GEORGIA STATE CLEARINGHOUSE MEMORANDUM
EXECUTIVE ORDER 12372 REVIEW PROCESS

TO: William Bailey (ATTN:PD)
U.S. Army COE, Savannah District
100 W. Oglethorpe Avenue
Savannah, GA 31401-3640

FROM: Barbara Jackson

DATE: 11/17/2010

APPLICANT: Dept. of the Army - Savannah District, COE

PROJECT: Draft Tier II Environmental Impact Statement and Draft General Re-Evaluation Report for the Savannah Harbor Expansion Project (located in Chatham County, GA and Jasper County, SC)
[*Note: copy of Joint Public Notice (JPN) also included*]

STATE ID: GA101117002

FEDERAL ID:

Material related to the above project was received by the Georgia State Clearinghouse on 11/16/2010. The review has been initiated and every effort is being made to ensure prompt action. The project will be reviewed for its consistency with goals, policies, plans, objectives, programs, environmental impact, criteria for Developments of Regional Impact (DRI) or inconsistencies with federal executive orders, acts and/or rules and regulations, and if applicable, with budgetary restraints.

The initial review process should be completed by 12/18/2010 (*approximately*). If the Clearinghouse has not contacted you by that date, please call (404) 656-3855, and we will check into the delay. We appreciate your cooperation on this matter.

When emailing or calling about this project, please reference the State Application Identifier number shown above. If you have any questions regarding this project, please contact us at the above number.

Form SC-1
Aug. 2010

Vance C. Smith, Jr., Commissioner

GEORGIA DEPARTMENT OF TRANSPORTATION
One Georgia Center, 600 West Peachtree Street, NW
Atlanta, Georgia 30308
Telephone: (404) 631-1000

February 11, 2011

Colonel Jeffrey M. Hall
District Commander
U.S. Army Corps of Engineers
P. O. Box 889
Savannah, GA 31402

Dear Colonel Hall:

I would like to provide written comments from the Georgia Department of Transportation (GDOT) concerning the Savannah Harbor Expansion Project (SHEP) General Reevaluation Report (GRR) and Environmental Impact Statement (EIS) that was released in November 2010. My previous letters dated July 22 and August 18, 2010 stated our commitment to the SHEP, including our willingness to fund the Locally Preferred Plan (LPP) to a depth from 47 to 48 feet. It is still our hope that you will re-evaluate the information and agree with us that the 48 foot plan should be the National Economic Development Plan (NED). Please be assured that our commitment continues for this vital project. Our comments below are provided in the spirit of partnership.

1. Please revisit the impact of salinity change on ship buoyancy and the need for additional depth at the upper end of the harbor. The report mentions there are no effects. While the water at Garden City is not purely fresh, it does have less salinity than ocean sea water. The change in salinity may be enough to justify a third of a foot or so for additional draft and can be added to the other factors to contribute to make the NED a 48 foot rather than a 47 foot plan.
2. Since the release of the report in November, Egypt has experienced political unrest. As owners of the Suez Canal, there may be changes that could influence shippers to more heavily use the Panama Canal. This could increase the use of Savannah beyond what the report shows and require a 48 foot channel.
3. The project includes removing approximately 217,263 cubic yards of new work material between stations 4+000 and 6+375. This material is planned to be placed in Jones Oysterbed Island disposal area. Could that material be placed at the eroded area between Long and Bird Island near station 10+000? This would save capacity in the disposal areas.
4. Have you double checked to make sure the ships that will be used for rapid deployment of the military from Savannah will not need a 48 foot channel during the next 50 years?

We look forward to our continued partnership with the U.S. Army Corps of Engineers to improve transportation in our state. Please do not hesitate to contact me or Mr. John Phillips, Waterways Program Manager, at (404) 631-1230, if additional information is needed.

Sincerely,

Vance C. Smith, Jr.
Commissioner

VCS:HDK:jsp

cc: Gerald M. Ross, P.E., Chief Engineer/Deputy Commissioner
Todd Long, P.E., GDOT Director of Planning
Erik Steavens, GDOT Director of Intermodal Services
John Phillips, Waterways Program Manager

Georgia Department of Transportation

1149-MM-06-EC01

Comment: *I would like to provide written comments from the Georgia Department of Transportation (GDOT) concerning the Savannah Harbor Expansion Project (SHEP) General Reevaluation Report (GRR) and Environmental Impact Statement (EIS) that was released in November 2010. My previous letters dated July 22 and August 18, 2010 stated our commitment to the SHEP, including our willingness to fund the Locally Preferred Plan (LPP) to a depth from 47 to 48 feet. It is still our hope that you will re-evaluate the information and agree with us that the 48 foot plan should be the National Economic Development Plan (NED). Please be assured that our commitment continues for this vital project. Our comments below are provided in the spirit of partnership.*

Response: It is important to recall that the NED plan is the alternative that fulfills the Federal objective and maximizes the net economic benefits to the [entire] nation while taking into account environmental, societal, and other considerations. After a very thorough analysis and rigorous review, the NED Plan was found to be the -47 feet deepening alternative. In fact, benefits do increase beyond -47-feet; however, it is just that the *net* benefits (difference between benefits and costs) are maximized at -47-foot depth. The NED plan serves as the basis for cost-sharing, which in turn sets the limit for Federal government financing. If other alternatives are economically viable, the non-Federal sponsor has the option of recommending a plan other than the NED, i.e., a Locally-Preferred Plan. In this instance, the -48-foot alternative represents the Locally-Preferred Plan for the SHEP. In light of subsequent discussions held between Savannah District and the State, the Corps will not select the 48-foot depth alternative for implementation.

1149-MM-06-EN01, 1149-MM-06-EC02

Comment: *Please revisit the impact of salinity change on ship buoyancy and the need for additional depth at the upper end of the harbor. The report mentions there are no effects. While the water at Garden City is not purely fresh, it does have less salinity than ocean sea water. The change in salinity may be enough to justify a third of a foot or so for additional draft and can be added to the other factors to contribute to make the NED a 48 foot rather than a 47 foot plan.*

Response: The Savannah Harbor Pilots Association confirmed the difference in draft resulting from salinity differences between the entrance channel and Garden City is 20 cm or 0.66 ft. All drafts reported by the SHPA are referenced to a fresh water datum. Therefore, the presence of salinity would only serve to reduce the underkeel requirement as it would make the ship more buoyant.

The underkeel clearances stated in the Economics Appendix- Section 2.6 account for dynamic conditions, viz., squat, trim, and freshwater sinkage. Once these factors are netted out, the underkeel clearance requirements are represent the standard practice in the Port, which happen to be comparable to those of other ports. This issue will be clarified in the final GRR-Economics Appendix.

1149-MM-06-EC03

Comment: *Since the release of the report in November, Egypt has experienced political unrest. As owners of the Suez Canal, there may be changes that could influence shippers to more heavily use the Panama Canal. This could increase the use of Savannah beyond what the report shows and require a 48 foot channel.*

Response: The Corps of Engineers guidance on deep-draft navigation projects emphasizes using empirical data [whenever possible] and to make forecasts over a 50-year period of analysis. This is a prudent approach because data on past and present problems help shape the future without-project condition scenario. This, in turn, serves as a baseline for project formulation and evaluation [comparisons]. As expected, a 50-year forecast contains uncertainty; therefore, several sensitivity analyses were performed using lower growth rates, no growth, and increased packaging densities. For the most part, the results show project improvements [deepening] are economically justified.

Economic conditions can change markedly from year to year. For example, in 2009 there were dramatic declines in worldwide cargo volumes and shipbuilding [economic downturn], whereas more recently external events such as Middle East unrest and the tsunami in Japan have likewise affected the shipping industry. Therefore, application of a longer [50-year] period of analysis helps to reduce short-term volatility and provides a more accurate economic picture [smoothing the curve].

1149-MM-06-EV01

Comment: *The project includes removing approximately 217,263 cubic yards of new work material between stations 4+000 and 6+375. This material is planned to be placed in Jones Oysterbed Island disposal area. Could that material be placed at the eroded area between Long and Bird Island near station 10+000? This would save capacity in the disposal areas.*

Response: The subject area experiences erosion due to high current velocities. Without detailed engineering studies, it does not appear appropriate to place unconsolidated dredged material into such a dynamic area. Also, additional environmental clearances would have to be obtained to permit discharge of dredged material into open water at that location.

1149-MM-06-EC04

Comment: *Have you double checked to make sure the ships that will be used for rapid deployment of the military from Savannah will not need a 48 foot channel during the next 50 years?*

Response: Only commercial vessels were examined in the fleet analysis. Vessels used in deployment operations [civilian/military] generally require lesser drafts [33 feet]. Therefore, the existing channel should be able to address those needs.

#643

Georgia Ports Authority

P. O. Box 2406, Savannah, Georgia 31402
(912) 964-3811, Toll Free: (800) 342-8012

Paul A. Yarborough, Sr.
Manager Contracts / Planning

December 11, 2010

Re: SHEP

Dear Mr. William Bailey,

This letter is to manifestate my personal commitment and support for this project of national interest to the U.S Army Corps of Engineers, Secretary of the Army, Department of Commerce, Department of the Interior, Department of the Army and the Environmental Protection Agency for the deepening of the Savannah Harbor to 48 ft. at mean low water.

As you know, the U.S. Army Corps of Engineers is funded and tasked by Congress to provide information to our Senators and House of Representatives offering detailed analysis of such opportunities in the Corp's General Evaluation Reports; therefore, ensuring that international commerce has a safe and adequate access to ports throughout North America. In a decade long, $40 million dollar study and with extensive communication and collaboration with all mandatory agencies, the U.S. Army Corps of Engineers economic and environmental model has undoubtedly confirmed the need to fund and complete this project with immediate financial insistence from Congress and the President.

At this occasion, we must prepare to accommodate the larger vessels navigating the Panama Canal in 2014. This project, if correctly implemented, will assist the nation in successfully meeting the National Export Initiative created by Executive Order of President Obama, as well as secure the current and future Statewide employment base in Georgia.

Respectfully submitted,

Paul A. Yarborough, Sr.

Paul A. Yarborough, Sr.

Deepwater Terminals / Savannah, Brunswick
Barge Terminals / Bainbridge, Columbus
Trade Development Offices / Savannah, Brunswick, Atlanta
New York, USA; Tokyo, Japan; Athens, Greece, Oslo, Norway

Georgia Ports Authority

Comment: *This letter is to manifest my personal commitment and support for this project of national interest to the U.S. Army Corps of Engineers, Secretary of the Army, Department of Commerce, Department of the Interior, Department of the Army and the Environmental Protection Agency for the deepening of the Savannah Harbor to 48 ft. at mean low water.*

Response: Comment noted.

Georgia Ports Authority

Telephone: 912.964.3811
Toll Free (in U.S.): 800.342.8012

P.O. Box 2406
Savannah, GA 31402
USA

Curtis J. Foltz
Executive Director

Email: cfoltz@gaports.com
Call Direct: 912.964.3874
Fax: 912.966.3615

January 25, 2011

Mr. William Bailey
Attn: PD, U.S. Army Corps of Engineers
Savannah District
100 West Oglethorpe Avenue
Savannah, Georgia 31401-3640

Dear Mr. Bailey,

Please find enclosed herewith the comments of the Georgia Ports Authority regarding the Draft Environmental Impact Statement (DEIS) and General Reevaluation Report (GRR) for the Savannah Harbor Expansion Project (SHEP).

Regards,

Curtis J. Foltz

Curtis J. Foltz
Executive Director

www.gaports.com

+ Port of Savannah
+ Port of Brunswick

UNITED STATES ARMY CORPS OF ENGINEERS
SAVANNAH DISTRICT
DRAFT TIER II ENVIRONMENTAL IMPACT STATEMENT
AND
DRAFT GENERAL RE-EVALUATION REPORT
FOR
SAVANNAH HARBOR EXPANSION
CHATHAM COUNTY, GEORGIA
JASPER COUNTY, SOUTH CAROLINA (NOVEMBER 2010)

COMMENTS SUBMITTED BY GEORGIA PORTS AUTHORITY JANUARY 25, 2011

Table of Contents

LIST OF ACRONYMS

CDFs	confined disposal facilities
CEER	Corps Center for Expertise for Ecosystem Restoration
CEQ	Council on Environmental Quality
Corps	United States Army Corps of Engineers
DEIS	Draft Environmental Impact Statement
Draft GRR	Draft General Reevaluation Report
EFDC	Environmental Dynamics Code
EPA	United States Environmental Protection Agency
FWS	United States Fish & Wildlife Service
GADNR	Georgia Department of Natural Resources
GAEPD	Georgia Environmental Protection Division
GDP	Gross Domestic Product
GPA	Georgia Ports Authority
ICTF	Intermodal container transfer facilities
MACTEC	MACTEC Engineering and Consulting, Inc.
MLW	Mean Low Water
MPC	Maximum Practicable Capacity
NED	National Economic Development
NMFS	National Marine Fisheries Services
P&G	Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies
SCDHEC	South Carolina Department of Health & Environmental Control
SCDNR	South Carolina Department of Natural Resources
SEG	Stakeholders Evaluation Group
SHEP	Savannah Harbor Expansion Project
SNWR	Savannah National Wildlife Refuge
SOP	Standard Operating Procedures
TCSM	Total Transportation Cost Savings Model
TEUs	twenty-foot equivalent units
TMDL	Total Maximum Daily Load
WASP7	Water Quality Analysis Simulation Program Version 7.0
WRDA	Water Resources Development Act

INTRODUCTION

The Georgia Ports Authority (the "GPA") submits these comments in support of the Savannah Harbor Expansion Project (the "SHEP") and specifically in support of deepening the Savannah Harbor and Savannah River to a Mean Low Water ("MLW") depth of forty-eight (48) feet.

The GPA takes note of the fact that the SHEP analysis documents are by necessity of imposing quantity and detail. At the same time, GPA believes it is useful for all parties to begin their analysis in the context of the expansive structure of the SHEP review, as it has set a new and very high standard for environmental and economic study of port infrastructure development. The GPA believes that the SHEP draft Environmental Impact Statement ("DEIS") and the Draft General Reevaluation Report ("Draft GRR") reflect the most transparent, inclusive, and detailed review of any comparable harbor deepening project anywhere in the United States. This process was formalized through the unique Stakeholders Evaluation Group (the "SEG"). The SHEP has been studied over the course of 14 years, and under the detailed review of the SEG for ten years.

In an unprecedented way, the legislative authorization for SHEP and the SEG allowed more than a half dozen federal and state resource agencies, as well as environmental and public interest groups and the general public, to participate directly in the formulation of the SHEP studies and to periodically review the unfolding results of the scientific and other empirical data.

From the GPA perspective, these facts are worthy of special consideration:

- The benefit-cost ratio of 4.3 to 1, and the annual transportation savings of $150 million, is extraordinarily high. It is demonstrably and precisely the kind of high value investment that our nation urgently needs to expand employment opportunities and tax revenue. Indeed, as noted in our comments, the GPA believes the United States Corps of Engineers (the "Corps") analysis may significantly understate the benefits and should revise its report accordingly.

- Savannah's ability to stimulate export and import trade and job development would be profoundly impeded by its existing 42 foot channel as the new generation of deep-draft vessels begins to dominate world trade. Even now, these larger vessels are replacing older, smaller and less-efficient ships world-wide. Failing to implement the SHEP, and to do so quickly, would have long-term negative consequences for the nation as a whole and the 44 percent of the U.S. population served through Savannah and major adverse impacts to the economies of both Georgia and South Carolina.
- The Corps' Multi-Port Analysis and Regional Port Analysis considered and evaluated the SHEP's impact on the proposed and existing regional ports and concluded that the SHEP will not divert containerized cargo from those other ports. The report shows that there is a requirement for a network of East Coast facilities that can accommodate deeper draft vessels, and that this network complements all ports. In fact, meeting the President's export goals for the nation will require channel deepening work at Savannah and a number of other ports as well.
- The Corps has designed an expansion project that avoids, minimizes, or mitigates all impacts to the environment. Multi-year data sampling provided the most

comprehensive and accurate base line and analysis of the Savannah River in history, and extensive and practical testing of technical solutions and equipment verified the effectiveness of mitigation alternatives. Some critics have argued that the SHEP should provide less than 48 feet in new depth in order to reduce environmental impact/mitigation requirements. However, the Corps analysis shows that all depth alternatives have essentially the same net environmental impacts, but that a depth less than 48 feet would eliminate significant economic and navigation benefits.

SUMMARY OF CONTENTS

The Georgia Ports Authority ("GPA") submits these comments in support of Savannah Harbor Expansion Project (the "SHEP") and specifically in support of deepening the Savannah Harbor and Savannah River to a Mean Low Water ("MLW") depth of forty-eight (48) feet.

Over the past 12 years, the United States Army Corps of Engineers (the "Corps") leadership, staff and consultants have conducted a thorough investigation and analysis of economic and environmental issues, and have designed the project accordingly. Documentation of the SHEP in the Draft Environmental Impact Statement ("DEIS") and the Draft General Reevaluation Report ("Draft GRR") satisfies the letter and spirit of the President's Council on Environmental Quality ("CEQ") regulatory admonition that the Environmental Impact Statement "shall be concise, clear and to the point and shall be supported by evidence that the agency has made the necessary environmental analysis." The GPA's comments summarize and clarify that information as necessary to provide context for addressing questions and to correct misunderstandings that emerged during the planning process.

The Overview (Part I) summarizes the economics of the project and states why the SHEP should be approved, considering the strong economic benefits and full mitigation of unavoidable environmental impacts. In Part II, the GPA reviews and supplements details on the importance of the project and how the economic benefits support its approval. Part III addresses several environmental issues, including the extensive mitigation for adverse environmental effects that could not be avoided.

I. OVERVIEW

The Savannah Harbor is an important East Coast port that warrants continued federal, state and local investment based on the economic value of the project, including the following:

1. The Corps estimates that transportation cost savings alone will average more than \$150 million annually over the fifty-year life of the 48-foot channel and harbor. Net average annual national benefits of \$115 million provide a benefit to cost ratio of 4.3 to 1, which strongly justifies approval of the full 48-foot channel that the GPA has recommended.
2. According to the GPA's careful analysis, the ample net transportation benefits are understated. Adjustment of even a few of the overly conservative assumptions used by the Corps results in maximization of net benefits with a 48-foot channel, qualifying it as the National Economic Development ("NED") plan that the GPA recommended.

3. Savannah Harbor has exhibited robust growth with throughput of container cargo rising in 2010 to 2.6 million TEUs (twenty-foot equivalent units). Over the past ten year period, Savannah's share of East Coast container traffic grew from 11.2% to 18.6%, due to its favorable geographic location combined with service efficiencies that have resulted from major investments in cargo handling facilities and equipment.
4. As a consequence of its success, and in addition to the significant national benefits it offers, the port is a major contributor to the economies of Georgia and South Carolina. The GPA was responsible for $61.7 billion in sales in Georgia and $4.3 billion in South Carolina, even during the recession year of 2009, including approximately 315,000 jobs directly and indirectly in those two states alone.

In short, Savannah Harbor is a critical link in the nation's port system as it provides a crucial import/export gateway to more than 44% of the U.S. population and serves approximately 21,000 companies located in all 50 states.

Continued growth of the contributions to national and international commerce requires deepening the federal project channel from 42 feet to 48 feet. The world fleet is shifting rapidly to the larger, deeper draft post–Panamax vessels that are already arriving through the Suez Canal, and soon will transit a deeper Panama Canal. This is already occurring in Savannah. In calendar year 2010, 252 post-Panamax Gen I vessels and 5 post-Panamax Gen II vessels called on the Garden City Terminal. Failing to invest federal resources as recommended by the Corps is not a rational option. The SHEP deserves full support and approval.

The record supporting the DEIS and Draft GRR satisfies the letter and spirit of the various federal laws and regulations that affect navigation projects. These laws and regulations include among, numerous other federal provisions, the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (the P&G), President's Council on Environmental Quality ("CEQ") regulations to Implement the National Environmental Policy Act, Section 404(b)(1) of the Clean Water Act. We commend the Corps for fulfilling the CEQ regulatory admonition that the EIS "shall be concise, clear and to the point and shall be supported by evidence that the agency has made the necessary environmental analysis."

Environmental impacts have been identified and thoroughly characterized based on existing information and several new studies conducted at the direction of the Corps' Project Delivery Team. Potentially adverse effects are being addressed through an extensive process of avoidance, minimization and mitigation.[1] Scientific support for the project is strong.

A full range of alternatives was evaluated, including foregoing improvements at the Savannah Harbor in favor of expansion at other East Coast ports. The Corps considered several locations for expansion within the Savannah River, and considered alternative depths ranging from no expansion to deepening the harbor down to a MLW depth of 48 feet. An extensive and effective mitigation process was developed to avoid impacts and to minimize and mitigate impacts where avoidance was not feasible.

Studies and deliberations were coordinated with other federal and state agencies including the United States Environmental Protection Agency ("EPA"), the United States

[1] Mitigation Planning Appendix C to the DEIS.

Fish and Wildlife Service ("FWS"), the National Marine Fisheries Services ("NMFS"), the Georgia Department of Natural Resources ("GADNR"), including the Environmental Protection Division ("GAEPD"), the South Carolina Department of Natural Resources ("SCDNR"), the South Carolina Department of Health and Environmental Control ("SCDHEC"), and the federal and state historic preservation agencies.

The agencies and the many public and private participants in the Stakeholders Evaluation Group ("SEG") have participated steadfastly over the last ten years in offering insights into potential impacts and advice on strategies for mitigating adverse effects on the environment. The SEG has proved an extremely successful experiment enhancing opportunities for interested stakeholders to participate in the study and analysis of the SHEP. The full SEG held approximately seventy meetings, and its subcommittees held many more. Federal and state officials have participated in SEG meetings, as well as convened their own public forums. The dialogue with stakeholders has resulted in a better project.

The SHEP has been under study for 14 years. Now is the time to approve the SHEP so the Savannah Harbor can more efficiently accommodate the post-Panamax ships currently calling the port and projected to increase in the future. As a result of the active and continuing involvement of state and federal agencies and the public through the SEG, it is highly unlikely that additional study would reveal issues overlooked in the last decade, or would eliminate the need for the project. The only result would be to jeopardize fundamental benefits to the United States and its economy.

II. PROJECT ECONOMICS CONFIRM THE NEED FOR SHEP

The economics confirm that investing in the SHEP will benefit the United States and the region. The Corps analyzed the national economic benefits by focusing primarily on transportation cost savings. The Corps has concluded the 48-foot SHEP will generate $150 million in annual average transportation cost savings over the life of the project. The net transportation benefit is estimated as $115 million, providing a net benefit to cost ratio of 4.3 to 1. The GPA agrees with the Corps analysis to the extent it shows the SHEP will generate substantial economic benefits for transportation throughout the life of the project. The GPA, however, believes the Corps' economic analysis relied on excessively conservative assumptions and, as a result, substantially understates the project's economic benefits, especially in the 47- and 48-feet channel depth increments.

This Section summarizes the economic reasons for the 48-foot SHEP, which include the following:

(1) Using alternate reasonable assumptions that the GPA believes more accurately reflects the most likely future vessel fleet and utilization supported by extensive empirical data of industry operating practices would result in an NED plan of 48 feet;

(2) The transportation cost savings will exceed an annual average of $150 million and an average net benefit to the nation of $115 million annually over the life of the project;

(3) The Savannah Harbor is a significant employer for the Savannah region, creating jobs and economic activity for Georgia and South Carolina;

(4) The Savannah Harbor is the fastest growing port in the United States, already handling over 8 percent of the containerized traffic;

(5) The Savannah Harbor has made substantial investments in essential landside infrastructure to accommodate additional container cargo and has easy access to rail and roads;

(6) The Savannah Harbor is the only East Coast port where exports exceed imports; and

(7) The SHEP will not divert traffic from other East Coast ports because industry trade projections for the East Coast appear to require essentially all East Coast ports to operate at capacity in the reasonably foreseeable future.

A. The Corps Should Approve A 48-Feet Project

Whether the Corps should recommend expansion to a MLW depth of 47 feet or a MLW depth of 48 feet is an open issue. The GPA supports expansion to a MLW depth of 48 feet and asks that the final agency action adopt the 48-foot depth. The Corps calculated that a 48-foot SHEP would save more than $150 million in transportation costs annually, and that net economic benefits should average $115 million a year over the next 50 years. The resulting benefits to cost ratio of 4.3:1 satisfies Water Resources Development Act ("WRDA") criteria for supporting the project.

Transportation cost-savings is the primary focus of the Corps' cost-benefit studies under its policies and procedures. This allows the Corps to evaluate navigation projections based on navigation-focused benefits and not other economic benefits. The Corps has developed economic forecasting models to calculate the net economic benefits predicted to occur from water resources navigation projects such as the SHEP. The Corps employed two models, a Total Transportation Cost Savings Model ("TCSM") and a Harbor Sym model.

The TCSM was used to calculate the waterborne transit costs to and from other world locations to the Savannah Bar Channel. The Harbor Sym model used Savannah Harbor data to estimate the costs, delays and transportation savings within the harbor channel itself at different depths. The results of the two models were then used to estimate the costs, delays and transportation savings attributable to the Savannah channel depths ranging down to 48 feet below MLW.

The GPA agrees the SHEP will generate substantial transportation savings that easily justify project approval. However, the Corps analysis significantly understates the economic benefits the SHEP will generate, particularly in the 47 to 48 feet channel depth range, for several reasons. The Corps analysis relies on unrealistic conservative assumptions of the vessel fleet utilization and of the loading drafts of the vessels expected to call on the Savannah Harbor.

Table 165 (page 185) of the Economic Analysis summarizes the projected economic benefits from expansion of the Savannah Harbor to depths ranging from the current 42 feet to 48 feet. The Corps studies indicate modest additional or incremental benefits between expansion to 47 feet and expansion to 48 feet. The GPA disagrees and believes the Corps analyses were too conservative with respect to several assumptions incorporated into its transportation cost models. If the Corps incorporates the most likely regarding the several factors below based on actual industry practice, the benefits justify the 48-foot alternative.

First, the Corps assumes a certain percentage of post-Panamax ships calling on the Savannah Harbor will take advantage of favorable tidal conditions and adjust their loads accordingly. In fact, the Corps assigns maximum practicable capacity of vessels using 5-feet of usable tide as one of the considerations. This assumption is unrealistic, and the Corps provides no explicit rationale for assuming that vessel assignments will be made on the basis of using five feet of tide.

There are several statements in the Corps report that appear to contradict use of five feet of tide in vessel assignments.

In the Main Report at Section 4.6:

"Operating draft data for 3,372 inbound and outbound container ship transits of Savannah Harbor, in 2007, confirms that carriers are typically averse to waiting for tidal advantage. Less than 12% of all container ship transits were at drafts greater than -38.00 feet. Container ship operating drafts cluster at the threshold of unrestricted access. Nearly 42% of all container ship transits (41.9%) were at drafts ranging from -35.00 to -37.99 feet."

On Page 56 of the Main Report the effect of tide on vessel utilization is discussed:

"Waiting for the tide is a costly operational inefficiency for schedule-driven liner service carriers for two reasons. The first reason is that, for inbound vessels, waiting adds to the operational cost of the voyage by increasing the vessel's time at sea. Outbound vessels waiting for the tide must spend more time at the dock and may delay the arrival of a vessel scheduled to use the same berth. Vessels may increase speed between ports to make up time lost waiting for the tide, which also adds to the cost of the voyage. The second reason that carriers are averse to waiting for the tide is that the additional time spent getting into or out of Savannah Harbor disrupts the vessel's scheduled arrival time at the next and following ports. Vessels may be subject to penalty fees for missing their scheduled time slot at the Panama Canal or may need to pay overtime fees due to a late port arrival."

At page 23 in the Economic Appendix the Corps states:

"Most container vessels calling at Savannah Harbor are part of scheduled liner services that call at multiple East Coast ports in conjunction with Savannah Harbor. Consequently, shippers engage in the practice of "just in time" deliveries of cargo and avoid schedule disruptions whenever possible."

The concern about "just in time" arrivals would indicate that use of five feet of tide is not a predominant factor in vessel deployment decisions or operating practices. It was also clear from industry representatives and confirmed by empirical field data that a critically important factor in deployment of container vessels is maintaining the schedule. Waiting for five feet of tide does not comport with the need for dependable scheduling. By examining actual vessel calls at various ports, as noted below, design drafts are generally two to three feet greater than the channel design depth. To wait for five feet of tide is not "likely" according to operators and empirical data as described previously. Figure 19 on Page 25 of the Economic Appendix indicates very few vessels ride the tide more than a few feet. Assuming a tide utilization of two to three feet as reflected in the empirical data rather five feet as the Corps assumed would most likely increase the NED depth, probably by two or three feet.

Second, even if vessels would plan to use the tides, they could not plan to use five feet of tide. The trip from the ocean to the Garden City Terminal is over 30 miles and could take five hours to travel. Tidal influences typically do not last that long. So, there does not appear to be sufficient time to travel the length of the channel and reach the terminal before vessels could be grounded. Also, the number of vessels projected to be using the tide in the future is too many to be able to force through the tidal windows. Assuming this extreme use of tides for vessel navigation decreases the benefits of the project.

Additionally, it was not evident that the Corps included the costs of landside delays within its analysis of the costs resulting from tidal delays. In shipping, if a vessel is delayed from either arriving to or departing from the berth due to tide, significant direct and indirect costs are incurred with respect to landside activities including stand-by fees for labor, trucker wait time and fuel costs, rail administration from rebooking cargo, staffing times at distribution and deconsolidation centers and, with just-in-time deliveries, production delays at manufacturing facilities. The costs of landside delays need to be factored into the evaluations of benefits of deepening.

Third, the projected vessel fleet distribution projections do not seem to match extensive empirical data from other ports that are supported by industry studies, trade publications and academic studies. Data from Savannah and from other ports show that vessel fleets are comprised of a distribution of incremental vessel design drafts generally growing gradually from the smaller vessels then peaking at a design draft two or three feet greater than the channel design depth and then dropping off rapidly. This fleet distribution pattern is referred to in the Corps report as a "cluster" distribution. On occasion, vessels with design drafts more than two to three feet greater than the channel design depth call at ports, but that does not appear to happen on a regular basis.

The Corps reports on New York Harbor (1999), Miami Harbor (2004), Norfolk Harbor (2008), and Oakland Harbor (2000) show existing fleet distributions that follow the cluster effect and predict future fleets on that basis.

Page 16 of the Economic Appendix refers to Figure 10 on Page 17 and states that the existing fleet in Savannah has drafts that exceed Savannah's current channel design depth by up to three feet, similar to the cluster distribution described above. The report attributes the difference to vessels tide-riding. However, Figure 19 on Page 25 of the report also contains data on operating drafts for an overlapping time period that show vessels for the most part are traveling light, not riding tide as the report hypothesizes. The carriers will light-load to avoid the costs associated with delays due to tide.

The projected fleet in the Corps report does not reflect this distribution. In the absence of some compelling definitive reason to change the long-term data of fleet distributions, i.e., vessel design drafts cluster at two to three feet greater than the channel design depth it seems the "most likely" future would follow the distribution pattern established by long-term real data.

Additionally, the Corps defines "Maximum Practicable Capacity" (MPC) as follows:

> *"The highest reasonable practicable capacity based on weight and volume that a given vessel can hold assuming a fixed average import and export cargo weight (based on all cargo for a given service), a minimal rate of empty containers for all routes, bunkerage and ballast requirements, 5-feet of usable tide and other considerations. The TCSM does include some calls in which vessels exceeded its MPC, but never more than 15% of the time."*

The MPC calculation is critical to the analysis and identification of the NED Plan because it controls how much cargo would be carried on each vessel. While the GPA understands that vessels rarely sail at maximum design draft, vessels do regularly sail at drafts beyond the MPC assigned by the Corps in the report. The sensitivity analysis shows that if the MPC is adjusted for efficient vessel loading without the constraints assigned to the draft through the MPC, then the 48 foot depth has the maximum average annual benefits. The practice of limiting vessel drafts with an assigned MPC for vessel classes restricts the full benefits of the project from being identified.

Finally, the report mentions the use of the Suez Canal as an alternate route for Far East – East Coast US trade but apparently does not include using the Suez Canal as a reasonable alternate assumption to using the Panama Canal. At least two Corps reports, Miami and Norfolk, identified the Suez Canal as a reasonable alternate assumption for trade with Asia. There are also data to support that the Suez alternative is currently being used for Far East-ECUS trade. Whether that use will continue after the Panama Canal is expanded is unknown. While the assumption of a competitive Suez Canal may not have been reasonable in the past, it appears to be reasonable now. With the economies of scale in the current and most likely future world fleet as well as shifting points of origin of manufacturing in Asia from China to the sub-continent, as is happening, it would actually be more economical to ship FE-ECUS via Suez rather than Panama. This does not suggest the analysis should be revised, but only to recognize in the risk and uncertainty analysis that delay of an expanded Panama Canal would not affect the justification for channel deepening. Whether the NED benefits might be greater or less using the Suez route, the channel increment of depth maximizing net benefits would not likely change. That is to say, selection of the NED Plan is not dependent on or sensitive to completion of the Panama Canal expansion.

Another item that needs to be addressed with respect to the NED plan is the project cost analysis. While not a part of the economics analysis, the cost impacts NED plan identification. A 25% contingency factor is placed on essentially every element which seems excessive for many elements of the cost estimate. An explanation would be helpful to understand the 25% contingency factor particularly for dredging costs. The Corps dredges millions of cubic yards every year from the Savannah River Channel and has been doing so for many years. Data on the annual costs for each of the past 10 years might be helpful in judging whether the 25% contingency is appropriate. Regardless of whether 25 % is the appropriate contingency factor according to Corps regulations, those regulations describe maximum, most likely, and minimum levels of risk in the estimating process. It seems that the contingency factors for this report are reported at the maximum level of risk. In order to compare costs and benefits on an equal basis, it seems appropriate to use both costs and benefits at their "most likely" level in order to get appropriate comparison.

With respect to the Sensitivity Analysis of the Economics Analysis, the scenarios should be based on reasonable alternate assumptions as required by the Principles and Guidelines. Beginning at page 88 of the Economics Appendix, it notes:

"The Principles & Guidelines and subsequent ER1105-2-100 recognize the inherent variability to water resources planning. Navigation projects and container studies in particular are fraught with uncertainty about future conditions. A sensitivity analysis is a useful technique that addresses uncertainty by systematically adjusting parameters in a model to determine the effects of such changes."

Each of the individual sensitivity tests suggests only one or in a few cases two alternate assumptions. None of the alternate assumptions standing alone or in twos cause the outcome of the analysis to change. Examination of the sensitivity analysis shows the alternate assumptions used for sensitivity testing themselves do not reflect a reasonable range of assumptions. The two most critical assumption sensitivities are not addressed at all, i.e., use of five feet of tide in the loading calculations and recognizing and testing the sensitivity of the cluster effect of fleet distribution. The GPA believes these two assumptions should be tested with sensitivity analyses.

B. <u>The Savannah Harbor Is a Critical Economic Center</u>

The Corps' transportation cost-focused analysis overlooks other economic benefits the SHEP will generate. The full economic benefits from the SHEP will be more substantial for nearby Georgia and South Carolina populations that constitute the metro-Savannah region as well as for Georgia generally than the Corps analysis takes into account. The Corps does not consider investments made by port users, nor does it consider indirect multiplier impacts for the region.

The Savannah Harbor is a destination port for imports and exports of United States products. Investment in Savannah Harbor has supported and will continue to advance national economic and navigation interests because Savannah Harbor has unique advantages among other East Coast ports and particularly other southeastern ports. The port's location in the Georgia Bight provides a natural geographic advantage as the westernmost East Coast port able to offer substantially reduced travel distances and times to much of its hinterland. The Garden City Terminal location upriver and west of Savannah avoids surface transportation conflicts in the urban area, and facilitates rapid transfer of cargo to and from the nearby north-south and east-west Interstate highways and rail systems. Capitalizing on its favorable location, the GPA already has built the crucial infrastructure to load and unload cargo from larger vessels, and has provided efficient access to the extensive rail and road network that accommodates moving exports to the port and imports to commercial distribution hubs throughout the Southeast and Midwest.

The location and up-to-date efficiencies of its land-based facilities and infrastructure are why the Savannah Harbor is the port of choice for exports and imports. This is illustrated by the fact that it is the only East Coast port where exports exceed imports, with the port handling 12 percent of the nation's containerized exports in FY 2010. With 8.3 percent of the total containerized trade in the United States moving through the Garden City Terminal in FY 2010, Savannah Harbor is the second largest East Coast container port, the fourth largest container port in the United States and is among the fastest growing ports in the

United States. The Savannah Harbor moved over 2.6 million TEUs in fiscal year 2010. This volume of cargo is an increase of 9.4 percent over 2009, 25 percent over the last five years and 160 percent over the past decade.

Given the volume of containers serviced, it is no surprise the Savannah Harbor is a major jobs creator for the metro-Savannah region, including counties in Georgia and South Carolina. In order to obtain objective data, GPA commissioned Jeffrey Humphreys of the Terry College of Business at the University of Georgia to study the economic impacts Georgia's deepwater ports had on the economies of Georgia and South Carolina during fiscal year 2009.[2] Dr. Humphrey analyzed three distinct economic impacts attributable to the Savannah Harbor: (1) direct spending by the GPA and the ports industry on port investment and transportation of waterborne cargo; (2) direct spending by port users such as manufacturers, wholesalers, distributors and warehousing firms; and (3) secondary or indirect economic impacts.

The Humphrey Report estimates that the Savannah and Brunswick ports contributed $26.8 billion of value added or gross domestic product to the Georgia economy in fiscal year 2009. The contribution when measured as income is $15.5 billion. The employment impact is equally important. Overall, the Georgia ports account for over 295,000 full and part-time jobs, which equal 6.7 percent of Georgia's total employment. The two ports account for approximately 10 percent of this total and the Savannah Harbor, itself, directly employs over

[2] Dr. Humphreys is the Director of the Selig Center for Economic Growth. The study included data for the Savannah Harbor and the port at Brunswick, Georgia. The studies are attached to these comments as Exhibits A and B. The GPA requests that the Corps include these studies as part of the administrative record.

21,000 employees. The Savannah Harbor generates over $1.1 billion in state tax revenues, $850 million of local tax revenues and $2.7 billion in federal tax revenue.

The Savannah Harbor also contributes substantially to the South Carolina economy, particularly Jasper and Hampton Counties. Dr. Humphrey analyzed the economic activity of imports and exports that have South Carolina as the point of origination or destination and the port used was either Savannah or Brunswick. (Dr. Humphrey's study did not calculate the contributions solely from the Savannah Harbor. Nonetheless, the level of economic activity is substantial.)

Additionally, Georgia ports contribute $4.3 billion in sales to the South Carolina economy, and $1.5 billion to South Carolina's Gross Domestic Product ("GDP"). Georgia ports account for 19,700 full-time and part-time employees in the state of South Carolina. Federal, state and local taxes generated from Georgia ports exceed $330 million annually in South Carolina according to Dr. Humphrey's analysis.

In the Economic Appendix of the Draft GRR, the Corps analyzes the Regional Economic Development Benefits of several counties surrounding Savannah Harbor including Chatham, Effingham, Bryan and Liberty Counties in the inner ring, and Screven, Bulloch, Candler, Evans, Tattnall, Long and McIntosh Counties in the outer ring. The counties in South Carolina bordering Savannah Harbor were not included in the analysis, and certainly the GPA believes that the Corps should include the South Carolina counties. Numerous South Carolinians are employed directly by the GPA and by companies doing business at or through the GPA facilities. The GPA believes the project will have a positive benefit on these neighboring counties in South Carolina, particularly on bordering Jasper and Hampton Counties, two of the most economically depressed counties in the state.

The GPA has demonstrated an ability to grow the business of Savannah Harbor even during difficult economic times. The United States and the region will continue to benefit from having the Savannah Harbor expanded to service new generations of container ships as the world fleet continues its shift to larger, more efficient post-Panamax vessels.

C. The GPA Has Invested In Landside Infrastructure

The GPA has made extensive investments in landside infrastructure to improve harbor operations, and has plans for additional investments. These investments have contributed to the success and growth of the Savannah Harbor over the past decade and will continue to contribute to future growth.

The GPA has invested over $80 million to expand and improve operations at the Garden City Terminal. It has improved several berths and added cranes to service post-Panamax ships. The current master plan calls for of completion of improvements and expansion in 2020. The Garden City Terminal will become the largest single facility handling containers in the United States. The Terminal will have more than 1,200 acres of storage space and nearly 9,700 feet of berth. The Terminal now has 23 post-Panamax size cranes and will have 33 such cranes.

The Garden City Terminal is a gateway to extensive rail and road networks that enables shipment of goods to and from the Midwest and Southeast. As a result, the port services approximately 44 percent of the United States population. The Terminal is served by two Class I railroads, Norfolk Southern and CSX, and has two on-site intermodal container transfer facilities ("ICTF") that ship goods to Atlanta and the Midwest in a matter of days. Currently, about 20 percent of the cargo that the port handles moves by rail and this is expected to grow to as much as 25 percent over the next five to 10 years. The Norfolk Southern ICTF includes 12,500 feet of working tracks and 7,500 feet of storage tracks on approximately 25 acres. The CSX ICTF houses 6,435 feet of working tracks and 12,406 feet of storage tracks. These two facilities allow overnight delivery to Atlanta and other southeastern gateways, and two to four-day service to distribution centers including Charlotte, North Carolina; Dallas, Texas; Chicago, Illinois; and Memphis, Tennessee.

The Garden City Terminal has three separate gates and 37 lanes. Due to implementation of large and smaller improvements, the Terminal regularly accommodates more than 8,000 truck movements through the gates daily. The Corps analyzed the incremental cost differences of inbound shipment of goods to the hinterlands (see, e.g., summary in Table 37 of the Multi-Port Study). The Corps found that the Savannah Harbor was the least cost alternative among East Coast ports for shipping goods inland to Memphis, Tennessee; St. Louis, Missouri; Jackson, Mississippi; Birmingham, Alabama; Nashville, Tennessee; and Atlanta, Georgia.

In addition to the GPA-owned facilities, shippers and industry have established facilities at the Savannah Harbor within close proximity to the Garden City Terminal to accommodate containerized cargo, including large-scale warehouse sites, retail distribution centers, and construction-ready sites. Close proximity of such operations to a port terminal shrinks drayage costs and helps optimize equipment and freight turn-around. The GPA has developed an on-line tool that identifies port-dependent sites and warehouses along the major corridors to its terminals. More than 19 million square feet of retail distribution centers have been established near Savannah by the nation's largest retailers. Approximately 600,000 TEUs are handled by Savannah-area import distribution center activity.

The GPA has pursued a program of investment in comprehensive improvements necessary to accommodate the growth in traffic predicted from time to time over the last 20 years, and reconfirmed in the Draft GRR. The expansion project allows the Savannah Harbor to better service current traffic and to accommodate post-Panamax ships so that containerized and other cargo will be exported from or distributed within the United States efficiently. The Savannah Harbor is already an important link to the existing landside rail and road network that easily services the Midwest and Southeast. Approval and construction of the SHEP would assure optimal use of those networks.

D. The Savannah Harbor Exports More Than It Imports

The Savannah Harbor exports more goods than it imports handling12 percent of all US containerized cargo exports. This fact distinguishes the Savannah Harbor from other East Coast ports and even from most ports in the United States. The high volume of exports provides further justification for continued investment in the Savannah Harbor through approval of SHEP.

In fiscal year 2010, exports accounted for 54 percent of the traffic (as measured by TEUs) through the Savannah Harbor, while 46 percent of the traffic was imports. The opposite is true at most ports where imported goods traffic exceeds exports. The national average at ports is that 39 percent of the traffic is exports while 71 percent of traffic is imports.

The top five exports shipped from the Garden City Terminal are (1) wood pulp, (2) paper and paperboard, (3) food, (4) clay, and (5) chemicals. Food exports include refrigerated cargo and agricultural products. The Garden City Terminal is among the largest facilities for refrigerated cargo. The top five refrigerated exports are (1) poultry, (2) meats, (3) oranges, (4) citrus juices and concentrates, and (5) grapefruit and lemons. The exports are destined for markets throughout the world; mostly in Asia, and also in Europe, the Middle East, the Mediterranean, and Latin America.

The Savannah Harbor is a critical component in the East Coast ports system for handling exports efficiently and cost-effectively. Exports will become diffused, less efficient and more expensive if the SHEP is not approved.

E. <u>The SHEP Will Not Divert Traffic From Other Ports</u>

The Corps analysis also evaluated industry shipping trends. The Corps conducted a regional port analysis and a multi-port study, which are part of the Draft GRR. The Corps concluded that the SHEP will not divert containerized cargo from other East Coast ports. Rather, several East Coast ports will need expansion to handle the increased cargo expected at East Coast ports when Panama Canal improvements are completed and shippers add more post-Panamax ships to their respective fleets.

Cargo traffic diversion thus is not a factor as to whether the SHEP should be approved. Thus, decision makers and the public should discount comments focused on concerns that SHEP approval will harm the business of other East Coast ports. The Multi-Port Analysis and Regional Port Analysis dispel those concerns. These analyses demonstrate that the immediate and longer term growth in traffic requires servicing by a system of East Coast ports due to economic realities and environmental constraints.

The GPA supports the SHEP because it is in the national interest and will improve navigation. The economics fully support the SHEP and fully support continued investment in this vital East Coast port.

III. ENVIRONMENTAL ISSUES

The Corps conducted a thorough examination of all practicable alternatives as defined by the Section 404(b)(1) Guidelines. Environmental impacts were identified and thoroughly characterized based on existing information and the several new studies that were conducted at the direction of the Project Delivery Team. Potentially adverse effects were addressed through an extensive process of avoidance, minimization and mitigation.[3] The project and mitigation strategy fulfills the letter and spirit of the term "practicable" which means "available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes."[4]

A. Alternatives Analyses

The full range of alternatives has been evaluated, including foregoing improvements at the Savannah Harbor in favor of expansion at other East Coast ports. The Corps also considered several locations for expansion within the Savannah River, and considered alternatives ranging from no expansion to deepening the harbor to a MLW depth of 48 feet.[5]

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[3] Mitigation Planning Appendix C to the DEIS.
[4] 40CFR § 230.3(q).
[5] Appendix O of the DEIS.

An extensive mitigation process was pursued to identify alternatives for avoiding impacts, as well as to minimize and mitigate impacts where avoidance was not feasible.

Information used to evaluate alternatives to the currently proposed SHEP included the environmental resources constraints inventory developed for the Regional Port Study. The information collected allowed evaluation and comparison of the economic and environmental impacts of harbor expansions at Savannah with proposed expansion projects at other southeastern ports. See the Environmental Issues Survey, including table 9, in Section II of the Final Study.

The study and inventory confirmed that there are no practicable alternatives to deepening the Savannah River channel in order to achieve the harbor's need to accommodate traffic growth. The Regional Port Analysis compared environmental impacts caused by expansion projects at several southeastern ports, including a proposed port at Jasper, and the ports of Jacksonville, Savannah, Charleston, Wilmington and Norfolk. See Table 9 (page 13), entitled "Constraint Determination and Anticipated Impact Levels for Regional Port Expansion ROI [Region of Impact]" which identifies several environmental constraints for expansion projects at each port, and tentatively characterize them from Substantial to Minor.

Table 9 of the Regional Port Study allows analysis in several respects to compare the total number of parameters showing potential impacts, or to compare the magnitude of the impacts through some weighted average, or to focus on a few parameters deemed to be critical. These analyses show that expansion projects at all southeastern ports face substantial environmental constraints that may require mitigation. No one port appears to have substantially fewer, or greater, environmental constraints than any or all others. Thus, even if another port could expand to absorb all the additional traffic projected for the future, none stand out as clearly less environmentally constrained than Savannah.

B. The Corps Completed Extensive Study of the Savannah River Basin

1. Extensive Studies

The Corps has analyzed expansion alternatives from no expansion to expansion to MLW depths ranging from 44 to 48 feet using well-recognized models and engineering data to determine and to compare the impacts on the environment for each alternative and the appropriate measures to mitigate them. Based on extensive study during the past 14 years, the Corps has designed an expansion project that mitigates all impacts to the environment.

The Corps worked closely in identifying and developing mitigation plans with federal agencies, state agencies, local governments and other non-government stakeholder groups throughout, including through the SEG process, for the past ten years. Each participant had opportunities to identify issues, develop and propose studies and demonstration projects, and critique the quality and quantity of data upon which the DEIS and Draft GRR are based. After considering all available information, the Corps has recommended expanding the Savannah Harbor because the project is in the national interest.

The Corps also has found that expansion to a MLW depth of any increment of channel depth, with appropriate mitigation, does not cause significantly less damage than would occur if the port is expanded to a MLW of 48 feet with mitigation. As a result, all alternatives have essentially the same net environmental impacts. A depth less than 48 feet would eliminate economic and navigation benefits provided by a deeper port with no commensurate benefit to the environment.

The following describes the framework employed by the Corps to evaluate environmental impacts and to develop plans to mitigate those impacts, and then describes several key environmental impacts and how the SHEP will mitigate those impacts.

2. <u>Evaluation of Environmental Impacts Generally</u>

The Corps carefully and deliberately examined each alternative considered to identify potential environmental impacts. The Corps coordinated its examination with sister federal agencies (EPA, FWS, NMFS), state agencies of Georgia and South Carolina (GADNR, GAEPD, Georgia Department of Transportation ("GADOT"), SCDHEC, SCDNR), and with a broad range of other non-government stakeholders. The coordination efforts have ensured the SHEP Project Development Team: (1) conducted necessary evaluations; (2) used acceptable and recognized evaluation tools; (3) evaluated alternatives under conditions determined by the agencies to be appropriate; and (4) developed information each agency needs to reach a final decision on project approval.

3. <u>Development of Mitigation Plans Generally</u>

The mitigation plans developed for the SHEP are consistent with the policies and regulations for developing mitigation plans adopted by the Corps and other federal agencies. Applying a process common for civil works projects, the Corps' plan for the SHEP will avoid and minimize environmental impacts to the maximum extent possible, and otherwise address natural resources impacted by the SHEP. The specific measures to address, avoid, and minimize environmental impacts include channel design (*i.e.*, maintaining the existing side slopes), placement of dredged material in existing confined disposal facilities ("CDFs"), depositing and capping dredged material containing elevated levels of naturally occurring cadmium in one CDF, and designing a broad berm in the sediment basin to restrict upstream salinity movement.

The SHEP's mitigation measures include, but are not limited to, flow re-routing plans, an oxygen injection system that ensures the SHEP will not further depress dissolved oxygen levels in the Savannah River or the Savannah Harbor, and installing a fishway.

The last component of environmental impact planning concerns strategies to replace or compensate for resources adversely impacted when avoidance or mitigation are not feasible. Relative to replacement or compensation, the Corps' strategy in order of preference is as follows: restoration, enhancement, creation, preservation and compensation. Thus, prior to relying on preservation, the Corps intends to avoid and minimize project impacts and restore or enhance existing environmental functions where feasible.

C. Wetlands

1. Savannah River Wildlife Refuge and Freshwater Wetlands

The Corps and other agencies have made a thorough evaluation of potential impacts to tidal freshwater wetlands and for its development of mitigation plans designed to minimize the impacts. They collectively identified sites where freshwater wetlands might be restored, enhanced or created. For example, the wetlands mitigation plan is consistent with policy of Georgia resource agencies. The wetlands restoration and improvement component, through flow-altering features, is more than fifty percent of the mitigation plan recommended for each depth alternative considered. The Corps was vigilant in designing the SHEP so as to avoid and minimize impacts to wetlands. Only after exhausting those strategies has the Corps focused on additional strategies. The GPA supports the need for and agrees the Corps should acquire and preserve 2,683 acres to offset changes in wetland salinities associated with the 48-foot alternative.

The proposed magnitude of acquisition and preservation of existing wetlands is significant and meets all legal requirements. At the recommendation of EPA Region 4, the Corps used its Standard Operating Procedures ("SOP"), which have been adopted by the natural resource agencies in Georgia, to evaluate impacts and calculate compensatory mitigation necessary to offset remaining project impacts for the 45, 46, 47, and 48-foot alternatives. Preservation of lands and existing wetlands bordering the refuge is necessary to offset remaining impacts for each of these depth alternatives. The Savannah District consulted with the Corps Center for Expertise for Ecosystem Restoration (the "CEER") which confirmed the SOP was technically sound for use to determine the acreage needed for preservation to offset remaining project impacts. The proposed project mitigation plan also conforms to the new mitigation rule, jointly established by EPA and the Corps (published in the Federal Register on April 10, 2008), and meets the requirements of 33 C.F.R. Part 332.[6]

The 2,683 acres of buffers and wetlands identified for acquisition and preservation are among properties FWS and the Savannah National Wildlife Refuge ("SNWR") have identified within the estuary as ecologically valuable. They will provide positive contributions to the goals of SNWR and will enhance the area's fish and wildlife resources.

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[6] Although the proposed mitigation ratio for preservation (8:1) is below the ratio recommended by the EPA Region 4, Compensatory Mitigation Policy (2001) (10:1), the lower ratio for this project is not a reason to reject the mitigation plan for the SHEP. The EPA Region 4 Compensatory Mitigation Policy recognizes that its recommended ratios are "guides" and that "[d]etermination of the appropriate type of mitigation should be made on a case-by-base basis, based upon the condition and needs of the watershed in which the impacts are proposed and the nature of the impacts." EPA Region 4 Compensatory Mitigation Policy at i and 4. With respect to the SHEP, the Corps obtained substantial information about the quality and functions of the impacted wetlands and made a functional assessment of the project area using its professional judgment.

The proposed properties to be acquired and preserved are predominantly a mixture of tidal freshwater wetlands, bottomland hardwoods, and uplands bordering the SNWR. While the mitigation has been criticized as not being "in kind" mitigation, the locations of the properties proposed for mitigation are critical in buffering the refuge from encroaching residential development, generally found to be the most polluting type of development on neighboring wetlands. FWS has wanted to add these properties to the SNWR, but has lacked the funds to do so. The opportunity to have the SHEP fund these acquisitions is one reason why FWS supports preserving properties as mitigation for the project's impacts to tidal freshwater wetlands. One further point is worth noting and supporting.[7]

2. Fringe Brackish/Saltwater Marshes

Six locations will be directly impacted by the dredging of the shoreline of the navigation channel. In total, approximately 14 acres of brackish to saltwater marsh is expected to be impacted. Neither the area impacted nor the magnitude of impacts will vary due to the depth of the project. State and federal natural resource agencies have requested in-kind mitigation within the Savannah River Basin for these direct impacts. The GPA and the Corps agree. Thus, the Corps has proposed to restore a previously used sediment placement facility (CDF 1S) to a salt and brackish marsh system. This area is approximately 42 acres and is located adjacent to the confluence of Front River and Middle River and within the boundaries of SNWR. Natural resource agencies have approved the concept of restoring the site to a marsh.

[7] The proposed plan also includes an "escalator." In the event the impacts to wetlands exceed what the Corps predicts, the Corps is committed to acquire and preserve an additional five percent of wetlands.

Applying the SOP, the Corps found the acreage required for adequate compensation of direct excavation impacts is approximately 25.8 acres of restored salt marsh, or slightly less than 2:1 for the 14 acres to be impacted. Conversion of CDF 1S will fully compensate for direct impacts associated with dredging the channel at each depth alternative, and the excess acres of restored salt marsh will be credited to the SHEP as advance mitigation for possible offset of future maintenance activities.

D. Endangered Species – Shortnose Sturgeon

The evaluation of impacts to endangered species and their habitat is an excellent example of how the Corps coordinated its study and mitigation plan development with all key stakeholders, including federal agencies, state natural resource agencies, and the SEG. These efforts yielded a comprehensive study of potential impacts to shortnose sturgeon and measures to mitigate and offset them. Flow re-routing systems and the dissolved oxygen injection system (discussed in Part G) are the principle strategies for avoiding impacts to the shortnose sturgeon.

Other than construction of a sill in Middle River to protect important nursery habitat for juveniles, neither the Corps nor the other federal and state agencies has identified measures that would restore shortnose sturgeon habitat or enhance existing habitat located within the estuary. Therefore, the Corps proposes to construct a fishway around the New Savannah Bluff Lock & Dam designed specifically for shortnose sturgeon, which would allow fish to move by the lowest dam on the river and increase sturgeon habitat available. The fishway would open an additional 20 miles of habitat upstream of the dam and provide access to reaches of the river that shortnose sturgeon have used in the past. The design of the fishway would also allow fish to move downstream and ensure that young fish spawned upriver could access other habitat needed in later life stages. While potential adverse impacts to shortnose sturgeon habitat are expected to occur at each project depth analyzed even after flow re-routing and dissolved oxygen injection are completed, the federal and state natural resource agencies have confirmed the proposed mitigation measures, including the fishway, effectively will compensate for these potential impacts.

E. **Fisheries – Striped Bass**

The evaluation of potential impacts to the habitat, and directly to striped bass habitat, is similar to the evaluation for shortnose sturgeon. The Corps has acted in coordination with federal agencies, state agencies, and the SEG to identify, evaluate and mitigate potential impacts to striped bass habitat. The plans to address shortnose sturgeon habitat will also reduce impacts to striped bass habitat. The mitigation strategies include flow re-routing plans and an oxygen injection system.

The Corps and natural resource agencies have concluded the best additional measures to offset impacts caused by the SHEP is to participate in and expand the Georgia program for restocking striped bass. The Corps coordinated with GADNR and other natural resource agencies and confirmed that expanding the ongoing stocking program would compensate for the remaining impacts to striped bass habitat. The GPA fully supports the plan to expand the striped bass restocking program. The Corps has proposed to fund the stocking program in proportion to the extent of impacts expected to striped bass habitat. Thus, similar to other potential environmental impacts, the proposed mitigation plan will fully compensate for potential impacts to striped bass habitat at each depth alternative considered, including the 48-foot alternative.

F. **Energy Efficiency And Air Quality**

Energy efficiency and conservation is a significant component of the GPA's capital expenditure program for its terminal facilities. These green programs have reduced and will continue to reduce diesel fuel consumption, reduce air and noise pollution, and support minimization and reduction of potentially adverse effects on the human and natural environment.

The current elements of the energy efficiency program include several elements that combine to reduce the annual use of diesel fuel by 4.5 million gallons. For example, the GPA deploys electrified ship-to-shore cranes and not diesel fuel-operated cranes. The electric cranes consume less energy to operate than diesel powered cranes and generate less noise. Thus, crane operations have significantly reduced potential effects on air quality in nearby neighborhoods. By switching to electric ship-to-shore cranes, the GPA annually avoids the use of 1.9 million gallons of diesel fuel. The GPA has added refrigerated container racks, which annually will eliminate combustion of an additional 2.4 million gallons of diesel fuel. Two other projects of consequence, which together reduce annual diesel fuel consumption by over 200,000 gallons, are the repower of the rubber tire gantry cranes and the use of a diesel fuel additive in yard equipment including rubber tire gantry cranes and jockey trucks.

The positive impacts from these investments are apparent to any one who has toured the Garden City Terminal. The terminal is relatively quiet and the air quality is improved.

Such benefits are enjoyed by the thousands who work at the Savannah Harbor, the neighborhoods around the port and the metro-Savannah region.

Also, larger ships will carry more cargo and will result in fewer trips. This will generate less pollution on a per ton basis and will improve air quality.

G. Dissolved Oxygen

While the SHEP, if it were to be completed without mitigation, would impact dissolved oxygen levels, the Corps and the GPA have developed a comprehensive mitigation plan to address the predicted impacts. As a result, the SHEP is not expected to cause adverse impacts on dissolved oxygen levels throughout the estuary either under existing water quality standards or under the proposed Total Maximum Daily Load ("TMDL"), expected to be finalized later this year.

The central feature of this mitigation plan is injection of hyper-oxygenated water into the estuary. The system adds oxygen to the estuary at key points to offset deficits caused by having a deeper channel. The GPA has conducted a full-scale demonstration of the injection system technology, which confirms the system will achieve the expected results. Moreover, the Corps will ensure the dissolved oxygen injection system functions properly and will conduct extensive water quality monitoring to ensure the system is performing as modeled.

1. Savannah Harbor TMDL and Water Quality Standards for Dissolved Oxygen[8]

Today, the dissolved oxygen levels in the Savannah River estuary fall below regulatory requirements during summer months and during periods of low tide. These

[8] Documents attached to and referenced in the Draft EIS and Draft GRR should be updated to cite or refer to the most recent water quality standard and the 2010 TMDL for the Savannah Harbor.

conditions reduce dissolved oxygen concentrations in the river and estuary.[9] EPA and GAEPD issued a dissolved-oxygen TMDL for the Savannah River in 2006,[10] which imposed a zero-discharge requirement on oxygen-demanding pollutants. The 2006 TMDL is set to be superseded by new TMDL – the 2010 TMDL, which EPA has approved.[11] The 2010 TMDL, allows use of a "TMDL Calculator" – a system for evaluating discharge scenarios and for developing pollution reduction strategies. EPA and EPD expect dissolved oxygen conditions in the Savannah estuary to improve through the TMDL Calculator strategy.[12]

Georgia and South Carolina have adopted identical dissolved oxygen water quality standards – daily average of 5.0 mg/L and no less then 4.0 mg/L maintained in the waterbody.[13]

2. <u>Studies of Impact of SHEP on Dissolved Oxygen in the Savannah River Estuary</u>

The Corps has overseen several studies, which apply well-established models, of the impacts the SHEP may have on dissolved oxygen levels within the Savannah River at depths

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[9] The Savannah River between Fort Pulaski (River Mile 0.0) and the Seaboard Coastline Railroad Bridge (Mile 37.4) is predicted to be impacted.

[10] The 2006 TMDL was based on Georgia's dissolved oxygen standard that it had adopted, but that EPA never approved. Georgia adopted a new dissolved oxygen standard in 2009, which in turn, prompted development of a new TMDL.

[11] A copy of the 2010 TMDL is attached as Exhibit C.

[12] GRR Section 5.7.3.

[13] Both the Georgia and South Carolina standards provide flexibility when the dissolved oxygen levels are below the water quality standard because of the "natural condition" in a waterbody. Compare *Georgia Rules and Regulations for Water Quality Control*, Chapter 391-3-6-.03, Water Use Classifications and Water Quality Standards (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.); and *South Carolina Water Quality Standards*, Section 48-1-83, et seq., 1976 Code of Laws (For a naturally low dissolved oxygen water body, the quality of the surface waters shall not be cumulatively lowered more than 0.10 mg/L for dissolved oxygen from point sources and other activities)

ranging from 45 feet to 48 feet.[14] Federal and state agencies participated in the evaluation and selection of these models. The primary models are the Environmental Fluids Dynamics Code ("EFDC") model, which was used to develop the hydrodynamic data, and then was linked to the Water Quality Analysis Simulation Program Version 7.0 ("WASP7").[15] The models analyzed twenty-six spatial zones, extending from 61 miles above Fort Pulaski to the Atlantic Ocean, under both average and drought-river flow, and compared expected dissolved oxygen levels to the pertinent water quality standards. The Corps then determined the mitigation needed to offset predicted impacts on dissolved oxygen levels.

i Mitigation of Dissolved Oxygen Impacts

While modeling has predicted adverse impacts at all depths if the SHEP were completed without any mitigation, the Corps has developed reasonable and appropriate mitigation plans. First, the Corps retained MACTEC Engineering and Consulting, Inc. ("MACTEC"), a well respected environmental firm, to examine 25 mitigation strategies.[16] A dissolved oxygen injection system was found to be the best option for elevating depressed dissolved oxygen levels in the Savannah Harbor that would result from the SHEP. MACTEC further recommended Speece Cones as the appropriate land-based technology for such oxygen injection, which would super-oxygenate a portion of the river water for reintroduction.

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[14] DEIS, Section 5.2.1; DEIS Appendix C (Mitigation Planning) at VI.B and Appendix L (Cumulative Impacts Analysis) at 10.

[15] Additional detail regarding development and approval of the models in described in the Engineering Appendix to the GRR, including Engineering Supplemental Studies, 1.1.5; 1.1.8; and 1.1.18.

[16] DEIS, Appendix C, Mitigation Planning.

The GPA retained MACTEC to conduct a full-scale demonstration project of the dissolved oxygen injection system recommended to the Corps during the summer of 2007. MACTEC issued a report of the demonstration project in January 2008.[17] This was followed by additional analysis and modeling requested by the resource agencies and another report by Tetra Tech, Inc. in 2010, all of which confirmed the dissolved oxygen injection technology "can effectively add the required DO mitigation amount to the harbor and reduce in-stream DO deficits during critical summer months."[18] The demonstration project also confirms that the injected oxygen is dispersed quickly in the water column so there is no risk of harm to fishery resources from exposure to highly concentrated oxygenated waters. The Corps has refined the dissolved oxygen mitigation plan based on the real-world experiences of the demonstration project.[19]

To ensure that the full mitigation project performs as predicted, the Corps will implement the Monitoring & Adaptive Management Plan, included as Appendix D to the DEIS. Under this plan, the Corps will monitor the performance of the injection system and dissolved oxygen levels and make further enhancements to the mitigation process should the project fail to perform as predicted.

ii <u>Conclusion</u>

[17] MACTEC, 2008. Savannah Harbor Reoxygenation Demonstration Project, prepared for the Georgia Ports Authority. (January 8, 2008) (Attached hereto as Exhibit D).
[18] Tetra Tech. Inc. Oxygen Injection Design Report, Savannah Harbor Expansion Project, Savannah, Georgia prepared for USACE Savannah District (October 15, 2010). This may be found in the GRR's Engineering Supplemental Studies at 1.1.4.
[19] *Id.*

The proposed mitigation measure of oxygen injection in the Savannah Harbor has been demonstrated to be the most efficient and feasible means to mitigate the incremental adverse effects of the SHEP on the Savannah Harbor's dissolved oxygen regime and satisfy Georgia and South Carolina dissolved oxygen water quality standards at the 48-foot depth. This has been confirmed through hydrodynamic and water-quality predictive modeling and the full-scale demonstration project, as well as numerous other studies as presented in the DEIS and draft GRR. The appropriate technology, amount of oxygen to be injected and the locations of the systems have been determined. The Monitoring & Adaptive Management Plan will implement an extensive monitoring system throughout the SHEP to verify model predictions and allow modifications as needed based on the results of the monitoring.

H. Protection of Drinking Water Resources

The SEG and others requested that the Corps analyze whether the SHEP might cause saltwater intrusion or chloride levels to rise in areas used as potable water sources for the City of Savannah, other South Georgia communities. The Corps conducted the requested studies that confirmed the SHEP should not cause adverse impacts to the drinking water resources. The City of Savannah requested collection of additional data and modeling. The additional analysis and subsequent determinations will be included in the Final Environmental Impact Statement. The Corps will also continue to monitor saltwater and chloride levels during construction and thereafter as part of the Monitoring & Adaptive Management Plan.

1. Upper Floridan Aquifer

The Upper Floridan Aquifer is an extensive source of underground water that provides the primary water supply for much of South Georgia. Among other uses, the Upper Floridan Aquifer provides thirty percent of the total water supply to Chatham County.

The Corps performed six tasks to study the geologic and hydro geologic framework and to refine a regional United States Geological Service model of the aquifer.[20] Then, dredging scenarios were run assuming an additional three feet of sediment removal beyond the dredged depth and other factors were applied to produce best-case and worst-case scenarios under both dredging and no dredging conditions.

The studies and models confirm the SHEP would have minimal adverse impacts on groundwater.[21] Water withdrawals from the Aquifer, unrelated to dredging and the SHEP, would be the dominant cause of any saltwater encroachment. Reduced thickness of the confining layer due to the SHEP at 48 feet MLW also would not significantly affect chloride levels along the navigation channel. Further, the SHEP would have minimal impacts on the water quality in production wells that obtain raw water supply from the Aquifer.

2. Abercorn Creek

The City of Savannah has a water intake on Abercorn Creek to obtain source water for its water supply treatment plant. The City of Savannah asked the Corps to conduct studies to confirm the SHEP would not cause elevations in chlorides at the Abercorn Creek

[20] For additional discussion of evaluation of impacts to the Upper Floridan Aquifer, see DEIS, Section 5.5, DEIS App. L (Cumulative Impacts) at 11 and GRR Section 8.2.1 for additional discussion. These tasks included (1) Subbottom Seismic Survey; (2) marine drilling; (3) land drilling; (4) GIS; (5) 3-D Numerical Hydraulic Model; and (6) Aquitard Test Feasibility.

[21] US Army Corps of Engineers, Savannah District. Supplemental Studies to Determine Potential Groundwater Impacts on the Upper Floridan Aquifer, Savannah Harbor Expansion Project, Final Report, June 2007, found in GRR Engineering Supplemental Studies 1.1.36.

water intake. The Corps conducted the requested studies and those studies confirm the SHEP will not have an adverse impact on water quality at the Abercorn Creek water intake.[22]

The worst case scenario predicted an increase of chloride concentration by 3 percent.[23] Although the worst-case scenario is not a risk to the City of Savannah, the City has disagreed with the methodology and modeling. As noted, the Corps continues to collect data and is conducting additional modeling and analysis at the request of the City of Savannah. These results and any further recommendations will be included in the Final Environmental Impact Statement. The Corps will monitor chloride levels in Abercorn Creek as part on the monitoring plan to determine if chloride levels rise beyond the model predictions.[24]

I. Adaptive Management And Monitoring

The Corps has included an extensive adaptive management program and monitoring plan as part of the SHEP. The adaptive management program, one of the first ever implemented on a harbor project, is designed to evaluate if the project mitigation is performing as predicted, and then to change the mitigation if needed. The costs for such potential changes are included as part of the project cost, and factored into the net benefits determination. The adaptive management is a critical component of the project.

22 Industrial users require chloride concentrations below 12 mg/L; Georgia's secondary drinking water standard for chloride is 250 mg/L.

23 Tetra Tech, Inc. Savannah Harbor Expansion Project – Chloride Data Analysis and Model Development, prepared for USACE – Savannah District (November 15, 2008), found at GRR, Engineering Supplemental Studies, Item 1.1.7. For additional discussion of the modeling and development of the mitigation alternative, see DEIS, Section 5.2.3; DEIS App. C at VI.E; DEIS App. L at 11 and GRR 8.2.4

24 A detailed discussion of the evaluation and selection of mitigation alternatives can be found in the DEIS, Section 5.2.3; GRR Section 9.8; and DEIS, Appendix C (Mitigation Planning), Section V.C.3.

Some agencies are concerned that the funds will not be available for adaptive management should changes in the project be necessary. The GPA has committed to set aside the local sponsor share for the program in a separate account so the funds are available if needed. The Corps will request the federal share of funds as needed during its routine budgeting process. However, since Congress directed the Corps to employ adaptive management on water resource projects, the GPA submits that federal funds should also be budgeted and set aside during construction to make changes in mitigation for the ecologically sensitive areas within the Savannah Harbor.

The Corps has also developed an extensive monitoring plan for the Savannah Harbor to be conducted prior to, during and post construction. The components of the plan have been coordinated with the federal and state resource agencies to provide comprehensive information that could be used in updating models and evaluating mitigation performance. The Corps proposes to communicate the results of the monitoring throughout the program including posting the results on their public web site and providing an annual report to the agencies and public.

The Corps proposes that post construction monitoring would continue for five years after the completion of construction. The GPA, however, requests extension of that monitoring program to a length more appropriate to determine estuarine trends, but within the limits prescribed by Congress as part of the Water Resources Development Act of 2007.

EXHIBIT A

The Economic Impact of Georgia's Deepwater Ports On South Carolina's Economy in FY 2009

April 2010

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This study was supported by a grant from the Georgia Ports Authority.

Executive Summary

This summary highlights some of the findings regarding the economic impact of Georgia's deepwater ports on South Carolina's economy in fiscal year 2009. The ensuing sections contain the comprehensive technical report.

The statewide economic impact of Georgia's deepwater ports on South Carolina's economy in fiscal year 2009 includes:

- **$4.3 billion in sales (1.3 percent of South Carolina's total sales);**
- **$1.5 billion in state GDP (1 percent of South Carolina's total GDP);**
- **$959 million in income (0.7 percent of South Carolina's total personal income);**
- **19,704 full- and part-time jobs (1.1 percent of South Carolina's total employment);**
- **$190 million in federal taxes;**
- **$84 million in state taxes; and**
- **$63 million in local taxes.**

These economic impacts demonstrate that imports and exports through Georgia's deepwater ports translate into jobs, higher incomes, greater production of goods and services, and revenue collections for South Carolina. Ports operations in Georgia help to preserve South Carolina's manufacturing base, and foster growth of the state's logistics, distribution, and warehousing cluster. In addition, South Carolina benefits from the sizable economic impact that Georgia's deepwater ports have on Georgia's economy as multiplier effects of direct spending in Georgia spill over the state line into South Carolina.

Output Impacts

Measured in the simplest and broadest terms, the total economic impact of Georgia's deepwater ports on South Carolina's economy is $4.3 billion, which is 1.3 percent of South Carolina's output in 2009.

State GDP (Value Added) Impacts

Measured in terms of GDP or value added, deepwater ports located in Georgia contributed $1.5 billion to South Carolina's economy in 2009, which is 1 percent of South Carolina's total GDP.

Income Impacts

Measured in terms of income, deepwater ports located in Georgia contributed $959 million to South Carolina's economy in 2009, which is 0.7 percent of South Carolina's total personal income.

Employment Impacts

The economic impact of Georgia's deepwater ports on South Carolina's economy probably is most easily understood in terms of its effects on employment. Measured in these terms, Georgia's deepwater ports support 19,704 full- and part-time jobs in South Carolina, which is 1.1 percent of the state's total employment (household survey definition). This means that one job out of every 94 depends in some way on deepwater ports located in Georgia.

Federal Tax Impacts

The total economic impact of Georgia's deepwater ports on tax collections by the federal government in South Carolina in 2009 is $190 million.

State and Local Tax Impact

The total economic impact of Georgia's deepwater ports on tax collections by state and local governments in South Carolina is $84 million and $63 million, respectively.

Georgia's deepwater ports are important engines of South Carolina's economy, fostering the development of virtually every industry. Georgia's ports are especially supportive of South Carolina's manufacturing and wholesale/distribution businesses, but nearly all industries benefit from indirect and induced spending. As the state and national economies gain momentum, deepwater ports located in Georgia will generate even more substantial economic impacts in South Carolina. Indeed, the resurgence of both imports and exports in 2010 are good signs for South Carolina's economy, especially manufacturing and wholesale businesses.

Introduction

Although it is widely known that Georgia's deepwater ports create substantial economic impacts in Georgia, the positive impacts of these ports on South Carolina's economy are rarely discussed and heretofore have not been estimated. This study provides the first quantitative estimates of the changes in overall economic activity in South Carolina as a result of the presence and operations of deepwater ports in Georgia. The 2009 impacts are estimated in terms of output (sales), state GDP, income, employment, and tax revenues for the federal government as well as state and local government.

Three types of economic impacts are estimated: (1) the economic impact of exporters in South Carolina who use Georgia's deepwater ports; (2) the economic impact of importers in South Carolina who use Georgia's deepwater ports; and (3) the indirect and induced economic impacts (multiplier impacts) generated in South Carolina due to the direct spending that Georgia's ports generate for Georgia's economy.

Georgia's deepwater ports industry consists of public marine terminals in Savannah and Brunswick owned by the Georgia Ports Authority as well as private marine terminals. Please note that the dollar amounts expressed in this report are reported in current dollars (2009).

Economic Impact Highlights

The fundamental finding of this study is that deepwater ports located in Georgia contribute substantially to South Carolina's economy. The statewide economic impact includes:

- $4.3 billion in sales (1.3 percent of South Carolina's total sales);
- $1.5 billion in state GDP (1.0 percent of South Carolina's total GDP);
- $959 million in income (0.7 percent of South Carolina's total personal income);
- 19,704 full- and part-time jobs (1.1 percent of South Carolina's total employment);
- $190 million in federal taxes;
- $84 million in state taxes; and
- $63 million in local taxes.

Measured in the simplest and broadest possible terms, the total economic impact of Georgia's deepwater ports on South Carolina's economy is $4.3 billion. This amount represents the impact on output, which can be thought of as the equivalent of business revenue, sales, or gross receipts. The $4.3 billion output impact accounts for 1.3 percent of South Carolina's total output in 2009. Out of the $4.3 billion, $2.4 billion (57 percent) comes from exports, $251 million (6 percent) is from imports, and $1.6 billion (37 percent) represents the multiplier effects in South Carolina resulting from the economic impact of Georgia's ports on Georgia's economy.

Expressed in other dimensions, deepwater ports located in Georgia support $1.5 billion in South Carolina's GDP and $959 million in personal income, which account for 1 percent and 0.7 percent of the state's GDP and total personal income, respectively. The total economic impact on employment is 19,704 full- and part-time jobs. The impact of deepwater ports located in Georgia on South Carolina's state tax collections is $84 million; the impact on tax collections by local governments is $63 million; and the impact on federal tax collections is $190 million.

The Concept of Port Economic Impact

Many businesses physically located in South Carolina use Georgia's deepwater ports to export their products or to import finished products and/or raw materials. Thus, exporters and importers located in South Carolina that use Georgia's deepwater ports create two types of economic benefits for South Carolina: (1) direct spending by ports users, and (2) the secondary or indirect and induced spending – often referred to as the multiplier effects – created as direct expenditures by ports users are re-spent in South Carolina. The ports users are mainly manufacturers, wholesalers, distributors, and warehousing and storage firms that use the ports to transport materials and/or products. All of the economic activity (spending) generated by ports users whose decision to locate, remain, and/or expand in South Carolina because of Georgia's deepwater ports can be counted as direct economic impact. But since most ports users are only partially dependent on the presence of Georgia's deepwater ports, only a small portion of their total economic activity is counted as direct economic impact. For example, South Carolina firms that use Georgia's deepwater ports due to cost advantages over other ports or other modes of transportation are only partially dependent on Georgia's ports. Users that only ship a portion of their production and materials through Georgia's deepwater ports are only partially dependent on the ports. Therefore, this study estimates the economically dependent activity based on the value of the cargo exported or imported via Georgia's ports.

In addition, South Carolina's economy benefits from the large economic impacts that Georgia's deepwater ports generate in Georgia. A stronger (larger) neighboring economy conveys significant secondary economic benefits to South Carolina. These include indirect and induced spending—often referred to as the multiplier effects—that result when direct expenditures by Georgia's ports industry or ports users are re-spent in South Carolina. [Note that there are no direct impacts in South Carolina because all of the direct spending included in the economic impact estimates for Georgia takes place in Georgia.]

Secondary spending is frequently referred to as the multiplier effect of direct spending. There are two types of secondary spending: indirect spending and induced spending. Indirect spending refers to the changes in inter-industry purchases as the region's industries respond to the additional demands triggered by spending by either the ports industry or ports users. It consists of the ripples of activity that are created when the ports industry or ports users purchase goods or services from other industries located in the state. Induced spending refers to the additional demands triggered by spending by households as their income increases due to changes in production. Basically, the induced impact captures the ripples of activity that are created when households spend more due to the increases in their earnings that were generated by the direct and indirect spending.

The sum of the direct, indirect, and induced economic impacts is the total economic impact, which is expressed in terms of output (sales), state GDP, income, or employment. Output is gross receipts or sales, plus or minus inventory. Total output impacts are the most inclusive, largest, measure of economic impact. Because of their size, output impacts typically are emphasized in economic impact studies and receive much media attention. One problem with output as a measure of economic impact, however, is that it includes the value of inputs produced by other industries, which means that there inevitably is some double counting of economic activity. The other measures of economic impact (GDP, income, and employment) are free from double counting and provide a much more realistic measure of the true economic impact of Georgia's deepwater ports.

State GDP is value added, which consists of employee compensation, proprietor income, other property income, and indirect business taxes. It is equivalent to gross output (sales or receipts and other operating income, commodity taxes, and inventory change) minus intermediate inputs (consumption of goods and services purchased from other industries or imported). It is often referred to as the state-level counterpart of the nation's gross domestic product (GDP). Income is all forms of employment income, including wages, salaries, and proprietors' incomes. It does not include non-wage compensation (e.g., pensions and health insurance), transfer payments (e.g., welfare or social security benefits), or unearned income (e.g., dividends, interest, and rent). Employment includes total wage and salary employees as well as self-employed individuals. It includes both full- and part-time jobs and is measured in annual average jobs.

Methodology

Estimating the Economic Impact of South Carolina's Exports via Georgia's Ports

Data extracted from the U.S. Census Bureau's Foreign Trade Statistics, State Exports/Port Database indicates that the vessel value of exports originating in South Carolina and a U.S. Customs Port of Exportation Code of either Savannah or Brunswick was $1,601 million in 2009. The vessel value of exports reflects the value of the goods at the U.S. port of export, which is the selling price, or the cost if the goods are not sold. This amount was allocated to the industry sectors supported by the IMPLAN Version 3.0 economic impact assessment software system in a two step process. First, the i-PIERS Port Import Export Reporting Service provided 2009 data regarding vessel value (and tonnage) by 4-digit harmonized tariff code. According to i-PIERS, the vessel value of exports where the origin was South Carolina and the port of export was either Savannah or Brunswick was $1,564 million, which is only 2.3 percent lower than the total obtained from the State Exports/Port Database. A detailed discussion of i-PIERS, including a users' guide can be found at www.piers.com. Second, vessel values by 4-digit harmonized tariff codes reporting at least $1 million were allocated to industry sectors recognized by the IMPLAN Version 3.0 modeling system. The 121 harmonized tariff codes with at least $1 million in vessel value represented 87 percent of the total vessel value of the South Carolina's exports via Georgia's ports as reported by Foreign Trade Statistics. The Foreign Trade Statistics amount ($1,601 billion) was used as a control total, with the difference proportionally allocated to IMPLAN industries based on the methods described above.

The allocated vessel values constitute $1,601 million in direct economic impact on South Carolina's industries (primarily manufacturers). The IMPLAN system was used to estimate the indirect and induced economic impacts of these direct amounts. A detailed discussion of the IMPLAN modeling system, including its structure, methods, and use, can be found at www.implan.com.

Estimating the Economic Impact of South Carolina's Imports via Georgia's Ports

Although the process used to estimate the economic impact related to imported goods entering South Carolina via Georgia's ports is similar to that used to estimate the economic impact of exports, there were some differences. As is the case for exports, the i-PIERS Port Import Export Reporting Service provided 2009 data regarding vessel value (and tonnage) by 4-digit harmonized tariff code. According to i-PIERS, the vessel value of imports where the state of destination was South Carolina and the port of importation was either Savannah or Brunswick was $1,132 million. A comparable import total was not available from the U.S. Census Bureau, Foreign Trade Statistics, however.

The vessel values (by 4-digit harmonized tariff codes) were allocated to sectors recognized by IMPLAN, but only those shipments that reflected imports to wholesale trade businesses were considered to create net economic impacts in South Carolina. For example, shipments of goods likely to go directly to manufacturers as inputs in production were not included in the impact estimates. Consequently, only $439 million out of the $1,132 million reported by i-PIERS could be allocated to wholesale trade businesses.

One problem complicating the analysis of imports is that vessel values are typically expressed in customs value, which is defined as the price actually paid or payable for merchandise when sold for exportation to the U.S. The customs value therefore does not include either the wholesale or the retail margins (markups). IMPLAN requires that the value be entered in the event field for wholesale businesses as either a retail value (which is then margined) or as a wholesale value (which does not need to be margined). The approach used was to take the customs value reported by i-PIERS and impute the retail value by using the IMPLAN generated wholesale margin for South Carolina (18.9 percent) and the general merchandise retail margin (27.8 percent). Consequently, $439 million reported by i-PIERS equals $816 million when expressed as retail sales. The IMPLAN system was used to estimate the indirect and induced economic impacts of $816 million for South Carolina's wholesale businesses.

Estimating the Economic Impact of Spillover Impacts from Georgia

South Carolina's economy benefits from the large economic impacts that Georgia's deepwater ports generate in Georgia. These impacts consist of secondary, or indirect and induced, spending—the multiplier effects—created as direct expenditures by Georgia's ports industry or ports users are re-spent in South Carolina.

The multiplier effects of the direct impacts generated by Georgia's deepwater ports in Georgia on South Carolina's economy were estimated using a multi-regional analysis, which is a new feature available with IMPLAN 3.0. Multi-regional analysis makes it possible to track how a direct impact on any of the industries in one study area (e.g., Georgia) affects the production in any other region (e.g., South Carolina). A detailed discussion of the methods used to estimate direct spending that creates the spillover impacts can be found in the report titled *The Economic Impact of Georgia's Deepwater Ports on Georgia's Economy in FY 2009*, which was produced by the Selig Center and can be obtained from the Georgia Ports Authority. Direct spending in Georgia by Georgia's ports industry and Georgia's port users was $2,069 million and $34,461 million, respectively. These amounts were allocated to IMPLAN sectors and analyzed using a multi-regional analysis of the economies of Georgia and South Carolina.

The Results

The total economic impact of Georgia's deepwater ports on South Carolina's output, GDP, income, and employment is summarized in Table 1. The direct, indirect plus induced, and the total economic impacts in terms of output, income, and state GDP are reported in Table 2. Similarly, Table 3 and Table 4 report the employment and tax impacts, respectively.

■ Output Impacts ■

Measured in the simplest and broadest terms, the total economic impact of the Port of Savannah and the Port of Brunswick on South Carolina is $4.3 billion, which is 1.3 percent of South Carolina's output in 2009. Of the total output impact, $1.8 billion represents initial spending, or direct economic impact; $2.5 billion is indirect and induced spending, or the re-spending (multiplier) impact. Out of the $4.3 billion, $2.4 billion (57 percent) represents the results from exports, $251 million (6 percent) represent the results from imports, and $1.6 billion (37 percent) represents the multiplier effects in South Carolina resulting from the direct economic impact of Georgia's ports on Georgia's economy.

■ GDP (Value Added) Impacts ■

Measured in terms of GDP or value added, Georgia's deepwater ports contributed $1.5 billion to South Carolina's economy in 2009, which is 1 percent of South Carolina's total GDP. Of the total GDP impact, $499 million represents the direct effects of initial spending, or the direct economic impact; $1,045 million is indirect and induced spending, or the re-spending (multiplier) impact. Out of the $1.5 billion GDP impact, $831 million (54 percent) represents the results from exports, $155 million (10 percent) represent the results from imports, and $558 million (36 percent) represents the multiplier effects in South Carolina resulting from the direct economic impact of Georgia's ports on Georgia's economy.

■ Income Impacts ■

Measured in terms of income, Georgia's deepwater ports contributed $959 million to South Carolina's economy in 2009, which is 0.7 percent of South Carolina's total personal income. Of the total income impact, $341 million represents the direct effects of initial spending, or the direct economic impact; $618 million is indirect and induced spending, or the re-spending (multiplier) impact. Out of the $959 million income impact, $532 million (55 percent) represents the results from exports, $90 million (9 percent) represent the results from imports, and $337 million (35 percent) represents the multiplier effects in South Carolina resulting from the direct economic impact of Georgia's ports on Georgia's economy.

■ Employment Impacts ■

The economic impact of Georgia's deepwater ports on South Carolina's economy probably is most easily understood in terms of its effects on employment. Measured in these terms, Georgia's deepwater ports support 19,704 full- and part-time jobs in South Carolina, which equal 1.1 percent of South Carolina's total employment – based on the household survey definition of employment.

This means that one job out of every ninety-four that exist in South Carolina depends in some way on the deepwater ports located in Georgia. Of the total employment impact, 5,394 jobs represent the direct effects of initial spending, or the direct economic impact; 14,310 jobs reflect indirect and induced spending, or the re-spending (multiplier) impact. Out of the 19,704 full- and part-time job employment impact, 10,640 jobs (54 percent) represents the results from exports, 1,762 jobs (9 percent) represent the results from imports, and 7,302 jobs (37 percent) represents the multiplier effects in South Carolina resulting from the direct economic impact of Georgia's ports on Georgia's economy.

■ Tax Impacts ■

The total economic impact of Georgia's deepwater ports on tax collections by the federal government in South Carolina in 2009 is $190 million. The total economic impact of Georgia's deepwater ports on tax collections by state government is $84 million, and $63 million for local governments.

Closing Comment

This study investigates the economic impact of deepwater ports located in Georgia on South Carolina's economy, and finds substantial economic impacts in terms of output (gross receipts or sales), state GDP, income, employment, state and local tax revenues, and federal tax revenues. The findings are based on analytical methods that are standard in regional economics and economic consulting.

Table 1

Summary of the 2009 Economic Impact
of Georgia's Deepwater Ports on South Carolina
(millions of 2009 dollars)

	Total economic impact on: Output	State GDP	Income	Employment (jobs)
SC exports via Georgia's ports	2,443	831	532	10,640
SC imports via Georgia's ports	251	155	90	1,762
Spillover impacts from Georgia	1,583	558	337	7,302
Georgia's ports industry	43	21	13	291
Georgia's ports users	1,540	537	324	7,011
Total output/revenue impact	4,277	1,544	959	19,704

Note: SC exports via Georgia's ports refers to exports where the state of origin is South Carolina and the port of export is either Savannah or Brunswick. SC imports via Georgia's ports refers to imports where the state of destination is South Carolina and the port of import is either Savannah or Brunswick. Spillover impacts from Georgia refer to the indirect plus induced economic impacts in South Carolina of the direct spending associated with Georgia's ports industry and ports users located in Georgia.

Source: Estimated by the Selig Center for Economic Growth, Terry College of Business, The University of Georgia (www.selig.uga.edu), 2010.

Table 2

2009 Economic Impact of Georgia's Deepwater Ports
on Output (Revenue), Income, and State GDP in South Carolina
(millions of 2009 dollars)

	Direct Economic Impact on Output/Revenue	Indirect & Induced Economic Impact on Output/Revenue	Total Economic Impact on Output/Revenue
SC exports via Georgia's ports	1,601	842	2,443
SC imports via Georgia's ports	154	96	251
Spillover impacts from Georgia	0	1,583	1,583
Georgia's ports industry	0	43	43
Georgia's ports users	0	1,540	1,540
Total output/revenue impact	1,755	2,521	4,277

	Direct Economic Impact on Income	Indirect & Induced Economic Impact on Income	Total Economic Impact on Income
SC exports via Georgia's ports	283	249	532
SC imports via Georgia's ports	58	32	90
Spillover impacts from Georgia	0	337	337
Georgia's ports industry	0	13	13
Georgia's ports users	0	324	324
Total income impact	341	618	959

	Direct Economic Impact on Gross State Product	Indirect & Induced Economic Impact on Gross State Product	Total Economic Impact on State GDP
SC exports via Georgia's ports	400	431	831
SC imports via Georgia's ports	99	56	155
Spillover impacts from Georgia	0	558	558
Georgia's ports industry	0	21	21
Georgia's ports users	0	537	537
Total state GDP	499	1,045	1,544

Note: SC exports via Georgia's ports refers to exports where the state of origin is South Carolina and the port of export is either Savannah or Brunswick. SC imports via Georgia's ports refers to imports where the state of destination is South Carolina and the port of import is either Savannah or Brunswick. Spillover impacts from Georgia refer to the indirect plus induced economic impacts in South Carolina of the direct spending associated with Georgia's ports industry and ports users located in Georgis.

Source: Estimated by the Selig Center for Economic Growth, Terry College of Business, The University of Georgia (www.selig.uga.edu), 2010.

Table 3

2009 Economic Impact of Georgia's Deepwater Ports on Employment in South Carolina (full- and part-time jobs)

	Direct Economic Impact on Employment (full- and part-time jobs)	Indirect & Induced Economic Impact on Employment (full- and part-time jobs)	Total Economic Impact on Employment (full- and part-time jobs)
SC exports via Georgia's ports	4,510	6,130	10,640
SC imports via Georgia's ports	884	878	1,762
Spillover impacts from Georgia	0	7,302	7,302
Georgia's ports industry	0	291	291
Georgia's ports users	0	7,011	7,011
Total employment impact	5,394	14,310	19,704

Note: SC exports via Georgia's ports refers to exports where the state of origin is South Carolina and the port of export is either Savannah or Brunswick. SC imports via Georgia's ports refers to the imports where the state of destination is South Carolina and the port of import is either Savannah or Brunswick. Spillover impacts from Georgia refer to the indirect plus induced economic impacts in South Carolina of the direct spending associated with Georgia's ports industry and ports users in Georgia.

Source: Estimated by the Selig Center for Economic Growth, Terry College of Business, The University of Georgia (www.selig.uga.edu), 2010.

Table 4

2009 Economic Impact of Georgia's Deepwater Ports on Tax Collections in South Carolina (millions of 2009 dollars)

	Federal Taxes	State Taxes	Local Taxes
SC exports via Georgia's ports	103.4	40.9	30.9
SC imports via Georgia's ports	19.5	15.2	11.4
Spillover impacts from Georgia	66.8	27.7	20.9
Georgia's ports industry	2.5	1.1	0.8
Georgia's ports users	64.3	26.6	20.1
Total	189.7	83.8	63.2

Note: SC exports via Georgia's ports refers to exports where the state of origin is South Carolina and the port of export is either Savannah or Brunswick. SC imports via Georgia's ports refers to the imports where the state of destination is South Carolina and the port of import is either Savannah or Brunswick. Spillover impacts from Georgia refer to the indirect plus induced economic impacts in South Carolina of the direct spending associated with Georgia's ports industry and ports users in Georgia.

Source: Estimated by the Selig Center for Economic Growth, Terry College of Business, The University of Georgia (www.selig.uga.edu), 2010.

EXHIBIT B

The Economic Impact of Georgia's Deepwater Ports on Georgia's Economy in FY 2009

April 2010

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This study was supported by a grant from the Georgia Ports Authority.

Executive Summary:
The Economic Impact of Georgia's Deepwater Ports on Georgia's Economy in FY 2009

This summary highlights some of the findings regarding the economic impact of Georgia's deepwater ports on Georgia's economy in fiscal year 2009. The ensuing chapters contain the comprehensive technical report.

The statewide economic impact of Georgia's deepwater ports in fiscal year 2009 includes:

- **$61.7 billion in sales (8.6 percent of Georgia's total sales);**
- **$26.8 billion in state GDP (6.8 percent of Georgia's total GDP);**
- **$15.5 billion in income (4.6 percent of Georgia's total personal income);**
- **295,443 full- and part-time jobs (6.7 percent of Georgia's total employment);**
- **$3.5 billion in federal taxes;**
- **$1.5 billion in state taxes; and**
- **$1.1 billion in local taxes.**

These economic impacts demonstrate that continued emphasis on imports and exports through Georgia's deepwater ports translates into jobs, higher incomes, greater production of goods and services, and revenue collections for government. Ports operations help to preserve Georgia's manufacturing base, and foster growth of the state's massive logistics, distribution, and warehousing cluster.

■ Output Impacts

Measured in the simplest and broadest terms, the total economic impact of Georgia's deepwater ports on Georgia's economy is $61.7 billion, which is 8.6 percent of Georgia's output in FY 2009. Out of the total, $36.5 billion represents initial spending, or direct economic impact; $25.1 billion is indirect and induced spending, or the re-spending (multiplier) impact. Dividing the FY 2009 total output impact ($61.7 billion) by initial spending ($36.5 billion) yields an average multiplier value of 1.688. On average, therefore, every dollar initially spent by the ports industry and ports users generates an additional 69 cents for the state's economy.

■ State GDP (Value Added) Impacts

Measured in terms of GDP or value added, Georgia's deepwater ports contribute $26.8 billion to the state's economy in fiscal year 2009, which is 6.8 percent of Georgia's total GDP. Out of the total, $13.2 billion represents the direct effects of initial spending, or the direct economic impact; $13.6 billion is indirect and induced spending, or the re-spending (multiplier) impact.

- **Income Impacts**

Measured in terms of income, Georgia's deepwater ports contributed $15.5 billion to the state's economy in fiscal year 2009, which is 4.6 percent of Georgia's total personal income. Of the total, $7.8 billion represents the direct effects of initial spending, or the direct economic impact; $7.7 billion is indirect and induced spending, or the re-spending (multiplier) impact.

- **Employment Impacts**

The economic impact of Georgia's deepwater ports probably is most easily understood in terms of its effects on employment. Measured in these terms, Georgia's deepwater ports support 295,443 full- and part-time jobs, which is 6.7 percent of Georgia's total employment (as defined by a survey of households). This means that one job out of every fifteen is in some way dependent on the ports. Of the FY 2009 total employment impact, 128,733 jobs represent the direct effects of initial spending, or the direct economic impact; 166,710 jobs constitute the indirect and induced effect of spending, or the re-spending impact.

- **State Tax Impact**

The total economic impact of Georgia's deepwater ports on tax collections by state government in fiscal year 2009 is $1.5 billion.

- **Local Tax Impact**

The total economic impact of Georgia's deepwater ports on tax collections by local governments in fiscal year 2009 is $1.1 billion.

- **Federal Tax Impacts**

The total economic impact of Georgia's deepwater ports on tax collections by the federal government in fiscal year 2009 is $3.5 billion.

Deepwater ports are one of Georgia's strongest economic engines, fostering the development of virtually every industry. The ports are especially supportive of other forms of transportation, manufacturing, wholesale/distribution centers, and agriculture. The outstanding performance of Georgia's deepwater ports relative to other American ports reflects strong competitive advantages that allowed Georgia's ports to expand their share of activities. These advantages are largely the result of strategic investments in port facilities by the State of Georgia over many years. As the state and national economies gain momentum, Georgia's deepwater ports will thrive, generating even more substantial economic impacts in future fiscal years.

Chapter 1: Introduction

Georgia's deepwater ports industry consists of public marine terminals in Savannah and Brunswick owned by the Georgia Ports Authority as well as private marine terminals. Georgia's deepwater ports are thriving, and Savannah's port is one of the fastest growing container ports in the world. The superb performance of Georgia's ports relative to other ports reflects strong comparative advantages that allowed them to expand their shares of regional and national waterborne cargo traffic. These comparative advantages are the result of a series of strategic expansions over many years.

It is obvious that Georgia's deepwater ports create substantial economic impacts on the state in terms of output (sales), state GDP, income, employment, and tax revenues for federal, state, and local governments. Nonetheless, this study provides a quantitative assessment of the changes in overall economic activity as a result of the presence and operations of Georgia's deepwater ports in fiscal year 2009.

The facilities owned by the Georgia Ports Authority in Savannah and Brunswick will be referred to as the Port of Savannah and the Port of Brunswick, respectively; and cargo volumes, expenditures, and impact estimates for these facilities will be reported separately from those for private facilities/docks. The amounts expressed in this report (including the executive summary and appendices) are reported in current dollars (2009).

Chapter 2: Economic Impact Highlights

The fundamental finding of this study is that the strategic decisions by state government to invest public resources in the two deepwater ports have contributed to substantial economic activity in Georgia. The statewide economic impact of the deepwater ports in fiscal year 2009 includes:

- $61.7 billion in sales (8.6 percent of Georgia's total sales);
- $26.8 billion in state GDP (6.8 percent of Georgia's total GDP);
- $15.5 billion in income (4.6 percent of Georgia's total personal income);
- 295,443 full- and part-time jobs (6.7 percent of Georgia's total employment);
- $3.5 billion in federal taxes;
- $1.5 billion in state taxes; and
- $1.1 billion in local taxes.

Measured in the simplest and broadest possible terms, the total economic impact of Georgia's deepwater ports on Georgia's economy is $61.7 billion. This amount represents the combined impact of the ports industry and ports users on output, which can be thought of as the equivalent of business revenue, sales, or gross receipts. The $61.7 billion output impact accounts for 8.6 percent of Georgia's total output in FY 2009. Out of the $61.7 billion, $3.2 billion (5 percent) represents the results from the ports industry and $58.5 billion (95 percent) represents the results from ports users.

Of the FY 2009 total output impact, $36.5 billion represents initial spending, or direct economic impact; and $25.1 billion is indirect and induced spending, or the re-spending (multiplier) impact. Dividing the FY 2009 total output impact ($61.7 billion) by initial spending ($36.5 billion) yields an average multiplier value of 1.688. On average, therefore, every dollar initially spent by either the ports industry and ports users generates an additional 69 cents for the economy.

Expressed in other dimensions, the ports industry and port users together support $26.8 billion in state GDP and $15.5 billion in income, which account for 6.8 percent and 4.6 percent of Georgia's GDP and total personal income, respectively. The total economic impact on employment is 295,443 full- and part-time jobs. The combined impact of the ports industry and ports users on state tax collections is $1.5 billion. The combined impact of the ports industry and ports users on local tax collections is $1.1 billion. The combined impact on federal tax collections is $3.5 billion.

The distribution of total economic impacts of cargo-based activity at the Georgia Ports Authority's facilities in Savannah and Brunswick by mode of cargo indicates that containerized cargo accounts for 91 percent of the reported economic impacts. Breakbulk cargo accounts for 4 percent of the reported impacts, and auto/vehicle cargo accounts for 3 percent of the reported impacts. Liquid bulk and dry bulk cargoes each account for about 1 percent of reported impacts.

Chapter 3: The Concept of Port Economic Impact

The total economic impact of Georgia's deepwater ports consists of (1) direct spending by the ports industry, (2) direct spending by ports users, and (3) the secondary or indirect and induced spending – often referred to as the multiplier effects – created as direct expenditures by either the ports industry or ports users are re-spent.

The ports industry is defined to include economic activity (spending) that involves the transportation of waterborne cargo and ports services, including the ports themselves, the companies engaged in deepwater transportation as well as companies that provide ship services, and companies that provide inland transportation of waterborne cargo. Ports investment (capital expenditures) for additions and/or improvements to Georgia's deepwater ports also are included as part of the ports industry. This definition of the ports industry is identical to the definition used by the U.S. Department of Transportation, Maritime Administration in the MARAD Port Economic Impact Kit. Thus, the ports industry includes activities that take place on the vessel, at the terminal, and during the inland movement of cargo. Since the firms and enterprises that provide these activities locate in Georgia because of the existence of the ports, all of their activity (spending) can be counted as direct economic impact.

Ports users are mainly manufacturers, wholesalers, distributors, and warehousing and storage firms that use the ports to transport materials and/or products. Although most users are importers and exporters, some ship materials or products to and/or from domestic locations. All of the economic activity (spending) generated by ports users whose decision to locate, remain, and/or expand in Georgia hinges on the presence of these deepwater ports can be counted as direct economic impact. But since most ports users are only partially dependent on the presence of Georgia's deepwater ports, only a portion of their total economic activity is counted as direct economic impact. For example, firms that use Georgia's deepwater ports due to cost advantages over other ports or other modes of transportation are only partially dependent on Georgia's ports. Also, users that only ship a portion of their production and materials through Georgia's deepwater ports are only partially dependent on the ports. To avoid double counting, ports users' activity is defined to exclude their transportation expenditures associated with the waterborne cargo that is handled by Georgia's ports industry.

Secondary spending often is referred to as the multiplier effect of direct spending. There are two types of secondary spending: indirect spending and induced spending. Indirect spending refers to the changes in inter-industry purchases as Georgia's industries respond to the additional demands triggered by spending by either the ports industry or ports users. It consists of the ripples of activity that are created when the ports industry or ports users purchase goods or services from other industries located in the state. Induced spending refers to the additional demands triggered by spending by households as their income increases due to changes in production. Basically, the induced impact captures the ripples of activity that are created when households spend more due to the increases in their earnings that were generated by the direct and indirect spending.

The sum of the direct, indirect, and induced economic impacts is the total economic impact, which often is expressed in terms of output (sales), state GDP, income, or employment. Output is gross receipts or sales, plus or minus inventory. Total output impacts are the most inclusive, largest, measure of economic impact. Because of their size, output impacts typically are emphasized in economic impact studies and receive much media attention. One problem with output as a measure of economic impact, however, is that it includes the value of inputs produced by other industries, which means that there inevitably is some double counting of economic activity. The other measures of economic impact (GDP, income, and employment) are free from double counting and provide a much more realistic measure of the true economic impact of Georgia's deepwater ports.

State GDP is value added, which consists of employee compensation, proprietor income, other property income, and indirect business taxes. Value added is equivalent to gross output (sales or receipts and other operating income, commodity taxes, and inventory change) minus intermediate inputs (consumption of goods and services purchased from other industries or imported). It is often referred to as the state-level counterpart of the nation's gross domestic product (GDP). Income is all forms of employment income, including wages, salaries, and proprietors' incomes. It does not include non-wage compensation (e.g., pensions and health insurance), transfer payments (e.g., welfare or social security benefits), or unearned income (e.g., dividends, interest, and rent). Employment includes total wage and salary employees as well as self-employed individuals. It encompasses both full- and part-time jobs and is measured in annual average jobs.

Chapter 4: Methodology

Estimating the economic impact of Georgia's deepwater ports involved two distinct steps. First, data regarding tonnage by type and capital expenditures were obtained from the Georgia Ports Authority. The tonnage and capital expenditure data were imported into the U.S. Department of Transportation's MARAD Port Economic Impact Kit to estimate the direct, indirect, induced, and total economic impacts of the ports industry. Second, ports users' spending was estimated. Ports users were surveyed in 2003 to determine the degree to which they depend on Georgia's deepwater ports. To help correct for non-response and/or incomplete responses and to update the analysis, several types of government and administrative data were used to assess the proportion of revenue or sales in various industries that could be attributed to ports usage. The IMPLAN Version 3.0 economic impact assessment software system was used to estimate the indirect and induced economic impacts of the ports-related portion of spending by users.

Estimating the Ports Industry's Economic Impact

A revised version of the U.S. Department of Transportation's MARAD port economic impact model that was built specifically for Georgia was used to estimate the direct, indirect, and induced economic impact of spending by the ports industry. A detailed discussion of the model, including its structure, methods, and use can be found in the two-volume *MARAD Port Economic Impact Kit.*

The Georgia Ports Authority provided the fiscal year 2009 data on cargo volume (import and export) by mode of transportation for the Savannah and Brunswick facilities that the MARAD model required. The cargo volume reported for the Port of Savannah includes data for the Garden City and Ocean terminals. The cargo volume reported for the Port of Brunswick includes data for Colonel's Island, Brunswick East River, Logistec (Marine Port Terminals), and the Mayor's Point Terminal. Table 1 summarizes cargo volume for cars, containerized cargo, breakbulk cargo, dry bulk cargo, and liquid bulk cargo. Cargo volume is expressed on a per-vehicle basis for auto/vehicle cargo; a per-

TEU (Twenty Foot Equivalent Unit) basis for containerized cargo; and a per-short ton (2,000 pounds) for breakbulk, dry bulk, and liquid bulk. In addition, the Georgia Ports Authority provided estimates of cargo volume for the private facilities/docks based on an analysis of data obtained from PIERS, and the estimates are summarized in Table 2. The Georgia Ports Authority also provided capital expenditures (ports investment) in FY 2009 for the facilities that it owns. Capital expenditures by the private facilities/docks are not included in this analysis, however.

Estimating the Ports Users' Economic Impact

A confidential survey of the entire population of current users of the Georgia Ports Authority's facilities was conducted in 2003 to identify the industries that utilize the ports, their sales, and the extent to which they depend on the ports. *The Economic Impact of Georgia's Deepwater Ports on Georgia's Economy in FY 2003* (April 2004) contains both the survey instrument and a brief summary of responses. Secondary sources of information supplemented and updated the information obtained from the survey. These secondary sources include: (1) The U.S. Department of Commerce, Bureau of Economic Analysis' historical data on gross domestic product and output, gross state product, and personal income (estimates for 2009 were prepared by the Selig Center). (2) The U.S. Department of Labor's and the Georgia Department of Labor's historical data on employment by industry. (3) U.S. Department of Transportation, Maritime Administration, Office of Ports and Domestic Shipping on the economic impact of ports users at the national level. (4) A study of the economic impacts of the U.S. Deepwater Port System prepared for the American Association of Port Authorities. (5) The Georgia Department of Community Affairs and the Department of Industry Trade and Tourism's summary information from their survey of manufacturers regarding their international trade activity and current and future exports of their products.

Based on an analysis of both the survey and secondary information sources, it was determined that port-related sales (output) totaled $34.5 billion in Georgia in fiscal year 2009, or about 4.8 percent of Georgia's total output that year. Manufacturers were estimated to account for about 75 percent of port-related sales, while wholesale/

distribution/warehousing/storage activities accounted for about 19 percent of port-related sales, and agriculture, forestry, and mining accounted for the remaining 6 percent.

The IMPLAN Version 3.0 modeling system was used to estimate the indirect and induced economic impact of ports users' direct expenditures. A detailed discussion of the IMPLAN modeling system, including its structure, methods, and use, can be found at www.implan.com.

Chapter 5: The Results

The total economic impact of Georgia's deepwater ports on output, GDP, income, and employment is summarized in Table 3. The direct, indirect plus induced, and the total economic impacts of Georgia's deepwater ports in terms of output, income, and gross state product are reported in Table 4. Similarly, Table 5 and Table 6 report the employment and tax impacts, respectively. Table 7 reports the overall multiplier values for output, employment, income, and GDP. Table 8 reports the total economic impacts of cargo-based activity by mode of cargo at the Georgia Ports Authority's operations in Savannah and Brunswick. Table 9 shows the ports industry's employment impact by occupation. Table 10 details the employment impact of port users by industry. More detailed tabulations of the economic impact of Georgia's deepwater ports are included in Appendix 1.

■ Output Impacts

Measured in the broadest terms, the total economic impact of the Port of Savannah and the Port of Brunswick on Georgia's economy is $61.7 billion, which is 8.6 percent of Georgia's output in FY 2009.

Out of the total, $3.2 billion (5 percent) represents the results from the ports industry, of which the GPA's operations at the Port of Savannah contribute 76 percent. Ports users' total output impact, however, is nineteen times greater than that of the ports industry – $58.5 billion. Indeed, ports users account for almost 95 percent of the total output impact of Georgia's deepwater ports.

Of the FY 2009 total output impact, $36.5 billion represents initial spending, or direct economic impact; $25.1 billion is indirect and induced spending, or the re-spending (multiplier) impact. Dividing the FY 2009 total output impact ($61.7 billion) by initial spending ($36.5 billion) yields an average multiplier value of 1.688. On average, therefore, every dollar initially spent by either the ports industry or ports users generates an additional 69 cents for the state's economy.

■ GDP (Value Added) Impacts

Measured in terms of GDP or value added, Georgia's deepwater ports contributed $26.8 billion to the state's economy in FY 2009, which is 6.8 percent of Georgia's total GDP. Out of the total GDP impact, $1.5 billion (6 percent) represents the results from the ports industry. The GPA's operations at the Port of Savannah contribute 77 percent of this $1.5 billion. But the $25.2 billion GDP impact attributed to ports users is sixteen times greater than that of the port industry, so users account for 94 percent of the total GDP impact of Georgia's deepwater ports.

Of the FY 2009 total GDP impact, $13.2 billion represents the direct effects of initial spending, or the direct economic impact; $13.6 billion is indirect and induced spending, or the re-spending (multiplier) impact. Dividing the FY 2009 total GDP impact ($26.8 billion) by the direct GDP impact ($13.2 billion) yields an average multiplier value of 2.028. On average, therefore, every dollar of direct GDP produced by the ports industry and ports users yields an additional 103 cents for the state's economy.

- **Income Impacts**

Measured in terms of income, Georgia's deepwater ports contributed $15.5 billion to the state's economy in fiscal year 2009, which is 4.6 percent of Georgia's total personal income. Out of the total, $1.1 billion (7 percent) represents the results from the ports industry. The GPA's operations at the Port of Savannah contribute 77 percent of this $1.1 billion, but ports users' $14.4 billion income impact is almost thirteen times greater. Indeed, users account for 93 percent of the total income impact of Georgia's deepwater ports.

Of the FY 2009 total income impact, $7.8 billion represents the direct effects of initial spending, or the direct economic impact; $7.7 billion is indirect and induced spending, or the re-spending (multiplier) impact. Dividing the FY 2009 total income impact ($15.5 billion) by the direct income impact ($7.8 billion) yields an average multiplier value of 1.994. On average, therefore, every dollar of direct income produced by the ports industry and ports users generates an additional 99 cents for the state's economy.

- **Employment Impacts**

The economic impact of Georgia's deepwater ports probably is most easily understood in terms of its effects on employment. Measured in these terms, Georgia's deepwater ports support 295,443 full- and part-time jobs, which equal 6.7 percent of Georgia's total employment – based on the household survey definition of employment.

This means that one job out of every fifteen is in some way dependent on the ports. Out of the 295,443 jobs, 28,234 (10 percent) represent the results from the ports industry. The GPA's operations at the Port of Savannah contribute 77 percent of these 28,234 jobs, but ports users' 267,209-job impact is nine times greater, so users account for 90 percent of the total employment impact of Georgia's deepwater ports.

Of the FY 2009 total employment impact, 128,733 jobs represent the direct effects of initial spending, or the direct economic impact; 166,710 jobs constitute the indirect and induced effect of spending, or the re-spending (multiplier) impact. Dividing the FY 2009 total job impact (295,422 jobs) by the direct job impact (128,720 jobs) yields an average multiplier value of 2.295. On average, therefore, each job created directly by the ports industry and ports users yields an additional 1.3 jobs in the state.

- **State Tax Impact**

Spending by the ports industry and ports users generate substantial tax revenue for Georgia's state government. The total economic impact of Georgia's deepwater ports on tax collections by state government in fiscal year 2009 is $1.5 billion.

- **Local Tax Impact**

Spending by the ports industry and ports users generate substantial tax revenue for Georgia's local governments. The total economic impact of Georgia's deepwater ports on tax collections by local governments in fiscal year 2009 is $1.1 billion.

- **Federal Tax Impact**

Spending by the ports industry and ports users generate substantial tax revenue for the federal government. The total economic impact of Georgia's deepwater ports on tax collections by the federal government in fiscal year 2009 is $3.5 billion.

Chapter 6: Comparisons to Previous Estimates

In 2007, the Georgia Ports Authority retained the University of Georgia's Terry College of Business to estimate the economic impact of Georgia's deepwater ports on the state's economy. Economic impact estimates for FY 2006 were published in *The Economic Impact of Georgia's Deepwater Ports on Georgia's Economy* (2007). The methods used were very similar to those used in this study. The FY 2006 impact of Georgia's deepwater ports were \$55.8 billion in sales, \$24.8 billion in state GDP, \$14.9 billion in income, and 286,476 full- and part-time jobs.

In 2004, the Georgia Ports Authority retained the University of Georgia's Terry College of Business and Savannah State University to estimate the economic impact of Georgia's deepwater ports on the state's economy. Economic impact estimates for FY 2003 were published in *The Economic Impact of Georgia's Deepwater Ports on Georgia's Economy in FY 2003* (April 2004). The study found that the FY 2003 impact of Georgia's deepwater ports were \$35.4 billion in sales, \$17.1 billion in gross state product, \$10.8 billion in income, and 275,968 full- and part-time jobs.

In 1997, Booz-Allen & Hamilton, Inc. conducted the study and published its results (for 1996) in *Economic Impacts of Georgia's Deepwater Ports of Savannah and Brunswick* (March 20, 1998). Instead of using actual cargo volumes and standard macroeconomic input-output modeling systems (e.g., MARAD Port Economic Impact Kit, IMPLAN, RIMS, or REMI) to measure direct, indirect, and induced economic impacts, Booz-Allen & Hamilton relied primarily on direct survey methods, which they said is "somewhat unique." Due to the unique character of their methods as well as the use of non-conventional definitions of standard economic impact terms, it is very difficult to make meaningful direct comparisons of their results to the results of this study, or to those of any other port economic impact study.

Booz-Allen & Hamilton found that the total economic impact of Georgia's deepwater ports on output (sales) and employment were \$22.3 billion and 76,672 jobs, respectively. Their estimates of the economic impact on tax collections by state and local governments was \$569 million, and that the economic impact on wages was \$1.7 billion. The estimates produced by the Terry College of Business (based on data for FY 2003) were considerably larger. The order of magnitude of Booz-Allen & Hamilton's output impact ($22.3 billion), however, appears to be somewhat reasonable considering that: (1) the Port of Savannah and the Port of Brunswick both experienced exceptionally rapid growth in cargo volumes from 1996-2003 (implying that direct spending by the ports industry was much smaller in 1996 than it was in 2003); (2) Georgia's overall economy was much smaller in 1996 than it was in 2003 (implying that ports-related impacts were much smaller in 1996 than in 2003); (3) the survey-based approach did not capture all of the direct economic impacts; (4) the survey-based approach is incapable of capturing many of the indirect economic impacts; and (5) the survey-based approach does not capture any of the induced economic impacts.

In 1999, Georgia Southern University applied more conventional input-output modeling techniques to re-estimate the ports' 1996 economic impact. But it appears that they basically relied on Booz-Allen & Hamilton's estimate of direct economic impact. Nonetheless, Georgia Southern's use of the REMI model to re-estimate both the indirect and induced economic impacts more fully captured the indirect and induced economic impacts of the direct spending (as estimated by Booz-Allen & Hamilton). Consequently, their impact estimates were somewhat higher than those produced by Booz-Allen & Hamilton.

Chapter 7: Closing Comment

This study investigates the economic impact of Georgia's deepwater ports, and finds substantial economic impacts in terms of output (gross receipts or sales), state GDP, income, employment, state and local tax revenues, and federal tax revenues. The findings are based on analytical methods that are standard in regional economics and economic consulting.

EXHIBIT C

Draft Revised

TOTAL MAXIMUM DAILY LOAD (TMDL)

For

Dissolved Oxygen

In Savannah Harbor

Savannah River Basin

Chatham and Effingham Counties, Georgia

Jasper County, South Carolina

Region4 serving the southeast

Savannah Harbor Dissolved Oxygen TMDL

Executive Summary

This report establishes a revised Total Maximum Daily Load (TMDL) for dissolved oxygen (DO) for the Savannah Harbor from Fort Pulaski (River Mile 0) to the Seaboard Coastline Railway Bridge (River Mile 27.4). The Savannah Harbor is located at the mouth of the Savannah River where it discharges to the Atlantic Ocean. The Savannah River, including the Harbor, serves as the boundary between Georgia and South Carolina.

This TMDL is established at a level necessary to implement the applicable water quality standards, which include the newly adopted Georgia DO criteria and the existing South Carolina DO water quality criteria established for the Savannah Harbor. This TMDL identifies the range of loadings of oxygen-demanding substances that may occur in the watershed, from the Thurmond Dam near Augusta, Georgia through the Savannah Harbor, without exceeding the applicable water quality standards. Consistent with 40 CFR §122.44(d)(1)(vii)(B), EPA expects that the wasteload allocations for the oxygen-demanding substances contained in the TMDL, along with any relevant assumptions and requirements, will be implemented through NPDES permits. This TMDL provides the framework for the State permitting authorities to determine a range of appropriate oxygen-demanding substances (e.g., Ultimate Oxygen Demand [UOD], 5-day Carbonaceous Biochemical Oxygen Demand [CBOD5] and/or ammonia) permit limits using a TMDL Calculator.

The TMDL Calculator will allow the States to evaluate various scenarios and develop a practicable and equitable TMDL reduction implementation strategy. As long as the TMDL reduction implementation strategy and the resultant Ultimate Oxygen Demand (UOD) and National Pollutant Discharge Elimination System (NPDES) UOD, CBOD5 and/or ammonia permit limits selected meet the applicable TMDL as calculated via the TMDL Calculator, the TMDL scenario meets the goals of this TMDL. The allowable UOD will vary depending on the size and location of the individual CBOD5 and ammonia loads and which specific conditions of the Georgia and South Carolina Water Quality Standards are applicable. The initial TMDL target is a daily average delta DO of 0.1 mg/L for Georgia only waters and 0.10 mg/L for waters that are shared with South Carolina. For this initial TMDL target, established during the critical period, the allowąble TMDL range is 80,000 to 115,000 lbs/day.

This TMDL replaces the November 2006 United States Environmental Protection Agency (EPA) Savannah Harbor TMDL that was based on the previous Georgia DO Standard, which is no longer applicable for Clean Water Act purposes. EPA has worked with the Georgia Environmental Protection Division (EPD) and the South Carolina Department of Health and Environmental Control (DHEC) along with a Technical Modeling Advisory Group to develop this revised Savannah Harbor DO TMDL.

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1. Savannah Harbor Description

The Savannah River Basin is located on the border of eastern Georgia and western South Carolina and has a drainage area of 10,577 square miles. The Savannah River serves as the boundary between Georgia and South Carolina, and the Harbor is shared by both states. The portions of the Savannah River Basin included in this TMDL are the middle and lower watersheds encompassing the area from Thurmond Dam to the Atlantic Ocean. Land uses within these watersheds are mostly forestlands, wetlands, and agriculture.

The area of concern is the Savannah Harbor located at the mouth of the Savannah River where the Savannah River discharges to the Atlantic Ocean. The Savannah Harbor from Fort Pulaski (Mile 0) to Seaboard Coastline R/R Bridge (River Mile 27.4) is the segment identified on the State of Georgia's Section 303(d) list as impaired for dissolved oxygen. The basis for the 2006 TMDL was that the Savannah Harbor was on Georgia's 2002 Section 303(d) list for failing to meet the dissolved oxygen (DO) criterion associated with the Georgia's Coastal Fishing water quality use designation based on data collected in the summers of 1997 and 1999.

The hydrodynamic and water quality harbor model used to develop the TMDL extends upstream on the Savannah River to River Mile 61.0 near Clyo, Georgia, at United States Geologic Survey (USGS) station 02198500. The downstream end of the model extends approximately 25 miles offshore from Oyster Island to cover the navigational channel of Savannah Harbor. The model covers the Savannah River, the Front River, the Middle River, the Little Back River, the Back River, the South Channel, and the offshore portions in the Atlantic Ocean. Figure 1 is a map that shows the overall location of the study area.

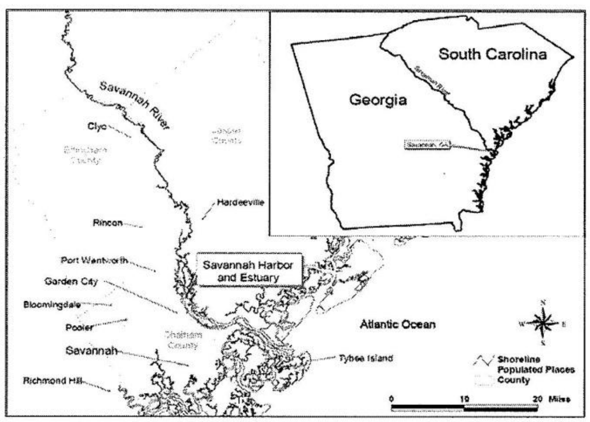

Figure 1 Savannah Harbor Location Map

Water quality studies, conducted over the past twenty years, were used to develop the TMDL. The purpose of the field studies was to characterize the DO regime of the harbor, to determine the principle causes of impairment, and to provide sufficient data and information to develop a complex hydrodynamic and water quality model. The data used in the calibration and confirmation of the hydrodynamic and water quality models were collected by the Georgia Ports Authority (GPA), the USGS, the Georgia Environmental Protection Division (EPD), the U.S. Army Corps of Engineers (USACE), and the United State Environmental Protection Agency (EPA). Additional details on the water quality and hydrodynamic modeling can be found in *Development of the Hydrodynamic and Water Quality Model for the Savannah Harbor Expansion Project, January 2006 (Tetra Tech 2006)* and in the draft EPA and Tetra Tech Z-Grid Modeling Report (EPA 2010).

2. TMDL Targets

2.1. Georgia DO Standard for Savannah Harbor

In Georgia, the water use classification for the Savannah Harbor is Coastal Fishing. The applicable water quality standards for DO for this use classification as stated in Georgia *Rules and Regulations for Water Quality Control*, Chapter 391-3-6-.03, Water Use Classifications and Water Quality Standards are:

"Dissolved Oxygen (D.O.): A daily average of 5.0 mg/L and no less than 4.0 mg/L is maintained at all times. If it is determined that the "natural condition" in the waterbody 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."

2.2. South Carolina DO Standard for Savannah Harbor

In South Carolina, the applicable water quality standards for DO state that "Certain 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 as prescribed below pursuant to the Act, Section 48-1-83, et seq., 1976 Code of Laws:

a. For purposes of section D of this regulation, the term "naturally low dissolved oxygen waterbody" is 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. The term does not include the months of November through February unless low dissolved oxygen levels are known to exist during those months in the waterbody. For a naturally low dissolved oxygen waterbody, the quality of the surface waters shall not be cumulatively lowered more than 0.10 mg/L for dissolved oxygen from point sources and other activities; or

b. Where natural conditions alone create dissolved oxygen concentrations less than 110 percent of the applicable water quality standard established for that waterbody, the minimum acceptable concentration is 90 percent of the natural condition. Under these circumstances, an anthropogenic dissolved oxygen depression greater than 0.10 mg/L shall not be allowed unless it is demonstrated that resident aquatic species shall not be adversely affected pursuant to Section 48-1-83. The Department may modify permit conditions to require appropriate instream biological monitoring.

c. The dissolved oxygen concentrations shall not be cumulatively lowered more than the deficit described above utilizing a daily average unless it can be demonstrated that resident aquatic species shall not be adversely affected by an alternate averaging period."

2.3. *Potential TMDL Targets*

Based on Georgia's and South Carolina's Water Quality Standards, the TMDL governing the discharge of wastewater CBOD5 and ammonia to the Savannah River and Harbor reflects a range from the 0.1 mg/L or 0.10 mg/L deficit from the "natural" dissolved oxygen value, up to a 10% deficit allowed if it is demonstrated that resident aquatic species shall not be adversely affected. Within this range, there are three potential TMDL targets:

1. The initial TMDL target established during the critical period based on a daily average delta DO of 0.1 mg/L for Georgia only waters and 0.10 mg/L for waters that are in South Carolina when Harbor waters naturally fall below 5 mg/L.
2. A 0.1 mg/L Delta DO target for all Harbor waters naturally below 5 mg/L. This target would be available if and when South Carolina changes the applicable Delta DO standard from 0.10 mg/L to 0.1 mg/L.
3. An "up to 10%" deficit DO TMDL target established based on a demonstration, acceptable to the States, that resident aquatic species will not be adversely affected. Such a target would allow for a delta DO range of greater than 0.1 mg/L up to 0.35 mg/L. Under such a scenario, the TMDL calculator can be used to determine the appropriate NPDES limits.

After this TMDL is established, EPA expects the States to select from these potential targets to implement the TMDL based on the then-applicable water quality standards (i.e., either 0.1/0.10 mg/L DO deficit based on the current expression of the standards; 0.1 mg/L DO deficit based on a change to the South Carolina standard; or up to 10% DO deficit based on an acceptable demonstration showing the protection of resident aquatic species).

3. Modeling Approach

EPA Region 4 used the Savannah Harbor Z-Grid Model to develop this TMDL (Tetra Tech 2008; EPA 2010). The Z-Grid model builds on the original harbor model developed for EPA Region 4 during the development of the Total Maximum Daily Load in 2004-2005 and the enhanced model for the United States Army Corps of Engineers (USACE) finalized on January 30, 2006 (2004, 2006 Tetra Tech).

The hydrodynamic model used is the Environmental Fluid Dynamics Code (EFDC) developed and maintained by Tetra Tech (Hamrick 1992). The water quality model used is the Water Quality Analysis Simulation Program (WASP) maintained by EPA.

The setup, calibration, and confirmation of the EFDC and WASP original Savannah Harbor models are well documented in the January 30, 2006 Tetra Tech modeling report. (2006 Tetra Tech) After two years of intense efforts by several modelers and many agency meetings, final acceptance letters approving the use of the model were received from the EPA Region 4, Georgia EPD, South Carolina DHEC, National Marine Fisheries, and the United States Fish and Wildlife Service (USF&W) in March 2006. Other reviewers of the enhanced models included the Harbor Committee (MACTEC as their consultant), the USACE Engineer Research and Development Center (ERDC), and the United States Geological Survey (USGS).

3.1. Z-Grid Model

During 2007, EPA Region 4 determined a need to convert the sigma grid of the enhanced model to a Z-Grid. The Z-Grid allows for varying number of vertical layers throughout the model domain. Where the sigma grid was six vertical layers with widely varying layer depths, converting to a Z-Grid with five vertical layers in the navigation channel and one vertical layer in the Middle, Back, Little Back, and Upper Savannah Rivers allowed all the layers to be similar depths. The Z-Grid allowed for the invert of the river bottom elevation to be modified with one vertical layer going upstream from the I-95 Bridge to the Clyo USGS gage on the Savannah River. The longitudinal slope was evenly distributed from the headwater cell to above the I-95 Bridge by adjusting bottom elevations. The water surface elevation at the headwater boundary cell was raised to better match the gage height reported at the Clyo USGS gage. In addition to the Z-Grid conversion, the watershed tributary flows and marsh areas were revised.

The Z-Grid model contains 608 horizontal cells and 1,778 total cells when including the vertical cells. Figure 2 shows the Harbor portion of the Z-Grid Savannah Harbor model.

Figure 2 Z-Grid Harbor Cells and Existing Marsh Areas

3.2. Updated Marsh Approach

The marsh areas were revised from the sigma grid model (Tetra Tech 2006) to include the areas downstream of Fort Jackson. One area upstream near the I-95 Bridge was added as well. Table 1 reflects the new marsh loadings. The color of each marsh indicates whether it was included in the model as a freshwater (blue), brackish (orange) or saltwater (red) marsh.

Table 1 Existing Marsh Loads

Marsh	Actual Area (ac)	Actual Depth (m)	BODU Export Rate (kg/day/acre)	BODU (kg/day)	BODU (lb/day)
	742	0.12	6	4,454	9,820
	3,467	0.25	12	41,606	91,726

	1,682	0.18	6	10,089	22,243
	421	0.21	6	2,527	5,570
	310	0.20	6	1,862	4,104
	570	0.16	6	3,423	7,546
	731	0.29	6	4,384	9,665
	845	0.14	6	5,070	11,177
	485	0.21	3	1,456	3,210
	602	0.22	6	3,613	7,966
	12,676	0.15	12	152,114	335,353
	1,548	0.15	12	18,580	40,963
	5,819	0.15	12	69,822	153,931
Q14	6,049	0.15		5,155	11,364 *
	1,633	0.15	3	4,898	10,798
			TOTALS =	**329,053**	**725,436**

* Q14 is Dredge Disposal Area Managed by the Corps, the load was calculated based on CBOD5 and weir flows as a peak load.

To address seasonality of the marsh loads, a reference paper was used that measured dissolved inorganic carbon (DIC) in tidal freshwater marshes in Virginia and the adjacent estuary. The paper is titled "Transport of dissolved inorganic carbon from a tidal freshwater marsh to the York River Estuary" by Scott C. Neubauer and Iris C. Anderson from the Virginia Institute of Marine Science, School of Marine Science, College of William and Mary. The percentages in Table 2 below were derived from the referenced study and were applied to the loads listed in Table 1 (for existing) to develop the monthly WASP loads for Ultimate Carbonaceous Biochemical Oxygen Demand (CBODu) from the marsh areas.

Table 2 Seasonal Distribution of Marsh Loads

Month	Percent of Total Load
January	20
February	20
March	40
April	40
May	60
June	80
July	100
August	100
September	80
October	60
November	40
December	40

3.3. Updated Hydrodynamics

The original flow, velocity, elevation and temperature predictions were calculated using the EFDC hydrodynamic model and calibrated to the extensive 1997 and 1999 data set (2006 Tetra Tech). The EFDC model inputs were updated to reflect more recent information. This information includes new flow gages by USGS in the harbor, long-term DO data at the USACE Dock, updates to the boundary conditions, connection to EPD's river model, and updates to water quality kinetics. Figure 3 shows the original sampling locations for the 1999 study, some of which were also used for the 2008 data collection.

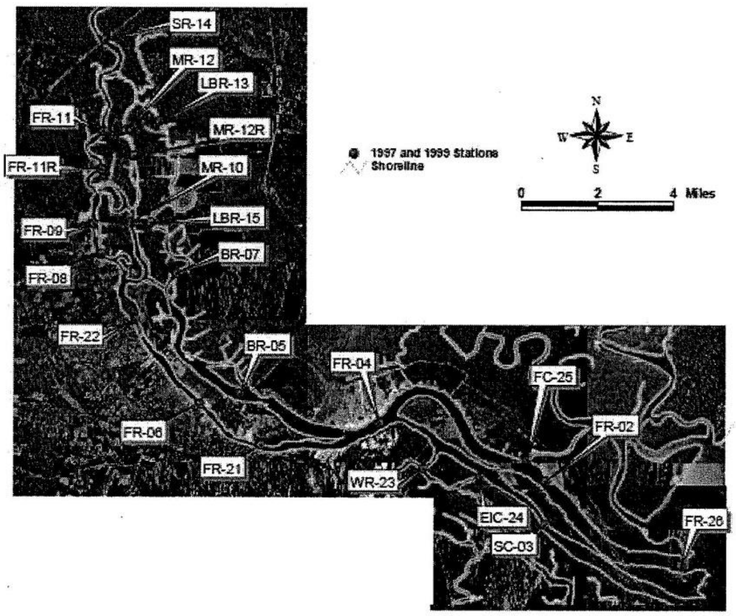

Figure 3 1999 Sampling Locations

3.3.1. Middle and Back Rivers Updated Hydrodynamics

The USGS collected detailed (15 minute) water surface elevation, velocity and flow data during the fall and winter of 2008 – 2009 at the Middle and Back Rivers near the Houlihan Bridge crossings at Stations MR-10 and LBR-15, respectively. These data were used to improve the hydrodynamic predictive ability of the model in the Middle and Back Rivers. The updates focused on improving the width and depths of the river channels in the model and changing the marsh storage areas to better reflect the movement of water through the channels so the model would better reflect the measured flows, velocities and elevations. (2010 EPA Region 4) Figure 4 and Figure 5 illustrate an example of the models predictive capabilities for gage height and flows for Little Back River at Houlihan Bridge. The performance of the model is considered very good.

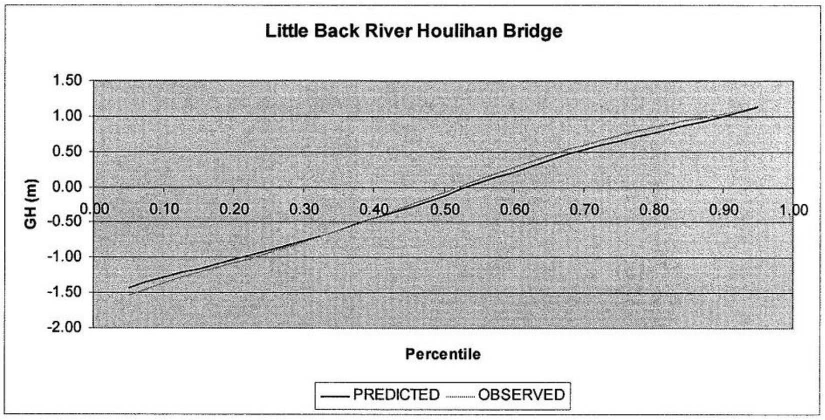

Figure 4 Percentile Comparison of Predicted and Measured Gage Heights

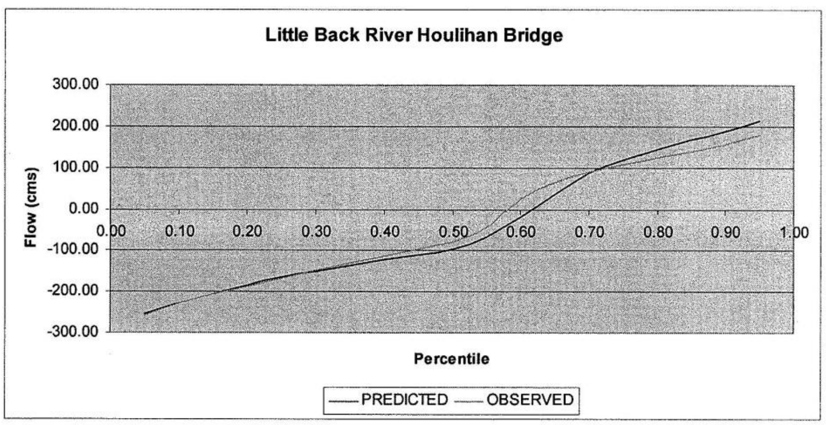

Figure 5 Percentile Comparison of Predicted and Measured Flows

3.3.2. Upstream Boundary Conditions at Clyo

Georgia EPD has developed a hydrodynamic and water quality model (EPDRiv1 Model) for the Savannah River from the Augusta Canal diversion dam to the USGS stage recorder (02198760) near Hardeeville, South Carolina. This model was used to transport the oxygen demanding substances from the upper watershed to the Harbor Model. The River Model (2010, GaEPD) provided the flow, DO, Temperature, CBOD (fast and slow) and ammonia boundary conditions for the calibrated TMDL Harbor Model. (2010 EPA Region 4)

The 2006 EFDC model used USGS gage flow data and monthly measured temperatures at Clyo for the upstream boundary. Since 2006, EPD has updated and recalibrated the Savannah River EPDRiv1 Model. The flow and temperature hourly outputs at Clyo, from the River Model were used as the headwater conditions for the Harbor model. This provides a seamless connection between the Savannah River Model and the Savannah Harbor Model. Figure 6 and Figure 7 illustrate the comparison of RIV1 flows and temperatures to observed data.

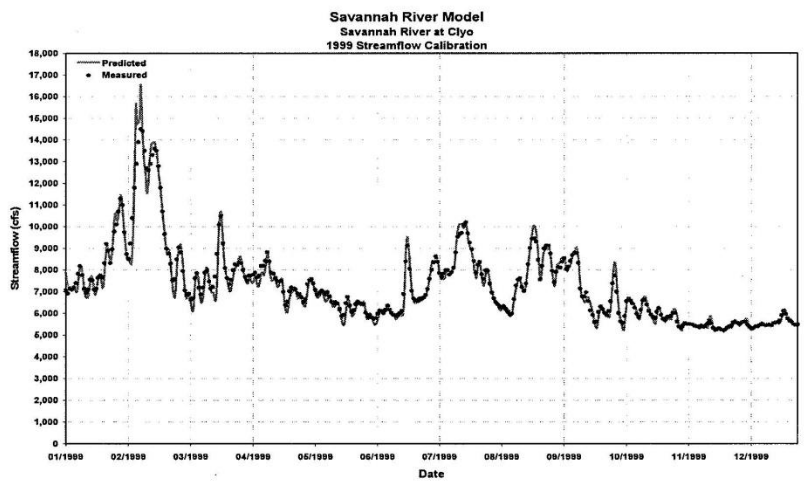

Figure 6 1999 Stream Flow Calibration at Clyo

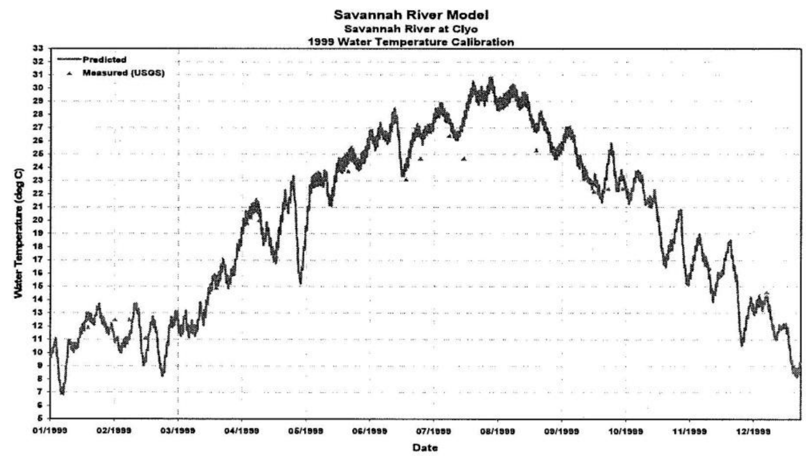

Figure 7 1999 Stream Temperature Calibration at Clyo

3.4. Updated Water Quality Rates and Kinetics

The main changes to the water quality portion of the 2006 Savannah Harbor model (2006 Tetra Tech) were an update of the reaeration approach and a fine tuning of the CBOD decay rates. The main modeling parameters impacting the DO balance of the Harbor are the reaeration rate, the sediment oxygen demand (SOD) rate and the oxygen demanding substances (CBOD and ammonia) decay rates. Table 3 provides a summary of the rates used in the Harbor Model.

Table 3 WASP Kinetic Rates

WASP Kinetic Parameters	Value
Reaeration Rate @ 20 °C (per day)	O'Connor-Dobbins Formulation
Sediment Oxygen Demand (g/m2/day) @20 °C	0.7 to 2.4
BOD (1) Decay Rate Constant @20 °C (per day)	0.06
BOD (2) Decay Rate Constant @20 °C (per day)	0.04
BOD (3) Decay Rate Constant @20 °C (per day)	0.02
Ammonia, nitrate, phosphorus rates @20 °C (per day)	0.015

3.4.1. Reaeration Rate and Sediment Oxygen Demand

The O'Connor-Dobbins Reaeration formulation that uses velocity and total depth (a WASP7 update) of the river was used to determine the reaeration rates for the Savannah Harbor System.

Sediment oxygen demand rates were revised and ranged from 0.7 to 2.4 $g/m^2/day$ at @20 °C:

- 0.7 $g/m^2/day$ for Ocean, Middle and Back Rivers
- 1.6 $g/m^2/day$ for Upper Savannah River Clyo to Hwy 17 bridge
- 2.0 $g/m^2/day$ for main Harbor area
- 2.4 $g/m^2/day$ for Sediment basin and Turning Basins.

3.4.2. Pollutant Decay Rates

The WASP 7 model has the option of using up to three separate CBODu inputs and decay rates i.e., the CBOD loads to the model can be divided into three CBODu state variables. Based on analyses of the Harbor's long term BODs and the wastewater dischargers effluent long term BODs, it was determined that the three CBODu decay rates of 0.02, 0.04 and 0.06 per day best reflected the BOD decay activity going on in the Harbor system. Each BOD load to the system was assigned to one of these compartments based on their specific long term BOD characteristics.

- Marsh BOD loads were put in the 0.04/day compartment
- River fast decaying BOD loads in the 0.06/ day compartment
- River slow decaying BOD loads in the 0.02/ day compartment
- Ocean BOD concentrations/loads half in 0.06 and the rest in 0.02/ day compartments
- Dischargers BOD loads in to their appropriate compartment(s) based on their specific long term data. More details in Section 4.

Note the original 2006 modeling had a CBODu decay rate compartment of 0.12/day to reflect the decay of secondary treated wastewater in the Harbor. Now most of the wastewater is more highly treated and the 0.12/day decay rate is no longer appropriate.

3.5. Modeling Technical Review Group

Interactive discussions between state and federal agency staff and dischargers regarding the Savannah Harbor DO issue have been ongoing for more than a decade. Formation of a group of technical experts, from the Savannah Harbor Committee (SHC), Central Savannah River Area TMDL (CSRA) Group and agencies, was established to provide ongoing input on model development for the river and harbor portions of the system. The participants in the modeling subgroup were nominated by USEPA, Georgia EPD, South Carolina DHEC, SHC, and CSRA for their expertise in modeling and for their specific knowledge of the Savannah River and Harbor ecosystem (2009 SHMTRG). These refined modeling tools reviewed by the modeling subgroup were used to develop this revised TMDL to achieve the recently adopted Georgia DO standard for Savannah Harbor.

Recommendations from the Modeling Technical Review Group:

1. River and Harbor Models as refined during 2009 subgroup work effort provide sufficient tools to develop a revised TMDL based on a relative change in DO concentrations (e.g. DO deficit). Use of the models for precise comparisons of predicted DO concentrations with individual species needs may require additional refinement.
2. Time-variable loading approach was utilized for TMDL development for the Savannah Harbor based on overall flow and DO target conditions developed by the modeling subgroup agency participants. (See section 4.2)
3. Development of the TMDL Calculator for the Savannah Harbor that allows multiple alternative scenarios to be evaluated without hours of model runs for each scenario. The Calculator is based on a unit response for BOD and DO discharged for each permit holder throughout the 2 mile segments of the Harbor model. (See Section 4.3)
4. Verification process for dischargers simulated with a variable-loading approach included an annual comparison of achieved effluent quality with the distribution used in the final TMDL simulation..
5. The modeling subgroup to remain as a resource to agency staff, throughout the TMDL development process, as technical questions arise that would benefit from the group discussions that have occurred over the past eleven months.

4. Source Assessment for Oxygen Demanding Pollutants

A TMDL evaluation examines the known potential sources of the pollutant of concern in the watershed, including facilities regulated by the NPDES program, non-point sources, other sources of pollution, and background levels of the pollutant in the affected waterbody.

4.1. NPDES Permits

The NPDES permitted discharges to the Savannah watershed can be separated into three groups:

- Direct Discharges to the Harbor
- Direct Discharges to Savannah River below Thurmond Dam to Clyo
- Watershed Discharges to tributaries feeding the Savannah River

4.1.1. Harbor NPDES Dischargers

Table 4 NPDES Permitted Dischargers BOD5 and Ammonia Loads to Harbor lists the relevant NPDES dischargers to the Harbor along with their permit number and permitted CBOD5 and ammonia loadings. Figure 8 shows the Harbor discharger locations in the Harbor.

Table 4 NPDES Permitted Dischargers BOD5 and Ammonia Loads to Harbor

Facility Name	Receiving Water	Permit Number	Effluent Flow Rate (MGD)	BOD5 (mg/L)	Ammonia (mg/L)	BOD5 (lbs/day)	Ammonia (lbs/day)
BASF	Harbor	GA0048330	--	--	--	--	880
Garden City WPCP	Harbor	GA0031038	2	30	17	500	290
Georgia Pacific - Savannah River Mill	Harbor	GA0046973	*18*	--	--	10,850	105
BJW&SA	Harbor	SC0034584	4	30	20	1001	667
International Paper Company - Savannah Mill	Harbor	GA0001988	*44*	--	--	25,000	257
PCS Nitrogen Fertilizer	Harbor	GA0002356	--	--	--	--	1,000
Savannah - President Street WPCP	Harbor	GA0025348	27	18.5 (CBOD5)	12.6	4,165	2,837
Savannah - Travis Field WPCP	Harbor	GA0020427	2	20	12	250	145
Savannah - Wilshire WPCP	Harbor	GA0020443	5	30	17.4	1126	653
US Army - Hunter Airfield	Harbor	GA0027588	1	20	17	209	181
Weyerhaeuser Company - Port Wentworth	Harbor	GA0002798	*13*	--	--	6,700	76

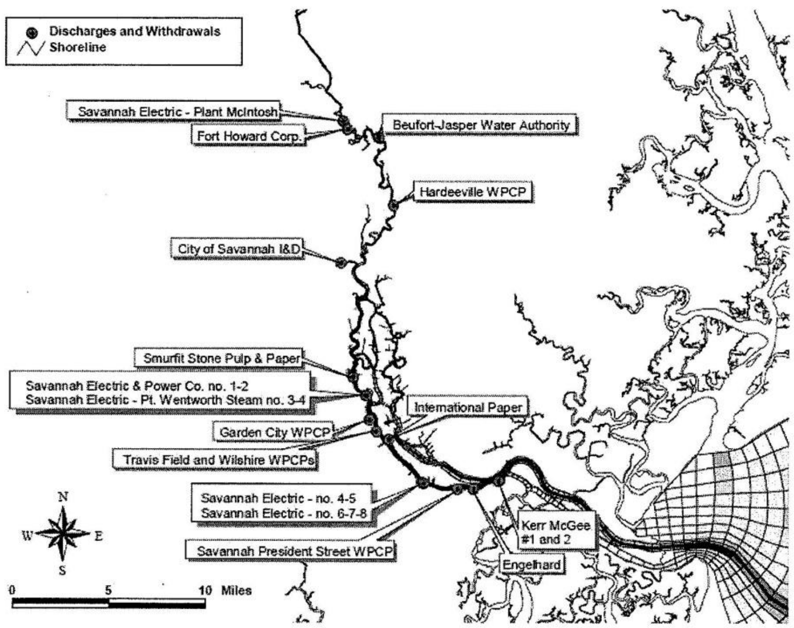

Figure 8 NPDES Permit Discharge Location

Long-term BOD analyses were completed (2000 and 2004 MACTEC; 2006 Tetra Tech; 2010 EPA Region 4) on the dischargers' wastewater to develop the appropriate f-ratios and CBODu category to input the CBOD5 loads into the model. Table 5 provides the permitted ultimate CBOD and ultimate Nitrogenous BOD (NBOD) loads to the Harbor Model. The specific WTFs' CBODu division between fast and slow CBODu decay rates is detailed in the updated Harbor Modeling Report (2010, EPA).

Table 5 Harbor Dischargers Permitted CBODu and NBODu Loads

Facility Name	Receiving Water	Permit Number	CBODu (lbs/day)	NBODu (lbs/day)
BASF	Harbor	GA0048330	--	4,022
Garden City WPCP	Harbor	GA0031038	2,760	1,325
Georgia Pacific - Savannah River Mill	Harbor	GA0046973	59,892	480
BJW&SW	Harbor	SC0034584	5,524	3,049

International Paper Company - Savannah Mill	Harbor	GA0001988	146,300	1,174
PCS Nitrogen Fertilizer	Harbor	GA0002356	--	4,570
Savannah - President Street WPCP	Harbor	GA0025348	22,991	12,965
Savannah - Travis Field WPCP	Harbor	GA0020427	1,380	663
Savannah - Wilshire WPCP	Harbor	GA0020443	6,216	2,984
US Army - Hunter Airfield	Harbor	GA0027588	1,154	827
Weyerhaeuser Company - Port Wentworth	Harbor	GA0002798	54,334	347
TOTAL	Harbor		300,551	32,407

4.1.2. River NPDES Dischargers

Table 6 lists the relevant NPDES dischargers along with their permit number and permitted CBOD5 and ammonia loadings to the Savannah River below Thurmond Dam to Clyo. Table 7 provides the permitted ultimate CBOD and ultimate Nitrogenous BOD (NBOD) loads to the River Model. The specific WTFs' CBODu division between fast and slow CBODu decay rates is detailed in the River Modeling Report (2010, GaEPD).

Table 6 NPDES Permitted Dischargers BOD5 and Ammonia Loads to River

Facility Name	Receiving Water	Permit Number	Effluent Flow Rate (MGD)	BOD5 (mg/L)	Ammonia (mg/L)	BOD5 (lbs/day)	Ammonia (lbs/day)
Aiken PSA/Horse Creek WWTF	River	SC0024457	26	30	11	6,505	2,385
Allendale	River	SC0039918	4	25	20	834	667
Augusta - James B. Messerly WPCP	River	GA0037621	46	30	17	11,534	6,690
Clariant Corp/Martin Plant	River	SC0042803	--	--	--	564	2,000
Columbia County - Crawford Creek WPCP	River	GA0031984	2	12	1	150	15

Columbia County - Little River WPCP	River	GA0047775	6	8	4	375	215
Columbia County - Reed Creek WPCP	River	GA0031992	5	30	17	1,151	668
Columbia County – Kiokee Creek WPCP	River	GA0038342	0.3	20	7	50	18
DSM Chemicals Augusta Inc	River	GA0002160	4	--	--	727	--
International Paper Company - Augusta Mill	River	GA0002801	24	--	0.7	30,000	140
Kimberly-Clark/Beech Island	River	SC0000582	11	--	--	4,031	--
PCS Nitrogen Fertilizer	River	GA0002071	1	30	--	350	1,162
Savannah River Site (SRS) Discharges (50% Reduction)	River	SC0000175				218	22

Table 7 River Dischargers Permitted CBODu and NBODu Loads

Facility Name	Receiving Water	Permit Number	CBODu (lbs/day)	NBODu (lbs/day)
Aiken PSA/Horse Creek WWTF	River	SC0024457	19,924	8,386
Allendale	River	SC0039918	3,019	3,048
Augusta - James B. Messerly WPCP	River	GA0037621	41,753	30,573
Clariant Corp/Martin Plant	River	SC0042803	2,042	9,140
Columbia County Combined	River	GA0031984	5,705	4,118
DSM Chemicals Augusta Inc	River	GA0002160	2632	--
International Paper Company - Augusta Mill	River	GA0002801	108,600	640
Kimberly-Clark/Beech Island	River	SC0000582	14,592	--

PCS Nitrogen Fertilizer	River	GA0002071	1,267	5,310
Savannah River Site (SRS) Discharges (50% Reduction)	River	SC0000175	789	101
TOTAL	River		204,491	63,899

4.1.3. Watershed NPDES Dischargers to Tributaries

The watershed discharges to the Savannah River tributaries at their existing loadings have an insignificant impact on the DO levels in the Harbor and are not included as contributing sources in this TMDL. Current or future tributary discharger loadings, including municipal and industrial stormwater, are allowable if it is demonstrated, via modeling that their loads are at background conditions by the time they reach the river.

The SRS dischargers, although multiple watershed discharges, was handled as a direct discharge because of its proximity to the River. A fifty percent decay of the effluent load was assumed to account for the travel time to the River. The Columbia County dischargers were assumed to enter the Savannah River at 100 percent of their load.

The CBOD5 and ammonia loadings from future discharges or expansions of existing dischargers over their 2009 loadings to the Savannah River should be examined and if significant included in the River Model and TMDL Calculator.

4.1.4. Total Ultimate Oxygen Demand for NPDES Dischargers

The summary of the Ultimate Oxygen Demand (UOD) loads from NPDES Dischargers to the Savannah Harbor and River System is listed in Table 8.

Table 8 Summary of the Permitted UOD Loads for the Harbor and the River

Receiving Water	CBODu (lbs/day)	NBODu (lbs/day)	UOD (lbs/day)
Harbor	300,551	32,407	332,958
River	204,491	63,899	268,390
TOTAL	505,042	96,306	601,347

4.2. *Time-variable loading approach for NPDES Discharger Inputs*

The traditional TMDL and wasteload allocation (WLA) approach uses steady state models with 7Q10 stream flows, average tides, and constant WTF discharger loads incorporated into monthly permit limits. The Savannah Harbor Variable Discharge Approach uses a dynamic three dimensional model with actual flows, tides, and meteorological data and variable (daily) WTF discharger loads. These variable loads, through a TMDL Calculator, are incorporated into the analysis and are developed into appropriate NPDES monthly permit limits. The Variable Loading Approach considers assimilative capacity of the flows above the 7Q10 and provides protection for flows below the 7Q10.

The variable discharger load time-series are based on historical wastewater effluent CBOD5 and ammonia data for each facility and then simulated using monthly permit load and Coefficient of Variance CV. For the smaller dischargers, a constant load based on the monthly permitted load and CV was used with the result that the Permit monthly load equals 1.5 times the TMDL daily load. For the five largest discharges, three years of daily time-series loading were used with each year time-series representing a high, medium, and low loading year. These three loading years were based on and are representative of fifty years of simulated discharge loadings. HydroQual's 2010 report provides the details for each of the wastewater dischargers (2010 HQI). Figure 9 illustrates the relationship between the monthly permitted load and the actual discharge daily time-series for CBOD5.

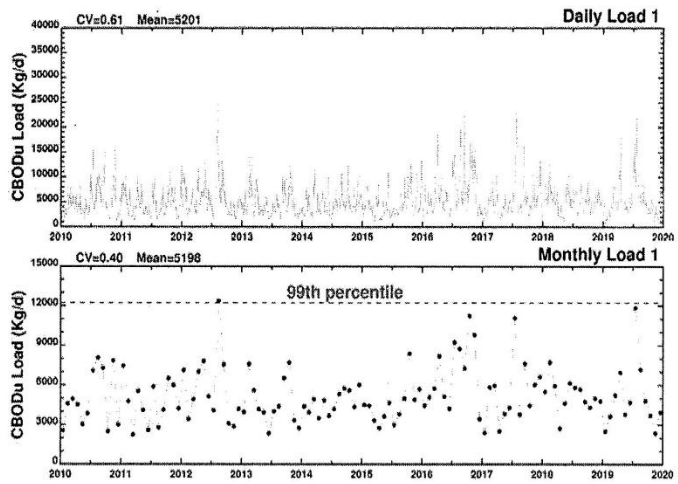

Figure 4. Savannah Model, CBODu Loads L1 and L2 (2010-2036)
Existing (red) and Reduced (blue)

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Figure 9 Monthly Permit CBODu Load and the 99 Percentile

The use of variable discharge loads in permits is not a "new" idea. The MeadWestvaco Pulp and Paper Mill in Covington, Virginia has a variable discharge NPDES permit. Also EPA's Technical Support Document (TSD) for Toxics provides methodology and examples of incorporating variable load calculations in permits using 99 percentile and an appropriate CV, while the Anacostia TMDLs set a clear precedent that daily maximum loads can allow for daily variability in continuous point sources.

Additional details of this approach are laid out in the HydroQual's 2010 report. (2010 HQI).

4.3. TMDL and NPDES Permit Limit Calculator for the Savannah Harbor

The Savannah DO TMDL Calculator was developed as an efficient method to calculate the effect of various combinations of the 22 wastewater effluent dischargers on the DO levels in the Savannah Harbor and all the conditions allowable in the Georgia and South Carolina Water Quality Standards for the Harbor. The potential TMDL targets governing the discharge of wastewater CBOD5 and ammonia to the Savannah River and Harbor are described in Section 2.3 of this TMDL.

With 22 wastewater dischargers, there are many combinations of wastewater effluent CBOD5 and ammonia that could meet this TMDL target. Given the run time of an annual water quality model simulation, it is impractical to evaluate a sufficient number of wastewater CBOD5 and ammonia loading combinations to adequately satisfy all the potential alternatives. The TMDL Calculator, based on hundreds of Savannah River and Harbor model runs, provides an accurate estimation of the DO impact of each discharger and can be used to evaluate various discharge scenarios and to develop the appropriate TMDL that meets the applicable standard.

4.4. Background Sources

The vast majority of the nonpoint source loadings of oxygen-demanding substances are from natural background sources including detritus transported in the stream, detritus from marsh areas flowing directly into the Harbor, and tidally-transported detritus from the ocean. These natural background loads are not controllable and therefore additional nonpoint source reduction to improve water quality is not an option.

In developing the TMDL, EPA evaluated oxygen-demanding loads from industrial and municipal stormwater sources discharging pursuant to an NPDES permit into, or upstream of, the Harbor. These loads were shown to have no measurable impact on the dissolved oxygen levels in the critical areas of concern in the Harbor. During critical periods, permitted stormwater loads were considered to be equivalent to, and part of, the natural background. EPA expects that stormwater pollution prevention plans will continue to provide for use of best management practices to ensure that such stormwater loadings do not increase above natural background levels. As long as stormwater loads continue to be less than, or equivalent to, natural background loads, the TMDL does not necessitate reductions to existing industrial and municipal stormwater sources discharging pursuant to an individual or general NPDES stormwater permit (e.g., MS4, industrial and construction general permits). [Note: This text was taken directly from EPA's August 27, 2007 letter to the States in resolution of the first round TMDL dispute.]Tributaries discussed in 4.1.3 are also included in the background condition.

As a matter of practice, EPA has established, acknowledged and approved TMDL *de minimis* thresholds below which dischargers are not subject to specific wasteload allocations or reduction expectations. Any new or existing discharger that can demonstrate that its loading is within natural background shall be considered a background source. For purposes of this TMDL, background includes those dischargers whose impact on the delta DO deficit is of such an inconsequential nature that such discharges may be deemed part of the background load.

5. TMDL Development

A TMDL establishes the total pollutant load that a waterbody can assimilate and still achieve the applicable water quality standard. The components of a TMDL include a wasteload allocation (WLA) for facilities and sources regulated by the NPDES program, a load allocation (LA) for all other sources including natural background, and a margin of safety (MOS), either implicitly or explicitly, to account for uncertainty in the analysis. Conceptually, a TMDL is defined by the equation:

$$\text{TMDL} = \Sigma\ \text{WLA} + \Sigma\ \text{LA} + \text{MOS}$$

Since the TMDL is established based on the allowable *point source* deficit below natural background conditions, the LA is not relevant to the TMDL calculation itself.

The TMDL for the Savannah Harbor in the Savannah River Basin is in terms of oxygen-demanding substances expressed as UOD, where:

UOD = CBODu + NBODu

CBODu = CBOD5 multiplied times a f-ratio associated with the appropriate CBODu decay rate(s).

NBODu = ammonia multiplied times 4.57 conversion factor

The TMDL provides for the calculation of the appropriate WLA and NPDES UOD, CBOD5 and/or ammonia effluent limits through the use of the TMDL Calculator.

Because of the distribution of the NPDES dischargers and associated loads throughout the Savannah Harbor and River system, the different conditions allowable in Georgia and South Carolina Water Quality Standards and the potential for numerous allocation strategies, along with trading scenarios to be evaluated by the States, a single TMDL UOD cannot be developed but a range of values will be proposed. The final implementation of the TMDL must provide for a UOD and associated NPDES parameters such as UOD, CBOD5, ammonia, and/or DO limits that comply with the applicable TMDL target (see Section 2.3 above).

5.1. Critical Conditions

For an estuarine TMDL, critical conditions are more complex than the critical conditions typically considered for a river system (e.g., summer temperatures and 7Q10 flow). Tidal dynamics play an important role in the DO levels of the Savannah Harbor. Calendar year 1999 was determined as the set of model flow, tide, and metrological inputs that represents the critical period and was used to develop the TMDL model and to construct the TMDL Calculator. Critical conditions were established to include an event that would occur once in ten years on the average or less often. In May 2000 and May 2003 letters, Georgia and South Carolina set the critical conditions for Savannah Harbor as:

- Upstream boundary determined by the States' Savannah River Model;
- Harbor model kinetic rates and parameters as determined by the Savannah Harbor Model calibration;
- 1999 harbor channel bathymetric physical conditions;
- A critical flow including a seven-day ten-year low-flow (7Q10), taking into account the low-flow release from Thurmond Dam;
- Meteorological and tidal conditions based on 1999 data.

Therefore, critical conditions applied to the Savannah Harbor DO TMDL are based on model runs for March through October 1999 incorporating the existing harbor physical conditions and the upstream low flow, as well as actual 1999 tidal regimes, temperature, and other meteorological conditions measured during these periods.

Additional analysis of the critical condition was completed through the Technical Model Group Review. SCDHEC conducted a flow analysis of the Savannah River and concluded that period of record 1955 through 2008 was an appropriate time frame to evaluate for appropriate critical conditions. See Appendix A. HydroQual (HQI) conducted a fifty year DO analysis and showed that 1999 was a year that adequately represented the past 50 years (2010 HQI).

Based on the critical conditions defined here, the TMDL and its associated wasteload allocation only applies during the critical months. NPDES permits may provide for different limits, not based on the TMDL, during the non-critical season.

5.2. *TMDL Numeric Target*

Pursuant to the Clean Water Act (CWA), TMDLs are established at a level necessary to implement the applicable water quality standard for the waterbody. For several months during the critical period, the natural background DO for the Harbor is below the daily average standard of 5 mg/L. Therefore the initial TMDL target DO is a daily average delta DO of 0.1 mg/L for Georgia only waters and 0.10 mg/L for waters that are shared with South Carolina.

The Savannah Harbor system was divided in to 27 zones as listed in Table 8. The models predicted DO values were volumetrically and daily average to produce a daily average DO time series per zone.

Table 8 Savannah Harbor Zone Descriptions and Extent

Zone	Zone Name	Ga and/or SC Waters
FR-01	Main Channel RM 0 to RM 2	Ga/SC
FR-03	Main Channel RM 2 to RM 4	Ga/SC
FR-05	Main Channel RM 4 to RM 6	Ga/SC
FR-07	Main Channel RM 6 to RM 8	Ga/SC
FR-09	Main Channel RM 8 to RM 10	Ga/SC

FR-11	Main Channel RM 10 to RM12	Ga/SC
FR-13	Main Channel RM 12 to RM 14	Ga
FR-15	Main Channel RM 14 to RM 16	Ga
FR-17	Main Channel RM 16 to RM 18	Ga
FR-19	Main Channel RM 18 to RM 20	Ga
FR-21	Main Channel RM 20 to RM 22	Ga
FR-23	Main Channel RM 22 to RM 24	Ga
FR-25	Main Channel RM 24 to RM 26	Ga
FR-27	Main Channel RM 26 to RM 28	Ga/SC
FR-29	Main Channel RM 28 to RM 30	Ga/SC
FR-35	Main Channel RM 30 to RM 40	Ga/SC
FR-45	Main Channel RM 40 to RM 50	Ga/SC
FR-55	Main Channel RM 50 to RM 60	Ga/SC
MR-01	Lower Middle River	Ga
MR-02	Upper Middle River	Ga
BR-01	Back River	Ga/SC
LBR-02	Lower Little Back River	Ga/SC
LBR-03	Upper Little Back River	Ga/SC
SC	South Channel	Ga
Ocean1	Ocean Channel Mouth to 10 miles	Ga/SC
Ocean2	Ocean Channel 10 to 20 miles	Ga/SC
SedBas	Sediment Basin - connecting Back River to Main Channel	Ga/SC

The 1999 Baseline Model - a Harbor and River model with no point source dischargers BOD and ammonia loadings - was run and a daily average DO per zone computed. Figure 10 illustrates the daily average DO time series for Zone FR-13, one of the lower DO areas of the Harbor. Figure 11 illustrates the natural daily average Zone DO for August 30, 1999. Various Scenario Model runs were then completed. These runs include the point source dischargers' BOD and ammonia loads.

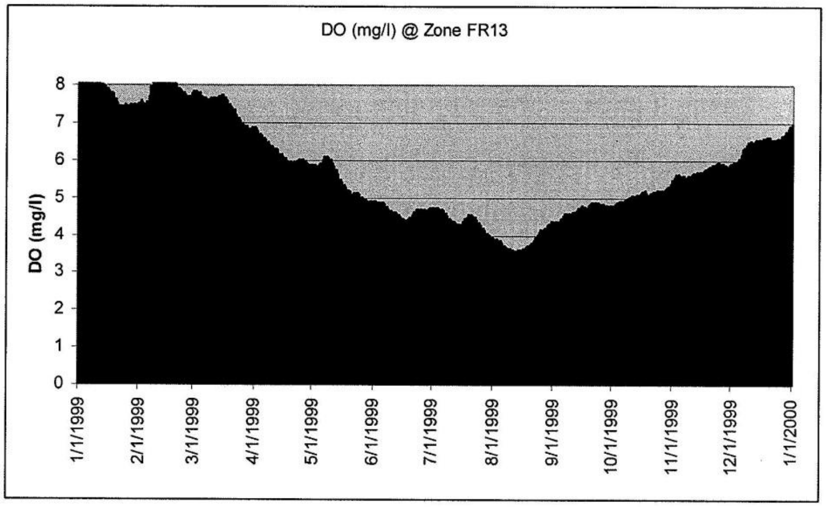

Figure 10 1999 Time Series Daily Average DO for Zone FR-13

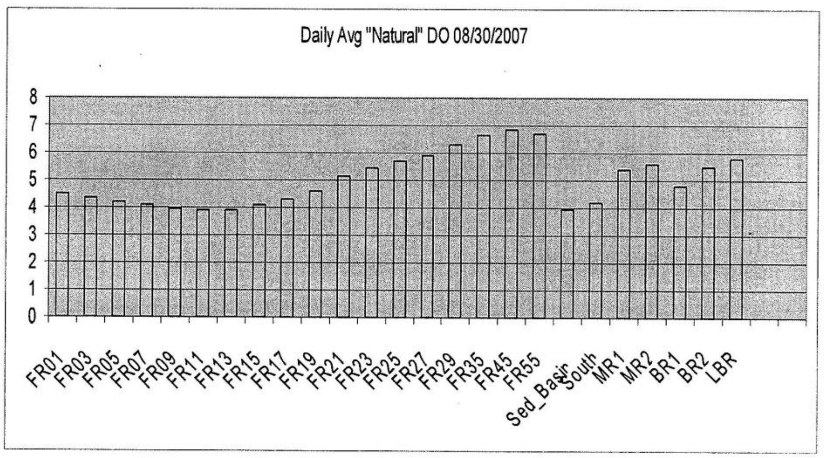

Figure 11 Daily Average DO by Zones

The initial delta DO TMDL target is calculated by taking the 90 percentile of the daily delta DOs difference calculated by subtracting the Baseline Model outputs by the Scenario Model outputs for each zone for the time period March through October. The 90 percentile was identified by the MTRG to allow for the natural variability as defined by GaEPD regulations. The March through October time frame is defined by SCDHEC regulations. Figure 12 illustrates the Calculated Delta DOs between the Baseline and Permit Limits scenarios for all the Zones.

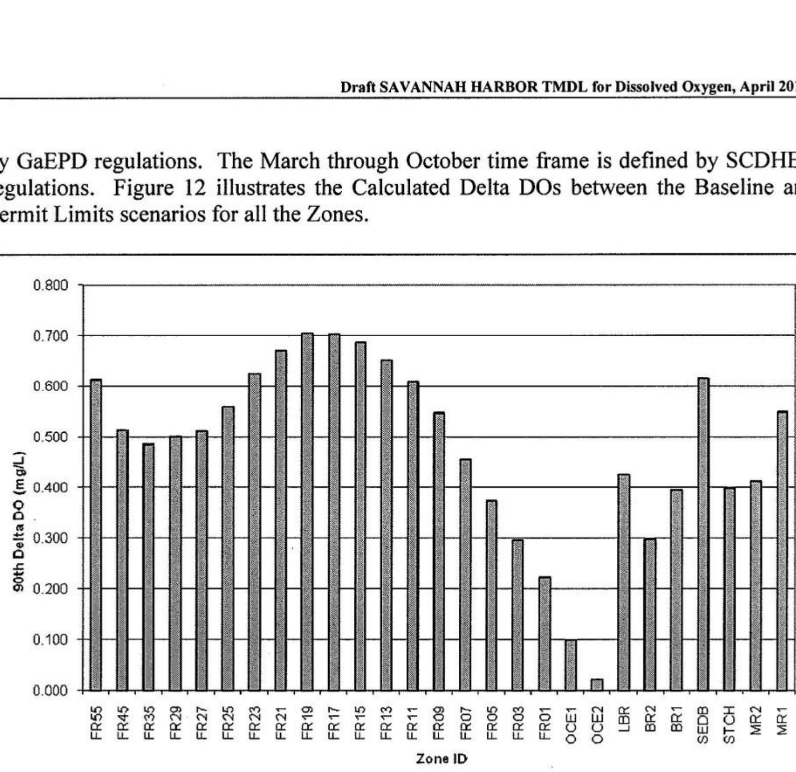

Figure 12 Delta DOs by Zone due to Point Sources at Permitted Loads

5.3. Wasteload Allocation (WLA)

The WLA component of the TMDL is the portion of the receiving water's loading capacity that is allocated to NPDES regulated point sources. This TMDL establishes the total WLA for continuous non-storm water dischargers. The individual WLA for each discharger will be determined using the TMDL Calculator.

The background sources described in Section 4.4 are not considered to be subject to the WLA.

5.4. Load Allocation (LA)

The LA component of the TMDL is the portion of the receiving water's loading capacity that is attributed to the non-NPDES regulated sources of oxygen-demanding substances, including non-point source discharges and natural background sources. The majority of the non-NPDES loadings are from natural background sources. Non-point sources are a very minor contributor of oxygen consuming wastes under critical low flow conditions because of the absence of storm water runoff. Therefore, the non-point source contribution is aggregated with the natural background loads in this TMDL. LA is used in overall modeling of the Harbor, but is not included in the Delta DO TMDL range. If, at a later date, a significant upstream non-point source is identified, the TMDL will be revised to account for this source.

The natural background loadings to the harbor are as follows:

- Upstream loads from natural riverine UOD = 85,000 lbs/day
- Marsh loadings UOD= 145,000 lbs/day
- Ocean boundary conditions for CBODu = 5 mg/L and ammonia = 0.07 mg/L

5.5. Margin of Safety

A margin of safety (MOS) is a required component of a TMDL to account for the uncertainty in the relationship between the pollutant loads and the quality of the receiving waterbody. For Savannah Harbor, the amount of uncertainty is considered low. This system has been the subject of extensive study, including extensive data collection, and model development by various state and federal agencies. The Savannah Harbor MOS is implicitly provided by the abundance of data, the calibrated and verified three dimensional model and conservative critical condition assumptions used to develop the TMDL.

5.6. Seasonal Variation

Seasonal variation is incorporated in the Savannah Harbor TMDL by evaluating multiple years of data. For the hydrodynamic and water quality model, the years of 1997 through 2008 were evaluated. The TMDL recognizes that permit loads can be larger in the winter months when the DO standard of a daily average of 5.0 mg/L not less than 4.0 mg/L applies. Thus the River and Harbor Models can also be used to develop seasonal WLAs and seasonal NPDES permit limits, which can be done outside the TMDL as a Water Quality Based Effluent Limitation.

6. TMDL and WLA Range

There are hundreds of possible discharge reduction scenarios that could achieve the Delta DO TMDL Target. The TMDL Calculator will allow the States to evaluate various scenarios and develop a WLA or Point Source Load distribution and reduction strategies that will most practicably allow the TMDL target to be met. As long as the TMDL reduction strategy and the resultant WLA Ultimate Oxygen Demand (UOD) and National Pollutant Discharge Elimination System (NPDES) CBOD5 and ammonia permit limits selected meet the TMDL target as calculated via the TMDL Calculator, the WLA or Point Source Load distribution scenario meets the goals of this TMDL.

The allowable WLA will vary depending on the size and location of the individual CBOD5 and ammonia loads and which conditions of the Georgia and South Carolina Water Quality Standards are applicable.

The TMDL targets, based on Georgia and South Carolinas' Water Quality Standards, governing the discharge of wastewater CBOD5 and ammonia to the Savannah River and Harbor are 1) the 0.1 mg/L or 0.10 mg/L deficit from the "natural" dissolved oxygen value, 2) the 0.1 mg/L deficit from "natural" dissolved oxygen value (provided the S.C. standard is changed), and 3) up to a 10% deficit allowed if it is demonstrated that resident aquatic species shall not be adversely affected.

The Savannah Harbor TMDL is equal to the selected WLA UOD alternative plus the background LA as listed in Section 5.4.

The TMDL targets, based on Georgia and South Carolinas' Water Quality Standards, governing the discharge of wastewater CBOD5 and ammonia to the Savannah River and Harbor are 1) the 0.1 mg/L or 0.10 mg/L deficit from the "natural" dissolved oxygen value, 2) the 0.1 mg/L deficit from "natural" dissolved oxygen value (provided the S.C. standard is changed), and 3) up to a 10% deficit allowed if it is demonstrated that resident aquatic species shall not be adversely affected.

6.1. Alternative TMDL Scenarios

To demonstrate the capability and usefulness of the TMDL Calculator in determining the WLA reduction and load distribution strategy to meet the applicable TMDL target, the following scenarios are presented.

6.1.1. Initial TMDL Target

To establish the likely range for the WLA UOD values to meet the initial TMDL target of 0.1 mg/L for Georgia waters and 0.10 mg/L for joint Georgia/South Carolina waters, the distribution of loading within the system was varied resulting in a range of from 80,000 to 115,000 lbs/day UOD, depending on how the load was distributed. The WLA strategy that is ultimately implemented will depend on the distribution and location of the UOD sources and the output of the TMDL Calculator.

6.1.2. Alternative TMDL Target #1

An alternative TMDL target could be a 0.1 mg/L Delta DO for all Harbor waters naturally below 5 mg/L. This would occur if South Carolina changes their Delta DO standard from 0.10 mg/L to 0.1 mg/L. To meet the initial TMDL target of 0.1 mg/L for Georgia waters and South Carolina waters, the WLA could range from 100,000 lbs/day UOD to 130,000 lbs/day UOD. Again, the actual WLA that is ultimately implemented will depend on the distribution and location of the UOD sources and the output of the TMDL Calculator.

6.1.3. Alternative TMDL Target #2

Alternative target #2 could be if a demonstration is completed showing an increased DO delta, not to be greater than 10% of natural, does not impact the resident species. This demonstration would have to meet the requirements of both Georgia and South Carolina Water Quality Standards. This new delta DO may range from greater than 0.1 mg/L to 0.35 mg/L. If the new Delta DO were 0.25 mg/L, then the WLA could range from 200,000 lbs/day UOD to 250,000 lbs/day UOD. Again, the actual WLA that is ultimately implemented will depend on the distribution and location of the UOD sources and the output of the TMDL Calculator.

6.2. Oxygen Injection Scenario

One treatment alternative the dischargers are considering, along with other treatment upgrades, is injecting super-saturated levels of oxygen in their effluent. This could be done regardless of which of the 3 TMDL targets described above becomes the final target. Note the testing will be required to assure these oxygen levels are non-toxic and additional analysis will be required to assure oxygen entrainment under ambient conditions at injection locations.

For the initial TMDL Target scenario (Section 6.1.1) with 15,000 lbs/day of Oxygen injected equally divided between the three (3) Harbor Pulp and Paper Mill Dischargers, the WLA to meet the initial TMDL target of 0.1 mg/L for Georgia waters and 0.10 mg/L for joint Georgia/South Carolina waters, would range from 175,000 lbs/day UOD to 245,000 lbs/day UOD, depending on where the actual loads are introduced into the system

7. Trading and Implementation Considerations

EPA embraces the concept of water quality trading in watersheds with multiple sources of pollutants, and specifically endorses the use of trading to implement this TMDL. Appropriate trading of pollutant allocations and/or DO deficits between or among sources, or through oxygen injection into the Harbor, is allowed under this TMDL as long as the total TMDL is not exceeded. The TMDL Calculator will allow the States' to evaluate and determine UOD (CBOD5 and Ammonia) load and oxygen injection trading in accordance with EPA's Trading Policy.

7.1. EPA Trading Policy

Water quality trading (also called effluent trading) is an innovative way for water quality agencies and community stakeholders to develop cost-effective solutions to address water quality problems in their watersheds. EPA's regulatory requirement under Section 303(d) of the Clean Water Act to establish Total Maximum Daily Loadings (TMDLs) for each impaired water body provides a tremendous opportunity to apply market-based conservation strategies. Water quality trading may achieve these environmental goals at a lower cost than other regulatory approaches.

A TMDL provides a method for allocating pollutant discharges among sources, by establishing waste load allocations for each point source, and a load allocation for non-point (non-permitted) sources as a whole. These allocations quantify the relationship between pollutant sources and water quality. More specifically, a TMDL is the sum of the waste load allocations to point sources, the load allocations to non-point sources, and natural background, which are set at a level needed to ensure achievement of water quality standards in the impaired water body. A margin of safety is also included in the TMDL to account for any lack of knowledge concerning the relationship between the pollutant loads and the quality of the receiving water body. One result of the TMDL allocation is that discharge sources with the ability to reduce at the lowest cost are not necessarily encouraged to make substantial reductions, since they need only reduce to the level of their load allocation. Other sources may need to make considerable reductions, but their costs may be very high.

Water quality trading allows sources to use the marketplace to determine who will reduce and by how much, by allowing the buying and selling of the assigned allotments. For example, a source that reduces more than what was required can quantify that amount and create a marketable "credit." That credit, in turn, can be purchased by another source, which allows them to increase their discharge by the amount of the credit. The total discharge by both sources remains the same, thereby maintaining overall water quality standards. With trading, the market price determines the most cost-effective distribution. Sources can use the trading of allotments to accommodate anticipated growth or other increases of their discharge, and avoid expensive last-minute technology investments. They may also profit from the adoption of pollution prevention techniques that reduce their discharge by selling their excess allotment in the market.

EPA issued a Water Quality Trading Policy ("policy") on January 13, 2003 to provide guidance to states and tribes on how trading can occur under the Clean Water Act and its implementing regulations. The policy discusses Clean Water Act (CWA) requirements that are relevant to water quality trading including: requirements to obtain permits, anti-backsliding provisions, and development of water quality standards including antidegradation policy, National Pollutant Discharge Elimination System permit regulations, total maximum daily loads (TMDLs) and water quality management plans. (http://www.epa.gov/owow/watershed/trading/tradingpolicy.html)

7.2. Implementation Considerations

EPA also endorses the full range of administrative and regulatory tools available to the States to provide flexibility in implementing the TMDL, including the tools described in EPA's letter to the States dated August 27, 2007.

EPA recognizes that the Clean Water Act does not limit compliance schedules to the five-year permit term where a longer period is justified under Section 502(17) of the Act and 40 CFR §§ 122.2 and 122.47. With respect to implementation of the Savannah Harbor TMDL in particular, EPA recognizes that the required process alterations and improvements will vary and, in some cases, the States may need to allow long-term compliance schedules consistent with the regulatory requirements noted above.

When finalized, this TMDL will establish the total WLA for continuous , non-storm water dischargers. The individual WLAs and NPDES permit limits for each discharger will be determined using the TMDL Calculator and set forth in an overall load distribution plan. As required under 40 C.F.R. Section 130.7, EPA will establish a final TMDL for oxygen demanding substances for portions of the Savannah River and Savannah Harbor. The final TMDL will include the total WLA and a load distribution plan that includes individual WLAs.

Georgia and South Carolina have committed to develop a load distribution plan that includes a mutually agreeable set of individual WLAs for their dischargers that meets the target as defined in Section 6 above, using the TMDL Calculator. This load distribution plan, with individual WLAs, will be included in the final TMDL and will form the basis for future NPDES permitting. EPA recognizes this is a fluid process and individual WLAs and NPDES permit limits may change due to trading or other future circumstances. The total WLA depends on the locations and distribution of the individual WLAs, so the total WLA may also change due to future circumstances. Any alternate WLAs shall be deemed in compliance with the final TMDL as long as the total of the individual WLAs for the dischargers meets the requirements of the final TMDL as determined by the TMDL Calculator.

REFERENCES

Development of the EFDC Hydrodynamic Model for the Savannah Harbor, March 2004. Report prepared for U.S.A.C.E. Savannah District and EPA Region 4. (2004 Tetra Tech, Inc.)

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Draft Savannah Harbor Water Quality Model Update, April 2010. Prepared by Tetra Tech Inc and EPA Region 4. (2010 EPA)

Wastewater Characterization Study, Lower Savannah River, Final Report, May 2000. Report prepared for the Savannah Harbor Committee. (2000 MACTEC formerly LAWGIBB Group)

DO TMDL Calculator and Supporting Analyses report, *April 2010,* Report prepared for the Savannah Harbor Committee. (2010 HQI)

Draft Savannah River Water Quality Model, March 2010. Prepared by GaEPD. (2010 GaEPD)

8. Appendix A: Savannah Harbor DO TMDL Model Critical Conditions for Savannah River Flow

The effect of NPDES oxygen demand loads on dissolved oxygen (DO) in Savannah Harbor depends on upstream flow in the Savannah River. High river flow dilutes wastewater and helps flush the estuary, which reduces impact from effluent loading. The reverse is true during low flow conditions. The TMDL model endpoint delta DO is highly sensitive to river flow, so selection of the river design condition was an important consideration in the TMDL analysis. A dynamic upstream flow condition was chosen over the traditional steady 7Q10 approach to take full advantage of available data and modeling. In the dynamic approach, the model is run using an actual flow period that represents the range and distribution of hydrologic conditions.

The USGS gage at Clyo (02198500) is the upstream boundary in the Harbor Model. Daily mean stream discharge is continuously reported from 1929 forward. The Model Technical Review Group (MTRG) evaluated the Clyo data and considered three questions: 1) what historical period from the flow record best represents existing and future conditions? 2) which year, or combination of years, from the modeled period 1997 forward best represents the historical period? and 3) what to do if future conditions change due to Drought Plan modification or reauthorization of the Corps lakes?

Historical period. The period before completion of Thurmond Dam in 1954 does not represent current or foreseeable future conditions and was excluded. The record from 1955 forward shows a change in the flow data during the 1980s, when low flows appear to decrease. Conversations with Corps staff indicated project operation might have changed during the 1980s from maintaining downstream navigation flows to maintaining summer lake levels, which could have reduced downstream flows. Savannah River flows were compared to flows on Brier Creek (02198000), an unregulated tributary. Brier Creek showed a similar pattern of reduced low flows (Figure 13). Based on the comparison to the natural stream, the MTRG concluded that basin hydrology was a significant factor in addition to any possible effects from the dam. In order to capture the full range of hydrologic variation as well as any operational changes, the historical period from 1955 forward was evaluated.

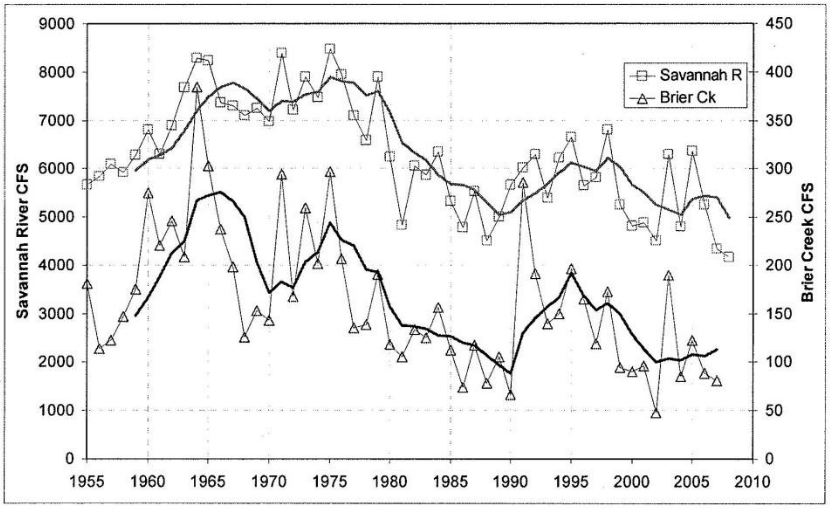

Figure 13 Savannah River and Brier Creek Flow Comparison

Representative year. It is not practical to simulate the entire period from 1955 forward in the DO model. Sufficient DO model input data are available only for recent years, and DO model runtime is a significant constraint. A representative year was selected from the modeled period in order to represent the variability in the historical record and to maximize the number of simulations that could be completed in a reasonable timeframe.

HydroQual completed a 50 year empirical modeling analysis (2010 HQI) and illustrated that 1999 was both a critical year and a year that represented the 1955 to 2008 period of record. Based on these analyses, the MTRG selected 1999 as the representative critical condition year for TMDL modeling.

Future conditions. In response to the recent drought, state and federal agencies, and other stakeholders with an interest in Savannah basin water management issues are considering a range of alternatives including modification of the Savannah Drought Plan, which balances lake levels and downstream flows during drought conditions, and changes to the Federal Authorization of the Corps lakes, which determines authorized lake uses. This TMDL is based on historical river flow conditions, which could change in the future depending on the outcome of these discussions. Proposed changes to these management plans would require NEPA review, and it is expected that TMDL issues arising from changes to the river flow regime would be addressed during the NEPA process.

EXHIBIT D

SAVANNAH HARBOR REOXYGENATION DEMONSTRATION PROJECT

SAVANNAH, GEORGIA

Prepared for:

GEORGIA PORTS AUTHORITY

Savannah, Georgia

January 8, 2008

January 8, 2008

Doug J. Marchand
Georgia Ports Authority
P.O. Box 2406
Savannah, GA 31402

Subject: **Savannah Harbor ReOxygenation Demonstration Project Report**
Georgia Ports Authority, Savannah, Georgia
MACTEC Project 6110-07-0004

Dear Mr. Marchand:

The attached Draft Report presents the results of the Savannah Harbor ReOxygenation Demonstration performed from August 7, 2007, to September 16, 2007. Due to the large volume of supporting-data collected during the project, a DVD is included that contains the pertinent data files.

If you have any comments or questions, please feel free to give us a call at (770) 421-3400.

Sincerely,

MACTEC ENGINEERING & CONSULTING, INC.

Margaret E. Tanner, P.E.
Project Manager

Larry Neal, P.E.
Senior Principal
Vice President

Cc: Hope Moorer
Leonard Ledbetter
File

Enclosures: 1 – DVD

SAVANNAH HARBOR REOXYGENATION DEMONSTRATION PROJECT

SAVANNAH, GEORGIA

Prepared for:

GEORGIA PORTS AUTHORITY

Savannah, Georgia

Prepared by:

MACTEC ENGINEERING AND CONSULTING, INC.

January 8, 2008

MACTEC Project Number: 6110-07-0004

ACKNOWLEDGEMENTS

MACTEC Engineering and Consulting, Inc. (MACTEC) first approached the Georgia Ports Authority (GPA) about a Savannah Harbor reoxygenation (ReOx) demonstration design in late 2006. From these initial discussions, GPA director Doug Marchand was quick to recognize that a successful and timely ReOx demonstration in Savannah Harbor could directly prove the feasibility of large-scale dissolved-oxygen (DO) mitigation in support of GPA's critically-needed harbor-deepening expansion project. So rather than just a ReOx demonstration design as MACTEC had initially envisioned, GPA further challenged MACTEC to also assemble, operate, and monitor the envisioned ReOx demonstration system in time for the upcoming summer "critical season" of 2007. This was an exceptionally fast-track project from the outset and MACTEC deeply appreciates the trust and "can do" spirit that Doug Marchand and his Ports Authority team brought to all phases of the project.

We particularly want to recognize GPA's Hope Moorer, who made it possible to complete the demonstration project with such an accelerated schedule, and Dick Speece, inventor of the Speece Cone superoxygenation technology, whose wise counsel made it possible to quickly adapt the technology for full-scale application in such a large tidal system as Savannah Harbor.

MACTEC would also like to acknowledge the subcontractors and equipment suppliers who contributed to the work and participated to a major degree at one stage or another during the ReOx Demonstration Project as follows: Eco-Oxygen Technologies (ECO2), Savannah Marine Services, Georgia Power, Godwin Pumps, Air Liquide, The Industrial Company, YSI Instruments, and Pine Environmental. The individuals representing these companies contributed their time and, more importantly, their technical skills and knowledge without reservation and the successful and timely completion of the demonstration project is a direct result of their collective efforts.

In addition, MACTEC acknowledges the dedicated MACTEC employees who spent long hours on the harbor in the hot summer months to develop the documentation needed for this report.

ACRONYMS

cfs	cubic feet per second
DO	dissolved oxygen
DVD	Digital Versatile Disc
EPD	Georgia Environmental Protection Division
GPA	Georgia Ports Authority
gpm	gallons per minute
KITB	Kings Island Turning Basin
MG	million gallons
mg/L	milligrams per liter
O&M	operation and maintenance
ppd	pounds per day
ppt	part per thousand
QA/QC	quality assurance/quality control
ReOx	ReOxygenation
RM	River Mile
ROM	rough order of magnitude
SC DHEC	South Carolina Department of Health and Environmental Control
TMDL	Total Maximum Daily Load
USACE	U.S. Army Corps of Engineers, Savannah District
USEPA	U.S. Environmental Protection Agency Region IV
USGS	United States Geological Survey
YSI	Yellow Springs Instrument Company

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EXECUTIVE SUMMARY

Background

Modeling previously performed by the U.S. Army Corps of Engineers (USACE) indicated that proposed further deepening of Savannah Harbor would result in lost reaeration capacity and that the lost reaeration could be offset (i.e., mitigated) by the addition of approximately 20,000 pounds per day (ppd) of dissolved oxygen (DO) to the deepened harbor during the critical summer months. The 20,000 ppd figure is called the DO "mitigation amount", (TetraTech, 2007).

On March 23, 2007, MACTEC Engineering & Consulting, Inc. (MACTEC) was contracted by the Georgia Ports Authority (GPA) to conduct an accelerated full-scale demonstration of "Speece Cone" oxygenation technology in Savannah Harbor as possible DO mitigation in support of harbor deepening. A temporary re-oxygenation (ReOx) demonstration system was designed, assembled, and operated in the harbor for a 40-day test period beginning August 7, 2007and ending September 16, 2007. The Savannah Harbor ReOxygenation Demonstration Project was performed so that questions regarding the performance of the Speece Cone technology could be addressed. This report presents the ReOx demonstration project results and provides recommendations for permanent ReOx installations.

Project Goal

The goal of the ReOx demonstration project was to prove that the DO mitigation amount of 20,000 ppd could be added to the harbor during the summer critical season and that the resulting instream DO response could be determined through instream DO monitoring.

ReOx demonstration system configuration

The ReOx demonstration system consisted of two custom-built, 12-foot diameter ECO2 Speece Cones with river water supplied by four 400-horsepower water intake pumps mounted on a 110-foot barge temporarily moored at The Industrial Company waterfront property on Hutchinson Island (river mile [RM] 14.1). Electrical power for the water intake pumps was supplied from a temporary on-shore transformer and oxygen for the Speece Cones was supplied from a liquid oxygen storage tank located on land. Liquid oxygen was delivered to the storage tank by truck every 24 to 36 hours during the 40-day demonstration period.

Speece Cone operating principles

The two Speece Cones have a combined pure oxygen dissolution maximum design capacity of approximately 30,000 ppd. The nominal water-flow capacity for the pump configuration was about 15,000 gallons per minute (gpm) at a hydraulic head of 150 feet (in the center of the cones). In operation, water was continuously pumped from the river at a depth of about 10 feet and delivered under pressure to the small-diameter top of the Speece Cones where pure oxygen bubbles are added to the incoming water flow. As the water and oxygen bubble mixture is forced downward inside the expanding cross section of the cones, the downward force of the flowing water counteracts the natural buoyancy of the pure oxygen bubbles and, thereby, suspends an oxygen "bubble swarm" inside the cones. The extended bubble-swarm contact time with the down-flowing water results in superoxygenation of the water exiting the bottom of the cones. This superoxygenated flow from the Speece Cones was piped directly back to the river to a depth of about 30 feet and mixed in the river by tidal action, without benefit of a diffuser. Some effervescence of oxygen was evidenced at the water surface in the form of rising fine bubbles. Toward the end of the 40-day test period, additional coarse-bubble oxygen releases were episodically observed due to diminishing pump-flow capacity caused by the progression of intake-screen fouling.

Limited down time experienced

Over the 40-day demonstration period, the ReOx system operated for a total of 39 days. Down time was due to occasional equipment malfunction, running out of oxygen (twice), pump maintenance, and intake screen cleaning.

27,000 pounds per day of oxygen added to the harbor

A total of 1,272,080 pounds of oxygen was delivered and consumed over 39 days of ReOx system operation, giving an average oxygen consumption rate of 32,600 ppd. The overall transfer efficiency was 85 percent for the temporary demonstration system with some loss during tank filling, the average amount of oxygen added to the river was about 27,000 ppd. The oxygen concentration delivered from the cones to the river ranged from about 120 to 180 milligrams per liter (mg/L).

Instream monitoring to estimate DO improvement

Intensive instream DO monitoring was conducted before, during, and after the 40-day operating period in order to estimate the level of DO improvement resulting from operation of the ReOx demonstration system. Fixed-location continuous monitoring included shallow, middle, and deep zone multi-parameter recording instruments deployed at three near-shore locations: GPA Berth 20 dock at river mile (RM) 15.6, ReOx barge at RM 14.1, and USACE dock at RM 13.7. Periodic manual instream monitoring included repeated slack-tide longitudinal full-depth profiles at mid channel and cross-channel transects at five locations spaced along a three-mile river "target segment" centered on the ReOx barge location. Parameters measured or computed included: water temperature, DO concentration, DO saturation percentage, DO deficit, pH, conductivity, salinity, water density, and instrument depth.

Photosynthesis and respiration evident

The continuous near-shore monitoring results, at shallow and mid depth, often showed daily DO patterns indicative of light-driven photosynthesis and respiration with maximum DO concentrations occurring in the late afternoon and minimums occurring at dawn. This photosynthetic and respiration effect has no impact on the Speece Cone oxygen addition technology as long as instream DO concentrations at the shallow depth remain below saturation concentrations as was the case throughout the demonstration project.

ReOx system reduces target segment average DO deficit by 0.6 to 0.7 mg/L

Mid-channel low-tide longitudinal DO profiles show a target-segment average DO deficit (DO deficit is defined in Section 3.0, Page 3-1) of 3.9 mg/L just before the ReOx system began operation on August 7, 2007. After about one month of ReOx system operation, the average mid-channel low tide DO deficit was reduced to 3.3 mg/L and after the ReOx system had been shut down for about one week at the end of the 40-day demonstration period, the target segment low-tide DO deficit had returned back to the starting baseline deficit of 3.9 mg/L. This means that the ReOx system operation reduced the mid-channel average low tide DO deficit along the three-mile-long target segment by about 0.6 mg/L. Similarly, independent cross-channel transect monitoring at five locations along the target segment showed an average DO deficit reduction of about 0.7 mg/L during the ReOx demonstration period which compares favorably to the 0.6 mg/L DO deficit reduction determined from the longitudinal mid-channel profiles.

Delayed instream DO response a stabilizing benefit

Instream DO monitoring shows that it takes about three continuous days of oxygen addition to begin reducing mid-channel DO deficits and that some residual effects of oxygen addition remain locally evident near the ReOx barge for about one week after oxygen addition is ended. This delayed DO response is not unexpected for such a large and dispersive tidal system like Savannah Harbor and suggests that short interruptions of oxygen addition are not likely to cause an abrupt or significant DO decrease. This same dispersive nature of the harbor system might also be conducive to the timing of daily oxygen additions that coincide with off-peak electric power rates as a potential cost-savings measure.

Recommendations going forward

Overall, the 2007 ReOx demonstration project confirmed that the Speece Cone technology can effectively add the required DO mitigation amount to the harbor and reduce instream DO deficits during critical summer conditions. The demonstration also confirmed the soundness of the prototype design. We recommend the following actions:

- Develop a modular land-based ReOx station design specific to Savannah Harbor conditions, taking into account the "lessons learned" from the 2007 demonstration project.
- Identify, characterize, and acquire suitable shore locations for construction of two land-based dual cone ReOx stations.
- Obtain the necessary permits and approvals for construction and operation of the land-based ReOx stations.
- Construct the foundations and permanent shore-based infrastructure and service access for each ReOx station in advance and make the stations ready for subsequent seasonal installation and operation of the ReOx equipment in concert with harbor deepening.
- Until permanent land based ReOx systems are operational, temporary barge mounted systems could be used to provide oxygen for seasonal mitigation.

1.0 INTRODUCTION

The proposed deepening of Savannah Harbor is critically important to the Georgia Ports Authority (GPA) and the State of Georgia. Without deepening, the Port of Savannah and Georgia risk losing significant business and revenue to other east-coast ports that can accommodate the growing number of larger deep-draft ships. An aerial view of Savannah Harbor with river mile (RM) references is shown on Figure 1-1.

Harbor deepening will have the unintended consequence of reducing atmospheric reaeration into the harbor's deepened water. This reduced reaeration can result in reduced dissolved oxygen (DO) concentrations, particularly during the critical season from about mid June through mid October when river temperatures are higher and lower river flows are more prevalent. Three-dimensional hydrodynamic and water quality monitoring performed by the U.S. Environmental Protection Agency (USEPA) Region 4 and the U.S. Army Corps of Engineers, Savannah District (USACE) indicated that the proposed deepening of Savannah Harbor to 48 feet would result in lost reaeration capacity in the river that equates to a reduction of approximately 20,000 pounds per day in the river DO, (TetraTech, 2007).

The GPA contracted with MACTEC Engineering and Consulting, Inc. (MACTEC) to conduct the Savannah Harbor ReOxygenation (ReOx) Demonstration Project. The ReOx Project was performed to directly demonstrate the feasibility and effectiveness of pure oxygen injection technologies (specifically the Speece Cone) as a mitigation measure for the proposed deepening of the harbor. The ReOx Project was a full-scale temporary installation of the Speece Cone technology conducted in the summer of 2007. The ReOx demonstration system was designed and sized to provide sufficient quantities of oxygen to the harbor to mitigate the expected impacts to the DO levels attributed to the proposed harbor deepening.

As part of the ReOx project, MACTEC conducted extensive river water quality monitoring activities from June through September and evaluated various design features to assess performance of the ReOx system. This report summarizes the project activities and conclusions and presents conceptual design considerations for permanent ReOx systems in the harbor.

1.1 BACKGROUND

The mission of the Georgia Ports Authority is to develop, maintain, and operate ocean and inland river ports within Georgia; foster international trade and new industry for state and local communities; promote Georgia's agricultural, industrial and natural resources; and maintain the natural quality of the environment. The Savannah River and the Port of Savannah have long been influential in the economic development of Georgia. The Port of Savannah is the second largest container port on the East Coast and is the 4th largest container port in the nation. To maintain its place as a world class container port, the GPA approached the USACE regarding further expansion of the harbor by increasing the capacity of the navigation channel. As part of the federal authorization to deepen the channel, mitigation for environmental impacts from the proposed action must be implemented. Currently, the GPA and the USACE are conducting the Savannah Harbor Expansion Project. Results of the Savannah Harbor Expansion Project have provided assessments of the projected impacts and mitigation requirements for the proposed harbor deepening project. As part of its mission, the GPA is committed to completing environmental mitigation related to further expansion of the harbor, including the expected impacts to the reaeration capacity.

In 2005, MACTEC completed a feasibility level study for the USACE that identified and evaluated alternative techniques for improving DO concentrations in the harbor (MACTEC, 2005). Based on the MACTEC study, the USACE identified molecular oxygen injection using the Speece Cone technology as a cost effective technique to improve harbor DO.

In addition to the activities ongoing as part of the Savannah Harbor Expansion Project, the USEPA Region 4, the Georgia Department of Natural Resources, Environmental Protection Division (GA EPD), and the South Carolina Department of Health & Environmental Control (SC DHEC) are coordinating the development of new DO criteria for Savannah Harbor. The completion of this coordinated effort will result in the DO criteria being included in Georgia's Water Quality Standards. The quantity of oxygen added for mitigation of dredging is independent of the DO standard for the harbor because it is the quantity of additional dissolved oxygen needed to offset the predicted DO impacts of the proposed deepening.

1.1.1 SPEECE CONE OPERATING PRINCIPLES

The Speece Cones that were used were each capable of injecting up to 15,000 pounds per day (ppd) of oxygen. The estimate of the oxygen needed for DO mitigation associated with the proposed deepening is 20,000 ppd. The injection of this quantity requires the operation of at least two Speece Cones during summer critical conditions. The nominal water-flow capacity for the pump configuration that supplied water to the Speece Cone was about 15,000 gallons per minute (gpm) at a hydraulic head of 150 feet (in the center of the cones). In operation, water was continuously pumped from the river at a depth of about

10 feet and delivered under pressure to the small-diameter top of the Speece Cones where pure oxygen bubbles were added to the incoming water flow. As the water and oxygen bubble mixture is forced downward inside the expanding cross section of the cones, the downward force of the flowing water counteracts the natural buoyancy of the pure oxygen bubbles and, thereby, suspends an oxygen "bubble swarm" inside the cones. The extended bubble-swarm contact time with the down-flowing water results in superoxygenation of the water exiting the bottom of the cones (Figure 1-2). This superoxygenated flow from the Speece Cones was piped directly back to the river and discharged at a depth of about 30 feet where it was dispersed in the river by tidal action without benefit of a diffuser. Some effervescence of oxygen was evidenced at the water surface in the form of rising fine bubbles. Toward the end of the 40-day test period, additional coarse-bubble oxygen releases were episodically observed due to diminishing pump-flow capacity caused by the progression of intake-screen fouling.

1.1.2 ReOx SYSTEM DESIGN CONSIDERATIONS

The ReOx system was a temporary barge-mounted Speece Cone system capable of providing up to 30,000 ppd of oxygen using two separate Speece Cone systems and was assembled and demonstrated on an accelerated schedule. A barge-mounted ReOx system had several potential advantages that made this approach a good alternative for the GPA.

- Because oxygen addition is typically only a seasonal need (e.g., mid June through mid October), a flexible and modular barge-mounted ReOx system can potentially be dismantled into major components and removed to land storage during the off season, thereby making the barge available for other duty.
- A barge-mounted configuration substantially eliminates the need for landside disturbances. The only landside connection needed is a seasonal power-and-oxygen umbilical running from shore to the moored barge. There is no fixed intake or discharge pipe construction required because these assemblies are attached to the barge.
- A barge-mounted ReOx system can be positioned in the harbor to minimize potential navigation hazards and can be moved on fairly short notice to accommodate harbor emergencies such as approaching meteorological events.
- Obtaining permits and approvals for fabrication and operation of a floating barge-mounted seasonal system is less difficult and time consuming than obtaining the permits and approvals required for fixed land-based installations.
- The Speece Cones fabricated for a barge-mounted system can later be reused in a permanent land-based system.
- Design is easily expanded to meet additional oxygen requirements.
- Optionally, a barge mounted system design could be used until permanent land-based systems are constructed or as the permanent system design during the critical season.

2.0 DEMONSTRATION SYSTEM DESIGN

Because the ReOx demonstration system was a temporary installation, the original design concept incorporated the use of a barge as the base for the re-oxygenation station and the use of available rental equipment. It was determined that the test would require two Speece Cones each capable of transferring a maximum of 15,000 ppd, four 400 horsepower pumps, and a single liquid oxygen storage tank and vaporization system, Figure 2-1. The intake pipes leading to the pumps employed a screen to prevent foreign matter, including debris and fish, from being entrained in the system. The intake screens were mounted to the pipes approximately 8 feet below the water surface (top of the screen) and extended to approximately 12 feet below the water surface (bottom of screen) (Figure 2-2). The return pipes for the cones extended approximately 30 feet below the water surface (Figure 2-2) and were angled to direct the super-oxygenated water toward the center of the navigation channel in the river.

During the conceptual design stage, it was determined, due to the logistics of supply, safety, and environmental issues, that diesel powered pumps and generators were unsuitable. Therefore, electrical power was supplied from a stationary site on shore. Also, due to logistical considerations liquid oxygen converted from liquid to gas on shore, was supplied by use of an umbilical to the barge. Both of these elements were located at the temporary mooring site for the barge at river mile (RM) 14.1.

3.0 SYSTEM PERFORMANCE VERIFICATION

The ReOx system was operated from August 7 to September 16, 2007 and required a total of 1,272,080 lbs of oxygen (provided at the storage tank). This oxygen was dissolved into approximately 837 million gallons (MG) of river water that was reintroduced at a depth of 30 feet below the water surface. The amount of oxygen dissolved into the river system averaged 27,000 ppd over the 39 days of operation. The project demonstrated that it was possible to achieve the main project goal of reliably injecting a minimum of 20,000 ppd of oxygen into the Savannah Harbor system to offset the estimated DO impact from the proposed deepening.

To assess the amount of oxygen added to the river system three checks were in place: 1) A log was kept of the amount of oxygen that was supplied to the liquid oxygen storage tank; 2) Water quality meters (Yellow Springs Instrument Company [YSI] 6920 data sondes) were used to periodically measure a side stream sample of super-oxygenated water from the return pipes; and 3) A control panel attached to each cone recorded flow, temperature, pressure, and oxygen usage. In addition to the three oxygen usage checks, the intake river water DO concentration was also monitored.

As part of the evaluation of the performance of the Speece Cones, extensive instream water quality monitoring was conducted before, during, and after the demonstration period. In analyzing DO data sets for Savannah Harbor, there are many concurrent and variable influences on DO concentrations that can confound interpretation of DO monitoring results. Atmospheric oxygen is only sparingly soluble in water and the DO solubility limit, or DO saturation concentration, is a direct function of water temperature, salinity and barometric pressure for a water sample; colder water can hold more DO than warm water, fresh water can hold more DO than saline water, and all water can hold more atmospheric DO as barometric pressure increases.

The DO deficit is the difference between the calculated DO saturation concentration for the prevailing temperature, salinity, and barometric pressure and the directly measured DO concentration in a water sample. By normalizing the DO concentration data to DO deficit concentrations, the data are, thereby, automatically normalized for the direct and highly variable effects of changes in temperature, salinity, and barometric pressure. Therefore, changes in the DO deficit substantially reflect only those DO changes resulting from factors and processes other than changes in water temperature, salinity, and barometric pressure. For these reasons, changes in the instream DO deficit distributions are considered the single best direct indicator of oxygen addition results. Therefore, representative measurement of the DO deficit distribution in the target segment of the harbor is a key monitoring objective.

The two Speece Cones (Cone 1 and Cone 2) were turned on August 7 and turned off September 16, 2007. Cone 1 was shutdown for a total of 2 days, 5 hours, and 58 minutes for an effective operation of 37 days, 13 hours, and 9 minutes. The total amount of water pumped through Cone 1 during operations was 418 MG. Cone 2 was shutdown for a total of 21 hours and 54 minutes for a total effective operation of 39 days. The total amount of water pumped through Cone 2 during ReOx operations was 419 MG. Thus, the total amount of water pumped through the pump configuration for two cones was 837 MG. On average the ReOx system pumped at a rate of 15,000 gallons per minute. The demonstration project consumed 960,000 kWh. The energy usage cost approximately $89,000.

3.1 INFLUENT MONITORING

Continuous water quality monitoring was performed using the 6920 sondes. A sample of river water from the intake side of the cones was pumped to a monitoring station located on the barge deck. Monitoring of the influent began August 4, 2007, approximately three days before startup and continued until September 16, 2007, when the system was turned off. Influent water quality monitoring data are available in Appendix A Geodatabase referenced as Table Intake_Zone located on the Digital Versatile Disc (DVD) provided as part of this report.

Results from continuous monitoring of the intake water are shown in Figure 3-1. The water temperature intake data show a significant nighttime cooling effect on the Savannah River. Additionally, the data indicate that there was no significant short circuiting from the superoxygenated return flow to the intake. The intake DO deficit (daily average) was 3.4 milligrams per liter (mg/L) at startup on August 7, 2007. The smallest DO deficit (daily average) was observed on August 24, 2007 at 2.7 mg/L. During operations, the highest daily average DO deficit measured from the intake was on August 29, 2007 at 3.8 mg/L when the ReOx system was off for a brief time during the day for oxygen flow adjustments.

3.2 OXYGEN USAGE INFORMATION

A total of 1,272,080 pounds of oxygen was delivered and consumed over 39 days, from August 7 to September 16, 2007, of ReOx system operation, giving an average oxygen consumption rate of 32,600 ppd. The overall transfer efficiency was 85 percent for the temporary demonstration system with some loss during tank filling, the average amount of oxygen added to the river was about 27,000 ppd. The oxygen concentration delivered from the cones to the river ranged from about 120 to 180 milligrams per liter (mg/L). Return flow concentrations varied with flow rates through the cones.

3.3 SPEECE CONES DATA REPORTING

The control panel on each Speece Cone records oxygen flow rates entering the cone, the intake water flow rate, water temperature, and system pressure. These data are shown graphically on Figures 3-1 through 4-2 and the data are in Appendix A. Each cone was set to have a nominal oxygen flow of 15,000 ppd. During the ReOx system operation, it was noted that Cone 2 was not performing similar to Cone 1. The oxygen flow valve on Cone 2 (31 percent) was opened significantly less than Cone 1 (46 percent) and fewer bubbles were noted in the view ports on Cone 2. Discussions with the Speece Cone representatives concluded that the oxygen flow meter on Cone 2 was likely mis-calibrated and that the oxygen flow in Cone 2 was too low previously. Therefore, after several oxygen flow ramp-up tests on August 29 and August 30, 2007 were conducted, an appropriate setting for the percent open for the oxygen flow valve for Cone 2 was determined. Once completed, the oxygen flow range setting on the control panel was adjusted to represent a set oxygen flow of 15,000 ppd for Cone 2. Both flow meters (Cones 1 and 2) were returned to the manufacturer after completion of the demonstration project and recalibrated so that they can be reinstalled when the cones are redeployed at a later date.

3.4 SYSTEM PERFORMANCE

Water Intake System Performance

Biological growth, recognized as several species of hydroid (Class Hydrozoa), began to accumulate on the intake screens. The amount of biological growth on the intake screens was not anticipated by MACTEC or the screen manufacturers who had experience in the conditions in the harbor. Cleaning of the exterior of each intake screen box was performed twice by a diver. However, no contingencies were made for cleaning the interior of the intake screen boxes. Therefore, there was notable progressive head loss in the pumping system, primarily in Cone 2. As part of the observations of the demonstration project, regular cleaning or replacement of the screens must be part of the design and operations of permanent systems. Photographs of the intake screens before and after the demonstration period may be found in Figure 3-2.

Maintenance was performed on the pumps approximately every 250 hours of operation. The system was turned off for maintenance on August 16, August 27, and September 6, 2007. In the beginning, the maintenance was performed one cone at a time thus the pumps for only one cone would be off at a time. Once it became necessary for a diver to remove biological growth from the intake screens, it was decided to shut down both systems during pump maintenance due to diver safety concerns.

Oxygen Delivery to Cones

During routine oxygen tank refills the pressure would drop in the liquid oxygen storage tank and result in a temporary loss of pressure in the oxygen supply lines. This pressure drop could result in system shutdown. By working with the liquid oxygen supply company it was possible to minimize occurrences of this problem. Also, the control panel settings were initially set to shut the system down when a change of 200 ppd of oxygen flow was detected. An oxygen flow drop of this magnitude would occur during the filling of the storage tank. Because it was more important to maintain system flow, the alarm/shutdown setting was adjusted to allow a maximum change of 1,000 ppd of oxygen before an automatic shutdown. Additional adjustments of the appropriate set points for the alarm system would be needed for permanent installations. Approximately 32,600 ppd of liquid oxygen were delivered to the liquid oxygen storage tank. Spot checks of oxygen concentrations in the discharge line showed concentrations from approximately 120 mg/L to 180 mg/L.

4.0 RIVER MONITORING

Various activities were going on during the demonstration project. The activities that occurred during the ReOx system demonstration period are shown on a timeline of events prepared as Figure 4-1. Events noted included USACE dredging schedule and system operations.

During the ReOx Demonstration Project water quality monitoring was conducted by MACTEC at three stationary near-bank locations (at GPA Berth 20 (RM 15.6), at the barge location (RM 14.1), and the USACE Dock (RM 13.7) shown in Figure 4-2. In addition to the stationary monitoring locations, periodic monitoring along mid-channel profiles (Figure-4-3, 4-3.1, and 4-3.2) including extended long run monitoring to the KITB (RM 19) and five cross-channel transects was conducted during low and high tide events (Figures 4-4, 4-4.1 and 4-4.2. Water quality parameters measured, or calculated from primary measurements, included: water temperature, DO, DO percent saturation, DO deficit, salinity, conductivity, pH, density, and instrument depth. Sampling locations for the periodic measurements are shown on Figures 4-3 and 4-4. Long run monitoring locations are shown on Figure 4-5.

Water quality monitoring was conducted to assess instream conditions before, during, and one week after the 40-day ReOx project demonstration period. At both the stationary locations and periodic locations, YSI 6290 multi-parameter sondes were used to monitor water quality parameters. Instrument calibration and maintenance was conducted in accordance with the manufacturer's instructions and the procedures specified in the Monitoring Plan in Appendix B. Additional instrument calibration checks were performed as site conditions dictated. Calibration data were recorded and filed with the project field records and may be found in Appendix A, Geodatabase. At the beginning and end of each sampling event, equipment was inspected for damage, or faulty parts, and problems reported to the monitoring team leader. The monitoring team leader was responsible for equipment, its repair status, and ordering of parts.

For the periodic monitoring events, quality control grab samples were taken at monitoring locations using a Kemmerer type water sampler to collect a corresponding DO sample for comparison with the water quality monitoring instrument (YSI 6920 sondes). This grab sample is taken to the field laboratory for testing using the EPA approved Winkler method. DO grab samples were fixed in the field and returned to the field laboratory for DO titration (Hach Water Analysis Handbook, 2003). Data from the Winkler titrations were used as a quality assurance/quality control (QA/QC) check of the field instrument measurements. A minimum of ten percent (10 percent) of the discrete monitoring points in the river had QA/QC water samples collected. The measurement of these "field duplicate samples" met the measure of precision necessary to maintain and follow the quality control protocols for this water quality monitoring specified in the Savannah Harbor ReOxygenation Water Quality Monitoring Plan (Appendix B).

4.1 DREDGING ACTIVITIES

Dredging disturbs sediments on the bottom of the river and some are released to the water column. Such sediments generally contain an organic component that may cause an increased oxygen demand in the water column as dredging is under way. Therefore, dredging in the harbor is limited to times when the DO of the river is greater than 3 mg/L. Generally, dredging activities occur less during the summer when water temperatures are higher and DO concentrations are lower. When MACTEC activated the stationary background water quality monitoring stations on July 9, 2007, USACE dredging was occurring near the Marsh Island Turning Basin and this dredging continued until August 24, 2007. The USACE dredging began in the King's Island Turning Basin (KITB) on August 25 and continued through September 30, 2007, at several locations well after the ReOx system shutdown on September 16, 2007. The USACE measured water quality in the harbor during dredging operations. These USACE data are tabulated in Appendix C.

MACTEC was notified on August 25 that a break in the USACE dredge line had occurred. Increased sediment in the on-deck monitoring system at the ReOx barge location was noted from August 21 to August 24, 2007. The break in the dredge line released high concentrations of sediment to the water column. This high sediment load likely resulted in increased oxygen demand in the river system.

4.2 MONITORING AT STATIONARY LOCATIONS

Eighteen water quality sondes were deployed at the near-shore stationary monitoring stations (GPA Berth 20, the barge location, and the USACE Dock). Six sondes were used at each location. Sondes were placed in pairs (designated as primary and secondary) at selected depths (approximately 1 meter below the surface, near mid depth, and 1 meter from the bottom) to continuously monitor water quality (DO concentration, DO percent saturation, water temperature, conductivity, salinity, and depth). Each sonde was set to record water quality data at 15 minute intervals. The monitoring data collected at these stationary locations are available in electronic format in the Geodatabase (Appendix A) on the attached DVD. These data have been subjected to the appropriate QA/QC checks.

Due to the volume of the data collected, the data are summarized in graphical displays. Figure 4-2 (multiple figures for each stationary location) presents the continuous near-shore monitoring series:

- Figure 4-2.1 is based on data collected upstream from the ReOx system (at GPA Berth 20, RM 15.6);
- Figure 4-2.2 is based on data collected at the ReOx barge location, (RM 14.1); and
- Figure 4-2.3 is based on data collected downstream from the ReOx system (at the USACE Dock, RM 13.7).

The secondary sondes were deployed at each location and depth to duplicate the primary sonde readings in order to reduce the potential for data gaps resulting from instrument problems. Personnel checked on the sondes remotely (via internet) and visited the deployment locations approximately once per week to replace the sondes (one set at a time – primary or secondary) with recalibrated instrumentation. Sondes removed from a site underwent a calibration check (to check for potential instrument drift), data collection (downloaded from the memory of the sonde), cleaning, maintenance as needed, and were recalibrated prior to redeployment at a new location.

Monitoring Procedures

The reference standards for field instrument calibration are described in the monitoring plan (Appendix B). If there was evidence of fouling on the sondes or notable drift in the data, then the sondes were changed out more often than required by the standards. To allow for uninterrupted data monitoring, scheduling for the change out and recalibration of the sondes was such that a continuous monitoring sonde and its associated duplicate were not being changed at the same time. Calibration of the sondes was in accordance with the manufacturer's specification and the guidelines that are outlined for instrument calibration in the monitoring plan, Appendix B.

Findings From Stationary Locations

Monitoring data from the stationary locations show a noticeable diurnal pattern of the DO concentration. These diurnal DO swings are particularly noticeable on the shallow series data for each stationary location as shown in the Figure 4-2 series. This diurnal swing, not as notable in the mid or deep data, is likely caused by photosynthetic activity in the upper layers of the water column. Also observed are fairly stable and higher water temperatures prior to August 24, 2007 and a cooling trend afterward. This indicates that the ocean boundary cooled and produced higher oxygen concentrations (lower DO deficits) near the ocean and during high tides.

Upstream of the ReOx system (at GPA Berth 20, RM 15.6):

The GPA Berth 20 monitoring station was approximately 1.5 miles upstream from the ReOx system. The station was attached to the Berth 20 dock located on the right side of water (city side). It was necessary to locate the continuous monitoring stations on fixed structures in the harbor and out of the navigation channel; therefore, the placement was not ideal to monitor the effects of the ReOx system in the navigation channel.

Prior to startup on August 6, 2007 the DO deficit was 3.7 mg/L (shallow zone), 4.0 mg/L (middle zone), and 4.2 mg/L (deep zone). Within 48 hours the average DO deficit was improved (decreased) at the GPA monitoring location (1.5 miles upstream from the ReOx system) by about 0.1 mg/L. After 4 days of reoxygenation the average DO deficit was improved by 0.4 mg/L. These comparisons use the daily average DO.

GPA (RM 15.6)	Prior to ReOx System Startup	Elapsed time after ReOx system startup			
	8/6/2007 DO deficit (mg/L)	48-hour DO deficit (mg/L)	48-hour DO Deficit improvement (mg/L)	4-day DO deficit (mg/L)	4-day DO deficit Improvement (mg/L)
Shallow zone	3.7	3.6	0.1	3.3	0.4
Middle zone	4.0	3.9	0.1	3.6	0.5
Deep zone	4.2	4.1	0.1	3.9	0.3

Prepared By: TRK 11/19/07
Checked By: LMS 11/19/07

After running for about 10 days straight, the ReOx system was turned off for operations and maintenance (O&M) on August 16, 2007. At shutdown the DO deficit was 3.4 mg/L (shallow zone), 3.7 mg/L (middle zone), and 3.9 mg/L (deep zone). The ReOx system was reactivated on August 17, 2007. Forty-eight hours after restarting the ReOx system the average DO deficit across the water column at the GPA location was improved by 0.5 mg/L.

GPA (RM 15.6)	System shutdown	While system was off	Elapsed time after ReOx system restart	
	8/16/07 DO Deficit (mg/L)	8/18/2007 DO deficit (mg/L)	8/20/07 DO deficit (mg/L)	4-day DO Deficit improvement (mg/L)
Shallow zone	3.4	2.9	2.5	0.9
Middle zone	3.7	3.6	3.3	0.4
Deep zone	3.9	4.0	3.7	0.2

Prepared By: TRK 11/19/07
Checked By: LMS 11/19/07

On the day of final system shutdown (9/16/07), the DO deficit at the GPA monitoring location was 3.1 mg/L (shallow zone), 3.4 mg/L (middle zone), and 3.6 mg/L (deep zone). Eight days after the ReOx system was shutdown, the DO deficit averaged 3.6 mg/L in the water column which was significantly less than the 40 day earlier DO deficit average of 4.0 mg/L in the water column. This decrease in DO deficit is attributed to the influence of cooler ocean water with lower DO deficits during high tides.

At the ReOx system location, (Barge, RM 14.1):

Prior to startup on August 6, 2007 the DO deficit was 3.9 mg/L (middle zone) and 4.0 mg/L (deep zone). After 48 hours the DO deficit was improved at the ReOx monitoring location by 0.3 mg/L in the middle zone and 0.2 mg/L in the deep zone. After 7 days the ReOx system had improved the DO deficit by 0.5 mg/L in the middle zone and 0.6 mg/L in the deep zone.

After running for about 10 days straight, the ReOx system was turned off for O&M on August 16, 2007 at which time the DO deficit was 3.3 mg/L (shallow zone), 3.3 mg/L (middle zone), and 3.5 mg/L (deep zone).

On the day of final shutdown (9/16/07), the DO deficit at the ReOx barge location was 3.0 mg/L (middle zone) and 3.2 mg/L (deep zone). Eight days after shutting the system down, the DO deficit was still less than it was prior to startup conditions.

ReOx System (RM 14.1)	**Prior to ReOx System Startup**	**Elapsed time after ReOx system startup**			
	8/6/2007 DO deficit (mg/L)	**48-hour DO deficit (mg/L)**	**7-day DO deficit (mg/L)**	**14-day DO deficit (mg/L)**	**9/16/07 Shutdown deficit (mg/L)**
Shallow zone	No data	3.7	3.4	2.4	No data
Middle zone	3.9	3.6	3.4	3.0	3.0
Deep zone	4.0	3.8	3.5	3.3	3.2

Prepared By: TRK 11/19/07
Checked By: LMS 11/19/07

The minimum DO deficits at the ReOx barge location were observed between September 12 and September 14, 2007. The deep zone had a DO deficit of 2.9 mg/L on September 12, 2007 began and the shallow and middle zone had a DO deficit of 2.3 mg/L and 2.8 mg/L respectively, on September 14, 2007, some 38 days after ReOx injection began.

Downstream of ReOx system (at the USACE Dock, RM 13.7):

Just prior to ReOx system startup the water temperature was rising and the DO deficit at the USACE dock was 3.7 mg/L in the middle zone and 3.8 mg/L in the deep zone. Approximately 24 hours later, after the system began operating, the DO deficit had decreased by 0.2 mg/L in both the middle and deep zones.

The ReOx system was shut down on August 18, 2007 for O&M. The water column average DO deficit was reduced by 0.3 mg/L about 24 hours after the system resumed normal operation on August 19, 2007 when water temperatures remained relatively constant. Forty-eight hours after operations were resumed August 20, 2007, the middle zone DO deficit daily average was 2.6 mg/L which was the best improvement noted during the demonstration project from the initial 3.7 mg/L DO deficit on August 6, 2007, thus the deficit was reduced by 1.1 mg/L. The best observed DO deficit daily average for the shallow zone was on August 22, 2007 at 2.4 mg/L and the minimum deficit for the deep zone was on August 24, 2007 at a deficit of 2.9 mg/L.

The system was operating at a steady rate on September 12, 2007, four days before shutdown, with the DO deficit daily water column average of 2.9 mg/L, which is similar to the water column four days after shutdown.

USACE Dock (RM 13.7)	Prior to ReOx System Startup	Elapsed time since ReOx system startup			
	8/6/2007 DO deficit (mg/L)	14 Day DO deficit (mg/L) 8/20/07	1 day after Shutdown DO deficit (mg/L)	4 days after Shutdown DO Deficit (mg/L)	8 days after Shutdown DO Deficit (mg/L)
Shallow zone	No data	2.5	3.1	2.7	3.3
Middle zone	3.7	2.6	3.3	2.9	3.5
Deep zone	3.8	2.9	3.2	2.8	3.4

Prepared By: TRK 11/19/07
Checked By: LMS 11/19/07

4.3 MONITORING ALONG MID-CHANNEL

Water quality sampling in the middle of the navigation channel was performed periodically (at least weekly) at 14 locations, V1 – V14, which extended from GPA Berth 20 to the USACE Dock (Figure 4-3). Due to the strength of the tides and the need to sample during slack tide conditions, the sampling was performed in a 2 to 3 hour window centered on a high or low slack tide.

Sampling locations were monitored using the hand held YSI 6920 sondes. These mid-channel DO measurements were taken at four (4) depths: 3 feet below water surface; 1/3 of total depth; 2/3 of total depth; and 3 feet above bottom. At the request of EPD, MACTEC assessed the potential for conducting more detailed water column measurements at 1-foot intervals for the top 10 feet and 2-foot intervals to the bottom. Since the mid-channel depths ranged from 48 feet (low tide) to 55 feet (high tide), the total number of measurements at one point would have been as high as 32 discrete measurements. Since it took a minimum of two to three minutes for the instrument to stabilize, the total time for measurement of one location approached one and a half hours. Since there were 14 sampling locations and it was important to keep the measurement period as short as possible so that the data were obtained under similar conditions and to avoid high currents (maximum time three hours per event), this methodology was not feasible, within available resources, for the periodic river sampling events.

The pH, specific conductivity, salinity, and DO instrumentation were calibrated prior to deployment and the calibration was checked after completion of the sampling event.

4.3.1 Mid-Channel Findings – DO Deficit

Table 4-1 summarizes the grid averaged DO deficit calculations. The grid average is the average DO deficit of the water column. The following details the Figures 4-3 s mid-channel isopleths.

Figure 4-3.1 a-b – Mid-Channel Monitoring DO Deficit at Low Tide
Figure 4-3.1 c-d – Mid-Channel Monitoring DO Deficit at High Tide
Figure 4-3.1 e-f – Mid-Channel Monitoring DO Concentration at Low Tide
Figure 4-3.1 g-h – Mid-Channel Monitoring DO Concentration at High Tide
Figure 4-3.1 i-j – Mid-Channel Monitoring DO Percent Saturation at Low Tide
Figure 4-3.1 k-l – Mid-Channel Monitoring DO Percent Saturation at High Tide

Low Tide Events

The results from the mid-channel monitoring events at low tide indicated that the improvement from August 6, 2007 to September 7, 2007 of the grid average DO deficit from the operation of the ReOx system was approximately 0.6 mg/L. The mid-channel low-tide monitoring event that occurred just prior to system startup indicated that the three-mile river segment being monitored had a grid average DO deficit of 3.9 mg/L. Once the effects of the ReOx system operation stabilized, on August 20, 2007, the grid average DO deficit after 13 days of reoxygenation was 3.3 mg/L, thus the DO deficit was improved by 0.6 mg/L. The average DO deficit based on all five low tide event grid averages was 3.4 mg/L, a DO deficit improvement of 0.5 mg/L, though after August 24, 2007 a cooling trend began to occur in the water temperature, which meant the stabilized condition on August 20, 2007 was more representative of the ReOx system effect during critical conditions than the period of time when the cooling trend began. The final monitoring event for the 3-mile segment 10 days post system shutdown indicated that the average DO deficit at low tide had returned to 3.9 mg/L, thus the effects of the system lasted for days after the system shut down.

These mid channel monitoring locations act as "snapshots" of the water quality profiles along the three-mile long target segment of the river centered on the ReOx barge location. Figure 4-3.1 graphically presents the low tide sampling results for all events.

High Tide Events

At mid-channel high tide improvement in DO was observed but was not as predominant and clear as the low tide measurements. Table 4-1 summarizes the grid average DO deficit calculations. Figures 4-3.2 present the high tide events. Prior to startup a DO deficit of 3.9 mg/L was observed a few weeks prior to startup during fairly steady critical conditions of high temperatures and low water flows. A week after the startup of the ReOx system, the DO deficit had been improved by 0.7 mg/L from July 16, 2007 to August 27, 2007. The average DO deficit from two high tide events during stable water temperature conditions was 3.2 mg/L. After August 24, 2007, the high tide deficits continued to further naturally decrease as a result of cooling sea temperatures and lower DO deficits.

4.3.2 Other Water Quality Data Findings

Mid-channel data for pH, salinity, and temperature are presented in a low and high tide series on Figures 4-3.2 as detailed below.

Figure 4-3.2 a-b – Mid-Channel Monitoring pH at Low Tide
Figure 4-3.2 c-d – Mid-Channel Monitoring pH at High Tide
Figure 4-3.2 e-f – Mid-Channel Monitoring Salinity at Low Tide
Figure 4-3.2 g-h – Mid-Channel Monitoring Salinity at High Tide
Figure 4-3.2 i-j – Mid-Channel Monitoring Temperature at Low Tide
Figure 4-3.2 i-j – Mid-Channel Monitoring Temperature at High Tide

Low Tide Events

During low tide conditions, the pH in the river is relatively neutral and is slightly greater at the bottom of the river. Salinity tends to have a low surface salinity and gradually increases with depth. The salinity ranges from approximately 6 parts per thousand (ppt) at the surface to 16 ppt at the bottom of the river. The temperature trends are very apparent on the Figure 4-3.2i-j; hotter temperatures appear red to yellow and cooler temperature appear green or blue.

At low tide the river was stratified through the first several weeks of monitoring (7/9/07 through 9/4/07). Salinity in the river was highest around August 20, 2007; this date 4900 cubic feet per second was observed (Figure 4-8.2) as a period of low flow as measured at the U.S. Geological Survey (USGS) Gage 02198500 near Clyo, GA. Water temperature was also highest during this same time. Figure 4-3.2 shows effects of the ReOx project on the river temperatures on August 20, 2007. This gradient effect was likely due to the lower river flows (as measured at the USGS Gage near Clyo, Georgia) and the fact that the intakes were located at the edge of water near the surface where water temperatures were warmer, particularly during daylight hours.

High Tide Events

Generally, high tide conditions brought a higher pH water into the harbor. The highest pH values occurred at the bottom of the river. Salinity at high tide conditions have a similar gradient as at low tide events, low values at the surface and higher at the bottom. However, a much higher salinity values are observed at high tide throughout the water column. Water temperatures during high tide events are generally cooler than during low tide events.

4.3.3 Long River Run Monitoring (RM 4 to RM 19)

In addition to the three-mile target segment in the vicinity of the ReOx system, monitoring over a 15 mile segment was also conducted. These "long run" monitoring events extended from approximately RM 4 to RM 19 as included at the end of Figure 4-3.1. Shortly after the ReOx system had been turned on, the USACE noticed an increased DO level at their KITB monitoring location approximately eight miles up river from the ReOx system location. After reviewing the data, it became apparent that long run monitoring would be helpful to assess a larger scope of the influence of the ReOx demonstration project. Beginning the week of September 6 to September 25, 2007, long run monitoring was completed weekly in Savannah Harbor. This was accomplished by beginning at RM 4 off Long Island upstream of Fort Pulaski and conducting a vertical profile (3 depths) every half mile until reaching RM 19 at the KITB (Figure 4-5). Profile readings were taken at shallow, middle, and deep depths. Long run results may be found in Appendix A, Geodatabase, Table Additional_Sampling_Water_Quality_Data.

Results from the long run monitoring indicated that DO levels were higher near the ocean and that the three-mile target segment under study for the ReOx Demonstration Project (USACE Dock to GPA Berth 20) was the critical segment identified in the TMDL report (USEPA, 2004). Also, data revealed that the KITB appeared to act as a storage location for higher DO water. As the flood tide moved upstream, the higher DO water from the ReOx system filled the KITB. As the tide moved out, the higher DO water was released and flowed downriver. A subset of the long run data (from RM 13 to RM 16) was incorporated in the mid-channel "target zone" series depicted on Figure 4-3. The long run monitoring data was collected on September 6, 7, 13, 19, and 25, 2007 and referenced as "Long Run" on the Figure 4-3.1 low and high tide series.

4.4 CROSS SECTIONS

Water quality was measured at five cross-section transects (at Berth 20, upstream of the Talmadge Bridge, the barge location, the convention center, and the USACE Dock) were measured (Figure 4-4). Figure 4-4.1 shows transect sampling points as follows:

- Overbank (river left facing downstream at A1 and A2)
- Channel toe (river left facing downstream at B1 through B3)
- Mid-channel (T1 through T5 readings at C1 through C4)
- Channel toe (river right facing downstream at D1 through D3)
- Overbank (river right facing downstream at E1 and E2)

These cross section transects act as slack tide "snapshots" of water quality within the ReOx demonstration target zone. Figures 4-4.2 depicts the low and high tide transects monitoring results for all events.

As with the periodic mid-channel sampling events, the cross section monitoring events were timed to coincide with local slack tide conditions (low or high). The pH, specific conductivity, salinity and DO instrumentation were calibrated prior to sonde deployment and checked at the completion of the sampling event.

Cross-Section Monitoring Findings

Table 4-2 shows the average DO deficit within each cross section and for all five cross sections for each tidal event.

The cross check between the mid-channel readings and the cross section readings are quite similar. The low-tide cross section point averaged DO deficit prior to ReOx injection was 3.9 mg/L. The cross section transects DO deficit at low tide was reduced from 3.9 mg/L to 3.0 mg/L after 14 days of ReOx system operation. During relatively stable river water temperatures between 8/10/2007 and 8/21/2007 the average DO deficit was 3.3 mg/L. This indicates that the DO deficit improvement was 0.6 mg/L.

4.5 NEAR BARGE MONITORING

Additional river monitoring included near barge monitoring shown on Figure 4-4 during the demonstration period to evaluate the local instream extent of notably supersaturated water from the ReOx system. Near-barge monitoring included taking profile readings at locations (S0A– 4A, S0B-S2B, S0C – S2C) adjacent to the barge on the day of ReOx system start up, August 7, 2007. Monitoring was completed in the center of the return line flow on the river side of the barge as shown in Figure 4-5.1. Readings were taken from a radius of 25 feet to 100 feet surrounding the barge at shallow, middle, and deep readings. As shown on Figure 4-5.1, the reoxygenated water dispersed quickly into the river and no extreme initial gradients were observed. The near barge monitoring consisted of 33 points taken on the day of the ReOx system startup, which averaged a 46 percent DO percent saturation, 3.4 mg/L DO concentration, and a DO deficit of 3.8 mg/L. This DO deficit at startup is consistent with the 3.9 mg/L measured in the mid-channel and cross section transects data sets.

As observed during the demonstration project, some effervescence was occurring, particularly as noted during slack tide conditions (Figure 4-6). This effervescence was attributed to turbulence occurring around the gate valves that controlled system pressure and flow at the discharge end of the ReOx system return lines. The gate valves were closed about 80 percent to create sufficient pressure in the cones. Effervescence was not noticed at mid-tide conditions because there was substantially more mixing of the water as a result of tidal flow in the river for mixing. Estimates from Dr. Richard Speece indicated that the oxygen lost to effervescence was likely much less than five percent of the total oxygen input. During near-barge monitoring several readings were taken in the center of the noted effervescence bubbles to assess DO concentrations; the highest DO concentration measurement was 4.3 mg/L. A permanent system design may utilize valves with a smoother transition and a multiport diffuser to further limit the potential for effervescence.

4.6 QA/QC REVIEW

For the ReOx Demonstration Project, MACTEC achieved a greater than 98 percent data recovery. The field monitoring data collected from the continuous monitoring stations and weekly sampling stations are stored in a non-relational database in Appendix A, Geodatabase. These data were reviewed by MACTEC so that the necessary parameters, measurements, and analytical results were properly recorded; the analytical results were evaluated for completeness and accuracy and suspected errors were investigated and resolved, as possible.

Data from the YSI 6290 sondes were considered valid if the post deployment calibration check did not deviate from pre-deployment calibration by more than ten percent. Data from sondes that did deviate by more than 10 percent were considered outliers and the corresponding measurement from the duplicate sondes were used to fill such data gaps.

In addition, during sonde deployment at the USACE dock it was noted that tidal/wave actions were causing the sondes to bounce on the support bolt in the sonde standpipes. This caused damage to the sonde batteries resulting in some data loss before this problem was identified and rectified. Data lost includes:

- Stationary Monitoring Location USACE-Mid (8/11 5:45pm to 8/13 4:00 pm), (8/24 11:00am to 8/27 3:00pm), and USACEM (9/15 11:30am to 9/16 2:00pm);
- Stationary Monitoring Location USACE-Deep (7/30 9:30am to 8/1 4:30pm) and (8/24 11:30am to 8/27 2:30pm)

Additionally, there were occasional events where data was lost due to the following: a floating surface sonde was caught by river debris and restrained at depth or by the support rope and came out of the water during low tides; at The Industrial Company due to available location for sonde placement prior to the barge setup that resulted in sondes being out of the water; and the monitoring station on the barge coming loose from the supports as a result of a boat collision.

Data Quality Objectives

The data quality objective for the ReOx project was to obtain sufficient and credible data that would support, with a reasonable level of certainty, that the monitoring results are correct. The quality controls for the ReOx project included assessing the precision, representativeness, comparability, and accuracy of the monitored parameter values, with particular emphasis on changes in DO deficit concentrations. See Appendix B, Savannah Harbor ReOxygenation Water Quality Monitoring Plan, for more detail on the data quality objectives. These data quality objectives were met for the project and a greater than 98 percent data recovery for all data collected by MACTEC was achieved.

4.7 DYE TEST OBSERVATIONS

A dye test was conducted near the end of the operation period to assess the dispersion characteristics of the superoxygenated water in the river. This test was planned as a qualitative observation of the behavior of the dye as it was released in the return lines. The dye test on September 12, 2007, was conducted at low slack conditions and as the river started flowing upriver toward the Kings Island Turning Basin. At approximately 17:05 hours on September 12, 2007, 55 gallons of permailon blue dye was injected into the ReOx system. Observations were made of the visible dye movement in the river.

Photograph log:

- Digital photographs were taken during the test every minute for the first 10 minutes and every 5 minutes thereafter until the dye had dispersed.
- Photographs were taken from the following locations during the dye test:
    - Barge location
    - Hyatt Hotel (located on River Street directly across the river)
    - Talmadge Bridge (upstream of the barge)
    - Boat

Visual observations did not note substantial quantities of dye at the surface of the river; this indicated that the superoxygenated return flow was entrained at deeper depths. There was some drag up of dye from the effervescence but the color noted indicated a large dilution of dye injected. To compare the injected dye color noted at the surface to the potential color if the flow had short-circuited to the surface, five gallons of dye were released from a boat to the surface of the river. Figure 4-7 shows the comparison of the deep dye injection versus the surface dye release.

In addition to field observations, water samples taken with a Kemmerer type sampler were also collected at 1 foot, 10 feet, 20 feet, 30 feet, and 40 feet below the river surface and placed in glass sample bottles. Visual observations of the samples indicated that the darkest dye color was noted at 30 feet and 20 feet. Medium color (as compared to the darkest samples) was noted at 40 feet and 1 foot. Samples collected at 10 feet were the lightest indicating that the surface color noted was likely due to drag up of dye from the effervescence noted during slack tide conditions and that the bulk of the supersaturated water was dispersed in the mid-depth of the water column that corresponded to the return line outlet depth.

Observations were made to determine if the dye was noticeable upstream of the ReOx System. Observations made showed that the only visual evidence was from the surface release. There was little evidence at the GPA Berth 20 Dock of the dye. This confirmed the hypothesis that the superoxygenated water remained largely within the navigation channel.

4.8 OTHER MONITORING AND ANALYSES

4.8.1 USGS Gage at USACE Dock

Provisional water quality data from the USGS Gage 021989773 Savannah River at USACE Dock, at Savannah, GA matched very closely the data from deep monitoring zone USACE monitoring station data collected by MACTEC, Appendix B Geodatabase, referenced as Table USGS_Gage_Data. The USGS station was set at approximately 4 feet from the bottom at the USACE dock. Figure 4-8.1 presents the USGS provisional water quality data at the USACE dock (USGS, 2007a).

4.8.2 USACE Kings Island Turning Basin Monitoring

The USACE provided water quality data taken at various locations in the Savannah River while dredging was occurring upstream from the ReOx barge location. These data are shown in Appendix C.

4.8.3 USGS Gage at Clyo

The USGS gage station data from the Savannah River near Clyo, GA, USGS 02198500, for July 9, 2007 through September 25, 2007, are provided in Appendix A, Geodatabase, referenced as Table USGS at Clyo and are provisional. Figure 4-8.2 depicts streamflow data for the Clyo gage. The data showed an average flow rate of 5086 cubic feet per second (cfs) during the ReOx project (USGS, 2007b). The maximum flow, 5650 cfs, on 7/14/2007 and the minimum flow, 4590 cfs, on 7/25/2007 at the Clyo gauge were both prior to the ReOx system startup. During the monitoring period of July 9 through September 25, 2007, instream flow was observed at and sometimes below critical instream flow conditions of 5000 cfs.

4.8.4 Rainfall Monitoring

The rainfall data have been included on Figures 4-2 of the stationary monitoring locations. These data are provided in Appendix A Geodatabase as provisional from the USGS Gage 021989773 Savannah River at USACE Dock, at Savannah, GA weather station, referenced as Table USGS_Gage_Data. The maximum rain event between July and September 2007 was on 7/30/2007 with 12.59 centimeters (approximately 5 inches) of precipitation. The maximum weekly rain event occurred between July 30th to August 5th with a total weekly precipitation of 18.84 centimeters (7.4 inches) (USGS, 2007a).

4.8.5 Data Analysis by Georgia Tech Students

- Data provided by GPA to Civil and Environmental Engineering students at Georgia Tech.
- Reviewed/analyzed only data from continuous near-bank monitoring locations. and did not analyze more-representative centerline or cross section monitoring.
- Compared DO percent saturation before, after, and during project for all tides combined such that progressive sea cooling effect on high tide data masked low-tide deficit reductions
- Concluded there was not a statistically strong positive impact on DO as a result of oxygen addition.
- While MACTEC appreciates the contribution of the Georgia Tech students, it is important to note that their conclusions are based entirely on the near-bank monitoring while the dominant influence of the ReOx project was on the central part of the river (USACE, 2007).

5.0 FULL-SCALE DESIGN CONSIDERATIONS

Locations for permanent stations will require certain infrastructure to support the operations of the ReOx systems. For example, a station incorporating liquid oxygen will require a road so that the tanker trucks delivering the liquid oxygen would be able to have access to the site. A station incorporating an oxygen generator would be able to utilize a more rudimentary road for access for the personnel who will be servicing and operating the system. Electrical service will be needed to supply power for the pump system.

The ReOx discharge lines should be placed as deep in the river as possible and preferably discharge toward the navigation channel or river bottom. For example, the design of the demonstration project included discharge lines that sloped downward approximately 10 degrees (from horizontal), and the momentum of the water flow transported the supersaturated water into the navigation channel. A similar approach should be considered for the permanent installation to simplify the discharge pipe layout. Discharge lines should be placed so they present the least possible impact on normal river operations (ship traffic, dredging, etc.) and may be seasonally deployed.

5.1 CONCEPTUAL DESIGN SCHEMATICS

Based on the results of the demonstration project, MACTEC anticipates that two permanent installations would be sufficient to provide oxygen to mitigate the effects of harbor deepening, with one station having one cone (but designed with the contingency of adding a second cone) and the other station having two cones (an extra to allow one cone to be down for maintenance at either station). Additionally, each system should have a backup pump system so that operation could continue during pump maintenance or failure.

Depending on the sites selected for permanent installation of ReOx stations, there are several possible design scenarios to consider, including:

- River bank below ground installation of the Speece Cone (Figure 5-1)
- Above ground installation of the Speece Cone (Figure 5-2)
- Barge mounted systems similar to the demonstration project

Each of these alternatives, depending on site location and access, could take advantage of various design alternatives such as: a single or dual cone design; intake screen type; and oxygen generation or liquid oxygen supply. Figures 5-1 and 5-2 provide a general conceptual layout of two types of mounting configurations for single cone systems that may be adapted to dual cones systems as needed. Final design layouts for a permanent system will depend on site-specific requirements.

5.2 ESTIMATED COSTS TO CONSTRUCT

As a planning tool, MACTEC has prepared rough order of magnitude (ROM) estimated costs for one cone stations based on the conceptual designs presented in Figures 5-1 and 5-2. Table 1 presents the ROM estimated costs for a basic one-cone land-based ReOx Station. These costs do not include land procurement, utility installation, or roadway construction as these are highly dependent on the actual sites selected. Costs presented in Table 5-1 are summarized below:

- Above Ground Installation – Oxygen Generator: $1.90 million
- Above Ground Installation – Liquid Oxygen Supply: $2.05 million

- Below Ground Installation – Oxygen Generator: $4.80 million
- Below Ground Installation – Liquid Oxygen Supply: $4.95 million

Additional considerations for the design of each permanent ReOx station location would be the annual O&M requirements. Estimated ROM annual O&M costs per cone are presented in Table 5-2 and are summarized below.

- Oxygen Generator: $24,000
- Liquid Oxygen Supply: $131,000

Additional costs would include the cost of a support building at each ReOx Station. The support building would house equipment, control panels, oxygen generation equipment (if applicable), and provide off-season storage of ReOx pumps, Speece Cone(s), and other equipment. Building costs will vary depending on the type (prefabricated, block, or concrete) and the finish required (some areas may have specific design requirements, i.e. brick, rock, etc.) for a specific location selected. These costs range from $150,000 to $300,000 or more. The below ground installation is more expensive because sheet piling and dewatering would be required during installation.

6.0 ANECDOTAL INFORMATION

- The Nature Conservancy conducted sturgeon monitoring in the vicinity of the ReOx project using underwater receivers to monitor whether tagged fish pass by a particular Savannah River section. No tagged sturgeons were noted during the ReOx demonstration project.

- It was necessary to scrape off barnacles from the continuous monitoring sondes routinely as part of the operation and maintenance procedures.

- When the ReOx system return lines were disassembled and brought to the surface, blue crabs were noticed on the return lines which they were using as habitat structure.

- The mid-channel and cross section transect data were collected from a registered boat and carefully coordinated with the United States Coast Guard and other pilots navigating the Savannah River.

- The ReOx demonstration project used four 400 horsepower pumps that were mounted on the barge deck. The rated decibel levels were 72-76 decibels for each pump at 30 feet. It is expected that the vertical pumps planned for the permanent installations would generate approximately 65 decibels for each pump at the pumps on the barge deck.

7.0 CONCLUSIONS

1. **The ReOx system was able to meet the target oxygen mitigation quantity of 20,000 ppd.** The goal of adding enough oxygen, approximately 20,000 ppd, to mitigate the effects of harbor deepening was achieved using two Speece Cones each designed for up to 15,000 ppd.

2. **Operation of the ReOx system resulted in an average decrease of the DO deficit of 0.6 mg/L.** Mid channel DO profiling along the river study length indicated that about three days of continuous oxygen injection were needed to initiate measurable DO deficit reduction and that an overall average deficit reduction of approximately 0.6 mg/L was achieved during the demonstration period as compared to pre- and post- monitoring data.

3. **The positive effects on water quality from the ReOx system were notable after system shutdown.** For at least seven days after the ReOx system was shut down, residual positive effects of oxygen addition were still clearly evident in nearby cross-section transects taken at low tide. Ten days after ReOx system shut down there was no continuing evidence of residual instream DO improvement, and mid-channel low tide DO deficits had substantially returned to pre start-up deficit levels of 3.9 mg/L.

4. **Near barge monitoring did not detect excessively high DO concentrations in the river.** Immediately after startup, the near barge monitoring performed around the ReOx system at the request of EPD indicated that the superoxygenated river water was dispersing quickly into the tidal flow of the Savannah River system. Continuous stationary and periodic mid-channel and cross section monitoring also indicated that the superoxygenated river water was dispersing quickly into the river system.

5. **Influent monitoring concluded no short circuiting of the reoxygenated water.** The influent water pumped into the system from the river was not oxygen rich; thus, tidal movement effectively transported new water into the target injection area.

6. **Data collected by project monitoring activities was verified by USGS monitoring.** USGS water quality gaging station data closely matched MACTEC water quality deep monitoring data at the USACE dock.

8.0 REFERENCES

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USGS, 2007b. 15-min Data for the Savannah River Near Clyo, GA (02198500). http://waterdata.usgs.gov.

TABLES

FIGURES

APPENDIX A

GEODATABASE
(Electronic Only)

APPENDIX A

Appendix A contains the project database located on the attached DVD in Microsoft Access format. In addition to the database file, selected tables have been prepared as referenced in the text.

APPENDIX B

SAVANNAH HARBOR REOXYGENATION WATER QUALITY MONITORING PLAN

TITLE

Text begins here.

APPENDIX C

USACE Water Quality Monitoring Data, 2007

APPENDIX C

USACE Water Quality Monitoring Data, 2007

The USACE Water Quality Monitoring Data as provided by the USACE, Savannah District is provided here in tabular format. This data is also available on the Project DVD (Appendix A).

Georgia Port Authority

Page 4

767-MM-21-EC01
Comment: *According to the GPA's careful analysis, the ample net transportation benefits are understated. Adjustment of even a few of the overly conservative assumptions used by the Corps results in maximization of net benefits with a 48-foot channel, qualifying it as the National Economic Development ("NED") plan that the GPA recommended.*

Response: The study team used empirical data and input from independent consultants in the shipping industry to develop the transportation figures used in the economic analysis. To address some of the uncertainties in the future without project condition, the study team ran several sensitivity analyses. Nearly all of these scenarios resulted in the -47 foot depth being the NED alternative. Admittedly, there are added efficiency savings beyond -47 feet, but the incremental costs offset the additional savings [lower net benefits].

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767-MM-21-EC02
Comment: *Whether the Corps should recommend expansion to a MLW depth of 47 feet or a MLW depth of 48 feet is an open issue. The GPA supports expansion to a MLW depth of 48 feet and asks that the final agency action adopt the 48-foot depth. The Corps calculated that a 48-foot SHEP would save more than $150 million in transportation costs annually, and that net economic benefits should average $115 million a year over the next 50 years. The resulting benefits to cost ratio of 4.3:1 satisfies Water Resources Development Act ("WRDA") criteria for supporting the project.*

Response: The Corps' *Principles & Guidelines* defines the Federal objective as "contributing to National Economic Development (NED) consistent with protecting the environment". The NED plan represents the alternative that reasonably maximizes the project's defined benefits [to the nation] in comparison to its economic costs.

In the case of Savannah Harbor, the 47-foot deepening alternative resulted in the highest net change in benefits over costs, thus rendering it the NED plan. In accordance with Corps policy, a non-Federal project sponsor has the choice of choosing another option, i.e., the locally-preferred plan - 48-foot depth. However, departures from the NED alternative have cost-sharing implications and need to be approved by the Assistant Secretary of the Army, Civil Works.

Using numbers in the Draft GRR and EIS, the Corps recognizes that the difference in net benefits between the 47-foot NED plan and the 48-foot Locally-Preferred Plan is roughly $300,000 per year, which is less than 1/2 percent of the calculated benefits. In light of the 25 percent contingency placed on project costs, the difference is small. However, Corps policy states that when two plans produce roughly the same amount of benefits, the Corps should generally select the plan that costs the least to implement. In this case, the 47-foot NED plan would cost roughly $37 million less to implement than the 48-foot Locally-Preferred Plan. Therefore, Corps policy indicates that the 47-foot depth should be selected.

With the authorization provided by Congress for the SHEP, the views of the four Federal agency heads are of particular interest. In this case, the USFWS and their parent Department of Interior identified that the 48-foot depth alternative would produce greater environmental impacts to resources over which they are responsible. As a result, they do not support the 48-foot depth alternative.

As a result of both Corps policy and in recognition of the views of the Department of Interior, the Corps elected to select the 47-foot NED depth alternative for implementation rather than the 48-foot Locally-Preferred Plan.

Page 10

767-MM-21-EC03
Comment: *The GPA agrees the SHEP will generate substantial transportation savings that easily justify project approval. However, the Corps analysis significantly understates the economic benefits the SHEP will generate, particularly in the 47 to 48 feet channel depth range, for several reasons. The Corps analysis relies on unrealistic conservative assumptions of the vessel fleet utilization and of the loading drafts of the vessels expected to call on the Savannah Harbor.*

Response: The assumptions used by the study team were based on empirical field data and from input provided by independent consultants [within and outside the shipping industry]. These suppositions were vetted several times by technical reviewers, policy specialists, and independent panels. While some may feel the District was overly conservative in its assumptions, the agency is confident those assumptions are reasonable and will be validated by future events in the shipping industry.

767-MM-21-EC04
Comment: *First, the Corps assumes a certain percentage of post-Panamax ships calling on the Savannah Harbor will take advantage of favorable tidal conditions and adjust their loads accordingly. In fact, the Corps assigns maximum practicable capacity of vessels using 5-feet of usable tide as one of the considerations. This assumption is unrealistic, and the Corps provides no explicit rationale for assuming that vessel assignments will be made on the basis of using five feet of tide.*

Response: The determination or measure of underkeel clearance (UKC) on economic studies is in accordance with Corps planning guidance, which recommends evaluation of actual vessel operator and pilot practice with adjustment as appropriate or practical for with-project conditions. General "rules of thumb" such as allowing 10 percent of the transit draft for clearance have been long superseded with efforts to evaluate actual practice because such guidelines tended to be conservative and overly generous in allowance compared to what is often actually employed or needed. With respect to reviewer concerns that the allowances of 4.0 feet seem more than needed or excessive it may be of value to present a general discussion of allowances for underkeel clearance. Generally, practices for underkeel clearance are determined through review of written pilotage rules and guidelines, interviews with pilots and vessel operators, and analysis of actual past and present practices based on relevant data for vessel movements. With regard to evaluation of data concerning actual practices, typically underkeel clearance is benchmarked or measured relative to measured immersed vessel draft in the static condition (i.e., motionless at dockside). Evaluation of when the vessel is moved or initiates transit relative to immersed draft, tide stage and commensurate water depth allows reasonable evaluation of clearance throughout the course or time of vessel transit within a given waterway. When clearance is measured in the static condition explicit estimation or allowances for squat, trim, and sinkage are unnecessary as the pilot or vessel operator has already accounted for such influences within allowances observed. Alternatively explained, if a pilot or vessel operator is willing to move a vessel with three feet of clearance as measured in the static condition this indicates that net clearance in the dynamic (moving condition) may be actually one and a half (1.5) to two (2.0) feet given allowances of perhaps as much as a foot to 1.5 feet for squat relative to speed, net changes in trim, and degree of influence for sinkage (where applicable). Evaluation of all movements renders a distribution of clearance, with many observations or vessel movements employing more than is needed simply due to timing and varying degree of unconstrained drafts for relatively smaller vessels. Evaluation of minimized clearance (i.e., some level of clearance below which operators or pilots will not move a vessel due to concerns for insufficient safety) helps to quantify the window(s) of time each day a given vessel with a specified immersed draft can be moved relative to tide. Given the measurement of clearance in the described manner combined with input from pilots on their practices has revealed that underkeel clearance in Savannah is slightly more than many US coastal ports.

General evaluation of practices for UKC at most coastal ports in the United States has revealed that clearances for all vessel types are often 2.0 to 3.0 feet measured in the static condition for many historical fleets having Panamax or lesser service with an average of approximately 2.7 feet for vessels of Handymax up through about Panamax size. Most coastal ports also have comparatively limited runs or distances between ocean approaches and dock facilities (i.e., less than 20 miles) so loss of tidal advantage during transit is less of a concern compared to Savannah. Regarding vessel size under with-project conditions it is understood that most post-Panamax vessels need more clearance depending on blockage factors, currents, and relative confinement of the waterway with most post-Panamax containerships needing about 3.3 to 3.6 feet for vessels with breadths of 120 to nearly 150 feet, lengths overall (LOA) approaching 1,150 feet and summer loadline drafts of 46 to approximately 49.0 feet. At Savannah, the required clearance for vessel sizes of Panamax and up through the first generation of post-Panamax hulls (approximately 123 feet in breadth and up to approximately 1,120 feet in length) based on pilot guidance and actual experience is approximately 4.0 feet. The additional margin above 3.3 to 3.6 feet is due to time for the relatively long run upriver and downriver between the ocean approach and dock facilities (about 25 miles), currents and blockage, and the notable change in salinity and resulting influence for sinkage associated with the more prevalent freshwater environment upriver. During the course of studies it was discussed with the pilots whether the larger classes of containerships (beyond first generation post-Panamax hulls) would require more clearance and it was indicated that larger hulls would likely require some increase in UKC to maintain an acceptable level of safety, though how much had not been determined. Given experience with hydraulics of the waterway, past traffic, and the relative stability in clearance allowances based on size progression from Handymax and Panamax through first generation post-Panamax, it was asked if another quarter of a foot would be sufficient and the pilots indicated this to be acceptable for study purposes with the estimate rounded up to the nearest tenth of a foot (to 4.3 feet) as ultimately applied for analysis of second generation post-Panamax containerships. Given the preceding discussion concerning distance for transit and freshwater influence characteristic of Savannah Harbor, the allowances for UKC applied for studies of Savannah Harbor are considered reasonable and consistent when compared to other deep-draft harbors situated along the coastline of the United States.

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767-MM-21-EC05
Comment: *There are several statements in the Corps report that appear to contradict use of five feet of tide in vessel assignments.*

Response: See previous response.

767-MM-21-EC06, 767-MM-21-EC07

Comment: *The concern about "just in time" arrivals would indicate that use of five feet of tide is not a predominant factor in vessel deployment decisions or operating practices. It was also clear from industry representatives and confirmed by empirical field data that a critically important factor in deployment of container vessels is maintaining the schedule. Waiting for five feet of tide does not comport with the need for dependable scheduling. By examining actual vessel calls at various ports, as noted below, design drafts are generally two to three feet greater than the channel design depth. To wait for five feet of tide is not "likely" according to operators and empirical data as described previously. Figure 19 on Page 25 of the Economic Appendix indicates very few vessels ride the tide more than a few feet.*
Assuming a tide utilization of two to three feet as reflected in the empirical data rather five feet as the Corps assumed would most likely increase the NED depth, probably by two or three feet.

Response: See response to 767-MM-21-EC04.

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767-MM-21-EC08

Comment: *Additionally, it was not evident that the Corps included the costs of landside delays within its analysis of the costs resulting from tidal delays. In shipping, if a vessel is delayed from either arriving to or departing from the berth due to tide, significant direct and indirect costs are incurred with respect to landside activities including stand-by fees for labor, trucker wait time and fuel costs, rail administration from rebooking cargo, staffing times at distribution and deconsolidation centers and, with just-in-time deliveries, production delays at manufacturing facilities. The costs of landside delays need to be factored into the evaluations of benefits of deepening.*

Response: The PDT explored the issue of obtaining information on landside costs of tide delay from the GPA. Following coordination with the USACE chief economist it was determined that this information would not qualify as NED benefits. However, while vessel delays due to landside reasons were not accounted for, the delays for ocean side are. A vessel can be delayed for a variety of reasons - insufficient channel depth, another transiting vessel, etc. The unloading rate at the dock is a variable input to the HarborSym analysis that was performed. The user inputs three likely loading/unloading scenarios (Minimum, Most Likely, Maximum) that ensure a vessels time at the dock varies slightly throughout the period of analysis.

Page 13

767-MM-21-EC09

Comment: *Third, the projected vessel fleet distribution projections do not seem to match extensive empirical data from other ports that are supported by industry studies, trade publications and academic studies. Data from Savannah and from other ports show that vessel fleets are comprised of a distribution of incremental vessel design drafts generally growing gradually from the smaller vessels then peaking at a design draft two or three feet greater than the channel design depth and then dropping off rapidly. This fleet distribution pattern is referred to in the Corps report as a "cluster" distribution. On occasion, vessels with design drafts more than two to three feet greater than the channel design depth call at ports, but that does not appear to happen on a regular basis.*

Response: An updated world fleet forecast by vessel [depth] class was obtained from MSI. The relationship between the world fleet and the vessels predicted to call at Savannah has been updated and the revised analysis included in the Final GRR. This update included an evaluation of the recent economic downturn [in the worldwide economy], its effects on order cancellations and new purchases, and the most currently available outlook of fleet expansion through 2030. This evaluation includes an update of vessels [by capacity] calling at Savannah during the 2000-2010 timeframe and the subset of that capacity which will be in PPX1 and PPX2 vessels.

Page 14

767-MM-21-EC10

Comment: *The MPC calculation is critical to the analysis and identification of the NED Plan because it controls how much cargo would be carried on each vessel. While the GPA understands that vessels rarely sail at maximum design draft, vessels do regularly sail at drafts beyond the MPC assigned by the Corps in the report. The sensitivity analysis shows that if the MPC is adjusted for efficient vessel loading without the constraints assigned to the draft through the MPC, then the 48 foot depth has the maximum average annual benefits. The practice of limiting vessel drafts with an assigned MPC for vessel classes restricts the full benefits of the project from being identified.*

Response: Containerships carry cargo destined for multiple ports, but the goods are loaded onto a single vessel [at a given time]. This necessitates that the load factor analysis use averages to estimate the amount of cargo [and associated drafts]. The only way to perform a true directional deployment analysis would be to know the "vessel's manifest" for an entire journey. Since that information is proprietary, the study team was compelled to rely on data for cargo being loaded/unloaded at Savannah. Nonetheless, by applying average empties, bunkerage, and other factors, the team was able to estimate the aggregate tonnage on a vessel at a particular time given the vessel's draft.

767-MM-21-EC11

Comment: *Finally, the report mentions the use of the Suez Canal as an alternate route for Far East – East Coast US trade but apparently does not include using the Suez Canal as a reasonable alternate assumption to using the Panama Canal. At least two Corps reports, Miami and Norfolk, identified the Suez Canal as a reasonable alternate assumption for trade with Asia. There are also data to support that the Suez alternative is currently being used for Far East-ECUS trade. Whether that use will continue after the Panama Canal is expanded is unknown. While the assumption of a competitive Suez Canal may not have been reasonable in the past, it appears to be reasonable now. With the economies of scale in the current and most likely future world fleet as well as shifting points of origin of manufacturing in Asia from China to the sub-continent, as is happening, it would actually be more economical to ship FE-ECUS via Suez rather than Panama. This does not suggest the analysis should be revised, but only to recognize in the risk and uncertainty analysis that delay of an expanded Panama Canal would not affect the justification for channel deepening. Whether the NED benefits might be greater or less using the Suez route, the channel increment of depth maximizing net benefits would not likely change. That is to say, selection of the NED Plan is not dependent on or sensitive to completion of the Panama Canal expansion.*

Response: More recent trade data support the growing importance of transit through the Suez Canal for Asian trade and concomitant decreased reliance on the Panama Canal for same. The updated economic analysis includes the expectation of additional use of the Suez Canal for some routes.

Page 15

767-MM-21-EN01, 767-MM-21-EN02

Comment: *Another item that needs to be addressed with respect to the NED plan is the project cost analysis. While not a part of the economics analysis, the cost impacts NED plan identification. A 25% contingency factor is placed on essentially every element which seems excessive for many elements of the cost estimate. An explanation would be helpful to understand the 25% contingency factor particularly for dredging costs. The Corps dredges millions of cubic yards every year from the Savannah River Channel and has been doing so for many years. Data on the annual costs for each of the past 10 years might be helpful in judging whether the 25% contingency is appropriate. Regardless of whether 25 % is the appropriate contingency factor according to Corps regulations, those regulations describe maximum, most likely, and minimum levels of risk in the estimating process. It seems that the contingency factors for this report are reported at the maximum level of risk. In order to compare costs and benefits on an equal basis, it seems appropriate to use both costs and benefits at their "most likely" level in order to get appropriate comparison.*

Response: While individual project elements certainly vary, the District seeks to realize a cumulative 80% confidence in its estimate of the total project cost. The 25% contingency [used for this project] was necessary to obtain the noted overall resultant of all risk at this 80% confidence interval. Given the variation in risk levels, those which vary the most are captured on a sensitivity chart in the cost/risk appendix.

Page 16

767-MM-21-EC12

Comment: *Each of the individual sensitivity tests suggests only one or in a few cases two alternate assumptions. None of the alternate assumptions standing alone or in twos cause the outcome of the analysis to change. Examination of the sensitivity analysis shows the alternate assumptions used for sensitivity testing themselves do not reflect a reasonable range of assumptions. The two most critical assumption sensitivities are not addressed at all, i.e., use of five feet of tide in the loading calculations and recognizing and testing the sensitivity of the cluster effect of fleet distribution. The GPA believes these two assumptions should be tested with sensitivity analyses.*

Response: The 5-foot of usable tide is based on analysis of physical conditions in the harbor and is not a parameter that the project could change. Therefore, analysis of altering that parameter is not warranted. Section 5.2 of the Economic Appendix describes the sensitivity analyses that the Corps performed related to vessel availability and loadings. Sensitivity analyses 6 – 13 result in different vessel fleets, as suggested in the comment.

767-MM-21-EC13

Comment: *The Corps' transportation cost-focused analysis overlooks other economic benefits the SHEP will generate. The full economic benefits from the SHEP will be more substantial for nearby Georgia and South Carolina populations that constitute the metro-Savannah region as well as for Georgia generally than the Corps analysis takes into account. The Corps does not consider investments made by port users, nor does it consider indirect multiplier impacts for the region.*

Response: An updated and expanded socioeconomic resources section for the SHEP EIS is included in the final document. Output from the economic *Impact Forecasting System Model* has also been included to describe the project's potential economic impacts to the local economy.

Page 18

767-MM-21-EV01

Comment: *Dr. Humphreys is the Director of the Selig Center for Economic Growth. The study included data for the Savannah Harbor and the port at Brunswick, Georgia. The studies are attached to these comments as Exhibits A and B. The GPA requests that the Corps include these studies as part of the administrative record.*

Response: As requested, Exhibits A and B of the GPA comments (Dr. Humphrey's reports) will be included in the administrative record for the SHEP.

Page 19

767-MM-21-EC14

Comment: *In the Economic Appendix of the Draft GRR, the Corps analyzes the Regional Economic Development Benefits of several counties surrounding Savannah Harbor including Chatham, Effingham, Bryan and Liberty Counties in the inner ring, and Screven, Bulloch, Candler, Evans, Tattnall, Long and McIntosh Counties in the outer ring. The counties in South Carolina bordering Savannah Harbor were not included in the analysis, and certainly the GPA believes that the Corps should include the South Carolina counties. Numerous South Carolinians are employed directly by the GPA and by companies doing business at or through the GPA facilities. The GPA believes the project will have a positive benefit on these neighboring counties in South Carolina, particularly on bordering Jasper and Hampton Counties, two of the most economically depressed counties in the state.*

Response: An updated and expanded socioeconomic resources section for the SHEP EIS is included in the final document. Output from the economic *Impact Forecasting System Model* has also been included to describe the project's potential economic impacts to the local economy.

Page 29

767-MM-21-EV02

Comment: *The proposed magnitude of acquisition and preservation of existing wetlands is significant and meets all legal requirements. At the recommendation of EPA Region 4, the Corps used its Standard Operating Procedures ("SOP"), which have been adopted by the natural resource agencies in Georgia, to evaluate impacts and calculate compensatory mitigation necessary to offset remaining project impacts for the 45, 46, 47, and 48-foot alternatives. Preservation of lands and existing wetlands bordering the refuge is necessary to offset remaining impacts for each of these depth alternatives. The Savannah District consulted with the Corps Center for Expertise for Ecosystem Restoration (the "CEER") which confirmed the SOP was technically sound for use to determine the acreage needed for preservation to offset remaining project impacts. The proposed project mitigation plan also conforms to the new mitigation rule, jointly established by EPA and the Corps (published in the Federal Register on April 10, 2008), and meets the requirements of 33 C.F.R. Part 332.*

Response: The District has evaluated the wetland impacts and proposed mitigation with respect to the Final Mitigation Rule (33 CFR Part 332). Those findings are reported in Appendix C – Mitigation Planning, Section VII- Consideration of the USEPA/USACE Mitigation Rule.

Page 39

767-MM-21-EV03
Comment: *The City of Savannah has a water intake on Abercorn Creek to obtain source water for its water supply treatment plant. The City of Savannah asked the Corps to conduct studies to confirm the SHEP would not cause elevations in chlorides at the Abercorn Creek water intake. The Corps conducted the requested studies and those studies confirm the SHEP will not have an adverse impact on water quality at the Abercorn Creek water intake. The worst case scenario predicted an increase of chloride concentration by 3 percent. Although the worst-case scenario is not a risk to the City of Savannah, the City has disagreed with the methodology and modeling. As noted, the Corps continues to collect data and is conducting additional modeling and analysis at the request of the City of Savannah. These results and any further recommendations will be included in the Final Environmental Impact Statement. The Corps will monitor chloride levels in Abercorn Creek as part on the monitoring plan to determine if chloride levels rise beyond the model predictions.*

Response: As you are aware,the District collected additional recent data which was used to update both the predictive tool and its assessment of potential project impacts to chloride levels in Abercorn Creek. The updated analysis is included in the final reports. This updated analysis indicates that construction of the SHEP would increase chloride levels at the City of Savannah's water intake on Abercorn Creek during high tides and low flows. Concerns associated with this increase in chlorides include an increase in lead corrosion in pipes and the formation of disinfection byproducts which would be caused by the need for the City to treat the water with more chlorine. Lead and disinfection byproducts are both regulated by EPA in regards to drinking water. Consequently, the FEIS includes the construction of a raw water storage impoundment which would allow the City to use this stored water in times of high chloride spikes. The Monitoring Plan includes monitoring chloride levels at the City's water intake before, during and after construction.

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767-MM-21-EV04
Comment: *Some agencies are concerned that the funds will not be available for adaptive management should changes in the project be necessary. The GPA has committed to set aside the local sponsor share for the program in a separate account so the funds are available if needed. The Corps will request the federal share of funds as needed during its routine budgeting process. However, since Congress directed the Corps to employ adaptive management on water resource projects, the GPA submits that federal funds should also be budgeted and set aside during construction to make changes in mitigation for the ecologically sensitive areas within the Savannah Harbor.*

Response: The District appreciates the commitment made by the State to set aside its portion of the funds expected to be needed to carry out the Monitoring and Adaptive Management Plans. The District intends to obtain its share of the expected Adaptive Management costs as the dredging occurs, so that they will be available if/when needed.

767-MM-21-EV05

Comment: *The Corps proposes that post construction monitoring would continue for five years after the completion of construction. The GPA, however, requests extension of that monitoring program to a length more appropriate to determine estuarine trends, but within the limits prescribed by Congress as part of the Water Resources Development Act of 2007.*

Response: The District revised the Monitoring Plan in the FEIS to include post-construction monitoring for a 10-year period. During that time frame, the field data would be used in conjunction with the updated hydrodynamic and water quality models to evaluate the project's performance and the success of its mitigation measures.

#1121

GEORGIA DEPARTMENT OF LABOR

148 ANDREW YOUNG INTERNATIONAL BLVD., N. E.
ATLANTA, GEORGIA 30303-1751

MARK BUTLER
COMMISSIONER

January 19, 2011

William Bailey
ATTN: PD, US Army Corps of Engineers, Savannah District
100 West Oglethorpe Avenue
Savannah, GA 31401-3640

Dear Mr. Bailey,

As Commissioner of the Georgia Department of Labor, I submit this letter of support for the proposed deepening of the Savannah Harbor.

It is my understanding that by increasing the Savannah River's channel depth to 48 feet, the Savannah Harbor Expansion Project (SHEP) will provide U.S. exporters and importers the infrastructure required to efficiently accommodate global commercial demands. The SHEP will allow access to the new generation of larger container vessels, using the expanded Panama Canal beginning in 2014. In turn, this will provide Georgia businesses cost savings and efficiencies in ocean commerce that are essential to create new jobs for the American people. This is an important national priority because the Port of Savannah serves more than 44 percent of the U.S. population and is the fastest growing container port in the nation and the second largest on the East Coast. Furthermore, Savannah handles 12 percent of all U.S. containerized exports.

It is also important to note the statewide economic impact of Georgia's Deepwater Ports. According to Georgia Ports Authority, it is estimated that more than 295,000 jobs, approximately seven percent of Georgia's total employment will be created and $15.5 billion in income (five percent of Georgia's total personal income) will be generated.

In this challenging economic environment, it is important for our government to make the investments required to support job growth in the United States. With a nearly 5-to-1 benefit-to-cost ratio, America cannot afford to pass up the opportunity for economic growth created by this important project.

I appreciate your time and efforts towards the successful completion of this nationally significant project.

Sincerely,

Mark Butler

An Equal Opportunity Employer

Georgia Department of Labor

Comment: Letter of support.

Response: Comment noted.

GEORGIA
DEPARTMENT OF NATURAL RESOURCES
HISTORIC PRESERVATION DIVISION

MARK WILLIAMS
COMMISSIONER

DR. DAVID CRASS
DIVISION DIRECTOR

December 17, 2010

Mr. William Bailey
ATNN: PD
US Army Corps of Engineers
Savannah District
100 West Oglethorpe Avenue
Savannah, Georgia 31401-3640
CESAS-PD@usace.army.mil

RE: Savannah Harbor Navigation Channel Project
Chatham County, Georgia
HP-911120-001

Dear Mr. Bailey:

The Historic Preservation Division (HPD) has received the Draft Tier II Environmental Impact Statement (DEIS) and General Reevaluation Report (GRR) for the above referenced undertaking in Chatham County, Georgia. Our comments are offered to assist the US Army Corps of Engineers (USACE) in complying with Section 106 of the National Historic Preservation Act of 1966, as amended. Since the proposed project will occur in South Carolina as well as Georgia, please note that our comments are directed to the portion of the overall project that have an area of potential effects (APE) in Georgia.

Based on the information provided, HPD agrees with the findings of the DEIS. Specifically, we agree that the draft Programmatic Agreement (PA) will be adequate to address impacts associated with this undertaking. We look forward to further consultation with USACE to finalize this PA among the USACE, the South Carolina SHPO and our office.

Please note that HPD requests hard copies of any future documentation provided for our review and comment. If you have any questions, please contact Elizabeth (Betsy) Shirk, Environmental Review Coordinator, at 404-651-6624 or via email at elizabeth.shirk@dnr.state.ga.us.

Sincerely,

Karen Anderson-Córdova

Karen Anderson-Córdova, Program Manager
Environmental Review & Preservation Planning

KAC/ECS

cc: Rebekah Dobrasko, South Carolina SHPO, dobrasko@scdah.state.sc.us
Jason Kotarski, Coastal Georgia RC

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Georgia Department of Natural Resources Historic Preservation Division

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Comment: *Please note that HPD requests hard copies of any future documentation provided for our review and comment. If you have any questions, please contact Elizabeth (Betsy) Shirk, Environmental review Coordinator, at 404-651-6624 or via email at Elizabeth.shirk@dnr.state.ga.us*

Response: Savannah District will comply with the request.

GEORGIA
DEPARTMENT OF NATURAL RESOURCES
COASTAL RESOURCES DIVISION

MARK WILLIAMS
COMMISSIONER

A.G. 'SPUD' WOODWARD
DIRECTOR

January 25, 2011

Mr. William Bailey
Attn: PD, USACE, Savannah District
100 West Oglethorpe Avenue
Savannah, Georgia 31401-3640

RE: SHEP Tier II DEIS & GRR, Savannah Harbor Deepening Project, Federal Consistency Determination

Dear Mr. Bailey:

Staff of the Georgia Coastal Management Program (GCMP) has reviewed your November 15, 2010 letter and attached Savannah Harbor Expansion Project (SHEP) Tier II Draft Environmental Impact Statement (DEIS) and General Re-Evaluation Report (GRR) to determine the Savannah Harbor Expansion Project's consistency with the Georgia Coastal Management Program. The Federal Coastal Zone Management Act, 16 USC 1451 et seq., as amended, requires each Federal agency activity performed within or outside of a state's coastal zone boundary that affects land or water uses, or natural resources of the coastal zone, to be carried out in a manner that is consistent to the maximum extent practicable with the enforceable policies of the approved coastal management program.

Georgia Coastal Management Program staff has worked for years with staff of the Corps, Georgia Department of Transportation, stakeholder groups, the City of Tybee and those with a vested interest in the project and especially the disposition of dredged material from the project, and the public. Program staff appreciates the access to Corps staff that has been afforded throughout the project development process.

The documents describe six harbor deepening plans. Alternative A is a No Action Alternative that maintains the current harbor depth at –42 feet mean low water. Alternative B dredges to –44 feet mean low water. Alternative C dredges to –45 feet mean low water. Alternative D dredges to –46 feet mean low water. Alternative E dredges to –47 feet mean low water and is the National Economic Development (NED) plan. Alternative F dredges to –48 feet mean low water and is the recommended plan of the non-federal sponsor of the project, the Georgia Department of Transportation (GaDOT). In addition to the dredging plan alternatives, the documents also describe, in varying levels of detail, dredged material disposal alternatives, positive and adverse impacts of the project, and the mitigation of adverse impacts.

In general, the proposal to deepen the Savannah Harbor by dredging to any of its alternative depths, as described above, is consistent with the enforceable policies of the Georgia Coastal Management Program. The Georgia Coastal Management Program especially supports dredging

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the project to –48 feet mean low water, the recommended plan of the non-federal sponsor of the project, GaDOT. However, the disposition of dredge materials is not described with sufficient detail, clarity, or finality for a determination to be made at this time that the dredged material placement portion of the project is consistent with the enforceable policies of the Georgia Coastal Management Program. Also, Georgia DNR's Environmental Protection Division and Wildlife Resource Division are submitting comments that will likely affect the GCMP's final federal consistency determination letter.

A particular concern at this time is that the described project would place **new work dredge material** in nearshore areas that could have adverse affects to the City of Tybee Island's economic and environmental interests. The City has determined that new work dredge material proposed for placement is unsuitable for placement in state waters. The State supports Tybee's position and finds that placement of dredge material at locations in state waters that would be adverse to the quality of the Tybee nearshore environment and/or its beach nourishment borrow site is not acceptable.

Further, placement of **new work dredge material** in federal waters outside of the Environmental Protection Agency (EPA) Approved Ocean Dredge Material Disposal Site (ODMDS) is likely to cause long-term adverse impacts to marine habitat, commercial and recreational offshore fishing, and cultural resources. Enhanced fish habitat benefits will be short lived from placement at sites outside of the ODMDS. Prevailing currents will quickly dissipate the materials. The State's experience with placing concrete rubble on offshore artificial reefs, as proposed, has been that the rubble quickly settles into the sea floor without retaining the mounded sand beneath. Also, two unmarked structures exist in close proximity to proposed dredge disposal Site #11 and Site #12 (a plane and a vessel) that are currently targeted by anglers and could be negatively impacted by shifting dredge materials. Therefore, disposal at Sites #11 and #12 should not occur. It is unknown if other hard bottom habitats exist nearby which could also be negatively impacted by placement of dredge materials.

New work material from the Outer Channel Extension (Station -57+000B to Station -98+600B, estimated volume = 4,652,033 cubic yards), located in Federal water but not proposed for beach replenishment, is expected to meet City of Tybee suitability criteria for nearshore placement (≤ 10% fines and minimal marine clays). Nearshore placement and beneficial use of these materials would allow the Corps to accomplish several objectives stated in the DEIS:

a. Offset deflation of the Tybee shelf and beach caused by historic construction and maintenance of the Harbor;
b. Meet environmental management and restoration measures set out in the Long Term Maintenance Strategy (LTMP) and Dredge Material Management Plan (DMMP);
c. Mitigate environmental consequences; and
d. Improve sustainability of the navigation project and the shore protection project.

The project GRR indicates that all future **maintenance dredging** will be performed by hopper dredge and in all probability taken to the ODMDS. Maintenance material excavated by hopper dredge having overflow capability that separates fine grained fractions could be highly suitable for both nearshore and potentially onshore placement on Tybee Island. The proposal notes that some 325,000 cubic yards of sediment excavated annually between Stations -30+000B and -

40+000B could be recovered and placed in a beneficial manner by a hopper dredge with pump-out capability. The City of Tybee Island has determined that this is acceptable and the State supports that determination and disposal alternative. Further, the possibility of beneficially using material from the Jones/Oysterbed area should be explored.

Based on the above, the project's compliance with the River and Harbor Development Act needs to be redressed. We believe that Outer Channel Extension new work dredged material, and Operation and Maintenance materials from Station –30+000B to –40+000B and Jones/Oysterbed (Station +28+000 to 0+000) are suitable for beach replenishment. To determine the feasibility of using these materials for beach replenishment, the costs or savings to the project, irregardless of how those costs might be met, must be identified and provided to the State.

The Program looks forward to working with the Corps to resolve these matters discussed above and is committed to doing so as quickly as possible. Please feel free to contact Kelie Moore at 912-262-2334 or me at 912-262-3130 if you have questions, need of additional information, or if we can be of additional assistance.

Sincerely,

B. Gane

Brad Gane, Chief
Ecological Services Section

cc: Mayor Jason Beulterman, City of Tybee Island
Allen Barnes, Ga DNR EPD
Dan Forster, Ga DNR WRD

Georgia Department of Natural Resources, Coastal Resource Division

Page 1

762-BB-09-EV01, 762-BB-09-EV02, 762-BB-09-EV03

Comment: *In general, the proposal to deepen the Savannah Harbor by dredging to any of its alternative depths, as described above, is consistent with the enforceable policies of the Georgia Coastal Management Program. The Georgia Coastal Management Program especially supports dredging the project to –48 feet mean low water, the recommended plan of the non-federal sponsor of the project, GaDOT. However, the disposition of dredge materials is not described with sufficient detail, clarity, or finality for a determination to be made at this time that the dredged material placement portion of the project is consistent with the enforceable policies of the Georgia Coastal Management Program. Also, Georgia DNR's Environmental Protection Division and Wildlife Resource Division are submitting comments that will likely affect the GCMP's final federal consistency determination letter.*

Response: Concur. The Corps is pleased that GA DNR-CRD agrees (in general) that the proposed action is consistent with the Georgia Coastal Management Program.

The Corps acknowledges GA-DNR CRD's support of the 48-foot depth alternative, the alternative recommended by the non-Federal sponsor.

After receipt of this letter and others during the public comment period, and subsequent coordination with GA DNR-CRD and the City of Tybee Island, Georgia, the District has revised the dredged material placement plan for sediments excavated from the entrance channel. The final reports show that new work materials from the entrance channel would be deposited in previously-approved areas: either in the Offshore Dredged Material Disposal Site or an upland confined disposal site.

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762-BB-09-EV04

Comment: *A particular concern at this time is that the described project would place new work dredge material in nearshore areas that could have adverse affects to the City of Tybee Island's economic and environmental interests. The City has determined that new work dredge material proposed for placement is unsuitable for placement in state waters. The State supports Tybee's position and finds that placement of dredge material at locations in state waters that would be adverse to the quality of the Tybee nearshore environment and/or its beach nourishment borrow site is not acceptable.*

Response: The Corps acknowledges the position of both the City of Tybee Island and GA DNR-CRD. Based on input from both parties, the placement plan has been revised in the Final EIS. All new work will be placed in previously-approved areas: either in the Offshore Dredged Material Disposal Site or an upland confined disposal site.

762-BB-09-EV05

Comment: *Further, placement of new work dredge material in federal waters outside of the Environmental Protection Agency (EPA) Approved Ocean Dredge Material Disposal Site (ODMDS) is likely to cause long-term adverse impacts to marine habitat, commercial and recreational offshore fishing, and cultural resources. Enhanced fish habitat benefits will be short lived from placement at sites outside of the ODMDS. Prevailing currents will quickly dissipate the materials. The State's experience with placing concrete rubble on offshore artificial reefs, as proposed, has been that the rubble quickly settles into the* *sea floor without retaining the mounded sand beneath. Also, two unmarked structures exist in close proximity to proposed dredge disposal Site #11 and Site #12 (a plane and a vessel) that are currently targeted by anglers and could be negatively impacted by shifting dredge materials. Therefore, disposal at Sites #11 and #12 should not occur. It is unknown if other hard bottom habitats exist nearby which could also be negatively impacted by placement of dredge materials.*

Response: After receipt of this letter and others during the public comment period, and subsequent coordination with GA DNR-CRD and EPA, the dredged material placement plan has been revised and Sites 11 and 12 have been removed from the proposed project. The Final EIS shows the revised sediment placement plan.

762-BB-09-EV06

Comment: *New work material from the Outer Channel Extension (Station -57+000B to Station -98+600B, estimated volume = 4,652,033 cubic yards), located in Federal water but not proposed for beach replenishment, is expected to meet City of Tybee suitability criteria for nearshore placement (≤ 10% fines and minimal marine clays). Nearshore placement and beneficial use of these materials would allow the Corps to accomplish several objectives stated in the DEIS:*

Response: After receipt of this letter and others during the public comment period, and subsequent coordination with GA DNR-CRD and the City of Tybee Island, Georgia, the dredged material placement plan has been revised and placement of all sediments excavated from the entrance channel will be deposited in previously-approved areas: either in the Offshore Dredged Material Disposal Site or an upland confined disposal site. The new work material from Stations -57+000B to -98+600B had been proposed for beneficial use at Sites 11 and 12, but GA DNR-CRD, EPA, NOAA-Fisheries, and the City of Tybee Island indicated they did not concur with the proposed action. As such, sediments from those reaches would be placed in the ODMDS.

Since Sites 11 and 12 will no longer be used, the Base Plan (the plan that is most cost efficient and environmentally acceptable) for disposal of new work material from the entrance channel extension is to place those sediments into the ODMDS. Placing these sediments in the nearshore sites (Site MLW 200, Site MLW 500, ERDC Nearshore, Site 2, Site 2 Extension) as requested would exceed the costs of the Base Plan and thus require a separate cost-sharing sponsor.

762-BB-09-EV07, 762-BB-09-EV08

Comment: *The project GRR indicates that all future maintenance dredging will be performed by hopper dredge and in all probability taken to the ODMDS. Maintenance material excavated by hopper dredge having overflow capability that separates fine grained fractions could be highly suitable for both nearshore and potentially onshore placement on Tybee Island. The proposal notes that some 325,000 cubic yards of sediment excavated annually between Stations -30+000B and -40+000B could be recovered and placed in a beneficial manner by a hopper dredge with pump-out capability. The City of Tybee Island has determined that this is acceptable and the State supports that determination and disposal alternative. Further, the possibility of beneficially using material from the Jones/Oysterbed area should be explored.*

Response: In regards to maintenance of the completed project, the Base Plan for disposal of material from Stations 0+000 to 28+000 will be to place the material into the Jones Island/Oysterbed Island CDF. As provided for in the LTMS, the Base Plan for maintenance of the entrance channel will be to place the material into the ODMDS or Sites 2 and 3 adjacent to the entrance channel. However, as also provided for in the LTMS, suitable maintenance material from Stations 0+000 to 28+000 or the entrance channel could be placed into the nearshore off Tybee Island (Sites MLW 200, MLW 500, ERDC Nearshore, Site 2, Site 2 Extension) or directly on Tybee Beach. The EPA has informed the District that any dredged material disposal site beyond the 3-mile line is considered an ocean dredged material disposal site which must be studied and approved pursuant to Section 103 of the MPRSA. Consequently, there are no plans to use Sites 4, 5, and 6 at this time. Sites 11 and 12 have been removed from consideration in view of the commenter's opposition.

The incremental cost of depositing these O&M sediments into the nearshore sites (MLW 200, MLW 500, ERDC Nearshore, Site 2, Site 2 Extension) or depositing this material directly on the beach is too great when compared to the benefit that would occur to warrant the additional Federal expenditure. Placing these sediments in the nearshore as requested would exceed the costs of the Base Plan and thus require a separate cost-sharing sponsor.

762-BB-09-EN01

Comment: *Based on the above, the project's compliance with the River and Harbor Development Act needs to be redressed. We believe that Outer Channel Extension new work dredged material, and Operation and Maintenance materials from Station –30+000B to –40+000B and Jones/Oysterbed (Station +28+000 to 0+000) are suitable for beach replenishment. To determine the feasibility of using these materials for beach replenishment, the costs or savings to the project, irregardless of how those costs might be met, must be identified and provided to the State.*

Response: The District provided this and other related information to the Coastal Resources Division in May 2011. The table we provided showed the expected additional incremental dredging/deposition costs for depositing new work sediments from the outer end of the entrance channel in the nearshore area, rather than in the ODMDS as planned, is expected to be $9 per CY. Additional costs would also be likely such as those necessary to obtain the environmental clearances for such placement if the Corps does not already have them, additional costs for engineering work (before and after surveys), mobilization and demobilization costs, and additional contract administration costs.

The use of maintenance material from Stations +28+000 to 0+000 and Stations -30+000B to -40+000B for beach replenishment was addressed in a previous response. The District's Operation and Maintenance dredged material disposal plans comply with NOAA, EPA and Corps policy and regulations. Consequently, the District does not believe these plans conflict with the provisions of the Georgia River and Harbor Development Act.

GEORGIA
DEPARTMENT OF NATURAL RESOURCES
WILDLIFE RESOURCES DIVISION

MARK WILLIAMS
COMMISSIONER

DAN FORSTER
DIRECTOR

January 24, 2011

Mr. William Bailey
US Army Corps of Engineers
Savannah District
100 West Oglethorpe Avenue
Savannah, Georgia 31401-3640

Subject: Comments on draft Tier II Environmental Impact Statement (EIS) and General Reevaluation Report (GRR) for Savannah Harbor Expansion Project

Dear Mr. Bailey:

Thank you for the opportunity to review and provide comment on the Draft Tier II Environmental Impact Statement (EIS) and General Reevaluation Report for the Savannah Harbor Expansion Project. The Georgia Department of Natural Resources, Wildlife Resources Division (WRD) has worked closely with you and your colleges at the Corps of Engineers and other cooperating agencies on this project for many years. We appreciate the level of cooperation, inclusion and data sharing that has occurred between our respective agencies through the 12-plus years we have been working together on this project. Through this process, our involvement has been primarily focused on the assessment of potential impacts on fishery resources, including the important Savannah River striped bass fishery. This once thriving population nearly collapsed in the late 1980's due to changes in bathymetry and increased salinity levels in important spawning grounds in the Savannah Estuary. WRD has made a long term commitment to the recovery of the Savannah River striped bass population and has made tremendous strides toward recovering this fishery. Recent signs of population recovery include increased numbers of adult striped bass and a measurable amount of natural recruitment. After nearly 17 years of a striped bass harvest moratorium, this popular sport fishery was successfully re-opened to limited harvest in October 2005. We continue our commitment to the striped bass fishery through annual population monitoring and stocking.

The EIS identifies the predicted impacts at alternative project depths from 44 to 48 feet and predicts the effectiveness of mitigation features at each depth. The National Economic Development Plan of 47' channel depth alternative and the maximum authorized depth alternative of 48' predict the loss of 26.9% and 27.8% of the remaining critical striped bass habitat in the Savannah River estuary respectively. This loss is after all flow altering and dissolved oxygen mitigation features of plan 6a are in place. This reduction in critical striped bass habitat warrants further mitigation. Permanent loss of this critical habitat will likely preclude the restoration of a naturally self-sustaining population in the Savannah River and require annual stocking of 6 to 8 inch striped bass. The striped bass compensatory mitigation, as

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outlined in the Draft EIS, should be provided to Georgia DNR WRD prior to inner harbor dredging associated with the deepening project. Should post monitoring efforts show that more habitat was lost than predicted, then we would ask that the loss be calculated and mitigated using the same methodologies that were used to determine the initial 27.8% loss.

Impacts to shortnose sturgeon remain after mitigation features are included. To compensate for this loss, a fish passage structure at the New Savannah Bluff Lock and Dam (NSBLD) and an earthen sill at the junction of Middle and Front River are proposed. The fish passage structure is intended to allow shortnose sturgeon to access historical spawning grounds above NSBLD. Although funds for monitoring the fish passage site have been allocated, no passage standards for shortnose sturgeon have been identified. A shortnose sturgeon passage standard would help to define success of the passage facility as well as guide any adaptive management measures implemented. The second part of mitigation proposed for shortnose sturgeon is the construction of an earthen sill at the junction of Middle and Front Rivers. Further clarification is needed as to the predicted effects of this proposed mitigation feature on additional saltwater intrusion up the Front River and sedimentation in the Middle River.

Thank you for the opportunity to provide additional input and review in this important process. If you need additional information or have further questions, please contact Tim Barrett (912-727-2112) at our Richmond Hill office. We look forward to continuing our work together on this project.

Sincerely,

Dan Forster

Dan Forster

DF/tab

Georgia Department of Natural Resources, Wildlife Resources Division

Page 1

764-BB-05-EV01, 764-BB-05-EV02, 764-BB-05-EV03

Comment: *The EIS identifies the predicted impacts at alternative project depths from 44 to 48 feet and predicts the effectiveness of mitigation features at each depth. The National Economic Development Plan of 47' channel depth alternative and the maximum authorized depth alternative of 48' predict the loss of 26.9% and 27.8% of the remaining critical striped bass habitat in the Savannah River estuary respectively. This loss is after all flow altering and dissolved oxygen mitigation features of plan 6a are in place. This reduction in critical striped bass habitat warrants further mitigation. Permanent loss of this critical habitat will likely preclude the restoration of a naturally self-sustaining population in the Savannah River and require annual stocking of 6 to 8 inch striped bass. The striped bass compensatory mitigation, as outlined in the Draft EIS, should be provided to Georgia DNR WRD prior to inner harbor dredging associated with the deepening project. Should post monitoring efforts show that more habitat was lost than predicted, then we would ask that the loss be calculated and mitigated using the same methodologies that were used to determine the initial 27.8% loss.*

Response: The mitigation plan includes funding for additional stocking of Striped bass fingerlings to compensate for the loss in population expected to occur as a result of the reduced spawning, egg, and larval Striped bass habitats. The schedule has been revised to provide for funding to be made available to the GA DNR earlier in the construction phase of the project. The Monitoring and Adaptive Management Plan (Appendix D) provides for a study to be conducted during Years 2, 4, and 9 of the Post-Construction Monitoring to assess project impacts on Striped bass habitat.

If monitoring efforts show that more striped bass habitat is lost than predicted, the Corps would coordinate with GA DNR-Wildlife Resources Division to determine an appropriate method to mitigate for the additional loss. Adaptive management funds could be used for that purpose.

Page 2

764-BB-05-EV04, 764-BB-05-EV05

Comment: *Impacts to shortnose sturgeon remain after mitigation features are included. To compensate for this loss, a fish passage structure at the New Savannah Bluff Lock and Dam (NSBLD) and an earthen sill at the junction of Middle and Front River are proposed. The fish passage structure is intended to allow shortnose sturgeon to access historical spawning grounds above NSBLD. Although funds for monitoring the fish passage site have been allocated, no passage standards for shortnose sturgeon have been identified. A shortnose sturgeon passage standard would help to define success of the passage facility as well as guide any adaptive management measures implemented. The second part of mitigation proposed for shortnose sturgeon is the construction of an earthen sill at the junction of Middle and Front Rivers. Further clarification is needed as to the predicted effects of this proposed mitigation feature on additional saltwater intrusion up the Front River and sedimentation in the Middle River.*

Response: The goal of the fish passage structure (Off-channel Rock ramp) at NSBLD is to achieve at least 75 percent upstream passage effectiveness for both Shortnose sturgeon 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. These objectives are included in the Biological Opinion (BO) prepared by the NMFS. The Corps would monitor the passage of Shortnose sturgeon through the structure to ensure it performs as intended (EIS-Appendix D). The Corps would coordinate with the Cooperating Agencies prior to construction to develop a detailed post-construction monitoring plan for Shortnose sturgeon passage at the New Savannah Bluff Lock and Dam.

The Middle River sill would have produced minimal beneficial effects on SNS habitat in the estuary. Because of its low cost effectiveness, that feature has been removed from the project. The project proposed in the FEIS does <u>not</u> include a sill in Middle River.