWR were higher than originally expected. The Tidegate was taken out of operation in March 1991 to reduce salinity levels in Back River and Little Back River near the SNWR. Recently, the Corps completed a major rehabilitation of the freshwater control structures located on the SNWR.

Future stresses that could affect the ability of the SNWR to obtain freshwater from the intake on Little Back River include construction of the SHEP, other harbor development projects, and sea level rise. Model studies conducted during the SHEP GRR/EIS indicate that all of the deepening alternatives evaluated would increase salinity levels in the vicinity of the intake at the SNWR without some form of mitigation. Consequently, all of the deepening alternatives evaluated during the SHEP contain flow diversion features which would increase the amount of freshwater coming down Little Back River and decrease the amount of saltwater coming up Back River. Implementation of these flow diversion measures would allow the SNWR continued access to freshwater in Little Back River.

The only other potential future harbor development project in Savannah Harbor is a proposed Jasper County Marine Terminal. Conceptual plans for this project indicate that it would be a container facility sited in what is now CDFs 14A and 14B in Savannah Harbor at about River Mile 6. If the SHEP is constructed, the deepened entrance channel and inner harbor channel would serve the needs of a Jasper facility. If the SHEP is not constructed, the developers would be required to deepen the entrance channel and inner harbor channel to the facility at River Mile 6. Deepening the inner harbor channel to River Mile 6 (compared to the SHEP which would deepen the inner harbor channel to Mile 18.6) would be expected to have only a minimal effect on the movement of saltwater to upstream areas. Consequently, construction of a Jasper County

Marine Terminal would not be expected to have adverse effects on the SNWR with respect to increased salinity levels.

Sea level rise will also cause salt water to move farther upstream and increase salinity levels in the SNWR. Model studies (assuming a 50 cm rise in sea level and average flows over 50 years) indicate that salinity levels at the SNWR intake will increase from 0.14 ppt to 0.45 ppt (10% exceedance).

The second wetland issue evaluated concerns the remaining tidal freshwater marsh located in the Savannah Harbor estuary. Freshwater tidal marsh is considered very valuable from a fish and wildlife production standpoint, and it is much rarer in the Savannah Harbor estuary when compared to saltmarsh and brackish marsh. The US Fish and Wildlife Service estimates that about 12,000 acres of tidal freshwater marsh were present in the Savannah Harbor estuary in 1854. Based on other map surveys and reports, the amount of tidal freshwater in the Savannah Harbor estuary appears to have dwindled to about 8,000 acres in 1940, and about 6,000 acres in 1974. Model studies conducted during the SHEP indicate that about 4,072 acres of tidal freshwater marsh remain in the estuary between the I-95 crossing of the Savannah River and the mouth of Back River. Most of the remaining tidal freshwater marsh is located between the I-95 crossing and the Highway 25 crossing (near the upstream limit of the Savannah Harbor Navigation Project) in the vicinity of the SNWR. The reduction of tidal freshwater marsh in the Savannah Harbor estuary can be traced to numerous factors including conversion of wetlands to rice fields, industrial and commercial development, conversion of wetland areas to dredged material disposal sites, sea level rise, and harbor deepening. While deepening the navigation channel does not destroy marsh, the resulting increase in the upstream movement of saltwater causes tidal freshwater marsh to give way to more salt tolerant types of wetland vegetation.

Future stresses that could impact the tidal freshwater marsh in the Savannah Harbor estuary include construction of the SHEP, other future harbor development projects, prolonged droughts, and sea level rise.

Model studies conducted during the SHEP revealed that all channel deepening alternatives would impact tidal freshwater marsh in the estuary due to an increase in upstream salinity levels. The flow diversion plan included in SHEP would greatly reduce this impact. However, there would still be some impacts to tidal freshwater marsh for the 45, 46, 47 and 48-foot projects ranging from 32 to 337 acres. An evaluation of the estuary revealed that there are no opportunities to restore areas or reestablish tidal freshwater marsh to mitigate for the loss of tidal freshwater marsh. Consequently, the remaining mitigation for the impacts to tidal freshwater marsh would involve the purchase and preservation of lands in the estuary that are ecologically valuable and of value to the SNWR. These lands would be purchased and given to the USFWS to be managed in perpetuity.

As previously discussed, the only other known potential future harbor development in Savannah Harbor is a proposed Jasper Terminal which would be located around River Mile 6. Development of this facility would be expected to have only a minimal effect on upstream salinity levels. Thus, construction of this facility would not directly adversely affect tidal

freshwater marsh in the estuary. The landside infrastructure needed to support the facility could result in the loss of some tidal freshwater marsh.

Prolonged droughts can also greatly impact the amount of tidal freshwater marsh in the estuary. Saltwater is able to move farther up river as the amount of freshwater entering the estuary is reduced. The result is that tidal freshwater marsh can be replaced by more salt tolerant species of plants. Over time, sea level rise will produce the same effects, as saltwater moves further into the estuary.

The third wetland issue evaluated concerns the remaining wetlands in the Savannah Harbor estuary, i.e., brackish marsh and salt marsh. Most of the brackish marsh in the estuary is located between the Highway 25 crossing (mile 21.5) and River Mile 17.0. Salt marshes are generally found downstream of River Mile 17. Most of the past impacts to these wetland types can be attributed to industrial development and use of these areas for the deposition of dredged material. Large expanses of wetlands along the banks (especially on the north side) have been diked and filled with dredged material. Loss of brackish marsh and salt marsh has been somewhat offset by conversion of freshwater marsh to brackish and salt plant species because of the upstream movement of saltwater. Estimates of salt marsh and brackish marsh in the Savannah harbor estuary developed for EPA for the Total Maximum Daily Load for Dissolved Oxygen in Savannah Harbor indicate there are about 5,903 acres of brackish marsh and approximately 23,510 acres of salt marsh in the estuary.

Future stresses that could impact the remaining salt and brackish marsh in Savannah Harbor include construction of the SHEP and other harbor development activities.

Construction of the SHEP would result in the loss of about 15.68 acres of brackish marsh. Approximately 3.0 acres of brackish marsh would be lost where excavation is required to expand the Kings Island Turning Basin, approximately 8.48 acres of brackish marsh would be excavated as a result of removal of the Tidegate Structure end walls and an additional 4.2 acres of brackish marsh would be removed due to other project excavation requirements. In keeping with the Corps' no net loss of function policy regarding wetlands, the SHEP provides in-kind mitigation for these wetland losses. The project provides for a 40.3 acre wetland restoration site in Disposal Area 1S located at about River Mile 20 which would provide more wetland compensation than is required.

Other development activities in Savannah Harbor could also adversely affect wetlands. A proposed Jasper Marine Terminal could be sited in what is now CDFs 14A and 14B, which are used for the disposal of dredged material from the Savannah Harbor Project. Based on recent conceptual plans for this facility, approximately 7.5 miles of rail infrastructure (to connect with the existing rail line) and 5.7 miles of new roadway to connect the facility to US Highway 17 would be required. Much of the area to be crossed by the new rail line and roadway is wetlands. The roadway and rail improvements would require a Section 10 and Section 404 Permit from the Charleston District Corps of Engineers Regulatory Branch.

If a Jasper County Marine Terminal is constructed in CDFs 14A (728 acres) and 14B (725 acres), the loss of sediment disposal capacity would have to be mitigated before the Federal

Government would release its dredged material disposal easements in these two areas. This could result in additional impacts to wetlands if replacement of this capacity involves construction of new disposal areas in wetlands. In view of wetland protection laws and wetland mitigation requirements, this avenue would be difficult. Construction of the landside infrastructure to support a Jasper County Marine Terminal could result in a substantial direct loss of salt and brackish marsh.

The **second** major concern addressed in the SHEP cumulative impact analysis concerned fisheries. More specifically, the Striped bass, American shad, and Southern flounder were selected as the primary species of concern.

A Striped bass sports fishery is located in the lower Savannah River. Studies in the early 1960s and 1970's indicated that the primary spawning area for Striped bass in the Savannah River system was the tidal freshwater zone located in Little Back River adjacent to the SNWR. Studies indicate that production of Striped bass eggs declined by about 95% between 1977 when the Tidegate and Sediment Basin Project became operational and 1989. Large population declines were observed in other estuaries along the east coast during that same time period. Operation of the Tidegate and Sediment Basin Project increased salinity levels in Striped bass spawning grounds and altered current velocities and pathways of water movement in the middle and lower estuary. Essentially most eggs spawned in the Savannah River estuary were transported downstream beyond Hutchinson Island into areas with toxic salinity levels within 30 to 48 hours of being spawned. Striped bass eggs hatch within 40 to 60 hours and thus larvae were exposed to toxic salinity levels before they became strong enough to swim out of the area.

The Tidegate was taken out of operation in 1991, which lowered salinity levels in traditional Striped bass spawning grounds. The Georgia DNR-WRD conducted a stocking program in the lower Savannah River from 1989-2002. Studies indicate that successful Striped bass reproduction has occurred and both GA DNR and SC DNR have reopened the recreational fishery in the estuary for Striped bass.

Populations of American shad have been severely stressed. Although many factors can be attributed to the decline of American Shad numbers, loss of traditional upriver spawning grounds and overfishing are probably the most contributing reasons. The NMFS has taken steps to reduce the fishing pressure on this species to allow populations to recover.

Populations of Southern flounder have experienced stress due to overfishing. Steps have been taken to reduce fishing pressure on the Southern flounder in some of the Atlantic coastal states which has helped the population of this species to recover.

Future harbor development projects such as the SHEP and a Jasper County Marine Terminal could have adverse impacts on fish habitat in Savannah Harbor.

Studies conducted during the SHEP indicate that the project would not affect Southern flounder and would have a negligible impact on American shad. Model studies conducted during the SHEP indicate that the project would adversely impact Striped Bass spawning, egg, and larvae habitat. Most of this impact can be attributed to an increase in salinity and a decrease in

dissolved oxygen levels that would result from the SHEP. Construction of the flow diversion measures and injection of oxygen would significantly reduce the magnitude of these impacts. However, there would still be a loss of Striped bass spawning habitat (2.9% or 30 acres), egg habitat (9.4% or 157 acres) and larvae habitat (5.6% or 32 acres) associated with the 44-foot project compared to 16.1% or 167 acres, 10.8% or 181 acres and 3.5% or 20 acres for the 48-foot project, respectively. The Fisheries Interagency Coordination Team felt that these residual impacts warranted mitigation. Consequently, the SHEP mitigation plan provides for annual funding to the Georgia DNR-WRD to stock Striped bass fingerlings in the lower Savannah River to help maintain this sports fishery.

As previously discussed, construction of a Jasper County Marine Terminal would likely have very little effect on upstream salinity levels. Consequently, construction of such a facility would not be expected to have any major impacts on upstream fish habitat. Construction of a Jasper facility could adversely affect fish habitat due to marsh impacts that might occur due to rail and road infrastructure requirements.

The **third** major concern addressed in the SHEP cumulative impact assessment was the dissolved oxygen regime in Savannah Harbor. The specific area of concern is that portion of the Savannah River between the Seaboard Coastline Railroad Bridge (Mile 27.4) and Fort Pulaski (Mile 0.0). Although water quality in the Savannah Harbor is generally good, low levels of dissolved oxygen are experienced in the summer months. Over time, the degradation of the dissolved oxygen regime in Savannah Harbor can be attributed to numerous factors including point source discharges from both industrial and municipal sources, non-point runoff, natural loading from adjacent marshes, and harbor deepening. This segment of the river failed to meet the dissolved oxygen criterion established by Georgia for a Coastal Fishing water use designation based on data collected during the summers of 1997 and 1999. Consequently, this section of the river is on the State of Georgia Section 303(d) list of impaired waters.

Future stresses that could impact dissolved oxygen levels in the harbor include construction of the SHEP, construction of a proposed Jasper County Marine Terminal and continued discharges of industrial and municipal wastewater and pollution from non-point sources.

As stated above, past harbor deepening has contributed to the low dissolved oxygen levels in Savannah Harbor. Studies conducted during the SHEP indicate that harbor deepening would adversely impact the dissolved oxygen regime in Savannah Harbor if not mitigated. Consequently, the SHEP mitigation plan includes installation and operation of an oxygen injection system in three locations to supplement dissolved oxygen levels during the summer months. Studies indicate that this system would eliminate the incremental effects of the SHEP on the dissolved oxygen regime in Savannah Harbor.

Construction of a proposed Jasper County Marine Terminal would require deepening of the inner harbor channel to about River Mile 6. Deepening of the inner harbor channel to River Mile 6 would be expected to have only minimal impacts on the dissolved oxygen regime in Savannah Harbor.

In 2010, the US EPA published a Draft Revised Total Maximum Daily Load (TDML) for dissolved oxygen in Savannah Harbor from River Mile 0.0 to Mile 27.4. The Draft TMDL is established to implement the applicable water quality standards which include the newly adopted Georgia dissolved oxygen criteria and the existing South Carolina dissolved oxygen criteria for Savannah Harbor. Implementation of this dissolved oxygen TMDL will improve water quality conditions in Savannah Harbor. The revised draft TMDL requires a reduction in loading from about 600,000 lbs/day Ultimate Oxygen Demand to about 130,000 lbs/day.

The **fourth** issue of importance addressed in the SHEP is the potential impacts of the project on groundwater resources. More specifically, it is the potential for the project to impact the principal drinking water aquifer in the coastal area – the Upper Floridan aquifer. Since the 1800s, increasing withdrawals of water from the Upper Floridan aquifer to support development in the coastal region has caused a cone of depression to form in the Savannah area and lowered the water level in the aquifer to as much as 100 feet below sea level. The long-term pumping of the Upper Floridan aquifer in the Savannah area and surrounding coastal areas has lowered groundwater levels and reversed the seaward hydraulic gradient that existed before development. Consequently, lateral encroachment is observed as the westward movement of the freshwater/saltwater interface toward the center of pumping (Savannah). Sustained pumping in the Savannah area has also resulted in a downward hydraulic gradient and induced significant head differences between the surficial aquifer and the confined Upper Floridan aquifer. This effect has resulted in the downward intrusion of water through the Miocene (protective layer over the aquifer) into the aquifer.

Future stresses to the upper Floridan aquifer center around the continued pumping of groundwater from aquifer to supply both drinking and industrial water use needs. In response to this concern, the Georgia DNR-EPD will not issue any new withdrawal permits for the upper Floridan aquifer in Chatham County as well as the southern portions of Bryan and Effingham Counties. The Georgia DNR-EPD has also reduced the total permitted volumes from pumping in Chatham County from the upper Floridan aquifer by 10 MGD.

Concerns were expressed during the SHEP studies regarding potential impacts on groundwater that could result from the dredging which would remove some of the protective layer (Miocene) of the Upper Floridan aquifer. This could enhance the movement of water through the Miocene. Since most of the water in the navigation channel is saltwater, this could increase chloride levels in the aquifer.

Several studies were conducted during SHEP to address these concerns. Construction of the current Savannah Harbor Navigation Channel has removed about 5 feet of the confining layer (Miocene) in some reaches of the channel. However, GIS analysis of confining material through time and groundwater model studies indicate that historical dredging has probably had minimal influence on the rate of saltwater intrusion. Three-dimensional model runs indicate that the expected increase in the downward flow of saline water from the area underlying the navigation channel due to deepening would be very minimal.

Information developed during the groundwater studies for the SHEP can be extrapolated and applied to construction of a proposed Jasper County Marine Terminal. Construction of this

facility (provided the scope of channel deepening is not increased) would not result in a significant increase in the movement of saltwater through the confining layer into the aquifer.

The **fifth** area of concern evaluated in the SHEP cumulative impact analysis was endangered species. More specifically, the Shortnose sturgeon was determined to be the primary species of concern in the Savannah Harbor estuary for the SHEP.

There are no estimates of the historic population size of Shortnose sturgeon from a national perspective. Likewise, the present population of Shortnose sturgeon in the Savannah River is unknown. Approximately 97,000 Shortnose sturgeon (19 % tagged) of various sizes were stocked in the Savannah River between 1984 and 1992 to evaluate the potential for Shortnose sturgeon stock enhancement. Subsequent surveys showed little evidence of reproduction. The 1999 population in the Savannah River was estimated at 3,000 fish. The fish are readily found by resource agencies when sampling is specifically targeted for them. Although the Savannah River Shortnose sturgeon population is considered to be improving since this species was placed on the endangered species list in 1967, the apparent low level of recruitment remains a concern.

The decline in Shortnose sturgeon populations can be attributed to a number of factors. Construction of mainstream dams on the Savannah River blocked access to traditional spawning grounds in shoal areas above Augusta, Georgia. Over-fishing, starting in colonial times and continuing into the 1950s also contributed to population declines of this species. Although the Shortnose sturgeon was rarely a targeted fishery, many were taken as a by-product of other fisheries such as the Atlantic surgeon and the American shad. Other factors influencing Shortnose sturgeon populations in the Savannah River include discharges of contaminants, thermal pollution and impingement on cooling water intake screens, etc.

The construction and maintenance of the Savannah Harbor Navigation Project has also impacted Shortnose sturgeon adult and juvenile habitat. The project has not affected Shortnose sturgeon spawning habitat, since their spawning habitat is located well upstream. Deepening of the Savannah Harbor Navigation Project has impacted adult and juvenile habitat because of impacts to dissolved oxygen and salinity levels. Adult Shortnose sturgeon can still be found throughout the estuary from River Mile 3.4 to 30.4. Juvenile Shortnose sturgeon are found in the upper parts of the estuary from about Mile 18.8 to Mile 29.5. From an endangered species standpoint, no critical Shortnose sturgeon habitat has been designated in the Savannah River.

Future stresses to the Shortnose sturgeon in the Savannah River center around the lack of access to traditional spawning grounds and construction of the SHEP. Studies conducted during the SHEP indicate that the project would adversely affect adult and juvenile Shortnose sturgeon winter habitat. Most of these adverse impacts center around an increase in upstream salinity levels and a decrease in dissolved oxygen levels that would result from implementation of the SHEP. Consequently, the SHEP mitigation plan includes flow diversion measures to reduce salinity levels and the injection of oxygen to increase dissolved oxygen levels. However, impacts to Shortnose sturgeon habitat would still occur for most of the channel depths evaluated even with implementation of these mitigation measures. For the 47-foot channel, approximately 6.9% (-266 acres) of Shortnose sturgeon adult winter habitat and about 7.6% (-251.0 acres) of Shortnose sturgeon juvenile winter habitat would still be impacted with the mitigation features in

place. Shortnose sturgeon adult summer habitat is expected to increase about 6.5% (+89 acres) due to the effects of oxygen injection.

Investigations revealed that there are no further measures that could be implemented in the lower Savannah River to offset the remaining effects of the SHEP on the Shortnose sturgeon. Loss of access to traditional spawning grounds in the Savannah River is one of the primary factors that has contributed to the population decline of the Shortnose sturgeon. Consequently, the remaining mitigation for the impacts of the SHEP on the Shortnose sturgeon consists of the construction of a fishway at the New Savannah Bluff Lock and Dam. The preferred design is an off-channel rock ramp. Construction of this fishway would provide Shortnose sturgeon the opportunity to move upstream around the dam thereby providing this species access to an additional 20 miles of potential spawning and foraging habitat.

Construction of the off-channel rock ramp at New Savannah Bluff Lock and Dam (NSBL&D) could provide additional benefits for Shortnose sturgeon access to traditional spawning grounds. Measures are in place to provide fish passage at two small dams above NSBL&D which are the Augusta Diversion Dam and Stevens Creek Dam. However, there is no need to implement fish passage measures at these two upstream dams unless fish passage is first provided at NSBL&D. If fish passage structures are provided at all three facilities, Shortnose sturgeon and other species of anadromous fish would have access to an additional 35 miles of potential spawning and foraging habitat in the Savannah River.

The **sixth** major concern addressed in the SHEP cumulative impact analysis is the Tybee Island Beach as well as the Tybee Shelf. The Tybee Shelf is part of a large ebb-shoal complex associated with the Savannah River inlet. Ebb shoals form as a balance of sediment that is jetted out of an inlet by offshore (ebb) currents and sediment that is returned to the inlet by onshore (flood currents) and waves. These ebb shoals are the pathway for sediment to travel around an inlet to the down-drift beach (Tybee Island).

The Corps conducted a study in 2007 to determine if the Savannah Harbor Navigation Project (mainly construction and maintenance of the entrance channel) is adversely affecting or has adversely affected the shores of Tybee Island. Based on the findings in the report, construction and maintenance of the Savannah Harbor entrance channel (including the two large jetties at the entrance) causes deflation of the Tybee Shelf, and the entrance channel serves as nearly a complete sink for any sediment moving from north to south along the shelf. The result is erosion on the north end of Tybee Island. Although some of these effects can be attributed to natural coastal processes, about 78.5% can be attributed to construction and maintenance of the entrance channel and the two large jetties at the mouth of the river.

In view of these findings, concerns were expressed that construction of the SHEP could exacerbate these effects and increase the erosion problem on the north end of Tybee Island. Additional studies were conducted which concluded that construction of the SHEP would have little impact on the shoreline of Tybee Island, the deepening would not change the overall pattern of sediment transport in the region, and the channel deepening would have negligible effect on the Tybee Shelf.

Based on the expected SHEP impacts and implementation of the project's mitigation plan, and the analysis contained in Appendix L, significant cumulative adverse impacts are not expected from the incremental impact of the SHEP when considered together with other past, present, and reasonably foreseeable future projects in the area.

5.16 Aesthetic and Recreational

The proposed action would not adversely impact any existing aesthetic values in the project area. Rifle Cut would be closed as one of the flow-altering measures in the mitigation plans. That feature would reduce salinity movement from Middle River to Back River. The cut is used by fishermen to pass between those two rivers. The amount of such use is unknown. With this blocked passageway, recreational boating access to Back River would be more difficult with implementation of the proposed depth alternatives.

The oxygen injection systems would be constructed at least 100 feet from the shoreline behind vegetation to screen their view from the river. Narrow openings would occur through the vegetation for pipe and maintenance access.

5.17 Recreational and Commercial Fishing

As indicated within Section 3.08, about 10.6 MCY of sediment excavated to deepen the ocean bar channel would be placed within the Savannah Harbor ODMS. This would not interfere with recreational or commercial fishing operations.

A boat ramp would be constructed on Hutchinson Island to mitigate for the closing of Rifle Cut. Concrete rubble from the Tidegate would be deposited in intertidal areas along the estuarine riverbanks to produce fish habitat.

No significant adverse impacts to either recreational or commercial fishing are anticipated by the proposed action.

5.18 Socio-economic Resources

The harbor deepening project is expected to reduce the cost of shipping containerized goods through the port. This is described in detail in the GRR-Economic Appendix. This should enhance the competitiveness of the businesses that transport goods through the port in that manner.

Most of the high ground areas bordering the Savannah Harbor are being used or are zoned to be used for port-related industry or as dredged sediment placement areas. The proposed action does not involve an upstream expansion of the harbor. No conflicts with existing land use plans are anticipated. SC DHEC-OCRM does not presently have a Special Area Management Plan for the Savannah River, Savannah Harbor, or Jasper County.

No adverse effects on employment, tax, and property value are expected from implementation of the proposed harbor deepening. Some temporary jobs may be available during construction.

5.19 Protection of Children and Environmental Justice

Executive Order 12898 addresses Environmental Justice in minority and low-income populations. Federal agencies are “to the greatest extent practicable and permitted by law” identify and address “as appropriate, disproportionately high and adverse human health and environmental effects of its programs, policies and activities on minority populations and low-income populations in the United States.”

Executive Order 13045 requires the Protection of Children from environmental health risks and safety risks. It states that the Federal government would review the effects of its proposed actions on children, because they may suffer disproportionately from environmental health risks and safety risks. Federal agencies are to “identify and assess environmental health risks and safety risks that may disproportionately affect children;” and “ensure that its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks.”

5.19.1 Overview

The Corps collected and analyzed information concerning the potential impact on minority populations, low-income populations, and children from the proposed Savannah Harbor Expansion Project, including demographics, proposed road improvements, and potential impacts on air quality, traffic, noise, and lighting. The information and analyses presented below demonstrate that the proposed action complies with Executive Orders 12898 and 13045 and would not cause disproportionately high and adverse impacts on minority populations, low-income populations, or children. Approval and construction of harbor deepening may benefit the environmental justice population because the project would sustain and may increase employment opportunities for minority and low-income populations in Garden City, metro-Savannah, and Jasper County.

Throughout the extensive public involvement process that began in 1999 until the release of the DEIS, representatives of the environmental justice population have not expressed concerns about the project. The project has held over 70 public meetings including meetings of the Stakeholders Evaluation Group, plus numerous committee meetings and Interim meetings. Three of those full meetings were held in Garden City within an area of concern for environmental justice issues – two meetings at the Masters Inn and one at the GPA Annex 1 located on Highway 25. Two public workshops were held at the beginning of the project (NEPA scoping) to identify issues that the public believed would be important during the course of the study. No one identified impacts to environmental justice communities or children as issues of concern. Upon release of the DEIS, several respondents, including the Keck School of Medicine and Citizens for Environmental Justice, submitted comment letters stating that the project would disproportionately impact Environmental Justice communities near Savannah Harbor. The Corps disagrees and detailed responses to their comments are included in Appendix A.

5.19.2 Demographics of Chatham County and Jasper County

The proposed project is located in Chatham County, Georgia and Jasper County, South Carolina. The City of Savannah is the largest community within Chatham County. According to US Bureau of Census 2006-2008 American Community Survey Estimates, the County has an estimated population of approximately 256,000. Minorities comprise approximately 45% of the population, most of whom are African Americans (40% of the County's population). Garden City -- where extensive existing shipping facilities are expanding to meet demand -- had a total population of approximately 11,400, of which approximately 53% were minorities (45% are African American). Port Wentworth (located northwest of the Garden City Terminal) had a population of 3,276, of which about 18% were minorities. The median household income was \$45,000 for Chatham County residents, \$33,000 for Garden City residents, and \$51,000 for Port Wentworth residents. More than 80% of Garden City residents earned less than \$75,000 per year. Section 4.13 provides additional economic information.

Hardeeville is the largest community in Jasper County. According to US Bureau of Census 2009 American Community Survey Estimates, the County has an estimated population of approximately 23,221. Minorities comprise approximately 48.4% of the population, most of whom are African Americans (46.6% of the County's population). In 2000, Hardeeville had a total population of 1,793, of which approximately 54.21% were minorities (40.83% were African American). Ridgeland, the County seat, had a population of 2,518, of which about 55.36% were minorities (49.17% are African American). The median household income was \$39,000 for Jasper County residents, \$29,000 for Hardeeville residents, and \$28,000 for Ridgeland residents.

Any individual with total income less than an amount deemed to be sufficient to purchase basic needs of food, shelter, clothing, and other essential goods and services is classified as poor. The amount of income necessary to purchase these basic needs is the poverty line or threshold and is set by the Office of Management and Budget (US Census 2010). The 2010 poverty line for an individual under 65 years of age is \$11,344. The poverty line for a three-person family with one child and two adults is \$15,030. For a family with two adults and two children the poverty line is \$22,491 (US Census 2010). A population density map for Chatham and Jasper Counties is shown in the figure below.

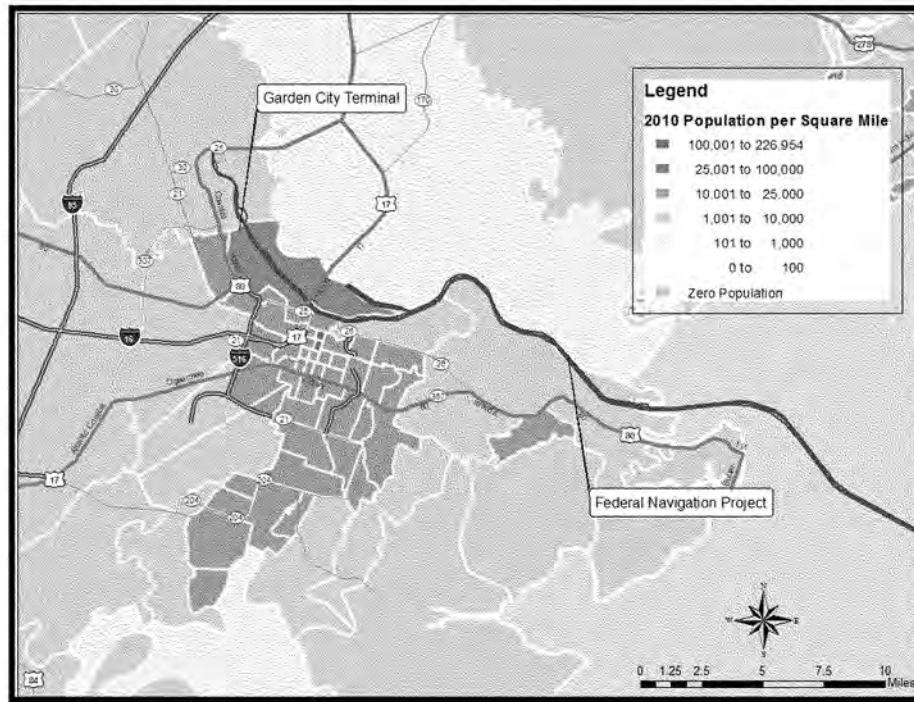


Figure 5-56. Population density map for Chatham County, GA and Jasper County, SC.

The following two figures show the location of various poverty levels within the vicinity of the upper end of the harbor, where the Garden City Terminal is located and most of the effects of the existing container terminal are experienced. The first figure shows that the closest area with the highest poverty level (40-100 percent) is located roughly a mile from the terminal. Similarly, the second figure shows the same area as being the closest one with the highest category of minorities (40-100 percent). Other areas with similar characteristics are located further away from the terminal.

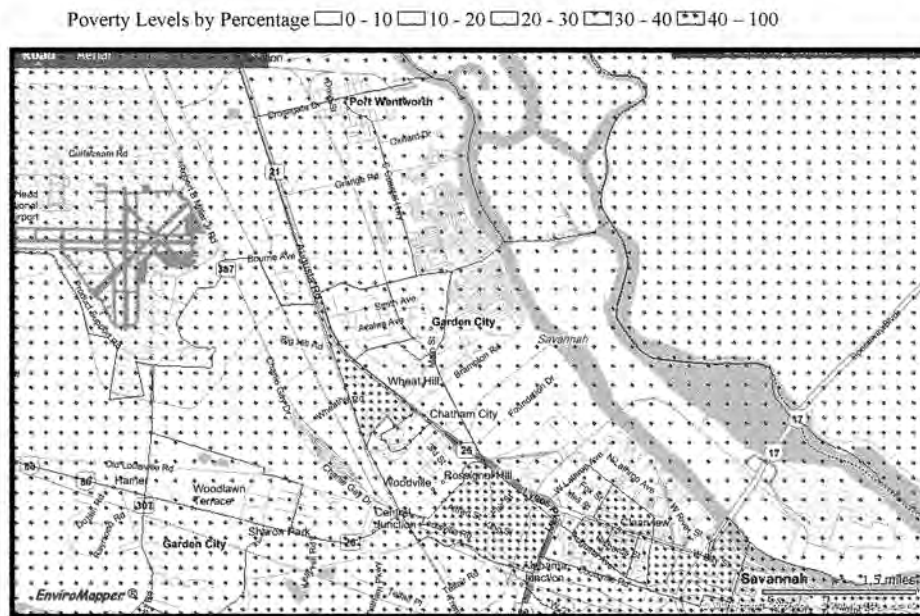


Figure 5-57. Poverty levels within the vicinity of the upper end of Savannah Harbor.

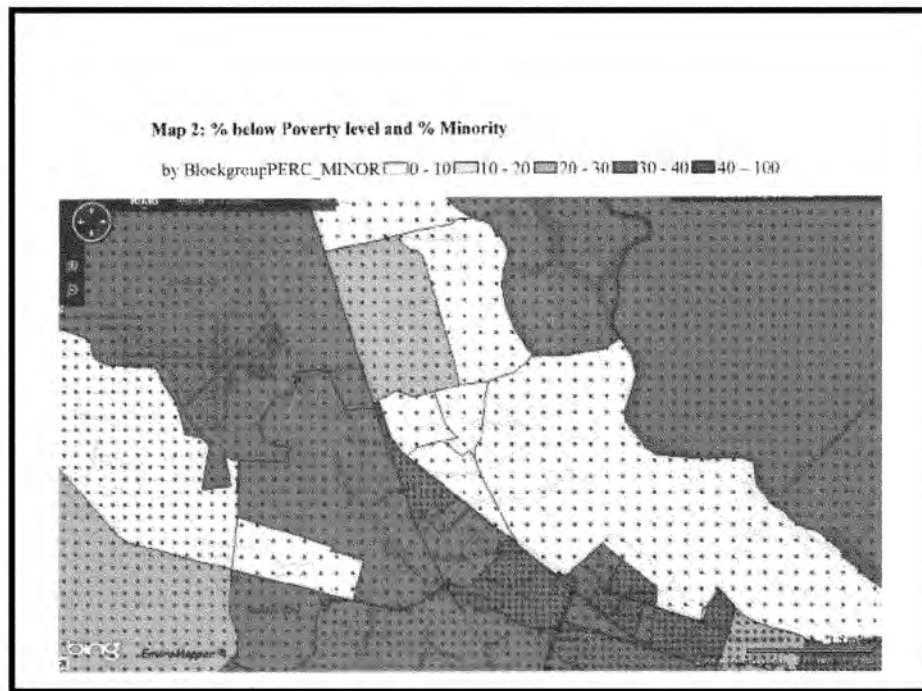


Figure 5-58. Poverty Levels within the vicinity of the upper end of Savannah Harbor.

The figure below shows the locations of schools, hospitals and child care facilities, along with the navigation channel where the majority of the construction would occur and the existing Garden City Terminal. These facilities are dispersed throughout the community and are not located disproportionately near the navigation channel of the Garden City Terminal. The proposed project includes dredging the Federal Navigation Project to accommodate larger Post-Panamax ships. The harbor deepening alternatives consist of deepening the navigation channel from the ocean past the City's Historic District to the existing Garden City Terminal. The dredging activities, including deposition of the dredged sediment, will not have significant impacts on any populations, including minority populations and low-income populations. The dredging activities would be focused in the Savannah River. Sediment deposition activities would be focused in existing CDFs in South Carolina or in the approved ODMDS. No construction activities would occur on land at the Garden City Terminal.

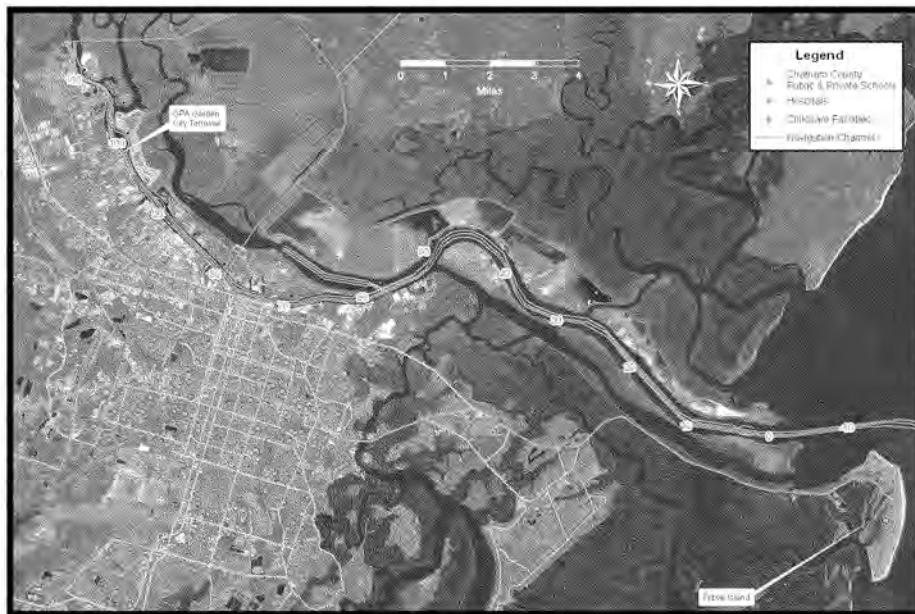


Figure 5-59. Locations of schools, hospitals and child care facilities along the navigation channel.

As summarized in Section 4.13, the area from the Atlantic Intracoastal Waterway downstream to the mouth of the Savannah River is undeveloped land. Neither the dredging activities nor the transit of larger vessels will impact local populations in this segment of the project. The area along the Georgia side of the Savannah River upstream of the mouth of the river and downstream from the City's Historic District is occupied largely by heavy industry and shipping facilities. The industrialized uses continue from Elba Island upstream beyond the Garden City Terminal. The residential area along River Street (located in the center of Savannah) contains a relatively affluent community. The section below provides a detailed discussion of the demographics of the project area and potential impacts to environmental justice communities. As a result, dredging activities and shipping activities will not have a disproportionate impact on environmental justice populations in Georgia, because they are essentially absent from the areas adjacent to the proposed construction.

The South Carolina side of the Savannah River consists of agriculture, silviculture and some recreation uses. Most of the South Carolina side of the river had been marsh, which has been converted for use as confined dredged material disposal facilities (CDFs). Such facilities extend from the Atlantic Intracoastal Waterway upstream to Highway 17 (Talmadge Bridge). The area from the Atlantic Intracoastal Waterway downstream to the mouth of the Savannah River is either CDFs or the Tybee National Wildlife Refuge. There is no residential development near the river. Some residential development has recently occurred in Jasper County on high ground in areas somewhat removed from the river. The section below provides a detailed discussion of the demographics of the project area and potential impacts to environmental justice communities. The dredging activities and shipping activities will not have a disproportionate impact on environmental justice populations in South Carolina, because they are absent from the areas adjacent to the proposed construction.

5.19.3 Demographics Analysis in the Project Area

Using 2010 and 2000 US Census data, the Corps expanded the demographics analysis to determine if there were disproportionate populations of environmental justice communities (minority, juveniles, or low-income) along the length of the navigation channel and adjacent to Garden City Terminal when compared to two base areas: surrounding towns and cities and Chatham and Jasper Counties as a whole. Data sets were collected from census.gov. Year 2000 census data was used for the low-income analyses, as 2010 data was not available at the time of publication.

For the minority and juvenile populations, the Area of Interest used for comparison was comprised of 2010 census tracts that were adjacent to the Garden City Terminal (Chatham County tracts 1, 3, 6.01, 106.01, 106.03, 106.05, 107, 116, and 9800) and the remainder of the navigation channel (Chatham County tracts 101.01, 111.07, 111.03 and Jasper County tract 9502.01).

Similar methodology was used to develop the comparison areas for the low-income analyses using year 2000 census data. As defined by OMB, the poverty level for a family of 4 was determined to be \$22,491.

The Area of Interest was compared to two Base Areas: the populations of the surrounding towns and cities (Savannah, Garden City, Port Wentworth, Pooler, and Jasper County tract 9502.01) and the populations of Chatham and Jasper Counties.

The population distributions for a given tract were added, and each demographic of interest was converted to a percentage of the total population for a given area. The percentages were then used to calculate ratios to compare the differences between the Area of Interest and the Base Areas. A ratio of 1.0 indicates that the population distributions are equal for each given area. If the resulting ratios for the Area of Interest to a given Base Area is less than 1.0, then the populations within the Area of Interest contains LESS of a percentage of a given environmental justice community when compared with the surrounding cities and/or counties. If the ratio is much greater than 1.0, then the populations within the Area of Interest contain MORE of a percentage of a given environmental justice community than the surrounding cities and/or counties. For all the comparisons completed, the ratios ranged from 0.7 to 1.2 (see figures below). Out of the six comparisons, only one of the computed ratios was greater than 1.0 (low-income families when compared to Chatham and Jasper Counties), and the ratio was still close to unity.

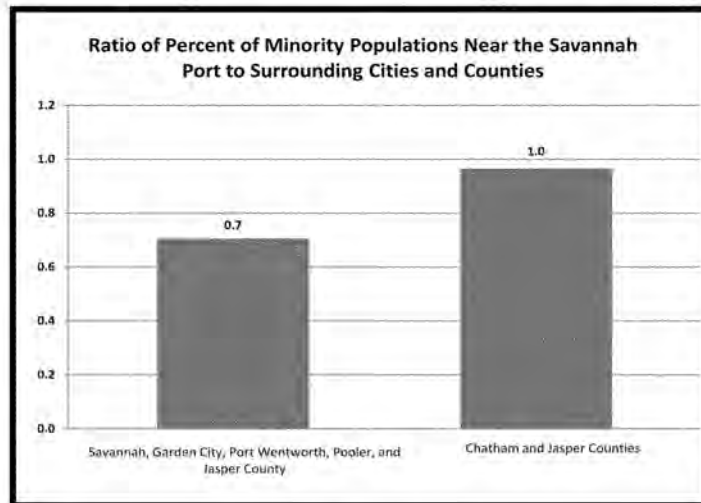


Figure 5-60. Ratio of percent of minority populations near the Savannah port to the surrounding cities and counties.

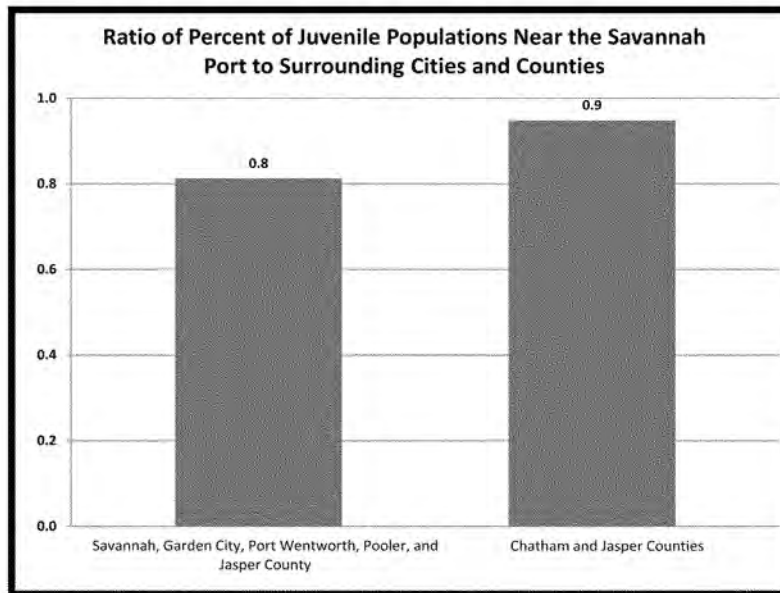


Figure 5-61. Ratio of percent of juvenile populations near the Savannah port to the surrounding cities and counties.

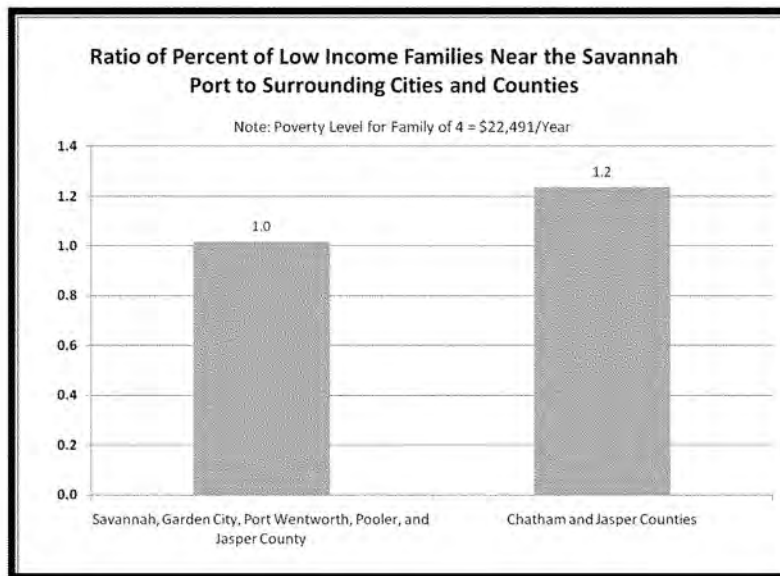


Figure 5-62. Ratio of percent of low-income families near the Savannah port to the surrounding cities and counties.

The results of the data indicate that the Area of Interest, i.e. the area potentially impacted by the project, does not contain disproportionate populations of minority, juvenile, or low-income communities when compared to the surrounding cities or counties. On the basis of the analysis described above, construction of the proposed project and port operations do not have a disproportional impact on areas of high concentration of low-income and minority populations. Nonetheless, a number of environmental justice considerations are presented below.

5.19.4 Landside Transportation of Cargo

No increases in cargo are expected to occur as a result of the proposed harbor deepening. As a result, the project would not affect the number of containers that move through the areas that surround the port. The economic benefits of the project would result from the use of larger, more cost-effective container ships, not an increase in the number of containers.

5.19.5 Terminal Infrastructure

The Garden City Terminal is located on a 1,250 acre site upstream of the Historic District of the City of Savannah. It currently is the largest container port on the East and Gulf Coasts. The terminal presently handles roughly 2.6 million TEUs per year, which are moved by either truck or rail. Truck movements predominate (82 percent) and average about 4,900 truck movements per day. The Corps expects the volume of containers handled at the Garden City Terminal to continue to increase until the terminal reaches its capacity of 6.5 million TEUs around 2032. The Economics Appendix of the GRR describes the Corps projections for cargo traffic through the port.

Cargo volumes have increased substantially in the past. In response, GPA has taken many actions to increase the efficiency of the cargo handling. They acquired larger cranes and equipment to move the containers within the terminal. They invested in newer cargo-handling equipment, which produce less air emissions. They rearranged the alignment of the container stacks to allow more efficient movement of the boxes. Expansions of the entrance/exit gates and state-of-the-art computer systems reduced the time it takes trucks to enter and leave the terminal, thereby reducing truck idling time and its associated air emissions.

The terminal now has two intermodal rail yards for two Class I carriers (Norfolk Southern and CSX) located on the property. The Garden City Terminal is the only US port terminal with two Class I rail service providers located on terminal. Approximately 18% of the cargo now moves through the terminal by rail. Since rail moves cargo with less fuel than trucks, use of rail reduces the total diesel emissions from the port operations. GPA plans to increase the percentage of containers that are handled by rail in the future.

GPA and the State have made substantial investments to increase the efficiency of cargo movement within the terminal and through the immediate surrounding areas. Although traffic volumes have increased over time, those investments have also minimized the effects of that cargo movement -- including the social and environmental effects (air quality) -- on the surrounding communities, some of which have high minority populations and high poverty levels.

GPA continues to work closely with the State of Georgia to develop more improvements to the highway system outside the terminal. GPA has developed a plan that would provide expressway connection of Interstate highways directly to the Terminal. In 2010, the State of Georgia approved \$120 million in bond revenue for use toward completing the Jimmy DeLoach Highway from Interstate 95 to the Garden City Terminal. The project entered the construction phase in December 2011, and is scheduled to be completed by the base year of the project. Additionally, the Georgia Department of Transportation's long-term highway plan includes construction of the Brampton Road Connector which will provide direct access from the Garden City Terminal to Interstate 516 and connections to Interstate 16. Once these road construction projects are completed, the GCT will have one of the best linkages to the Interstate highway system of any US port. Those road improvements are shown in the following figure. The completion of those roads will remove terminal traffic from neighborhoods and lessen congestion and the accompanying air quality impacts.

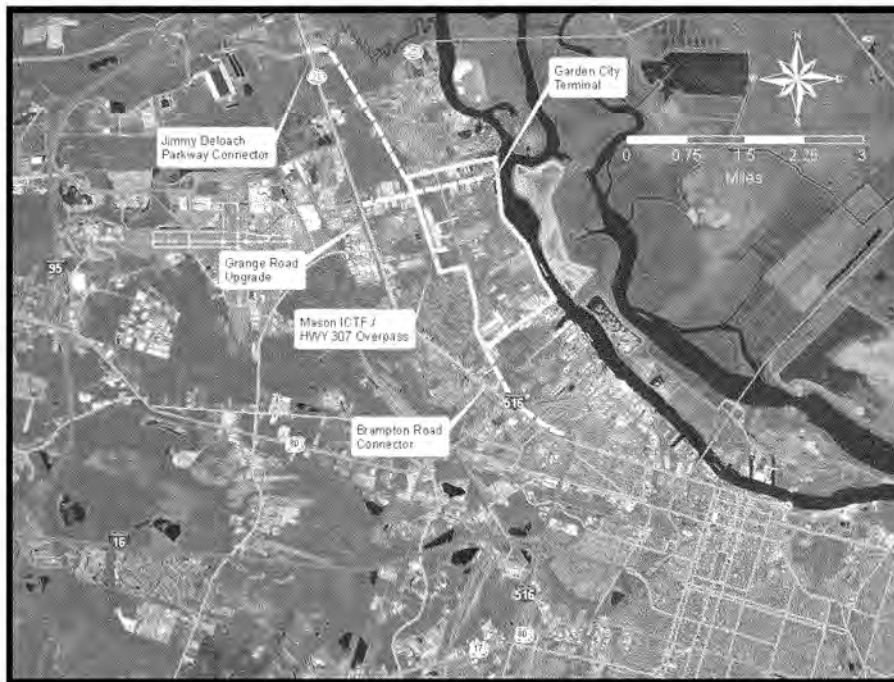


Figure 5-63. Proposed road improvements in the vicinity of Garden City Terminal.

5.19.6 Terminal Operations

GPA has programs that avoid, minimize and mitigate air quality, traffic, noise and lighting impacts on surrounding neighborhoods from operation of the Garden City Terminal. These programs are described below.

5.19.6.1 Diesel Fuel Programs. GPA continually evaluates methods to reduce diesel consumption and emissions. These actions protect the environment and the local population. Examples include the following:

- A. GPA has converted the older ship-to-shore cranes to electric and purchased new cranes that run off of electricity. Of the 23 ship to shore cranes, 21 are electric which avoids the use of 1.9 million gallons of diesel each year.
- B. The Garden City Terminal is the largest shipper of refrigerated cargo on the east coast and has installed electric refrigerated container racks which eliminate the use of diesel generators for the refrigerated containers. The use of these racks in place of generators avoids the consumption of nearly 2.4 million gallons of diesel annually.
- C. In 2010, EPA awarded GPA a Diesel Emissions Reduction Grant to repower 17 rubber tire gantry cranes (RTGs), which is one of the primary types of container handling equipment. By repowering these RTGs, GPA will avoid using 129,000 gallons annually throughout the life of the equipment. In January of 2012, the GPA board approved the purchase of four electric-powered rubber-tired gantry cranes (ERTG) which will introduce a cleaner and more efficient method of operation. GPA plans to convert all its RTGs to ERTGs by 2022.
- D. GPA recently conducted a pilot project on use of a diesel additive in the container handling equipment. The study showed that the additive reduced fuel consumption and lowered emissions. GPA now uses the additive in all container handling equipment. This avoids use of 100,000 gallons of diesel fuel annually.
- E. The Garden City Terminal has a total of 33 on-road truck container interchange lanes divided between two locations on the terminal, which have processed over 8,200 gate transactions on a single day. GPA's facility master plan includes construction of a third set of gates which would then provide access to the terminal from the east, west and south, thereby spreading out traffic and reducing waiting times at the gates. The dispersal of truck traffic reduces congestion and its accompanying air emissions. GPA expects to implement this improvement within the next 10 years.
- F. Containers are shipped by rail using the two Intermodal Container Transfer Facilities (rail yards). At those facilities, trains are built for particular destinations as far west as Chicago. This effort reduces transit times of up to 3 days and avoids central train yard switching of cars, thereby reducing emissions. Moving freight by rail emits three times less NO_x and PM than on-road trucks. With the only East Coast ICTFs located on the container terminal, GPA's on-dock rail volumes have increased 135% over the past five years (2008).
- G. During periods of heavy cargo volumes, GPA coordinates extended gate hours (earlier morning and later evening hours and Saturdays) to decrease on-road and terminal congestion. This improves productivity, reduces truck idling, and decreases diesel emissions.

- H. Forklifts of 15,500 pound capacity or smaller (86) are now fueled with LP gas, rather than diesel.

As a result of programs GPA implemented throughout the Garden City Terminal, approximately 4.5 million gallons of diesel and the associated emissions are avoided on an annual basis. While GPA has increased the total volume of containers moved, the gallons of diesel per container handled decreased 54% from FY01 to FY10.

The reduction in air emissions in the movement of cargo through the port reduces local and multi-state regional air pollution. The improved air quality benefits the thousands of personnel on GPA terminals and on neighboring industrial sites, as well as those who reside in nearby Georgia and South Carolina communities.

5.19.6.2 Noise and Lighting. The GPA currently has programs in place to avoid or reduce noise and lighting impacts on surrounding neighborhoods. The noise abatement includes construction of berms that absorb and deflect noise. GPA has reduced lighting at the facility, which conserves energy, and lessens lighting impacts on surrounding neighborhoods.

5.19.6.3 Employment. GPA directly employs approximately 950 workers, having added approximately 300 positions to service growth in cargo volumes over the last three years. Minorities comprise approximately 46% of GPA employment. To handle the projected future growth in cargo volume, the terminal is expected to need approximately 175 additional positions by 2020. The International Longshoremen Association employs workers at the terminal. The Longshoremen are represented by three local unions. Just one of the locals -- Local 1414 -- employs approximately 1,887 people, 99% which are minority. Forty percent of the members of that union reside in South Carolina. Growth is expected also in the several thousand person workforce that serves the surrounding logistics operations that handle and warehouse port cargo. The skill sets for those new positions will vary, but they should provide numerous opportunities for workers with less education. The jobs will benefit lower income populations in the metro-Savannah region. Employees working at port-related businesses are likely to reside in Garden City and throughout the metro-Savannah area.

5.19.7 Consideration of Other Terminal Locations

EIS Section 3.0 and Appendix O, and GRR Section 6.0 and Appendices A and D, describe the process the Corps used to identify and evaluate alternatives to address the navigation problems being experienced in the harbor. Both structural and non-structural methods of reducing navigation problems were considered. Potential alternative terminal locations were investigated in the South Atlantic region (other South Atlantic ports) and along the Savannah River (eight terminal locations). The proximity to major north-south and east-west highways and the support of rail are major factors that favor the Garden City Terminal over other locations along the Savannah River navigation channel. Other potential locations would require significant infrastructure projects. This would include projects that would minimize the additional traffic volumes on local roads and near neighborhoods, and to support rail transport of cargo. Sites located in Georgia south of the City's Historic District would likely result in significant increases in truck traffic on local streets in the Historic District and surrounding neighborhoods in route to

the major expressways located west of the City of Savannah. Potential air emissions and noise that would occur from increased ground transportation of cargo from the alternative downstream sites through Savannah environmental justice neighborhoods was also considered.

5.19.8 Summary of Project Effects on Environmental Justice Populations and Children

The proposed harbor deepening would not increase the number of containers moving through the port in a given year. Although the GRR Economics Appendix predicts an increase in the number of containers moving through the port over time as a result of increasing demand, that increase is expected to occur in the Without Project Condition – independent of a harbor deepening project.

According to the commodity forecast found in the GRR Economics Appendix, the port will reach its landside cargo handling capacity near 2030 when the total number of TEU's reaches 6.5 million. It is anticipated that without deepening (i.e., the -42 foot depth) more vessels would be required to transport this cargo. With deepening of the harbor to the -47 foot depth, the total number of vessels would decrease (when compared to without project conditions) as the vessels would be able to load more deeply under the improved conditions.

Since the number of containers per year is not predicted to increase as a result of deepening, no landside changes in emissions would occur as a result of the deepening. The Corps predicts a reduction in the number of vessels used to transport the number of containers predicted for each year (when compared to without project conditions) if the harbor is deepened. As a result, total air emissions would decrease in a given year if the harbor is deepened (when compared to without project conditions). Since overall air emissions in the port would decrease slightly as a result of the project (when compared to without project conditions), there is no technical need for the project to conduct a detailed analysis of how those emissions disperse. Additionally, since there would be an overall decrease in emissions (including air toxics) (when compared to without project conditions), the Corps does not expect any National Ambient Air Quality Standards (NAAQS) violations as a result of the harbor deepening. Therefore, a risk-based assessment of the health effects associated with the proposed action is not warranted. Any potential adverse effects of the presently permitted air emissions would be reduced if the harbor is deepened because of the reduction in vessels (when compared to without project conditions).

GPA is expected to continue its efforts to increase the speed of container movement through the terminal. With the State's help, GPA is also expected to continue their efforts to increase the speed of container movement through the surrounding area by improving road access to the terminal and increasing the proportion of containers handled by rail. GPA will continue their efforts to increase fuel efficiency. These actions will reduce the effects of the additional cargo on air quality and the surrounding communities. The increase in container volumes should require an increase in personnel. Since some of the work would not require specialized training, minority and low-income populations should see increases in employment.

The Corps evaluated potential project impacts of the proposed harbor deepening and found that the information shows that the proposed action would not cause disproportionately high and adverse impacts to minority populations, low-income populations, or children. Schools, hospitals and child care facilities are dispersed throughout the community and are not

disproportionately located near the navigation channel or the Garden City Terminal, so disproportionate impacts to children are not expected.

5.20 Other Items/Factors of Concern

5.20.1 Noise

The harbor area contains a mixture of industrialized areas, an urban tourist area along River Street, and a natural area in the Savannah National Wildlife Refuge. Dredging operations do not produce substantial amounts of noise, as the dredge engines are typically well within the vessel and shielded from the outside.

As discussed previously, the mitigation plan for the project includes the injection of oxygen to remove the incremental effects of the deepening on the dissolved oxygen regime in Savannah Harbor. This would require the construction and operation of three oxygen injection systems. Two would be placed on Hutchinson Island while the other system would be placed upstream near Georgia Power's Plant McIntosh. Comments received from EPA on the DEIS included concerns about operational noise levels that would be associated with operation of the oxygen injection systems. EPA requested that noise levels during operation be modeled and the anticipated seasonal schedule for operation be documented. The oxygen injection systems would be operated during the summer months when dissolved oxygen levels in Savannah Harbor are normally low.

In response to this request, the Corps prepared a noise analysis to address operation of the proposed oxygen injection facilities and their potential impacts on nearby receptors. A review of all industrial sources of noise associated with the project at both Plant McIntosh and the International Paper (Hutchinson Island) oxygen injection locations was modeled, propagated, and added to the existing estimated background noise levels to determine the level of effects.

Georgia has no state-wide noise regulations. However, both Chatham and Effingham counties maintain noise ordinances which set strict not-to-exceed noise thresholds. Table 5-50 shows the not-to-exceed sound levels per the county ordinances.

Table 5-51. Maximum Permissible Sound Levels per County Ordinances

Georgia Pacific Site - Effingham County		
Receiving Property Category	Time	Sound Level Limit (dBA)
Residential, public space, institutional, or noise sensitive area	7:00 a.m.—9:00 p.m.	60
	9:00 p.m.—7:00 a.m.	50
Commercial or business	7:00 a.m.—9:00 p.m.	70
	9:00 p.m.—7:00 a.m.	60
Industrial or manufacturing	At all times	80
International Paper Site - Chatham County		
Receiving Property Category	Time	Sound Level Limit (dBA)
Residential, public space, institutional, or noise sensitive area	7:00 a.m.—10:00 p.m.	60
	10:00 p.m.—7:00 a.m.	55
Commercial or business	All Times	65
Industrial or manufacturing	At all times	75

Sources: Effingham County, Georgia, Code of Ordinances, Part II, Chapter 30, Sections 30-43

Chatham County, Georgia, Code of Ordinances, Part II, Chapter 30, Sections 30-43

Existing sources of noise near the proposed oxygen injection sites include local road traffic, industrial activities, boating activities, high altitude aircraft overflights, and natural noises such as rushing water, leaves rustling and bird vocalizations. Existing noise levels were estimated for the proposed project site and surrounding areas using the techniques specified in the “American National Standard Quantities and Procedures for Description and Measurement of Environmental Sound Part 3: Short-term measurements with an observer present” (ANSI, 2003). Table 5-51 outlines the closest noise-sensitive areas (NSA) such as residences, schools, churches and hospitals, and the estimate existing noise levels at each location. The noise levels are shown as Day-night Sound Level (DNL) which is defined as the average sound energy in a 24-hour period with a 10-decibel penalty added to the nighttime levels (10 p.m. to 7 a.m.) and Equivalent Sound Level (Leq) which is the average sound level in decibels. There are no NSAs within 2,000 of either oxygen injection site.

Table 5-52. Estimated Background Noise Levels for Nearby Noise Sensitive Areas

Plant McIntosh Site					
Distance (Feet [Meters])	Direction	Description	DNL	L_{eq} (Daytime)	L_{eq} (Nighttime)
2,290 (700)	Northwest	Residence	55.0	53.0	47.0
2,740 (835)	Northwest	Residence	55.0	53.0	47.0
8,485 (2,590)	Southeast	Residence	45.0	43.0	37.0
15,200 (4,640)	East	Residence	45.0	43.0	37.0
International Paper Site					
Distance (Feet [Meters])	Direction	Description	DNL	L_{eq} (Daytime)	L_{eq} (Nighttime)
9,890 (3,015)	Northeast	Residence	45.0	43.0	37.0
11,880 (3,620)	East	Residence	45.0	43.0	37.0
10,870 (3,315)	West	Residence	55.0	53.0	47.0
4,875 (1,485)	Southwest	Residence	55.0	53.0	47.0

Source: ANSI, 2003.

The proposed oxygen injection systems are in the preliminary design stage and a complete equipment list and manufacturers' specifications are not available. In general, the water pumps would dominate the noise producing equipment associated with operation of the facilities. A demonstration project of the oxygen injection equipment was conducted that used four 400 horsepower pumps mounted on the barge deck. The rated decibel levels for each pump were 72-76 dB for each pump at 30 feet. It is expected that the vertical pumps planned for the permanent installations would generate approximately 65 dB for each pump (MACTEC, 2008). Noise that would be generated by operation of eight 400 horsepower pumps was estimated at 100% capacity (i.e. full load) operating 24 hours per day 7 days per week. The results are shown in Table 5-52. This represents the cumulative noise impacts of the proposed facility where the several pieces of equipment would be collocated. Sound level data for the proposed engines were derived using empirical formulas based on process and mechanical equipment data. Notably, operation of the system would only be necessary during the warmer months.

Table 5-53. Noise Levels Associated with Operation of Proposed Oxygen Injection Systems

Georgia Pacific Site							Exceeds County Noise Limits [Yes/No]
Distance (Feet [Meters])	Direction	Description	Sound Level (dBA) ¹				
			Existing DNL	Estimated Future DNL	Estimated Future L _{eq} (Daytime)	Estimated Future L _{eq} (Nighttime)	
2,290 (700)	Northwest	Residence	55.0	55.5	53.5	47.5	No
2,740 (835)	Northwest	Residence	55.0	55.3	53.3	47.3	No
8,485 (2,590)	Southeast	Residence	45.0	45.0	43.0	37.0	No
15,200 (4,640)	East	Residence	45.0	45.0	43.0	37.0	No
International Paper Site							Exceeds County Noise Limits [Yes/No]
Distance (Feet [Meters])	Direction	Description	Sound Level (dBA) ¹				
			Existing DNL	Estimated Future DNL	Estimated Future L _{eq} (Daytime)	Estimated Future L _{eq} (Nighttime)	
9,890 (3,015)	Northeast	Residence	45.0	45.0	43.0	37.0	No
11,880 (3,620)	East	Residence	45.0	45.0	43.0	37.0	No
10,870 (3,315)	West	Residence	55.0	55.0	53.0	47.0	No
4,875 (1,485)	Southwest	Residence	55.0	55.1	53.1	47.1	No

Source: Bies, 2003.

Notes: ¹ There would be no perceptible change over the existing noise environment at any noise sensitive receptor.

Operation of the oxygen injection systems would be audible to operators of the facilities, and depending on the wind conditions, to nearby areas. However, there would be no perceptible change in the overall existing noise environment at any noise receptor. The DNL would increase approximately 0.5 dBA at the nearest NSA to the Plant McIntosh site and 0.1 dBA at the nearest NSA to the International Paper site. These future levels would be for all intensive purposes identical to the existing noise conditions, and would not constitute a perceptible change in the noise environment. The noise levels would not exceed the local regulatory thresholds at either location.

5.20.2 Man-made and Natural Resources, Community Cohesion, and the Availability of Public Facilities and Services

Dredging in the Savannah Harbor navigation channels is not expected to cause significant interference with commercial and recreational boat traffic. The mobility of a hopper dredge avoids interference with regular commercial ship traffic. When a hydraulic pipeline dredge is used on the entrance channel, the pipeline from the dredge to the nearshore placement area would likely be submerged until it is close to the placement location. Regular commercial use of the harbor would not be stopped during the construction period. All dredge pipelines would be marked to let commercial and recreational boaters know of their presence. Work barges and other appurtenances associated with a pipeline dredge operating in open water would be moored in a manner to minimize interference with boat traffic in the area. Impacts to natural resources are discussed in Sections 5.01-5.09. Impacts to cultural resources are discussed in Section 5.10.

5.20.3 Climate Change

For this analysis, sea level rise and its potential effects were examined in detail and considered to be the most important factor to determine potential effects of the proposed action relating to climate change. The Corps performed impact analyses for several rates of sea level rise. The results of those analyses and their associated impacts are summarized in Sections 5.01 and 5.15 of this EIS, and Section 7.5 of the GRR. Appendix C describes the results of the detailed analyses that the Corps performed concerning various sea level rise scenarios.

The potential effects of other facets of climate change, including changes in storm frequency, intensity, and duration, are uncertain at present and the effects on a particular project site are even more unknown. Since agency agreements do not exist on the type of effects climate change may cause in this region, evaluating how those new conditions might impact the proposed project and quantifying the extent of those impacts would be difficult and speculative. The District examined literature on global warming that made specific predictions for the Savannah River Basin (Lettenmaier, 1999). The projected effects are expected to vary by the climate change scenario used and the time period being considered. As an overall summary, Lettenmaier predicts "For the Savannah system, the primary factor affecting system performance in most categories was runoff changes – both magnitude and variability." Lettenmaier states that the 2050 scenario was based on the assumption of a large incremental increase (~1,000 cfs) in required minimum flow at Augusta, to support a new raw water pumping facility. The Corps does not believe that assumption is valid. For all scenarios, runoff variability increased progressively and significantly as compared to the base case. Lettenmaier also states "M&I supply reliability was insensitive to the changes in runoff associated with the climate scenarios."

In recognition of the uncertainties in predicting future events, the Corps performed various sensitivity analyses. Those scenarios varied by resource and included evaluation of potential project impacts to dissolved oxygen and wetlands under average and drought flows; to Striped bass habitats under average, high and low river flows; and to wetlands under various amounts of sea level rise. The District consulted with the Interagency Coordination Teams to identify scenarios that the natural resource agencies believed would be required to evaluate harbor

deepening in sufficient technical depth so that they would reasonably understand the likely impacts from implementation of the project and the sensitivity of those predictions to other conditions. The Interagency Coordination Teams recommended sensitivity analyses to evaluate this project that include a sufficient range of conditions to address potential changes in conditions resulting from climate change.

5.20.4 Displacement of People, Businesses, and Farms

It is possible that land acquired for mitigation would be owned by a business or contain a residence. Since the precise properties to be acquired have not been determined at this time, but would be selected from a list previously identified by the USFWS for acquisition, the sites could contain a small number of residences. The sites could also be owned by a for-profit corporation or be run as a farm. These impacts are expected to be minimal, as <5 total properties are expected to be acquired for mitigation.

5.20.5 Community and Regional Growth

No additional cargo is expected to pass through the harbor as a result of the proposed project. Therefore, the project should have no adverse effects on community and regional growth. No increase in the growth rate of development at Tybee Island is expected as a result of the proposed action. Additional visitation to the Savannah National Wildlife Refuge could occur as a result of the expansion of the Refuge through the addition of mitigation lands. However, no increases in visitation are claimed as project benefit. No significant impacts to community and regional growth are expected from the proposed project.

5.20.6 Public Safety

As a public safety measure, boating would be prohibited near the operating construction equipment (excavation and sediment placement location). Recreational access to these areas would return to pre-construction conditions following completion of the project. Although short term impacts could occur, no long-term adverse effects are anticipated. Commercial shipping would continue in the Federal navigation channel. The Corps would provide information to the US Coast Guard so they could issue a "Notice To Mariners" prior to initiation of construction and each major change in the construction. This would make the boating public aware of the construction areas, so they could avoid those locations. The public would be excluded from landside construction areas. No significant adverse impacts to public safety are expected from the proposed project.

5.20.7 Invasive Species

As discussed in Chapter 4, the introduction of non-native or invasive species can have detrimental effects on an ecosystem. Invasive species have been introduced into new areas through the discharge of ballast water from deep-draft vessels. Increasing the amount of ballast water exchange within the port is the primary avenue through which the proposed harbor deepening could have an adverse effect on this issue. E.O. 13112, Invasive Species, charges the Federal government with not authorizing, funding, or implementing actions that it believes are likely to cause or promote the introduction or spread of invasive species in the United States or elsewhere unless, pursuant to guidelines that it has prescribed, the agency has determined and made public its determination that the benefits of such actions clearly outweigh the potential harm caused by invasive species; and that all feasible and prudent measures to minimize risk of harm will be taken in conjunction with the actions.

The proposed harbor deepening is not expected to increase the number of vessels that call at the port of Savannah. The economic analysis forecasts a decrease in the number of vessels with a deeper channel over that which would have been necessary to move the same volume of cargo through the port using a smaller fleet of vessels. Since there is no increase in the number of vessels expected to call as a result of the proposed deepening, there would be no additional risk from invasive species through ballast water. The existing risk is managed by the US Coast Guard. All vessels entering the Port of Savannah (no matter their size) will have to comply with NISA and the US Coast Guard guidelines mandated by this regulation. Failure to comply with these measures will result in civil penalties. Continued interest in this issue is appropriate, as invasive species have been shown to have large environmental effects on native US species, and exotic species have been identified at the port.

Invasive species can also enter the port as insect larvae in pallets or in soil containing seeds or plants. The increase in TEUs expected to pass through the port of Savannah would occur with or without the SHEP. Consequently, construction of the SHEP would not exacerbate the risk of invasive species entering the port in this manner.

5.21 Mitigation Planning

Mitigation planning consists of the following three major steps:

- A. Avoid Impacts
- B. Reduce Impacts
- C. Replace/Compensate for impacts that cannot be avoided or reduced

The project includes design features to avoid environmental impacts, as well as features that reduce the amount of impacts that otherwise occur.

The Corps has developed mitigation for impacts that could not be avoided or reduced further to wetlands, dissolved oxygen, Shortnose sturgeon, and Striped bass. These were discussed

previously in this EIS. The process through which the individual mitigation measures and the overall mitigation plans were developed are described in Appendix C.

The Corps has developed a Monitoring and Adaptive Management Plan to identify if the project produces adverse effects that are greater than expected and ensure the mitigation plans are successful. That plan is located in Appendix D.

The Corps believes the SHEP Mitigation Plan and Monitoring and Adaptive Management Plan provide adequate mitigation for those adverse impacts that cannot be avoided or further reduced.

5.22 Utility Crossings, Structures, and Aids to Navigation

A preliminary analysis indicates that no utilities or structures will be impacted by the proposed deepening of the harbor. The Corps contacted the US Coast Guard and they indicated that they would need to purchase and install new navigational markers for the approximately 38,000-foot extension to the existing ocean bar channel (from Stations -60+000 B to -97+680 B). If the proposed construction of the deepening project inadvertently damages any aids to navigation (i.e., existing beacons, electronic components in the lighted buoys or their hulls), the Corps would work with the Coast Guard to move, repair, and/or replace those navigational markers.

5.23 Coastal Barrier Resources Act

The Georgia-South Carolina coast is typified by coastal barrier islands located in front of expansive estuarine salt marshes, which in turn front the mainland. The barrier islands which are located within 10 miles of the harbor entrance are listed from the north as follows: **SC:** Hilton Head, Daufuskie, Turtle, Oysterbed; **GA:** Tybee, and Little Tybee. If the boundaries are expanded to 20 miles, St. Phillips Island is added in South Carolina and Wassaw Island is added in Georgia. This region is unique in its lack of commercial development of its barrier islands. Of the eight islands listed within a 20-mile radius, only two are significantly developed -- Hilton Head and Tybee Islands. Several receive special protection from the Federal government by their designation as units in the Coastal Barrier Resources Act -- St. Phillips, Daufuskie and Turtle Islands in South Carolina, and Little Tybee Island in Georgia. Turtle Island is within Unit SC-10P and Little Tybee Island is within the Unit GA-N01 of the Coastal Barrier Resources System.

Two other barrier islands are National Wildlife Refuges: Oysterbed Island in South Carolina, and Wassaw Island in Georgia. The islands also receive protection through various state laws or regulations. Turtle Island is owned by the State of South Carolina and is managed as a Wildlife Management Area. Little Tybee Island is owned by the State of Georgia and is managed as a Heritage Trust. Tomkins Island, a man-made island located in SC at the entrance to Savannah Harbor, is designated as a Heritage Trust Preserve.

Operation of the harbor has not resulted in significant adverse effects to most of these barrier islands. The southerly littoral drift essentially precludes impacts to islands located to the north. The existing Savannah Harbor Navigation Project was recently identified by ERDC as being the

cause of 79 percent of the reduction in sediment volume on the Tybee shelf and shoreline. The region's large tidal flows dominate hydraulic conditions at the inlets, so potential impacts to Tybee Island from removal of channel sediments from the nearshore sand sharing system are not easily distinguishable from other events that cause erosion at Tybee. No changes in shoreline erosion were identified after the last deepening of the harbor. No measurable adverse impacts to the Tybee Island shoreline or any nearby ocean shoreline are expected to occur from implementation of the proposed harbor deepening.

The Coastal Barrier Resources Act (CBRA) of 1982 (PL 97-348) and the Coastal Barrier Improvement Act of 1990 (PL 101-591) restrict federal expenditures in those areas comprising the Coastal Barrier Resources System (CBRS). Designated maps showing all sites included in the system in Georgia and South Carolina show Little Tybee Island (GA Unit N01) and Turtle Island (Unit SC-10P) to be within the Coastal Barrier Resource System and protected under the Coastal Barrier Improvement Act of 1990. Turtle Island, SC (Unit SC-10) is located north and Little Tybee Island (Unit GA-N01) is located southwest of the study area. Neither would be directly affected by the proposed deepening alternatives. The proposed action is in compliance with CBRA.

5.24 Hazardous and Toxic Wastes

None of the sediments that would be excavated during the proposed harbor deepening are considered to be or include hazardous or toxic wastes. Pursuant to ER 1165-2-132, dredged material and sediments beneath navigable waters proposed for dredging qualify as hazardous or toxic wastes only if they are within the boundaries of a site designated by the EPA or a state for a response action (either a removal action or a remedial action) under CERCLA, or if they are a part of a National Priority List (NPL) site under CERCLA. The Savannah Harbor has not been designated for a CERCLA (Superfund) response action nor is it listed on the NPL. Dredged material from Corps Civil Works projects is excluded from the definitions of hazardous waste, 40 CFR 261.4 (g); 33 CFR 336.1, 336.2. Potential impacts from excavating such materials would be evaluated in either a Section 404 (Clean Water Act) or Section 103 Evaluation (Marine Protection Research and Sanctuaries Act -- MPRSA).

Dredged material and sediments beneath the navigable waters proposed for dredging will be tested and evaluated for their suitability for disposal in accordance with the appropriate guidelines and criteria adopted pursuant to Section 404 of the Clean Water Act and/or Section 103 of the Marine Protection Research and Sanctuaries Act. The Corps has fulfilled the requirements for compliance with the Clean Water Act. See Section 5.02, Appendix H, and Appendix M. The Corps will provide its Section 103 Evaluation to EPA Region 4 for review and approval prior to initiating dredging.

Three rounds of sediment sampling and analysis were performed for the Savannah Harbor Expansion Project. Each round built on the results of the previous work. The second round of sampling was performed in 2005 and the analysis was completed in 2006. The conclusions from that evaluation were that the only sediment contaminant of concern for this project is naturally-occurring cadmium found in Miocene clays that would be dredged and/or exposed during

construction. The highest concentrations of cadmium (average 21.45 mg/kg) are found between Stations 16+000 and 45+000 (River Mile 3.0 to 8.5) and medium concentrations (average 6.67 mg/kg) are found between Stations 45+000 and 94+000 (River Mile 8.5 to 17.8). Even if the sediment was not naturally-occurring, the cadmium concentrations found are well below levels that would result in classification as a hazardous waste under the Resource Conservation and Recovery Act (RCRA). The environmental effects of excavating and depositing those sediments in a CDF are summarized in Section 5.08.4 and are described in detail in Appendix M.

During various inspections of the riverbanks, Savannah District staff identified areas along the river containing industrial debris and petroleum contamination. Those areas would not be affected by the proposed harbor deepening, but could serve as a source of contamination in the river.

The proposed action would not result in adverse impacts from hazardous or toxic wastes.

5.25 Summary of Environmental Consequences

The following is a summary of adverse effects which cannot be avoided should the SHEP be implemented.

5.25.1 Direct Adverse Impacts

For the purposes of this section, a project's direct adverse impact is defined as an effect on the environment in the project area that is immediately attributable to the project and caused directly by the project. With the 47-foot depth alternative, the following direct adverse impacts would occur:

- A. Loss of 15.68 acres of brackish marsh due to project excavation requirements
- B. Increase in chloride levels at the City of Savannah's water intake (municipal and industrial) during low flows and high tides
- C. Adverse impacts (salinity) to Striped Bass habitat
- D. Adverse impacts (salinity) to Shortnose sturgeon habitat
- E. Minor increase in saltwater intrusion into the aquifer
- F. Temporary, localized dredging and disposal impacts on water quality, benthic communities, etc. during construction
- G. Conversion of 223 acres (after mitigation) of tidal freshwater marsh to brackish marsh
- H. Conversion of 740 acres (after mitigation) of saltmarsh to brackish marsh
- I. Adverse impacts to the remains of the CSS *Georgia*

5.25.2 Indirect Adverse Impacts

For the purposes of this section, an indirect impact of a project can be defined as an effect on the environment in the project area that is not immediately attributable to the project but is caused indirectly by the project. In the case of SHEP, deepening the existing harbor could cause an increase in vessel calls in Savannah Harbor, and an increase in goods moving through Savannah harbor which in turn could lead to the need for more and larger facilities to handle the increased

vessel traffic and cargo. SHEP economic studies indicate that the growth of cargo moving through the Port of Savannah will occur with or without the project. Consequently, the construction of support facilities (warehouses, distribution centers, etc.) associated with this growth in cargo will continue regardless of harbor deepening. Construction of the SHEP would increase efficiency for both the existing vessels that call at the port as well as the larger vessels expected in the future. Construction of the SHEP is expected to actually decrease the number of vessels calling at the Port of Savannah as the larger vessels replace the smaller, aging vessels.

5.25.3 The Relationship Between Short-term Uses of Man's Environment and the Maintenance and Enhancement of Long-term Productivity

5.25.3.1 Wetlands. Construction of the SHEP would result in the excavation of 15.68 acres of brackish marsh regardless of which channel depth is selected. These wetlands would be permanently lost. However, mitigation for this loss involves the restoration of estuarine emergent wetlands that have been adversely impacted by the past deposition of dredged material. Approximately 40.3 acres of brackish marsh would be restored in Disposal Area 1S in Savannah Harbor to compensate for this loss. Approximately 28.8 acres of this marsh restoration would be required as mitigation for SHEP impacts while the remaining 11.5 acres of restored marsh could be used for any additional wetland mitigation requirements of either the SHEP or operation and maintenance requirements associated with the Savannah Harbor Navigation Project. Consequently, there would be no net loss of wetlands (actually a net gain in brackish marsh).

Construction of the 47-foot alternative would result in the conversion of 223 acres of tidal freshwater marsh to brackish marsh and 740 acres of saltmarsh to brackish marsh. Once the 47-foot channel is constructed, it will likely be maintained at that depth for an extremely long period of time. Consequently, the conversion of freshwater tidal marsh and saltmarsh to brackish marsh is a long-term impact. However, it should be noted that while this marsh conversion will change some of the plant species in these marshes, they would remain as functioning wetlands in the Savannah Harbor estuary.

5.25.3.2 Biological Resources. Construction of the proposed 47-foot project would result in some short term impacts to fish and wildlife resources especially during the construction process. Long-term impacts to fish and wildlife resources would occur in regards to the loss of Striped bass spawning, egg and larval habitat in the Savannah Harbor estuary due to the increase in upstream salinity levels and decrease in dissolved oxygen that would be caused by construction of the project. Since there are no known actions that could totally ameliorate this impact, the project provides funds to increase the stocking rate of this species in the Savannah River. Although this impact could be removed by not maintaining the 47-foot channel, it can be assumed that the channel would be maintained on an annual basis if it is constructed.

5.25.3.3 Endangered Species. Long-term impacts (increase in salinity) to Shortnose sturgeon foraging habitat in the upper Savannah Harbor estuary would result from construction of the project. However, based on findings in their BO, the NMFS believes that the Shortnose sturgeon will adjust by moving to upstream foraging habitat not impacted by the project. However, they cautioned that this may take a few years until the habitat has stabilized. They also believe that construction of the fish passage structure at New Savannah Bluff Lock and Dam

would satisfactorily compensate for those impacts and may increase the long-term spawning success of the Shortnose sturgeon.

Impacts to Loggerhead and Kemp's ridley sea turtles are expected to occur during construction of the SHEP because of anticipated takes during hopper dredging of the entrance channel. The NMFS predicts up to 16 Loggerhead and 11 Kemp's ridley sea turtles may be lost when the entrance channel is deepened. However, based on their knowledge of these species current populations and reproduction traits, they do not anticipate any long-term adverse effects to the recovery goals for these two species.

5.25.3.4 Chloride Levels at the City of Savannah's Water Intake on Abercorn Creek.

Construction of the project would increase chloride levels at the City of Savannah's water intake on Abercorn Creek during periods of low flows in the Savannah River and high tides. The project's mitigation plan includes the construction of a raw water storage impoundment that would allow the City to store water for use during periods of high chloride spikes.

5.25.4 Possible Conflicts Between the Proposed Action and the Objectives of Federal, Regional, State, and Local Land Use Plans, Policies and Controls for the Area Concerned

The SHEP involves deepening an existing Federal Navigation Channel. The dredged material would be placed in the existing CDFs in Savannah Harbor or the ODMDS. The proposed project does not conflict with current uses of the harbor area or land use plans.

Without mitigation, the proposed project would conflict with the objectives of the Savannah National Wildlife Refuge because construction of the project would increase salinity levels in the upper estuary in the vicinity of the Refuge. The main mission of the Savannah National Wildlife Refuge is to provide feeding and freshwater resting habitat for migratory waterfowl. Maintenance of freshwater habitat in their impoundments requires that they have access to freshwater (0.5 ppt) at their water intake off Little Back River. The SHEP mitigation plan includes the diversion of freshwater into Back River, which will maintain acceptable salinity concentrations at that intake. As a result, with mitigation, the project does not conflict with the USFWS's objective of providing freshwater habitats for migratory waterfowl.

The proposed project without mitigation would also conflict with the objective of the US Environmental Protection Agency to improve dissolved oxygen levels in Savannah Harbor, because construction of the project would lower dissolved oxygen concentrations in the harbor. Dissolved oxygen concentrations are low during the summer months in Savannah Harbor. EPA issued a revised TMDL for Savannah Harbor providing for a reduction in Ultimate Oxygen Demand from about 600,000 pounds a day to 130,000 pounds per day. The SHEP mitigation plan includes the construction and operation of three oxygen injection systems. Operation of these systems during the summer months would remove the incremental impacts of the SHEP on the dissolved oxygen regime in Savannah Harbor. As a result, with mitigation, the project does not conflict with EPA's objective of improving dissolved oxygen levels in the harbor.

Conceptual plans have been developed for a Jasper County Marine Terminal (container port) to be located in what is now CDF 14A and 14B (about River Mile 6). Some of the comments

received on the SHEP DEIS expressed concern that use of CDF 14A and 14B for deposition of dredged material from construction of the SHEP would conflict with that proposed project. On the contrary, the engineering consultant retained by the SC and GA Port Authorities to pursue development of a terminal stated in March 2011 that placement of sediment into CDF 14A and/or 14B would provide much of the fill that would be required should a terminal be constructed at those sites. That consultant also stated that a deeper channel (such as is proposed in SHEP) would be required for a Jasper County Marine Terminal to be successful. As a result, the SHEP would not conflict with the potential development of a new container terminal in Jasper County.

5.25.5 Irreversible and Irretrievable Commitment of Resources

An irreversible commitment of resources refers to the use of resources that are either non-renewable or recoverable. In the case of SHEP, examples of such resources include the fossil fuels that would be required to run the equipment to construct the project and the loss of biological resources (fish, other marine and aquatic life that would be incurred during construction). The loss of biological resources during construction would be mainly confined to the immediate construction area, which is the entrance channel, inner harbor channel and the areas where the various mitigation features would be constructed. Although difficult, restoration of the 15.68 acres of brackish marsh that would be excavated as part of the project could be performed. Therefore, that impact is not considered irreversible. Similarly, the expected impacts to Shortnose sturgeon and Striped bass habitat are not considered irreversible commitments of resources because those habitats could be recovered by allowing the deepened harbor to shoal in to its present depths.

An irretrievable commitment of resources is the loss of use of a renewable resource. The conversion of 223 acres of tidal freshwater wetlands and 740 acres of saltmarsh to brackish marsh are not considered to be irretrievable commitments of resources. Although these marsh habitats would undergo a change in plant species, these marshes would remain as fully functioning wetland systems in the Savannah Harbor estuary.

5.25.6 Energy Requirements and Conservation Potential of Various Alternatives and Mitigation Measures

Energy requirements for the proposed project would include fuel for the dredges, labor transportation, and other construction equipment. The flow-altering components of the mitigation plans would be relatively self-sustaining and not require yearly maintenance activities. Annual maintenance is expected to be needed at the fish bypass at the New Savannah Bluff Lock and Dam. That maintenance is expected to consist of removing woody debris from the fish bypass.

Electrical energy would be consumed during operation of the oxygen injection systems that are part of each depth alternative's mitigation plan. That requirement would be substantial, but would not require addition of any new electrical generating facility. Using 10 Speece cones operating 110 days per year, the yearly energy demand would be 5,487,000 KwHr/year. Using records published for the average residential electrical use in Georgia in 2008 (1,148

KwHr/month), the electrical demand of the oxygen injection systems is roughly equivalent to that of 1,320 additional homes during the 110 day operating period. With a cost of \$0.09/kwHr, the annual cost for electricity would be \$494,000.

No other project feature would produce a substantial effect on energy requirements or conservation.

The SHEP would allow the larger Post-Panamax vessels to use the harbor more efficiently in the future. These larger ships carry more cargo than the older, smaller vessels that they will eventually replace. Consequently, the Corps predicts that less ships will call at Savannah with the 47-foot channel, when compared to the Without Project Condition. The newer, larger vessels are also mandated to have more efficient engines. Therefore, construction of the 47-foot channel in conjunction with fewer and more efficient vessels calling on the Port Of Savannah may reduce energy requirements associated with port operations.

5.25.7 Natural or Depletable Resource Requirements and Conservation Potential

The sediments to be excavated to deepen the Navigation Project are a depletable resource associated with the proposed project. Fuel used by the construction equipment is a natural resource that would be consumed. Fuel used by the equipment required to maintain the harbor and its mitigation features is also a natural resource that would be consumed. Impacts to wetlands, fish and water quality have been discussed previously in this EIS. The electrical energy that would be used to operate the oxygen systems would be substantial, but the demand would continue over several months, so it could be provided by the fuels that the power company uses to generate its base loads. The use of these natural and/or depletable resources is not considered an unacceptable adverse impact of proposed project.

5.25.8 Urban Quality, Historic and Cultural Resources, and the Design of the Built Environment

Urban areas abutting the Savannah Harbor project include the cities of Tybee Island, Savannah and Garden City. The Corps evaluated potential impacts of the proposed harbor deepening and concluded that the proposed action would not cause disproportionately high and adverse impacts to minority populations, low-income populations, or children. Schools, hospitals and child care facilities are dispersed throughout the community and are not disproportionately located near the navigation channel or the Garden City Terminal, so disproportionate impacts to children are not expected.

The Corps also evaluated potential project impacts on cultural and historic resources, including sites on the National Register of Historic Places such as the Fort James Jackson National Historic Landmark, the Confederate ironclad CSS *Georgia*, the Savannah National Historic Landmark District, and the Fort Pulaski National Monument. These four resources are located in or along the Savannah River, with its existing Federal Navigation Project. With implementation of the Programmatic Agreement and completion of the surveys and investigations described in the EIS, the SHEP would be in compliance with Section 106 of the National Historic Preservation Act, and no unacceptable adverse impacts to historic properties would occur.

5.25.9 Selected Means to Mitigate Adverse Environmental Impacts

The mitigation plan includes the following components:

- A. Restoration of 40.3 acres of brackish marsh at Disposal Area 1S
- B. Construction of flow rerouting features at McCoy's Cut, Rifle Cut, Middle and Little Back Rivers, and the Sediment Basin
- C. Removal of the Tidegate
- D. Construction of an oxygen injection system
- E. Construction of a raw water storage impoundment
- F. Restoration of access for Shortnose sturgeon and other anadromous fish species to historic spawning areas at the Augusta Shoals through construction of a fish bypass at the New Savannah Bluff Lock and Dam
- G. Increase in the number of Striped bass fingerlings stocked in the estuary
- H. Recovery and preservation of the remains of the CSS *Georgia*
- I. Construction of a public boat ramp on Hutchinson Island

5.26 Construction Sequencing

A simplified construction schedule is shown below in Figure 5-64. The sequence of construction events includes consideration of the environmental impacts of the project, conditions of the NMFS Biological Opinion, the Georgia and South Carolina water quality certification, and other applicable environmental, cultural, and hydraulic factors. A summary of the conditions considered are listed below.

- A. Environmental
 - 1. Construction of McCoy Cut diversion structure must occur between May 15 and November 1.
 - 2. No hopper dredging conducted in the entrance channel between April 1 and 14 December.
 - 3. No inner harbor dredging conducted upstream of Station +63 between April 1 and May 15.
 - 4. CSS *Georgia* must be removed prior to dredging in that area (Stations 58+500 to 59+000).
 - 5. Small dredge must be used to construct broad berm at mouth of sediment basin.
 - 6. Mechanical dredge must be used for deepening the McCoy Cut/Middle/Little Back River areas.
 - 7. Cadmium-laden sediments should be distributed evenly across the CDF (14A and or 14B). Sediments must be maintained in a wet condition until capped and tested.
 - 8. Hutchinson Island oxygen injection system must be operational prior to commencement of dredging in the inner harbor.
 - 9. Plant McIntosh oxygen injection system must be operational no later than one year after commencement of dredging in the inner harbor.
 - 10. Real estate acquisition process for fish bypass must commence prior to/concurrent with start of entrance channel dredging.

11. Construction of fish bypass must start prior to/concurrent with start on inner harbor dredging and be operational within two years after construction start date.
12. No downstream in-water work conducted near fish bypass between February 1 and May 31.
13. No blasting at Tidegate will be conducted without agency coordination.
14. Striped bass payment made prior to commencement of dredging.

B. Hydraulic

1. Construction of raw water storage impoundment prior to construction of the McCoy Cut diversion structure.
2. Construction of sediment basin sill and broad berm prior to removal of Tidegate.
3. Construction of plug at the lower arm near McCoy Cut prior to construction of diversion structure.
4. Rock fill at Rifle Cut, lower western arm of McCoy Cut, and sediment basin sill could be concurrent.
5. Construction of boat ramp should occur prior to closure of Rifle Cut.

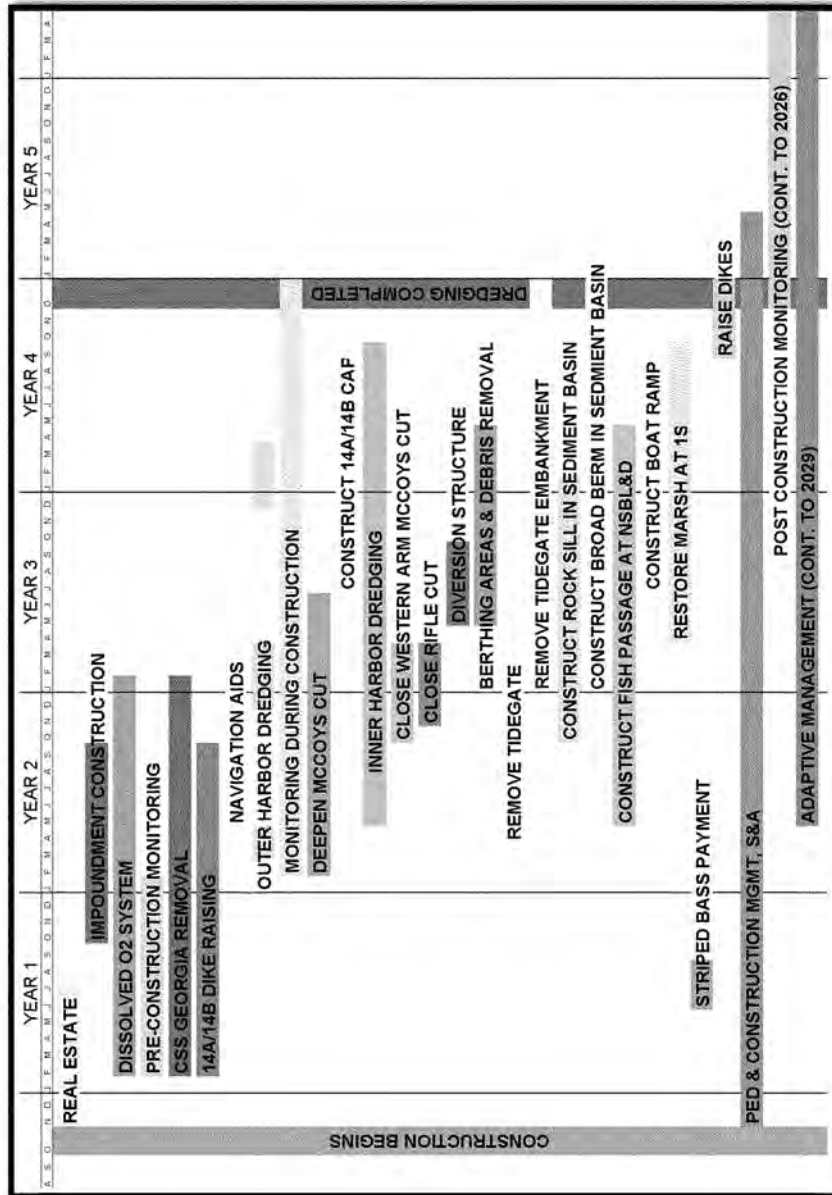


Figure 5-64. Sequence of construction for the Selected Plan.

6.00 COMPLIANCE WITH ENVIRONMENTAL REQUIREMENTS

Compliance with the following environmental laws, Executive Orders, regulations, etc. would be required for all alternative channel deepening plans under consideration (note: this is not necessarily an exhaustive list of all applicable environmental requirements).

6.01 National Environmental Policy Act of 1969 (NEPA), as amended, 42 U.S.C. 4321 *et seq.*

The Environmental Impact Statement (EIS), including all appendices and studies, and the General Re-Evaluation Report (GRR), with its appendices and studies, fulfill all requirements of the National Environmental Policy Act for the SHEP.

6.02 Clean Water Act (CWA), as amended, 33 U.S.C. 1251 *et seq.*

6.02.1 Water Quality Certification

The Corps has obtained water quality certifications from the States of Georgia and South Carolina pursuant to the Clean Water Act (CWA) for the discharge of dredged or fill material into navigable waters by the proposed activity. The GA DNR-EPD issued Georgia's water quality certification for the SHEP, with various conditions, on February 16, 2011. A copy of the Georgia water quality certification is included in Appendix Z of this document. On November 15, 2011, the South Carolina DHEC Board issued water quality certification and concurrence with the Federal Consistency Determination; these documents are included in Appendix Z. The issuance of water quality certification by the South Carolina DHEC Board has been challenged in various fora.

This FEIS contains sufficient information to demonstrate that the recommended plan is in compliance with the CWA and to enable the project to meet the criteria for exemption from the substantive and procedural water quality requirements under Section (§) 404(r) of the CWA. If a State water quality certification for this project, which is specifically authorized by Congress, were to be voided, revoked, reissued with improper conditions, or become a source of unreasonable delay to SHEP, the SHEP FEIS could serve as the basis for an exemption as provided for in the CWA.

A project may be exempted from substantive water quality and other legal requirements of Section 404 where sufficient information on the effects of the project is included in a project EIS which is submitted to Congress before the actual discharge of dredged or fill material for project construction and prior to either authorization of the project or an appropriation of funds for project construction (Section 404(r) of the CWA, 33 USC 1344). While, as stated above, the Corps did seek and obtain water quality certifications from Georgia and South Carolina, at the same time it has ensured that this FEIS contains sufficient information regarding water quality effects, including consideration of the Section 404(b)(1) Guidelines, to meet the EIS content requirements of Section 404(r), should that exemption be invoked.

In addition to meeting the requirements for 404(r), the FEIS can serve as part of the record on which the Secretary of the Army may elect to exercise the authority granted in Sections 404(t) and/or 511(a) of the CWA. Section 404(t) of the CWA, 33 USC 1344(t), Navigable Waters Within State Jurisdiction, contains a navigation exception which provides: "This section [CWA Section 404] shall not be construed as affecting or impairing the authority of the Secretary to maintain navigation." Section 511(a) is similar but broader and extends to any provision of the CWA. If a State water quality certification were to be voided, revoked, reissued with improper conditions, or become a source of unreasonable delay to SHEP, or in lieu of following the approval procedures for Section 404(r), the Secretary of the Army has the discretion to consider invoking the navigation exception under CWA Sections 404(t) and/or 511(a).

6.02.2 Wetlands

CWA Section 404 and related authorities such as Corps regulations at 33 C.F.R. 336(c)(4) and 33 C.F.R. 320.4(b) require the Corps to avoid, minimize, and mitigate impacts to wetlands.

6.02.3 Section 404 (b)(1) Guidelines

All of the harbor deepening alternatives under consideration involve discharges of dredged and fill material into waters of the United States. All sites designated to receive dredged or fill material, excluding sites covered under Section 103 (MPRSA), have been evaluated using the CWA Section 404 (b)(1) Guidelines and found to be in compliance with the requirements of these guidelines. The Section 404 (b)(1) Evaluation can be found in Appendix H. The Section 404 (b)(1) Evaluation also contains a detailed practicable alternatives analysis, which fully describes and draws together the comprehensive, iterative NEPA alternatives analysis conducted for SHEP including analysis of other potential options or sites for the project, such as other South Atlantic ports and alternative terminal locations along the Savannah River.

6.03 Section 103 of the Marine Protection, Research and Sanctuaries Act of 1972 (MPRSA, also known as the Ocean Dumping Act or ODA), as amended, 33 U.S.C. 1413

This Act governs disposal of dredged material in ocean waters. Sediments dredged from Stations +4+000 to -97+680B, if determined to meet Ocean Dumping Criteria, will be placed in the Savannah ODMDS. The ODMDS will receive both new work and maintenance sediments from the entrance channel. In 2005, samples of bottom sediments from the excavation area in the existing entrance channel were tested to evaluate contaminants which may be present in new work sediment materials. No contaminants were detected at levels of concern. Those evaluations are described fully in Appendix M - Sediment Quality Evaluation. Additional sampling and testing (bioaccumulation studies) for the existing and extension of the entrance channel are in progress to confirm that the new work material complies with the Ocean Dumping Criteria and is suitable for placement in the Savannah ODMDS. The results of these analyses would be used to prepare a Section 103 Evaluation for SHEP. The Corps would provide that evaluation to EPA Region 4, accompanied by a request that they concur with the Corps' determination that the SHEP new work and future maintenance material meets the Ocean Dumping Criteria and is suitable for placement in the Savannah ODMDS.

6.04 Magnuson-Stevens Fishery Conservation and Management Act (MSA), 16 U.S.C. 1801 *et seq.*

This Act requires Federal action agencies to consult with the National Marine Fisheries Service (NMFS) if a proposed action may affect Essential Fish Habitat (EFH). The Corps evaluated potential project impacts on NMFS-managed fish species and their Essential Fish Habitats (Appendix S). As indicated in Appendix S, the proposed action would adversely impact habitat of Striped bass and the endangered Shortnose sturgeon. Mitigation is proposed for these species and detailed information regarding this matter is found in the Mitigation Plan (see Appendix C in the EIS). Pre- and post-construction monitoring of Shortnose sturgeon is also proposed (see Monitoring Plan in Appendix D of the EIS). The Corps would perform post-construction assessments of impacts to Striped bass habitats (see Monitoring Plan in Appendix D of the EIS).

Conversion of freshwater marshes to brackish marsh would require mitigation for all channel depths except the 44-foot project. Mitigation would be accomplished through flow rerouting and preservation of wetlands in the Savannah River estuary.

Excavation of approximately 15.68 acres of estuarine emergent wetlands is a requirement of all dredging depths under consideration. In-kind mitigation would be provided by restoring 28.8 acres of wetlands in Savannah Harbor. Additional restoration (11.5 acres) would be performed that would be considered advance mitigation for use by the Corps for activities on the Savannah Harbor Navigation Project. Implementation of the mitigation and monitoring plans for the SHEP would bring all channel deepening alternatives under consideration into compliance with the provisions of the MSA.

6.05 Anadromous Fish Conservation Act, 16 U.S.C. 757, *et seq.*

All channel deepening alternatives under consideration are in compliance with this Act. The SHEP provides mitigation for adverse impacts to Striped Bass and Shortnose sturgeon. Mitigation for the Shortnose sturgeon includes the construction of an off-channel rock ramp fish bypass at New Savannah Bluff Lock and Dam. This fish passage facility would provide Shortnose sturgeon access to historic spawning areas above the dam at the Augusta Shoals. This facility would likely also benefit other species of fish such as Striped bass and American shad.

6.06 Fish and Wildlife Coordination Act, 16 U.S.C. 661-666(c)

The SHEP is in compliance with this Act. The project has been fully coordinated with the US Fish and Wildlife Service and other State and Federal natural resource agencies. The USFWS provided a Draft Section 2(b) Fish and Wildlife Coordination Act Report which was used in preparation of the DEIS. The USFWS provided a Final Report after their review of the DEIS. The Final Section 2 (b) Report can be found in Appendix E, along with Corps' responses to their recommendations and positions.

6.07 Endangered Species Act, (ESA), 16 U.S.C. 1531 *et seq.*

A Biological Assessment of Threatened and Endangered Species (BATES) evaluating the potential impacts of the proposed action on endangered and threatened species and their critical habitat was prepared (Appendix B). The assessment was coordinated with the USFWS (jurisdiction over the West Indian manatee, piping plover, wood stork, and nesting sea turtles) and NMFS (jurisdiction over other protected marine and aquatic species which may occur in the project vicinity) pursuant to Section 7 of the ESA. USFWS concurred by letter on April 28, 2011 that the SHEP as conditioned is not likely to adversely affect the species under their jurisdiction (Appendix Z). In its November 4, 2011 Biological Opinion (Appendix Z), NMFS concurred with the findings of the BATES that the SHEP may affect but would not likely adversely affect leatherback sea turtles, green sea turtles, hawksbill sea turtles, North Atlantic right whales, and humpback whales. As to Kemp's ridley sea turtles, loggerhead sea turtles, Shortnose sturgeon and Atlantic sturgeon, NMFS determined that with implementation of reasonable and prudent measures the project would not jeopardize the survival and recovery of these species, and the overall effect on these species would be acceptable.

6.08 Marine Mammal Protection Act (MMPA), 16 USC 1631 *et seq.*

The MMPA prohibits the take of marine mammals including the West Indian manatee, North Atlantic right whale, humpback whale, and sperm whale. The SHEP as conditioned will comply with the MMPA as well as other authorities (*e.g.*, a separate 1997 South Atlantic Regional Biological Opinion).

6.09 Clean Air Act (CAA), as amended, 42 U.S.C. 7401 *et seq.*

All harbor deepening alternatives are in compliance with the CAA. The Corps conducted an Air Emission Inventory (Appendix K) that determined that air emissions from port operations would be less if the harbor is deepened when compared to the No Action alternative.

6.10 Safe Drinking Water Act (SDWA), as amended, 42 U.S.C. 300 *et seq.*

The SDWA is the principal federal law intended to ensure safe drinking water for the public. The SHEP with mitigation will comply with the SDWA. One mitigation feature is construction of a raw water storage impoundment to mitigate for increased chloride concentrations expected to occur during drought conditions at the City of Savannah's Abercorn Creek water supply intake.

6.11 Section 106 of the National Historic Preservation Act (NHPA), 16 U.S.C. 470 *et seq.* and the Sunken Military Craft Act, 10 U.S.C. 1401 *et seq.*

The Corps evaluated the potential for adverse impacts to archaeological or historic resources. Impacts were identified to the Confederate ironclad, CSS *Georgia*, and actions are included in the project to address those effects. Savannah District, in consultation with the Georgia and South Carolina State Historic Preservation Officers (SHPOs) and the US Navy has developed a Programmatic Agreement for the project's compliance with Section 106 of the National Historic Preservation Act and will implement that Agreement. A copy of the revised executed Agreement is found in Appendix G. Savannah District will conduct archaeological data recovery of the CSS *Georgia* prior to or at the same time that deepening of the navigation project occurs. The SHEP will clear any remaining explosive ordinance that may be in the excavation area for the proposed deepened channel and meeting areas.

The concerns expressed during public review of the Tier I EIS about bank erosion at Old Fort Jackson have been addressed. In 2003, Savannah District partnered with the Georgia Department of Natural Resources (which owns the site) to stabilize the shoreline. The proposed deepening alternatives would not adversely affect that resource.

The Manager of the Fort Pulaski National Monument expressed concern about the ongoing erosion that is occurring along portions of their river shoreline. The Corps evaluated that erosion and the potential for the proposed project to increase that erosion. The Corps determined that the erosion is the result of several factors. An increase in vessel size is not expected to substantially increase the rate of the ongoing erosion.

The proposed avoidance and mitigation measures described in the Programmatic Agreement and consultation with the consulting parties would minimize or eliminate unacceptable impacts to historic properties. Based on the foregoing, the proposed action is in compliance with Section 106 of the National Historic Preservation Act.

6.12 Executive Order 11988, Floodplain Management

Dredged sediments would be placed in existing CDFs that are located in the floodplain. The proposed action is not anticipated to induce development of the floodplain or to otherwise adversely affect any floodplain, since no land use changes are expected to result from the project. The proposed action is in compliance with the requirements of Executive Order 11988.

6.13 Executive Order 11990, Protection of Wetlands

A small amount of brackish marsh (15.68 acres) would be lost through excavation of a turning basin and two widenings. These impacts would be mitigated and monitoring will take place when the restoration is complete (see Mitigation Planning in Appendix C and the Monitoring Plan in Appendix D). With implementation of the mitigation and monitoring plans, the proposed action would be in compliance with Executive Order 11990.

6.14 Executive Order 13112, Invasive Species

This Executive Order was issued to ensure that Federal programs and activities prevent the introduction of invasive species and provide for their control and to minimize the economic, ecological, and human health impacts that invasive species cause. Based on analyses conducted during the SHEP study, implementation of the project would not increase the potential for entry of invasive species into Savannah Harbor.

6.15 Executive Order 11593, Protection and Enhancement of the Cultural Environment

As discussed in more detail, above, the Corps evaluated the potential for adverse impacts to archaeological and historic resources. Impacts were identified to the Confederate ironclad, *CSS Georgia*, and actions are included in the project to address those effects. Savannah District, in consultation with the Georgia and South Carolina SHPOs and the US Navy, developed a Programmatic Agreement. The project would comply with that Agreement. Pursuant to the conditions and restrictions of the revised executed Agreement, the proposed action is in compliance with Executive Order 11593.

6.16 Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations

The proposed action would not impact minority communities or low-income populations. The proposed deepening would occur in the Savannah Harbor navigation channel and deposition of excavated sediments would occur within existing upland CDFs or in the Savannah ODMDS. Consequently, the SHEP would not require any minority communities or low-income populations to be relocated. Since no additional cargo is expected to move through the port as a result of the deeper channel, the project would not adversely impact noise, traffic, or air quality surrounding the Garden City Terminal. In light of these factors, the proposed action is in compliance with Executive Order 12898.

6.17 Executive Order 13045, Protection of Children from Environmental Health Risks and Safety Risks

This Executive Order mandates Federal agencies to identify and assess environmental health and safety risks that may disproportionately affect children as a result of the implementation of federal policies, programs, activities, and standards. The proposed action would not impact schools or housing areas. Since no additional cargo is expected to move through the port as a result of the deeper channel, the project would not adversely impact noise, traffic, or air quality surrounding the Garden City Terminal. Therefore, there would be no short- or long-term impacts on the health and safety of children. The proposed action is in compliance with Executive Order 13045.

6.18 Migratory Bird Treaty Act, 16 U.S.C. 703 *et seq.*; Executive Order 13186, Responsibilities of Federal Agencies to Protect Migratory Birds

The Act and Executive Order require agencies to protect and conserve migratory birds and their habitats. Under the Act, nests, eggs, or individual birds cannot be taken or destroyed unless a depredation permit is obtained from the USFWS. Under the Executive Order, agencies must ensure their actions will not have a measurable negative effect on migratory bird populations. Migratory birds commonly use the seven CDFs for foraging, nesting, and roosting habitat. Some species of migratory birds nest within the Savannah Harbor CDFs and on their confining dikes. Individuals of those species could be impacted by sediment placement operations or CDF maintenance activities if those activities are conducted during the nesting season. Once a CDF is flooded, nesting sites on the floor of the area are not available, and sediment placement operations would not impact nesting migratory birds. Due to the lead time resulting from required contracting procedures, precise timing of the start of sediment placement operations or area maintenance work is generally not available. Therefore, some degree of uncertainty often exists when those activities are scheduled for use during the May to August nesting season. If nests are present when work is ready to start, three options are available: (1) delay the start of work until the young birds have left the site, (2) work in areas where no nests are located, or (3) attempt to obtain a Depredation Permit from the USFWS. Contractors will be required to comply with one of these options. With these conditions in place, the proposed action is not expected to result in any take of migratory birds or cause a measurable negative effect on migratory bird populations. With those conditions, the proposed action would also comply with both the Migratory Bird Treaty Act and Executive Order 13186.

6.19 Federal Coastal Zone Management Act (CZMA), 16 U.S.C. 1451 *et seq.*

This Act requires each Federal agency activity performed within or outside the coastal zone (including development projects) that affects land or water use, or natural resources of the coastal zone to be carried out in a manner which is consistent to the maximum extent practicable, i.e. fully consistent, with the enforceable policies of approved state management programs.

To implement the CZMA and to establish procedures for compliance with its Federal consistency provisions, the US Department of Commerce, National Oceanic and Atmospheric Administration (NOAA), promulgated regulations which are contained in 15 C.F.R. Part 930. The Corps prepared Federal Consistency Determinations for both Georgia and South Carolina's coastal zone management programs in compliance with Part 930.30 through 930.44 of those regulations and the US Army Corps of Engineers' regulations implementing the CZMA at 33 C.F.R. Parts 336-337.

6.19.1 State of Georgia Coastal Zone Management Program

NOAA approved Georgia's Coastal Management Plan (GA CMP) in 1997. It later approved a routine program change in 2005 that incorporated the provisions of Georgia HB 727 and a Memorandum of Understanding with the Corps' Savannah District on Regional Sediment Management. Since the proposed action would affect estuarine waters and wetlands within the

coastal zone, Savannah District evaluated the proposed action for its consistency with the State's CMP.

In accordance with the CZMA, it was determined that the proposed harbor deepening would be carried out in a manner which is fully consistent with the enforceable policies of the Georgia Coastal Management Program. The proposed deepening would not adversely impact any beaches or dunes in Georgia. Intertidal areas that would be impacted are associated with dredging of bend wideners, the Kings Island Turning Basin, and removal of the Tidegate. The existing upland confined sediment placement areas (CDFs) in Georgia – Areas 1N and 2A – would continue to be used. These CDFs may be used for the placement of newly excavated sediment for the proposed deepening and long-term maintenance of the deepened channel. The existing diked CDFs will not be expanded as a result of the proposed action. Both new work and maintenance sediments would be deposited in the Savannah ODMS. Impacts to the environment are fully discussed within the Federal Consistency Determination for the Georgia Coastal Zone Management Program (see Appendix I), which was submitted to the Georgia DNR Coastal Resources Division for review and concurrence as part of the review process for the DEIS. The GA DNR-CRD responses to the review of the Federal Consistency Determination for the Georgia Coastal Zone Management Program can be found in Appendix Z.

6.19.2 State of South Carolina Coastal Zone Management Program

NOAA approved South Carolina's Coastal Management Plan (SC CMP) in 1977. Since the proposed action would affect estuarine waters and adjacent wetlands, Savannah District evaluated the proposed action for its consistency with the SC CMP.

In accordance with the CZMA, it has been determined that the proposed deepening of the Federal navigation channel would be carried out in a manner that is fully consistent with the enforceable policies of the SC CMP. The proposed deepening would not adversely impact any beaches or dunes in South Carolina. Intertidal areas would be impacted by removal of the Tidegate structure abutments, closure of the western end of McCoys Cut, construction of a flow diversion structure at McCoys Cut, channel improvements in Little Back River, and construction of a submerged berm across Back River. Seven of the existing upland confined sediment placement areas (CDFs) are located in Jasper County, South Carolina. These CDFs would continue to be used for the placement of newly excavated sediment for the proposed deepening and long-term maintenance of the proposed action. The existing diked CDFs will not be expanded as a result of the proposed action. Cadmium-laden sediment would be placed and covered in CDF 14A and 14B, which are located in South Carolina. These impacts to the environment are fully discussed within the Federal Consistency Determination for the South Carolina Coastal Zone Management Program (see Appendix J) and in the Sediment Quality Evaluation (see Appendix M). There will be no unconfined placement of dredged sediment in South Carolina. The Corps would deposit both new work sediment and rock to construct the broad berm at the lower end of the Sediment Basin, to allow natural processes to later fill that basin.

The Federal Consistency Determination for South Carolina's Coastal Zone Management Program was submitted to the Office of Ocean and Coastal Resource Management in the South

Carolina Department of Health and Environmental Control for review and concurrence as part of the DEIS review process.

The SC DHEC-OCRM did not initially concur that the SHEP was consistent with the SCCMP based on concerns about the project's impacts on the dissolved oxygen regime in Savannah Harbor, to Shortnose sturgeon and Striped bass habitats, to tidal freshwater marsh and saltmarsh, and from potential impacts of dredged material placement on a site proposed for a Jasper marine terminal. The Corps met with SC DHEC staff and provided additional information to address their concerns. As a result of the joint process described in Section 6.02.1 regarding the South Carolina water quality certification, on November 15, 2011 the SC DHEC staff determined there is reasonable assurance that the SHEP is fully consistent with enforceable provisions of the SC CMP, and the SC DHEC-OCRM removed their objection to the Federal Consistency Determination for South Carolina's Coastal Zone Management Program. The SC DHEC Board's Final Agency Decision, SC DHEC's water quality certification, and the SC DHEC-OCRM letter on the project's consistency with the SC coastal management plan can be found in Appendix Z.

6.20 Resource Conservation and Recovery Act (RCRA), as amended, 42 U.S.C. 6901 *et seq.*

RCRA controls the management and disposal of hazardous waste. Dredged material from Corps civil works projects is excluded from the definition of hazardous waste under 40 CFR 261.4(g), 33 CFR 336.1 and 33 CFR 336.2.

6.21 Comprehensive Environmental Response, Compensation and Liability Act (CERCLA or Superfund), 42 U.S.C. 9601 *et seq.*

CERCLA governs the liability, compensation, cleanup, and emergency response for hazardous substances released into the environment and the cleanup of inactive hazardous substance disposal sites. As discussed in EIS Section 5.24, Hazardous and Toxic Wastes, none of the sediments that would be excavated or dredged during the project would be considered a hazardous substance under CERCLA or addressed under that law.

7.00 PUBLIC INVOLVEMENT, REVIEW AND COORDINATION

7.01 Public Involvement and Review

Substantial efforts were made to inform and listen to the public, the local community, and State and Federal resource agencies regarding the proposed harbor deepening. After the project was authorized in WRDA 1999, GPA formed the Stakeholders Evaluation Group (SEG) in 1999 to provide a public forum and to assist in identifying scientific studies and analyses that should be performed to identify and quantify environmental impacts that may result from proposed deepening of the harbor. The SEG was comprised of environmental groups, municipalities, State and Federal agencies, and private citizens. The body typically met on a bi-monthly basis and all meetings were open to the public. The SEG had as its principal charge the development of consensus amongst the participants regarding:

- A. the scope and content of the scientific investigations and analyses to be performed pursuant to the development of the Final EIS,
- B. the appropriate increment of channel depth, and the appropriate mitigation measures.

Since its inception, the SEG provided input to GPA, Federal and State agencies on all aspects of the scientific investigations, analyses, and mitigation options for the proposed action. The input from the SEG provided invaluable information for the development of the project's mitigation, monitoring and adaptive management plans. The full SEG met approximately 70 times, which does not include numerous interim and committee meetings. As part of their efforts, the SEG produced a Summary Report documenting the processes by which the group operated, a summary of its 12-year involvement with the project, and lessons learned. The SEG Summary Report is included as Appendix Y.

A Notice of Intent (NOI) to prepare an EIS for this project was filed with the USEPA on January 22, 2002. With the NOI, the public and agencies were notified that a scoping meeting would be conducted for the proposed project. On February 21, 2002, Savannah District held a scoping meeting for the proposed action at the Savannah International Trade and Convention Center. Additionally, a NEPA scoping meeting was held on April 12, 2002. Comments on these scoping meetings were received from the following:

- U.S. Fish and Wildlife Service
- National Marine Fisheries Service
- Department of Health and Human Services, Atlanta, GA
- Georgia Chapter of the Sierra Club
- Harbor Committee, Savannah Area Chamber of Commerce
- Georgians for Clean Energy, Savannah Office
- City of Savannah
- Ogeechee Audubon Society
- National Park Service, Fort Pulaski National Monument
- Coastal Heritage Society
- Southern Bulk Industries

- City of Tybee Island
- Savannah Mill
- Southern Environmental Law Center
- Historic Savannah Foundation
- Tybee Island Beach Task Force
- Sons of the Revolution in the State of Georgia
- Historic Talbotton Foundation, Inc.
- Patsiliga Museum, Inc.
- Tybee Island Historical Society
- Hyatt Regency, Savannah
- Georgia Battlefields Association, Inc
- Convention Consultants Historic Savannah Foundation
- L. Scott Barnard and Associates Architects
- International Paper, Savannah, GA
- Coastal Engineering - Olsen Associates, Inc.
- City of Savannah, Water and Sewer Bureau
- Tom Crites and Associates International, Inc.
- Private Citizens

Comments and concerns expressed in these comments and letters, as well as the SEG were used in the preparation of the DEIS.

A Notice of Availability of the DEIS was published in the Federal Register on November 15, 2010 for 45-day period and advertised in local newspapers in both Georgia and South Carolina. In response to several requests, the District extended the review and comment period an additional 15 days until January 25, 2011 to provide the agencies and the public additional time to review the document. A summary of the mailing list for the DEIS is included as Table 7-1. In addition, copies of the DEIS were made available at public libraries, and the documents were posted on the Savannah District website. A public information meeting on the project was also held at the Savannah Civic Center on December 15, 2010. Participants were provided detailed information on the project and its associated mitigation plan and provided the opportunity to ask questions and submit oral or written comments.

For the Final EIS, a Notice of Availability will be published in the Federal Register and advertised in local newspapers. The documents will be mailed to those listed in Table 7-1, and they can be provided to additional parties upon request. The Final EIS will also be made available in public libraries and on the Savannah District website.

7.01.1 Summary of Comments Received on Draft EIS and GRR

Upon distribution of the Draft EIS and GRR on November 15, 2010, the Savannah District received over 1,100 written letters, e-mails, and dictated responses from Federal and State agencies, environmental groups, civic organizations, and private citizens. The comment letters and the Corps' responses are included as Appendix A to the Final EIS.

The majority of the 684 commenters provided general statements supporting the harbor deepening project. A demographic summary of the statements of support is shown in Figure 7-1.

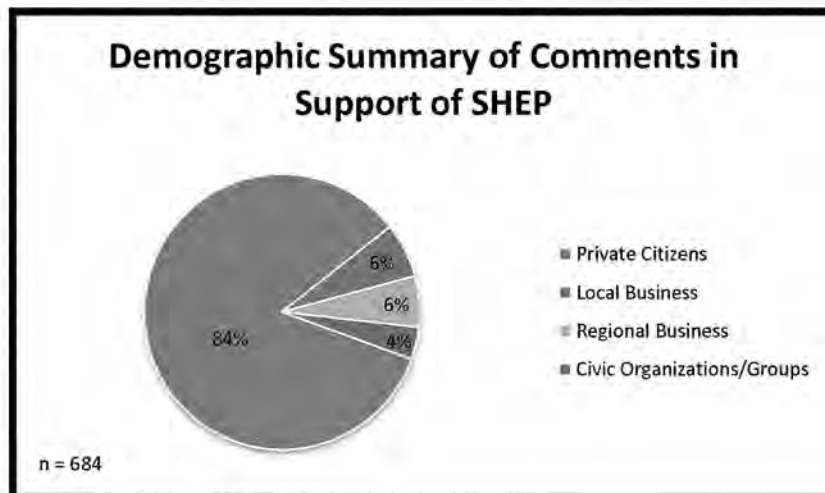


Figure 7-1. Demographic summary of comments in support of SHEP.

The remainder of the commenters submitted comments related to the environmental impacts, the economic analyses, and engineering studies associated with the proposed project. The comments contained in the letters were generally grouped into three broad categories (despite some overlap) as follows: Environmental (1,247), Economics (356), and Engineering (258). A summary of the comments by subject area including the 684 comments in support of the project is shown in the following figure:

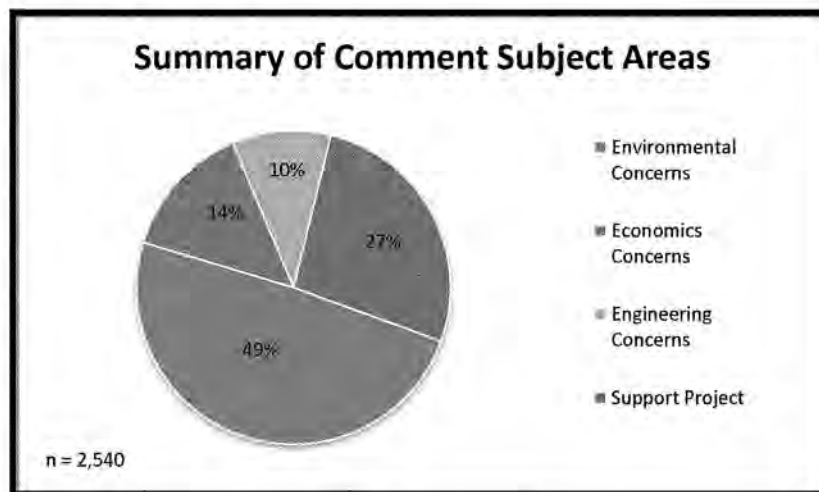


Figure 7-2. Summary of comment subject areas.

As illustrated in Figure 7-2 above, the majority of the comments were related to the environmental analyses and predicted impacts associated with the proposed project. In general, the environmental comments focused on two major issues: the proposed monitoring and adaptive management plan and the impacts to endangered species, specifically the Shortnose sturgeon. The District received comments from all the Federal Cooperating Agencies (Department of Interior (DOI), Department of Commerce (DOC), and the Environmental Protection Agency (EPA)) regarding the post-construction monitoring period. Both the DOI and EPA requested that the monitoring period be extended to as much as 10 years. The Federal Cooperating Agencies and the State resource agencies, with the Georgia Department of Natural Resources - Environmental Protection Division (GA DNR-EPD) in particular, requested additional elements be included in the monitoring plan to ensure the actual impacts do not exceed those expected for a particular resource.

Several resource agencies expressed concern that a 5-year monitoring period may be too short to adequately test the performance of the mitigation features. Some of the mitigation features are designed to address impacts that only become evident during low river flows. River flows are entirely dependent upon climate conditions, and it is possible to go through a 5-year monitoring period without experiencing low flows that would test the performance of the mitigation features. The risk of not observing significant low-flow data during a 10-year monitoring period is greatly reduced. Historic records from the Savannah River at the Clio streamflow gage indicate that 5 years of above-average flows are not uncommon, but even during so-called "wet decades" there have always been a few years of below normal flow.

To address these concerns, the Corps added elements to the monitoring plan and lengthened the monitoring period for some elements to as much as 10 years. Elements added to the plan include determinations of the location of the freshwater interface, addition of a twelfth wetland monitoring site, expanded monitoring of CDF effluent, and additional biological monitoring in the CDFs. The Corps believes the adaptive management plan, as proposed, would allow it to make necessary changes to the project should the environmental impacts exceed what is predicted or the mitigation features do not function as intended.

A number of commenters expressed concern about funding assurance for both the construction and operation and maintenance of the proposed mitigation features and any adaptive management features. To address their concerns, the State of Georgia has indicated that it would place costs for mitigation feature monitoring and adaptive management in an escrow account so the funds would be available if/when needed. The District will seek the Federal share of the adaptive management funds (estimated at \$2 million a year) 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. With regard to operation and maintenance of the mitigation features, the Corps' highest budget ranking is given to funding requests for operation of mitigation features.

In addition to the monitoring plan, a large number of comments, particularly from the DOC, were concerned with the proposed mitigation for impacts to Shortnose sturgeon habitat. A mitigation feature proposed in the Draft EIS to compensate for adverse impacts to Shortnose sturgeon habitat was construction and operation of a horseshoe rock ramp fish bypass around the New Savannah Bluff Lock and Dam, near Augusta, Georgia. In their comments, the DOC indicated that the proposed design was inadequate because the percentage of river flow passing through the structure (5%) did not provide adequate assurance that Shortnose sturgeon could find or use the structure. Based on these comments, the Corps held a fish passage workshop and invited representatives from the Federal and State natural resource agencies, fishway engineers, and academic experts to review the design. As a result of the input provided at the workshop and a follow-up site visit arranged by NMFS, the Corps revised the rock ramp design to accommodate 100% of the river flow a majority of the spring spawning season, while not increasing flooding upstream and maintaining an acceptable pool level. The revised design is presented in EIS Section 5 and Appendix C.

Both the GA DNR-CRD and the City of Tybee Island submitted comments regarding the proposed beneficial use of dredged materials, i.e. nearshore placement of new work sediments from the entrance channel. GA DNR-CRD's initial finding was that the SHEP is generally consistent with the enforceable provisions of the Georgia Coastal Management Program. However, certain changes were requested regarding the dredged sediment placement plan, viz., the State expressed concern about the proposed deposition in the nearshore sites and the two offshore [fish enhancement] sites. In light of GA DNR-CRD and the City of Tybee Island's concerns about the quality of the sediments, the Corps revised the dredged sediment placement plan and now intends to deposit all

sediments from the entrance channel in either the Ocean Dredged Material Disposal Site or approved upland confined sediment placement sites. Consequently, proposed dredged sediment placement areas: Site MLW 200, Site MLW 500, ERDC Nearshore, Site 2 Mound, Site 2 Extension, and Sites 3, 4, 5, 6, 11, and 12, were deleted from the proposed action and the Corps would not deposit dredged sediments in those locations as part of the Savannah Harbor Expansion Project.

The City of Savannah submitted comments concerning the potential impacts of increased chlorides to their water supply intake on Abercorn Creek. As a result of their comments, the Corps, Georgia Ports Authority, and the City of Savannah closely coordinated to perform additional impact analyses. The results of those analyses are summarized in Section 5.02 of the Final EIS. The analyses indicated that during drought conditions and high tide, the increased chloride concentrations would cause an increase in lead corrosion and disinfection byproducts, both of which are regulated by the EPA, at the City's municipal and industrial plant. Based on the outcome of the updated studies, the Corps has added a raw water storage impoundment to mitigate for these expected impacts.

A number of comments were also submitted concerning the engineering and design of the channel, in particular the Ocean Bar Channel (entrance channel) and channel extension. Respondents were concerned that the channel design presented in the Draft documents was not adequate to allow safe transit of the larger ships expected to call after the harbor is deepened. The preliminary channel design was determined using the Corps of Engineers' design standards and procedures outlined in EM-1110-2-1613, Hydraulic Design of Deep Draft Navigation Projects. In accordance with ER-1110-2-1403, final channel dimensions and navigation requirements were developed using the Corps' state-of-the-art ship simulator with input from the Savannah Harbor Pilots Association (SHPA). The use of ship simulators to establish final design parameters for deep-draft navigation channels is the standard practice worldwide and ensures that channels are safe and economical and result in minimal environmental impact and long term maintenance requirements. The use of ship simulators also provides the harbor pilots that work in the channel on a daily basis with the opportunity to provide input into the design and ensure the navigability and safety of the channel. The ship simulation study verified that the channel could be deepened and widened at three bends to maintain two-way traffic capability for the design vessel and a smaller vessel. Two meeting areas are also included to provide for meeting of two design vessels.

Currently the Savannah Harbor Pilots safely bring in vessels with a minimum of 4-foot underkeel clearance (UKC). The Corps expects this practice to continue with the deepened channel. The vertical motion study, which included the channel extension out to a maximum of Station -98+600B, showed that the pilots can safely navigate the design vessel through the deepened Ocean Bar Channel at a ship speed of 14 knots or less. Documentation for both the ship simulation and vertical motion studies can be found in Engineering Appendix Supplemental Materials.

With respect to economics, most respondents commented or asked questions about how deepening the harbor is economically justified if the cargo volume growth rate remains

the same in both the with- and without-project conditions. As indicated by the commodity forecast discussed in Section 5 of the GRR, under both the without- and with-project conditions, the District expects the Garden City Terminal to reach its build-out capacity near 2030 when the total number of TEUs processed reaches 6.5 million. The Corps anticipates that without deepening, more vessels would be required to transport a given volume of cargo, when compared to the with-project condition in which the vessels could load more completely (thereby requiring fewer vessels).

No increase in cargo is expected to occur as a result of the proposed harbor deepening. As a result, the number of containers that transit the areas that surround the port would not change as a result of a deeper harbor. The project's economic benefits accrue from the use of larger, more cost-effective container ships, not an increase in the number of containers moving through the port. These transportation cost savings are predicted to result in an average net benefit of over \$170 million annually to the Nation.

Documentation of the Corps' responses to all comment letters, e-mails, and dictated comments is included as Appendix A of this EIS.

7.02 Required Coordination

Cultural resources investigations have been coordinated with the Georgia and South Carolina Division of Archives and History, Underwater Archaeology Unit, and with the Georgia and South Carolina State Historic Preservation Officers (SHPOs), pursuant to the National Historic Preservation Act of 1966, as amended. The SHPOs have reviewed reports that have been prepared that assess the condition of cultural and historic resources that could be impacted by the proposed project. A Programmatic Agreement has been developed that describes the actions the Corps would take to comply with the National Historic Preservation Act. That Agreement is included as Appendix G. The SHPOs officially commented on Savannah District's Section 106 determination when they reviewed the Draft EIS. The District has agreed to further coordination with the SHPOs as further investigations are conducted.

This Final EIS contains Savannah District's Federal Consistency Determination with the Georgia Coastal Management Program. The determination was provided to the GA DNR Coastal Resources Division, which administers the Georgia CZM Program, for review and concurrence, in compliance with the Coastal Zone Management Act (CZMA), 16 U.S.C. 1451 et seq., as amended. The concurrence letter from the Georgia DNR Coastal Resources Division is included in Appendix Z.

This Final EIS contains Savannah District's Federal Consistency Determination with the South Carolina Coastal Management Program. The determination was provided to the Office of Ocean and Coastal Resource Management of the South Carolina Department of Health and Environmental Control, which administers the South Carolina CZM Program, for review and concurrence, in compliance with the Coastal Zone Management Act

(CZMA), 16 U.S.C. 1451 et seq., as amended. The concurrence letter from the OCRM of the SC DHEC is included in Appendix Z.

This Final EIS contains Savannah District's Section 404(b)(1) Evaluation on the proposed project. That evaluation was provided to the Georgia Department of Natural Resources, Environmental Protection Division. GA DNR-EPD administers the Section 401 water quality certification program in Georgia under the authority of the Clean Water Act. The Corps requested water quality certification as part of GA DNR-EPD's review of the DEIS. GA DNR-EPD issued a water quality certification for the project on February 16, 2011; it is included in Appendix Z.

Savannah District's Section 404(b)(1) Evaluation was also provided to the South Carolina Department of Health and Environmental Control. SC DHEC administers the Section 401 water quality certification program in South Carolina under the authority of the Clean Water Act. The Corps requested water quality certification as part of SC DHEC's review of the DEIS. SC DHEC issued a water quality certification for the project on November 15, 2011; it is included in Appendix Z.

EPA administers the Section 103 ocean disposal program in the southeast under the Marine Protection, Research, and Sanctuaries Act. Excavation, transport and deposition of sediments into the Savannah Ocean Dredged Material Disposal Site require EPA approval under Section 103 of MPRSA. At the request of EPA, the Corps is performing biological testing of new work sediments in the entrance channel. When the results of that testing are available, the District will prepare a Section 103 Evaluation and submit it to EPA Region 4 for review and approval prior to initiating dredging.

Consultation under Section 7(c) of the Endangered Species Act of 1973, as amended, was conducted with the US Department of the Interior, USFWS and the US Department of Commerce, NMFS. The Biological Assessment (BA) addressing these issues is included in Appendix B. The Concurrence Report of the USFWS and the Biological Opinion of NMFS are included in Appendix Z of this EIS.

The coordination required under the Fish and Wildlife Coordination Act, as amended (16 U.S.C. 661, et seq), was conducted. The Draft Coordination Act Report provided by the USFWS in November 2008 was included in the Draft EIS. The Final Coordination Act Report provided in April 2011 is included in Appendix E of this EIS. Appendix E also includes the Corps' response to the recommendations in the Final Fish and Wildlife Coordination Act Report.

Table 7-1. Mailing List for the EISFederal Agencies

US Environmental Protection Agency
 US Environmental Protection Agency, Region 4
 US Environmental Protection Agency, Region 4 Office of Federal Activities
 US Department of the Interior
 US Department of the Interior, Regional Environmental Officer
 US Department of the Interior, Fort Pulaski National Monument
 US Fish and Wildlife Service, Region 4
 US Fish and Wildlife Service, Ecological Services Office, Athens, GA
 US Fish and Wildlife Service, Ecological Services Office, Charleston, SC
 US Fish and Wildlife Service, Savannah Coastal Refuges
 US Department of Commerce
 National Oceanic and Atmospheric Administration
 National Marine Fisheries Service, Habitat Conservation Division
 National Marine Fisheries Service, Protected Species Division
 Advisory Council on Historic Preservation
 Forest Service, USDA
 Federal Emergency Management Administration
 HUD, Atlanta Regional Office
 Natural Resources Conservation Service
 Department of Health and Human Services
 US Coast Guard, Captain of the Port
 US Coast Guard, Navigation Aids
 US Geological Survey, Columbia, SC
 US Geological Survey, Georgia Fish and Wildlife Cooperative Research Unit
 US Geological Survey, South Carolina Fish and Wildlife Cooperative Research Unit
 US Geological Survey, Florida Fish and Wildlife Cooperative Research Unit
 Federal Highway Administration
 Naval Historical Center

Georgia

Department of Natural Resources, Environmental Protection Division
 Department of Natural Resources, Coastal Resources Division
 Department of Natural Resources, Wildlife Resources Division
 Department of Transportation
 Georgia Ports Authority
 State Historic Preservation Officer

Table 7-1. Mailing List for the EIS (Continued)

South Carolina

Department of Natural Resources
Department of Health and Environmental Control, Division of Water Quality
Department of Health and Environmental Control, Office of Ocean and Coastal
Resources Management
State Historic Preservation Officer
Savannah River Maritime Commission

Local Government

Chatham County, GA
City of Savannah
City of Savannah, Water and Sewer Department
City of Savannah, Engineering Department
Metropolitan Planning Commission
Jasper County, SC
Hilton Head, SC
Tybee Island, GA

Other

Coastal Heritage Society
Savannah Chamber of Commerce
Savannah Chamber of Commerce, Maritime Committee
Savannah Maritime Association
Savannah Pilots Association
Navy League, Savannah Council
The Propeller Club, Port of Savannah

Table 7-1. Mailing List for the EIS (Continued)

Conservation Groups

Georgia Conservancy
 Sierra Club
 Ogeechee Audubon Society
 The Nature Conservancy
 National Wildlife Federation
 National Audubon Society

Elected Officials

Senator Saxby Chambliss (R-GA)
 Senator Johnny Isakson (R-GA)
 Representative John Barrow (D-GA 12th)
 Representative Jack Kingston (R-GA 1st)
 Senator Lindsey Graham (R-SC)
 Senator Jim DeMint (R-SC)
 Representative Joe Wilson (R-SC 2nd)

Libraries

Chatham County Public Library, Main Library
 Chatham County Public Library, Mall Branch
 Chatham County Public Library, Port Wentworth Branch
 Chatham County Public Library, Port City Branch
 Chatham County Public Library, Ola Wyeth Branch

8.00 RISK AND UNCERTAINTY ANALYSIS

Savannah District evaluated the risk and uncertainties involved in its environmental evaluation. Upon completion of the Tier I EIS, the Corps and GPA held scoping meetings to identify issues that warranted further investigation. Federal and State natural resource agencies participated in the scoping. A Stakeholders Evaluation Group provided information about specific studies that should be conducted. Those studies were intended to reduce the uncertainties in information concerning potential environmental impacts from a harbor deepening.

The risk and uncertainty analysis contained in Appendix Q discusses the following subjects:

- A. Ways in which risks had been reduced
- B. Risks and uncertainties associated with the salinity predictions
- C. Risks and uncertainties associated with the wetland impact predictions
- D. Risks and uncertainties associated with the dissolved oxygen predictions
- E. Risks and uncertainties associated with the dissolved oxygen improvement technique
- F. Risks and uncertainties associated with biological responses
- G. Risks and uncertainties associated with the air quality analysis
- H. Risks and uncertainties associated with the sediment quality evaluation

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FOR CONTINUATION OF HOUSE DOCUMENT 112-153

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FINAL GENERAL RE-EVALUATION REPORT AND
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