APPENDIX A

USACE SCOPE OF WORK

SCOPE OF WORK

IDENTIFICATION AND SCREENIING LEVEL EVALUATION OF MEASURES TO IMPROVE DISSOLVED OXYGEN IN THE SAVANNAH RIVER ESTUARY

SAVANNAH HARBOR EXPANSION PROJECT & SAVANNAH HARBOR ECOSYSTEM RESTORATION STUDY CHATHAM COUNTY, GEORGIA

1.0 INTRODUCTION.

As components of both the Savannah Harbor Expansion Project and the Savannah Harbor Ecosystem Restoration Study, Savannah District needs to identify and conduct a screening level evaluation of potential measures that could improve dissolved oxygen in the Savannah River Estuary.

The Savannah Harbor Expansion Project is evaluating deepening the navigation channel in Savannah Harbor. Such deepening could reduce dissolved oxygen levels in some locations within the river during some periods of the year. The project desires to consider methods to reduce or eliminate that potential adverse effect. The project is also identifying cumulative impacts to the harbor's ecosystem that have resulted from previous developments.

The Savannah Harbor Ecosystem Restoration Study is examining ways to improve dissolved oxygen levels in the harbor. That study is focused on methods of improving existing levels of dissolved oxygen in the harbor during the critical summer months.

2.0 BACKGROUND.

Portion of Savannah Harbor has not met Georgia's water quality standards for dissolved oxygen in some locations during the summer months. The harbor is on Georgia's Section 303(d) list for waters that do not comply with water quality standards for dissolved oxygen. EPA Region 4 released a Draft TMDL for Dissolved Oxygen for the harbor in August 2004. That document identified a portion of the harbor which experiences low levels of dissolved oxygen during the summer months. The Draft TMDL calls for elimination of all point source waste loads exerted on the harbor, plus the addition of 90,000 lbs/day of oxygen to the harbor system during critical conditions. EPA's document indicates that the waste load from discharges within the harbor places a 99,000 lbs/day oxygen demand on the system, while the load from upriver discharges exerts an additional 100,000 lbs/day oxygen demand in the harbor. These combined loads equate to roughly a 0.4 mg/l of the oxygen deficit in the critical harbor segment. Roughly half of that load originates from discharges within the harbor, while the other half result from upriver discharges. EPA proposed an alternate TMDL consisting of a revised water quality standard and a 30 percent reduction in the total point source waste load to the harbor (a reduction of about 57,000 pounds/day TBODu to produce a remaining load of 132,000 pounds/day TBODu).

It is unlikely that the present Georgia water quality standard for dissolved oxygen will remain in place in its present form. EPA has stated that it is not effective and has proposed an alternate standard in the August 2004 Draft TMDL. The public comment period has not yet closed on EPA's proposal, so we cannot know if their proposal will be adopted as proposed. The effect of the deep-draft navigation channel on the system's ability to recover from the waste loadings is unknown at this time, but this factor is being investigated.

The Savannah Harbor Expansion Project has not determined the precise extent of its potential impact on dissolved oxygen levels. However, we believe it could reduce already low D.O. levels at the bottom by as much as 0.5 mg/L. The Expansion Project has identified several measures that could be used to improve dissolved oxygen within the harbor. Those measures are as follows:

- *Add air or oxygen to low dissolved oxygen waters*
    - Add air or oxygen upstream of the deep-draft harbor (Augusta to Savannah)
        - o Floating aerators, air injection system, D.O. injection system
    - Add air or oxygen within the deep-draft harbor
        - o Floating aerators, air injection system
        - o D.O. injection system on bottom of river
        - o D.O. injection system on Hutchinson Island
- Mix low dissolved oxygen waters on the bottom with higher D.O. surface waters
    - Inflatable weir
    - Pumps
- Increase releases from upstream reservoirs
- Reduce the BOD loads from industrial and municipal discharges in the harbor
- Reduce the BOD loads from industrial and municipal discharges further upriver

Other measures may also exist that are feasible and implementable. This initial study focuses on the potential improvements that are associated with BOD load reduction and addition of air or oxygen. The potential feasibility of other measures will be examined qualitatively. As part of its assessment of cumulative impacts, the Expansion Project is also identifying effects that past development of the harbor have produced on water quality.

3.0 OBJECTIVE. The objective of this study is to identify and conduct a screening level evaluation of potential measures that could improve dissolved oxygen in the Savannah River Estuary. This analysis will include an assessment of the engineering feasibility and cost effectiveness of potential improvement measures, as well as identification of implementation problems. This effort will be directed toward both the portion of the harbor and time of year that were identified in EPA's Draft TMDL for Dissolved Oxygen as having recurring low levels of D.O. The analysis will allow both Corps projects to consider alternate methods of improving dissolved oxygen from its present levels, as well as developing several increments of D.O. improvement.

4.0 METHODOLOGY. This study will be conducted in two phases, with multiple steps in each phase. Models currently exist for both the riverine portion of the Savannah River from Thurmond Dam to downstream of Clyo, Georgia (River Model) and for the Savannah Harbor from Clyo to the Atlantic Ocean (Harbor Models). These models need not be used in this screening level evaluation.

Phase I will be an assessment of potential D.O. improvement measures that could be used either singly or as a package to meet the Georgia water quality standard for dissolved oxygen. Since EPA has disapproved the present Georgia standard for D.O., this phase will include four steps. The first step will consider measures that would allow the harbor to comply with the present Georgia D.O. standard under existing waste loads. This would address the approximate 200,000 lbs/day excess oxygen demand presently in the harbor. The second step will consider measures that would allow the harbor to comply with the present Georgia D.O. standard under full permitted waste loads. This would address the discharged loads of approximate 367,000 lbs/day TBODu that are permitted in the harbor plus 75 percent of the 358,000 lbs/day TBODu that are permitted in the upriver areas. The third step will consider measures that would improve D.O. levels in the harbor to the extent that it meets the D.O. standard that EPA proposed for Georgia in its August 2004 Draft TMDL. This step would consider the effects of the existing waste loads. This step would develop plans that have the same effect as the 30 percent reduction in BOD loading proposed by EPA in its Alternate TMDL. The fourth step will also consider measures that would allow the harbor to comply with the D.O. standard that EPA proposed for Georgia in its August 2004 Draft TMDL. This step would consider the effects of full permitted waste loads -- 367,000 lbs/day TBODu permitted in the harbor area plus 75 percent of the 358,000 lbs/day TBODu that is permitted upriver. These steps can be summarized as follows:

Step	D.O. Standard	Point Source Loading
1	Present GA D.O. Standard	Present loading
2	Present GA D.O. Standard	Full permitted loads
3	EPA proposed standard	Present loading
4	EPA proposed standard	Full permitted loads

Phase II would consist of assessing potential measures that could be used either singly or as a package to further improve dissolved oxygen levels in the harbor. The improvements evaluated in this second phase could be larger scale designs of those identified in the first phase effort or could be a separate set of design solutions. This phase would also consist of four incremental steps, each improving bottom D.O. levels by 0.2 mg/L. Thus, this phase will develop four incremental designs for improving dissolved oxygen, the first capable of improving bottom D.O. levels by 0.2 mg/L, the second would improve D.O. levels by 0.4 mg/L, and the third would improve D.O. levels by 0.6 mg/L., and the fourth would improve D.O. levels by 0.8 mg/L. The work on this phase would assume the harbor already meets the D.O. standard the EPA proposed in August 2004.

5.0 WORK TO BE PERFORMED BY THE CONTRACTOR.

The scope of this study is to assess the feasibility and cost effectiveness of potential measures to improve dissolved oxygen (focusing on BOD load reduction and addition of air or oxygen) in the harbor during the summer months. Major steps within this study are:

1) Review the Draft TMDL for Dissolved Oxygen for the harbor that was proposed by EPA Region 4 in August 2004.
2) From EPA's Draft TMDL and the inputs to the computer models upon which it is based, conduct a screening level assessment of the potential contribution to the D.O. deficit from individual point source discharges along the river. This will include each of the discharges included in the TMDL models, whether they are located in Savannah, Augusta, or in between. Table 1 in EPA's Draft TMDL shows the permit loads calculated for dischargers in Savannah, while similar information for the upstream dischargers can be found in Appendix D of that report.
3) Develop a comprehensive list of potentially feasible measures to improve D.O. levels in Savannah Harbor during the summer months. This should include measures to address point source loads (upriver and in the harbor), non-point source loads, and storm water loads.
4) Identify and assess the largest contributors of BOD loads to the Savannah River. Develop a table ranking the BOD loads contributed by each source to identify the sources contributing the largest BOD loads. For the five largest point source contributors of BOD to the system, summarize their existing treatment systems. For each of those five sources, list the next two steps that would most traditionally be employed for additional BOD reductions and the estimated extent of reduction to be expected from each of those steps.
5) Assess the feasibility of each of the potentially feasible D.O. improvement measures identified above in step 3 in light of the conditions occurring in the Savannah River system. Briefly describe the conditions under which each measure would typically be most effective and the conditions that reduce its effectiveness.
6) For each step in Phase I, develop one suitable method for making the desired D.O. improvement. This will include a conceptual-level design for each alternative method. Coordination with either the point source dischargers or GA DNR-EPD may be necessary to obtain additional information on the physical and biological characteristics of each discharge. That information could be needed to assess the technical feasibility of potential improvement methods. This conceptual design will include description of the process to be employed and the size/scale of the major features. As part of the conceptual designs, identify problems or considerations that may limit the effectiveness of the measure or render it un-implementable. For Phase II, develop conceptual-level designs for making four incremental steps of improvement in D.O. in the harbor. Develop a conceptual design – as described above -- for each of those four levels of D.O. improvement. The conceptual designs are expected to be screening level design layouts and include major features and/or BOD load reductions. Modeling to assess the impact of the conceptual designs to D.O. in the harbor will not be performed in this study. As part of each conceptual design, include the reasoning for why the design identified would be the most cost effective approach.
7) Evaluate the cost-effectiveness of the four conceptual designs for improving D.O. levels that were developed in Phase I and the four designs developed in Phase II. This will include implementation (access, land, equipment, construction, etc.) and operation costs. Cost estimates provided will be feasibility level cost evaluations and will be used to assess the cost-effectiveness of each conceptual design.
8) Identify the most cost effective D.O. improvement measure for each of the four steps in Phase I.
9) For the most cost-effective D.O. improvement designs developed through Phase I and the designs developed through Phase II, provide the following information to aid in the description of those designs: (A) general location map, and (B) site map showing its

relation to nearby properties. Site maps will utilize readily available GIS/CADD tax parcel files. If files are unavailable, a figure showing predominant land use in the area may be substituted.

10) Prepare a report describing the procedures used, the measures that were considered, the conceptual designs that were developed, and the conclusions reached in the study.

6.0 MATERIALS TO BE FURNISHED BY SAVANNAH DISTRICT. Savannah District will provide no materials for this Delivery Order. However, the Savannah District may be able to research tax records in Savannah and surrounding areas.

7.0 DELIVERABLES. All deliverables should be provided to the U.S. Army Corps of Engineers, Attn: CESAS-PD-E (Mr. William Bailey), P O Box 889, Savannah, GA 31402.

7.1 MONTHLY PROGRESS REPORTS (Deliverable 1). Submit one (1) copy by the 10th of each month documenting the previous month's efforts.

7.2 DRAFT SUMMARY REPORT (Deliverable 2). Submit ten (10) bound copies of a report describing the procedures used in this work, as well as the findings and conclusions. Submit ten (10) CDs containing the report developed through this work.

7.3 FINAL SUMMARY REPORT (Deliverable 3). Submit twenty (20) bound copies of a report describing the procedures used in this work, as well as the findings and conclusions. Submit twenty (20) CDs containing the report developed through this work. Submit one (1) CD containing the report in both Microsoft WORD and ADOBE Acrobat formats.

8.0 SCHEDULE. The Contractor shall adhere to the following project schedule.

Milestone	Due Date
Initiate work	1 week after issuance of the Delivery Order
Monthly Progress Reports	10th of each month until completion of the D. Order
Draft Summary Report	12 weeks from issuance of the Delivery Order
Final Summary Report	3 weeks from receipt of comments on Draft Report

The Government expects to provide comments on the Draft Summary Report after a 30-day review period.

9.0 POINT OF CONTACT. Mr. William Bailey (CESAS-PD-E) will be the US Army Corps of Engineers' point of contact for this work. He can be reached at 912-652-5781 (FAX 912-652-5787) or at the following address:

Mr. William Bailey
ATTN: PD-E
US Army Corps of Engineers
Savannah District
P.O. Box 889
Savannah, GA 31406-0889

All billing invoices should be sent to Mr. William Bailey.

10.0 REFERENCES.

EPA, Region 4, August 2004. Draft Total Maximum Daily Load (TMDL) for Dissolved Oxygen in Savannah Harbor, Savannah River Basin, Chatham and Effingham Counties, Georgia. Report prepared by EPA Region 4, Atlanta, Georgia.

APPENDIX B

POINT SOURCE DISCHARGES

Appendix B

Point Source Dischargers[1]
Identification and Screening Level Evaluation of Measures to Improve Dissolved Oxygen in the Savannah River Estuary
Savannah Harbor Expansion Project & Savannah Harbor Ecosystem Restoration Project
Chatham County, Georgia

		Current Permit Limits				Oxygen Demanding Load Based on Current Permit Limits				
Facility Name	**NPDES ID**	**Flow[a] (MGD)**	**BOD_5[b] (lbs/day)**	**NH_3 (mg/L)**	**NH_3 (lbs/day)**	**F-Ratio**	**$CBOD_U$ (lbs/day)**	**$NBOD_U$ (lbs/day)**	**$TBOD_U$ (lbs/day)**	**Permit Limit $TBOD_U$ (lbs/day)**
Arcadian (PCS Nitrogen)	GA0002071	3.00	751		2,833			12,947	12,947	9,710[c]
City of Augusta (Butler Creek)	GA0037621	46.10	3,845	1.5	577	4	15,379	2,636	18,015	13,511[c]
City of Harlem	GA0020389	0.25	63			2	125		125	94[c]
City of Sardis	GA0020893	0.20	33	5.0	8	3	100	38	138	104[c]
City of Springfield	GA0020770	0.50	104	5.0	21	2	209	95	304	228
City of Sylvania	GA0021386	1.51	378	17.4	219	2	756	1,001	1,757	1,318[c]
City of Thomson	GA0020974	2.50	313	5.0	104	3.5	1,095	476	1,571	1,178[c]
City of Waynesboro	GA0038466	2.00	500	15.0	250	3.5	1,751	1,143	2,895	2,171[c]
Columbia County (Crawford Creek)	GA0031984	1.50	150	1.2	15	2	300	70	370	277[c]
Columbia County (Little River)	GA0047775	3.00	375	8.7	218	3.5	1,314	995	2,308	1,731[c]
Columbia County (Reed Creek)	GA0031992	4.60	384	2.0	77	4	1,535	351	1,885	1,414[c]
DSM Chemicals	GA0002160		250		6,000	3	750	27,420	28,170	21,128[c]
Fort Gordon	GA0003484	4.00	1,001	17.5	584	2	2,002	2,668	4,670	3502[c]
Fort James Paper (GA Pacific)	GA0046973		10,850			5	54,250		54,250	40,688[c]
Gracewood School and Hospital	GA0022161	0.50	125	17.4	73	2	250	332	582	436[c]
International Paper (Augusta)	GA0002801		30,000			6	180,000		180,000	135,000[c]
NIPRO			3,300		6,000	3	9,900	27,420	37,320	27,990[c]
Richmond County (Spirit Creek)	GA0047147	2.24	560	17.4	325	2	1,121	1,486	2,606	1955[c]
Engelhard	GA0048330				882			4,030	4,030	4,030
Garden City	GA0031038	2.00	500	17.4	290	2.4	1,201	1,325	2,526	2,526
International Paper (Savannah)	GA0001988	3.60	25,000			10.7	267,500		267,500	267,500
Kerr-McGee Pigments	GA0003646	0.60								
President Street	GA0025348	27.00	4,166	12.9	2,905	3.9	16,247	13,276	29,523	29,523
Travis Field	GA0020447	1.50	250	11.6	145	2.3	575	663	1,238	1,238
Weyerhaeuser-Port Wentworth	GA0002798	0.10	6,700			4.5	30,150		30,150	30,150
Wilshire	GA0020443	4.50	1,126	17.4	653	2.5	2,815	2,984	5,799	5,799
Georgia Power Co. Plant Votgle (Southern Nuclear)	GA0026786								0	0
Savannah Electric Plant Kraft	GA0003816								0	0
Savannah Electric Plant Riverside	GA0003751								0	0
Savannah Electric Plant McIntosh	GA0003883								0	0
City of Aiken (Horse Creek)	SC6641003	26.0	7,156	11.0	2,385	3	21,468	10,901	32,369	24,276[c]
Clariant Corporation-Martin Plant	SC0042803	1.8	564			3	1,692		1,692	1,269
Kimberly-Clark	SC0000582	11.2	4,031			3	12,093		12,093	9,070[c]
Savannah River Site										
SC Electric and Gas, Urquhart	SC0047431	142.9								0
Town of Allendale	SC0039918	4.0	834	20.0	667	3	2,502	3,048	5,550	4163c
Town of Hardeeville	SC0034584	1.0	253			2	506		506	380c

Prepared By: ____________
Checked By: ____________

Notes:

NPDES - National Pollutant Discharge Elimination System
MGD - million gallons per day
TMDL - Total Maximum Daily Load
BOD_5 - Biochemical Oxygen Demand
lbs/day - pounds per day
mg/L - milligrams per liter
$CBOD_U$ - Carbonaceous Ultimate Biochemical Oxygen Demand
$NBOD_U$ - Nitrogenous Ultimate Biochemical Oxygen Demand
$TBOD_U$ - Total Ultimate Biochemical Oxygen Demand
NA - Not Applicable
NH_3 - Ammonia
RM - River Mile
m^3/ton - cubic meters per ton

(1) Based on current permit limits as reported in USEPA EnviroFacts Database. For upstream dischargers 75% of the permitted load was used to complete the ranking.

[highlighted cell] Information not available

(a) As reported in the Draft TMDL (USEPA, 2004). Values for IP-Savannah, GAPAC, Weyerhaeuser are assumed to be erroneous. Permit limits and discharge monitoring report (DMR) data were used to provide flow information for design.

(b) USEPA, 2004. Draft Total Maximum Daily Load (TMDL) for Dissolved Oxygen in Savannah Harbor River Basin: Chatham and Effingham Counties, Georgia. U.S. Environmental Protection Agency. August 2004.

(c) Assumes 75% $TBOD_U$ reaches the Harbor.

APPENDIX C

CORRESPONDANCES

Subacz, Jonathan

From: Kinnard, Tanya
Sent: Wednesday, April 06, 2005 11:18 AM
To: Subacz, Jonathan
Subject: FW: Reuse system questions

From: Tanner, Margaret
Sent: Monday, March 21, 2005 3:40 PM
To: bob_scanlon@savannahga.gov
Cc: Neal, Larry; Kinnard, Tanya; Subacz, Jonathan; Latalladi, Monique
Subject: Reuse system questions

Here are our questions and information needs for the City of Savannah Reuse plan.

Current Water Reuse Plan

What were the costs to provide reuse water to the golf course on Hutchinson Island?
What is the average design flowrate to the golf course during the summer months?
What is the pipe diameter?
What is the BOD loading or BOD5 concentration in the reuse water?
What is the total golf course area currently being irrigated with the reuse water?

You mentioned that there was another golf course receiving reuse water. What is the name? Also, do you have information similar to the questions for the Hutchinson Island golf course? When did reuse start for this course (was it included in the flow estimates for the 1999 data)? Also, EPA is using DMR data to conduct the modeling from 1997-2003. When did the Hutchinson Island course go on line?

What is the total quantity of water currently designated for reuse?

Potential Future Water Reuse

On the City's website, we found information that suggested that there was some potential to provide reuse water to:

- Forsyth Park
- Daffin Park
- Paulsen Softball Complex
- Guy Minick Sports Complex
- County Soccer Complex

Can you provide addresses or (lat/lon data) for these sites?
Do you have the areas to be irrigated and the volume of reuse water to be provided for each of these sites?
Will each be supplied from the President's street facility? If not, what facility will supply the reuse water?
Has any type of cost analysis been done to assess the feasibility of this plan? If so, can this be provided?
Will the wastewater treatment plant need to be expanded to provide for increase reuse water usage? If so by what design flow? Have costs been developed for changes to the facility?

MARGARET E. TANNER – Senior Engineer
MACTEC Engineering and Consulting, Inc.
Kennesaw Technical Center
Office 770.421.7032 – **Mobile** 770.605.3957 – **Fax** 770.421.3486
Email metanner@mactec.com – **Web** www.mactec.com

Subacz, Jonathan

From: Whitlock.Steve@epamail.epa.gov
Sent: Thursday, February 10, 2005 6:02 PM
To: Bailey, William G SAS
Cc: greenfield.jim@epamail.epa.gov
Subject: RE: Question on Savannah RIV1 Model

Bill,
Preliminary results are in:
I ran scenarios with upper boundary DO at normal observed levels and then at 20% higher. At Clyo I saw no noticeable difference in DO. Also, since I did not change the BOD decay rate there was no difference in BOD. This means additions of DO at the Dam would only affect local DO and not the downstream reaches of the river or harbor.
....

Steve Whitlock
US EPA Region 4, Water Management Division
TMDL Modeling and Support Section
61 Forsyth Street, SW, Atlanta, GA 30303-3104
phone 404-562-9242, fax 404-562-9224
whitlock.steve@epa.gov
....

#37

INTERNATIONAL PAPER

Jeffrey S. Lynn
Manager of External Regulatory Affairs
Corporate Environment

International Place
6400 Poplar Ave.
Memphis, TN 38197
Phone 901-419-3956

January 29, 2005

Ms. Sibyl Cole
U.S. EPA Region IV
61 Forsyth St., S.W.
Atlanta, GA 30303

Re: Comments on the Savannah Harbor Draft TMDL for Dissolved Oxygen (DO) – August 2004

Dear Ms. Cole:

As the world's largest paper and forest products company with two major manufacturing operations in the Savannah River Basin, located in Augusta and Savannah, International Paper has a significant interest in the development and implementation of a scientifically defensible and equitable TMDL to mitigate the dissolved oxygen (DO) impairment for the Savannah River Harbor.

While International Paper recognizes that EPA was under a consent decree obligation to issue this proposed TMDL, the company strongly objects to finalizing the proposed TMDL or any alternative TMDL without further public notice and comment. As discussed in greater detail below, any final TMDL based upon the existing Georgia water quality standard or the modeling system underlying EPA's August 2004 proposal is scientifically unsound and without basis in fact or law. International Paper reserves its right to provide further comment on any revised or alternative TMDL.

Under the aforementioned objection and reservation of rights, International Paper submits the following comments on behalf of both International Paper mills.

INTRODUCTION

International Paper is vigilant in its efforts to protect water quality and is committed to assuring that water quality in the Savannah River Harbor is appropriately protected. We further recognize that water quality protection is critical to the viability of our multi-billion dollar assets in the Savannah River Watershed; hence it is critical that the TMDL accurately reflect the current hydrodynamic regime and physical setting of the Harbor and that the TMDL be based upon a water quality standard that defines the appropriate level of protection necessary for the Harbor.

It is furthermore essential that the final TMDL for the Savannah River Harbor be based on a water quality standard that is attainable and recognizes the level of water quality protection necessary for an industrial port, such as the Savannah Harbor. As highlighted in the draft TMDL, the Harbor, even under natural conditions with no inputs from point source dischargers, could not meet the existing water quality standard that was used to develop the draft. Use of this inappropriate water quality standard resulted in a totally unrealistic outcome for point source dischargers, that being "zero discharge." The concept of "zero discharge" is clearly unattainable, unachievable and wholly inappropriate. Neither municipal nor industrial point source dischargers can achieve such an impractical goal without significant social and economic disruption and the threat of abandoning continued operation. Another outcome MUST be achieved.

Prior to finalizing the TMDL, an appropriate water quality standard must be identified and incorporated into the TMDL. EPA's recognition that this critical point has not been met should, by itself, provide the foundation to withdraw the draft TMDL until such time that an appropriate standard is adopted and a revised TMDL can be recalibrated using an amended and more appropriate water quality standard. It is entirely inappropriate to advance the draft TMDL, as it cannot be practically implemented. Furthermore, the alternative TMDL is not appropriate and contains many of the same deficiencies as the draft TMDL – i.e., use of an insufficient model, etc.

NON-TECHNICAL COMMENTS

The TMDL Does Not Appropriately Account for Past and Potential Future Harbor Deepening Projects

In 1989, the Georgia's Environmental Protection Division (EPD) established the current Coastal Fishing DO standard for the Harbor. In 1989, the Harbor met that standard, with an authorized depth of 38 feet. The Harbor is currently authorized and dredged to a depth of 42 feet. In practice, this means that the Harbor can be anywhere from 44 to 46 feet deep in places where the COE overdredges to maintain the minimum 42 foot depth for ships to enter the port. The current depth of 42 feet was achieved in 1994. Since the deepening project in 1994, the Harbor has not met the DO standard. These past physical modifications (deepening events) have significantly impacted the water quality of the Savannah Harbor over the past several decades and are widely and logically believed to have had a specific impact on DO.

In addition, the Georgia Ports Authority and the US Army Corps of Engineers (COE) are reviewing yet another application to deepen the harbor an additional 6 feet which will further impact the Harbor's DO. There is an effort currently spearheaded by the COE to establish a re-aeration project to mitigate impacts of historic Harbor deepening events. This is a federal cost-shared project with participation by federal and state government agencies and local shareholders. The City of Savannah serves as the local sponsor for this project. NPDES permit holders in the Harbor, including International Paper, are also contributing time and resources to the project. The TMDL Project and the COE Restoration Project share a common goal - to quantify the oxygen deficit in the Harbor and determine options available for mitigation. A final plan of action has yet to be defined. However, at a minimum the Restoration Project must be coordinated and incorporated into the TMDL prior to its finalization and implementation. International Paper does not believe that public, nor for that matter private, funds should be used to alleviate a perceived water quality impairment based on a standard that is unattainable under present-day natural conditions.

The past and potential future deepening events are considered the "root cause" for the DO impairment of the Harbor. Point source dischargers are described as collectively contributing less than 0.5 ppm to the DO deficit in the Harbor. As such, it is completely inappropriate for point source dischargers to bear a 30% load reduction as suggested under the alternative TMDL scenario based on EPA's recommended DO standard. It is objectionable for point sources to bear such extreme costs associated with remedial actions to improve water quality when they are not the "primary" influence impacting DO levels in the Harbor.

Costs to Upgrade Wastewater Treatment Plants Exceed Point Source Contribution to the Impairment Problem

To further demonstrate the inequity of the 30% BOD load reduction proposed in the alternative TMDL we have conducted some preliminary engineering analyses to determine how the Augusta and Savannah Mills could achieve the proposed reductions. We also estimated the associated costs for these actions.

Both mills would have to significantly reconfigure their wastewater treatment systems to achieve the improved removal efficiencies mandated by the alternative TMDL. This action could only be achieved at a significant capital cost to each mill. Using standard engineering assumptions, the estimates to increase BOD removal efficiency at the Augusta and Savannah Mills, respectively, are $28,275,000 and $37, 492,000. These figures represent the total costs anticipated to increase BOD removal efficiencies and assure compliance with anticipated limitations based on the suggested alternative TMDL.

It is wholly inappropriate to expect point source dischargers that, in aggregate, only contribute 0.5 ppm to the DO sag in the Harbor, to this extraordinarily heavy expense. Any cost associated with achieving the final DO standard for the Harbor should be assumed proportionally by the entities contributing to the problem. The projected high costs associated with wastewater treatment system upgrades to meet a 30% BOD reduction brings into question the viability of both of these mills. It is inappropriate to propose such high cost remedies when point sources are not the predominant contributory factor to the problem.

EPA's Model Must Account for the Harbor Deepening Events

Prior to finalizing the TMDL for the Harbor, EPA must specifically evaluate the impact of the historic and proposed deepening events. As stated above, the Harbor was considered in compliance with its DO water quality standard prior to the deepening events that have modified the physical configuration of the Harbor, thus allowing greater tidal influence, reduced water velocity, and increased residence time for precursors to DO reductions. Each of these factors and others ultimately led to the Harbor's unique DO situation. It is necessary for the COE to continuously dredge the Harbor in order to maintain the currently approved depth. This is an ongoing activity that must also be addressed. Without these deepening and depth maintenance activities the Harbor would naturally return to a much shallower depth and it is logical that DO concerns would return to a more normal and water quality standard compliant situation, inclusive of the point source contributions.

The impact of Harbor deepening must be modeled to assure that any actions recommended in the final TMDL are focused on the primary contributing factors the TMDL seeks to remedy. International Paper strongly urges EPA to more fully model the Harbor based on historic depths versus the current and proposed depths in order to more fully understand the relationship these deepening events have on DO levels in the Harbor. In addition, the model must focus on the Harbor as a whole and not just the areas that have been deepened or undergone depth maintenance activities.

Recommended DO Standard

The draft TMDL proposed a "zero discharge" limitation for all point sources based upon an effort to protect the existing DO water quality standard. We support EPA's recognition of the Savannah Harbor's inability to meet the existing water quality standard under natural conditions. The inability to comply naturally with an overly restrictive water quality standard led the authors of the draft TMDL to recommend the need for development of a more realistic DO water quality standard. The authors suggested a revised site-specific marine DO criterion based on data from estuaries in the Virginian Province, which is defined as Cape Cod to Cape Hatteras.

It is unknown whether the recommended DO criterion is fully appropriate for the Savannah Harbor situation and as such, we would further encourage EPA to validate this alternative criterion as appropriate and applicable to the Savannah Harbor. International Paper supports EPA's effort to identify a suitable criterion and encourages EPA to continue this effort expeditiously. We do, however, caution EPA that whatever criterion is finally adopted for the Harbor it MUST recognize that this waterbody is an industrial port and the standard of protection MUST reflect that realization and the complexities associated with a heavily modified waterbody. Identification and selection of an appropriate water quality standard for the Harbor is critical to defining a TMDL that will be equitable to all stakeholders.

TECHNICAL COMMENTS

Model Comments

The model used to develop the existing draft TMDL significantly oversimplifies the dynamics of the Harbor and may not accurately portray the impact of point sources on DO concentrations in the harbor. The following technical comments and observations involving specific areas are offered:

Re-aeration
It is our understanding that EPA has efforts underway to enhance the model that was used to develop the draft TMDL by addressing re-aeration concerns. International Paper fully supports these efforts to advance the utility and validity of this model as a tool to reflect the Harbor regime more accurately and in its entirety. Full disclosure of the supporting data to construct the model is requested.

BOD Decay Rates
We further encourage EPA to reassess the BOD decay rates that were used in the model as they oversimplify the fate of BOD in the Harbor. Since the current model uses a single decay rate, the loadings for many point source dischargers are either overestimated or underestimated. The model should be refined so it reflects the Harbor system as a whole allowing for the differing decay rates from individual point sources. Incorporation of multiple decay rates into the model should vastly modify the results. BOD decay rates are available for all dischargers and the model has the capability to handle multiple decay rates. Full use of the model's capabilities is imperative so as to provide maximum model accuracy. The actual decay rates, as measured for each discharger, can be incorporated into the model and provide a much more realistic picture of the Harbor's DO situation. It is premature to finalize the TMDL until the modeling process is complete and can be used to characterize the Harbor with a much greater degree of rigor and precision.

The paper industry has conducted a considerable amount of research on decay dynamics of oxygen-demanding substances from pulp and paper mill effluents. The data collected shows that these dynamics are relatively complex and that much of the BOD in paper mill effluents decays relatively slowly, on the order of 0.02/day. Additional studies have also indicated that de-oxygenation kinetics of CBOD from pulp and paper mill effluents are in some cases poorly represented by single stage first order decay expressions. In the case of the Savannah Harbor there are multiple sources of BOD to the system including pulp and paper, other point sources and non-point sources. The Savannah Harbor model applies a first order decay model and a coefficient of 0.09/day for the modeled reach from Clyo to the ocean. This simplified decay rate constant has significant consequences for depicting an accurate model of BOD impacts on DO for the Harbor. Use of this overly simplified approach must be addressed. It is highly recommended that multiple rate decay coefficients be incorporated into another round of modeling prior to redrafting the TMDL so as to more accurately reflect the true decay dynamics of the system.

It is also unclear why the upstream river model uses a decay rate of 0.06/day until it enters the harbor and is reassigned a decay rate of 0.09/day. This may overstate the decay of upstream BOD in the harbor. This overestimate may need to be corrected by modeling it as a separate BOD component with a slower decay rate.

Deepening
As mentioned above, the harbor deepening events must be modeled to identify both pre-deepening and post-deepening impacts on the system as a whole. It is also recommended that a finer grid be used for the model prior to its use for developing a final TMDL.

Storm Water
The TMDL states that storm water is inconsequential as a contributing factor to the overall DO deficit as represented by the statement that storm water has "no measurable impact on DO levels in the critical areas of concern (p.13)." There is little to no data provided to support such a claim. However, it is noted that storm water did enter the system during data collection in 1999 and as such is implicitly included in the background data. This is a very important point and we suggest that storm water impacts be explicitly identified and incorporated into the TMDL. The State of Georgia has proposed new regulations for Industrial Storm Water Discharges that will impact business sites that discharge storm water to the Harbor. The TMDL needs to address how storm water dischargers will be impacted so as to maintain consistency between the TMDL and the requirements of the new General Industrial Storm Water Permit. We further reserve discussion on the allocation of storm water based on the insufficiency of data provided.

The draft TMDL describes the "vast majority" of non-NPDES loading of oxygen-demanding substances as derived from natural background sources, such as detritus and marsh outflow to the river. It is difficult to perceive how storm water, which would increase detritus inflow to the river and marsh outflow can be described as having "no measurable impact" on DO levels.

CONCLUSION

International Paper participates in two separate coalitions of dischargers representing the Savannah and Augusta areas. Respectively, these coalitions are the Savannah Harbor Committee and the Central Savannah River Area TMDL Group. Comments submitted by these individual coalitions are hereby incorporated by reference. The comments submitted by the American Forest & Paper Association are also incorporated by reference.

Although EPA's effort to expedite the development of this TMDL was predicated on achieving a judicially-driven timeline, we strongly recommend that EPA now take the necessary time to coordinate its efforts with stakeholders to determine an appropriate water quality standard and corresponding DO criterion for the Savannah River Harbor, redefine the TMDL based on the revised standard and resubmit the revised TMDL for review and comment. It is our understanding that EPA has initiated efforts to re-evaluate the model used to develop the initial draft TMDL and we fully support this action, however, the numerous activities described above must be coordinated with the model review in order to assure the final TMDL is appropriate, scientifically defensible and achievable.

International Paper encourages EPA to refocus its efforts to collectively, with stakeholders, revise and redraft the TMDL based on an appropriate water quality standard that recognizes the protections necessary for an industrial port. To this end, International Paper encourages EPA to adopt the above recommendations and actions as their own and fully commit to assuring the development of a practical and attainable TMDL. To discuss these comments further or answer any questions that may arise, please contact me at (901) 419-3956.

Sincerely,

Jeffrey S. Lynn
Manager External Regulatory Affairs

The above comments are submitted and endorsed on the behalf of International Paper's Augusta and Savannah Mills. Should you have additional mill-specific questions please contact either Jeremy Pearson (706-796-5363) at the Augusta Mill or Donna Katula (912-238-7054) at the Savannah Mill.

Respectfully Submitted,

Steve Bowden
Augusta Mill Manager

Timothy M. Kean
Savannah Mill Manager

January 31, 2005

FILE COPY

Bob Scanlon
City of Savannah
P.O. Box 1027
Savannah, GA 31402

Regarding: **Information request for the SHER and SHEP Projects**
Screening Level DO Improvement Alternatives for Savannah Harbor
USACE SHEP/SHER Project
Project Number: 6301-05-0001

Dear Mr. Scanlon:

As components of both the Savannah Harbor Expansion Project (USACE, 2004) and the Savannah Harbor Ecosystem Restoration Study (USACE, 2004.), the U.S. Army Corps of Engineers (USACE) has contracted with MACTEC Engineering and Consulting (MACTEC) to identify and conduct a screening level evaluation of alternative potential measures to seasonally improve dissolved oxygen (DO) concentrations in Savannah Harbor. Low DO levels in Savannah Harbor are the subject of an EPA Region 4 Draft Total Maximum Daily Load (TMDL) for Dissolved Oxygen (EPA, 2004). According to EPA, the particular harbor segment for which DO improvement is needed is an approximate four mile length between Talmadge Bridge and Elba Island and the critical season of the year for such DO improvement is the three-month period from June 15th through September 15th.

The EPA TMDL modeling attributes an approximate 0.5 mg/L critical segment DO deficit to all point sources of BOD (combined) with roughly one half of this point source deficit resulting from upriver point source BOD loads reaching the upper end of the estuary and the other half resulting from point source BOD loads directly to the estuary. This EPA finding means that total elimination of all point source BOD loads between Thurmond Dam and the sea could improve critical segment DO concentrations in Savannah Harbor by only 0.5 mg/L. The Draft EPA TMDL, based on meeting newly recommended DO criteria, calls for an approximate 30-percent overall reduction of point source BOD loading from the overall point source BOD loading experienced during the summer critical period of 1999.

The types of potential measures identified in the current harbor DO improvement screening for the Army Corps include: directly adding air or oxygen to low DO waters in the critical harbor segment; mixing low DO waters on the bottom of the harbor with higher DO surface waters; seasonally increasing flow releases from upstream reservoirs; seasonally reducing BOD loads from industrial and municipal discharges to the harbor and upriver. A potential benefit to point source BOD dischargers of the Corps' DO mitigation and restoration projects

is that the federal government may fund a portion of the costs for design and construction of whatever DO improvement measures may be authorized.

For purposes of screening the potential for seasonal BOD load reductions, MACTEC is contacting the larger point-source BOD dischargers seeking their ideas as to what measures might be considered for such screening. The objective is to identify potential means and general order of costs for reducing BOD discharges by about 30 percent or more during the three month critical season (June 15th through September 15th). Potential alternatives might include added effluent storage capacity, critical season land application or wetlands polishing, supplemental or short-term enhanced treatment, plant process changes, coordinated plant shut-down/maintenance schedules during the critical season, water conservation measures, or (in the estuary) piping BOD discharges farther seaward. Considering the limited impact of point sources on the critical DO deficit (only 0.5 mg/L according to EPA) it seems unlikely that point source BOD load reduction measures would prove to be a cost efficient means for significantly improving DO. Nonetheless, consideration of BOD load reduction alternatives is a required component of this DO improvement screening project.

To accomplish the screening level evaluation of potential BOD point source load reductions, MACTEC requests information relating to the wastewater treatment process at your facility. Specifically, waste stream generation process flow diagrams, wastewater treatment process flow diagrams, and unit operations information. Additionally, MACTEC recognizes that this information may be sensitive and will not include specific plans or diagrams in the final report and will only use them to identify the potential "next steps" for BOD reduction. Representatives of MACTEC will be calling from February 2 through February 11 (or as necessary) to discuss this project and information with you for your facility.

Thank you for your cooperation.

Sincerely,

MACTEC Engineering and Consulting

Larry A. Neal, P.E.
Senior Principal Engineer
Vice President

Margaret E. Tanner
Senior Engineer

References:

USACE, 2005. Savannah Harbor Expansion Project website.
http://www.sysconn.com/harbor/

USACE, 2005. Savannah Harbor Ecosystem Restoration Dissolved Oxygen (DO) website.
http://www.sas.usace.army.mil/projects/projects/shdo.htm

January 31, 2005

FILE COPY

Michelle Liotta
Georgia-Pacific
P.O. Box 828
Rincon, GA 31326-0828

Regarding: **Information request for the SHER and SHEP Projects**
Screening Level DO Improvement Alternatives for Savannah Harbor
USACE SHEP/SHER Project
Project Number: 6301-05-0001

Dear Ms. Liotta:

As components of both the Savannah Harbor Expansion Project (USACE, 2004) and the Savannah Harbor Ecosystem Restoration Study (USACE, 2004.), the U.S. Army Corps of Engineers (USACE) has contracted with MACTEC Engineering and Consulting (MACTEC) to identify and conduct a screening level evaluation of alternative potential measures to seasonally improve dissolved oxygen (DO) concentrations in Savannah Harbor. Low DO levels in Savannah Harbor are the subject of an EPA Region 4 Draft Total Maximum Daily Load (TMDL) for Dissolved Oxygen (EPA, 2004). According to EPA, the particular harbor segment for which DO improvement is needed is an approximate four mile length between Talmadge Bridge and Elba Island and the critical season of the year for such DO improvement is the three-month period from June 15th through September 15th.

The EPA TMDL modeling attributes an approximate 0.5 mg/L critical segment DO deficit to all point sources of BOD (combined) with roughly one half of this point source deficit resulting from upriver point source BOD loads reaching the upper end of the estuary and the other half resulting from point source BOD loads directly to the estuary. This EPA finding means that total elimination of all point source BOD loads between Thurmond Dam and the sea could improve critical segment DO concentrations in Savannah Harbor by only 0.5 mg/L. The Draft EPA TMDL, based on meeting newly recommended DO criteria, calls for an approximate 30-percent overall reduction of point source BOD loading from the overall point source BOD loading experienced during the summer critical period of 1999.

The types of potential measures identified in the current harbor DO improvement screening for the Army Corps include: directly adding air or oxygen to low DO waters in the critical harbor segment; mixing low DO waters on the bottom of the harbor with higher DO surface waters; seasonally increasing flow releases from upstream reservoirs; seasonally reducing BOD loads from industrial and municipal discharges to the harbor and upriver. A potential benefit to point source BOD dischargers of the Corps' DO mitigation and restoration projects

is that the federal government may fund a portion of the costs for design and construction of whatever DO improvement measures may be authorized.

For purposes of screening the potential for seasonal BOD load reductions, MACTEC is contacting the larger point-source BOD dischargers seeking their ideas as to what measures might be considered for such screening. The objective is to identify potential means and general order of costs for reducing BOD discharges by about 30 percent or more during the three month critical season (June 15th through September 15th). Potential alternatives might include added effluent storage capacity, critical season land application or wetlands polishing, supplemental or short-term enhanced treatment, plant process changes, coordinated plant shut-down/maintenance schedules during the critical season, water conservation measures, or (in the estuary) piping BOD discharges farther seaward. Considering the limited impact of point sources on the critical DO deficit (only 0.5 mg/L according to EPA) it seems unlikely that point source BOD load reduction measures would prove to be a cost efficient means for significantly improving DO. Nonetheless, consideration of BOD load reduction alternatives is a required component of this DO improvement screening project.

To accomplish the screening level evaluation of potential BOD point source load reductions, MACTEC requests information relating to the wastewater treatment process at your facility. Specifically, waste stream generation process flow diagrams, wastewater treatment process flow diagrams, and unit operations information. Additionally, MACTEC recognizes that this information may be sensitive and will not include specific plans or diagrams in the final report and will only use them to identify the potential "next steps" for BOD reduction. Representatives of MACTEC will be calling from February 2 through February 11 (or as necessary) to discuss this project and information with you for your facility.

Thank you for your cooperation.

Sincerely,

MACTEC Engineering and Consulting

Larry A. Neal, P.E.
Senior Principal Engineer
Vice President

Margaret E. Tanner
Senior Engineer

References:

USACE, 2005. Savannah Harbor Expansion Project website.
http://www.sysconn.com/harbor/

USACE, 2005. Savannah Harbor Ecosystem Restoration Dissolved Oxygen (DO) website.
http://www.sas.usace.army.mil/projects/projects/shdo.htm

January 31, 2005

FILE COPY

Jeremy Pearson
International Paper–Augusta Mill
P.O. Box 1425
Augusta, GA 30903

Regarding: **Information request for the SHER and SHEP Projects**
Screening Level DO Improvement Alternatives for Savannah Harbor
USACE SHEP/SHER Project
Project Number: 6301-05-0001

Dear Mr. Pearson:

As components of both the Savannah Harbor Expansion Project (USACE, 2004) and the Savannah Harbor Ecosystem Restoration Study (USACE, 2004.), the U.S. Army Corps of Engineers (USACE) has contracted with MACTEC Engineering and Consulting (MACTEC) to identify and conduct a screening level evaluation of alternative potential measures to seasonally improve dissolved oxygen (DO) concentrations in Savannah Harbor. Low DO levels in Savannah Harbor are the subject of an EPA Region 4 Draft Total Maximum Daily Load (TMDL) for Dissolved Oxygen (EPA, 2004). According to EPA, the particular harbor segment for which DO improvement is needed is an approximate four mile length between Talmadge Bridge and Elba Island and the critical season of the year for such DO improvement is the three-month period from June 15^{th} through September 15^{th}.

The EPA TMDL modeling attributes an approximate 0.5 mg/L critical segment DO deficit to all point sources of BOD (combined) with roughly one half of this point source deficit resulting from upriver point source BOD loads reaching the upper end of the estuary and the other half resulting from point source BOD loads directly to the estuary. This EPA finding means that total elimination of all point source BOD loads between Thurmond Dam and the sea could improve critical segment DO concentrations in Savannah Harbor by only 0.5 mg/L. The Draft EPA TMDL, based on meeting newly recommended DO criteria, calls for an approximate 30-percent overall reduction of point source BOD loading from the overall point source BOD loading experienced during the summer critical period of 1999.

The types of potential measures identified in the current harbor DO improvement screening for the Army Corps include: directly adding air or oxygen to low DO waters in the critical harbor segment; mixing low DO waters on the bottom of the harbor with higher DO surface waters; seasonally increasing flow releases from upstream reservoirs; seasonally reducing BOD loads from industrial and municipal discharges to the harbor and upriver. A potential benefit to point source BOD dischargers of the Corps' DO mitigation and restoration projects

is that the federal government may fund a portion of the costs for design and construction of whatever DO improvement measures may be authorized.

For purposes of screening the potential for seasonal BOD load reductions, MACTEC is contacting the larger point-source BOD dischargers seeking their ideas as to what measures might be considered for such screening. The objective is to identify potential means and general order of costs for reducing BOD discharges by about 30 percent or more during the three month critical season (June 15th through September 15th). Potential alternatives might include added effluent storage capacity, critical season land application or wetlands polishing, supplemental or short-term enhanced treatment, plant process changes, coordinated plant shut-down/maintenance schedules during the critical season, water conservation measures, or (in the estuary) piping BOD discharges farther seaward. Considering the limited impact of point sources on the critical DO deficit (only 0.5 mg/L according to EPA) it seems unlikely that point source BOD load reduction measures would prove to be a cost efficient means for significantly improving DO. Nonetheless, consideration of BOD load reduction alternatives is a required component of this DO improvement screening project.

To accomplish the screening level evaluation of potential BOD point source load reductions, MACTEC requests information relating to the wastewater treatment process at your facility. Specifically, waste stream generation process flow diagrams, wastewater treatment process flow diagrams, and unit operations information. Additionally, MACTEC recognizes that this information may be sensitive and will not include specific plans or diagrams in the final report and will only use them to identify the potential "next steps" for BOD reduction. Representatives of MACTEC will be calling from February 2 through February 11 (or as necessary) to discuss this project and information with you for your facility.

Thank you for your cooperation.

Sincerely,

MACTEC Engineering and Consulting

Larry A. Neal, P.E.
Senior Principal Engineer
Vice President

Margaret E. Tanner
Senior Engineer

References:

USACE, 2005. Savannah Harbor Expansion Project website.
http://www.sysconn.com/harbor/

USACE, 2005. Savannah Harbor Ecosystem Restoration Dissolved Oxygen (DO) website.
http://www.sas.usace.army.mil/projects/projects/shdo.htm

January 31, 2005

FILE COPY

Brittany Robinson
International Paper–Savannah
P.O. Box 570
Savannah, GA 31402

Regarding: **Information request for the SHER and SHEP Projects**
Screening Level DO Improvement Alternatives for Savannah Harbor
USACE SHEP/SHER Project
Project Number: 6301-05-0001

Dear Ms. Robinson:

As components of both the Savannah Harbor Expansion Project (USACE, 2004) and the Savannah Harbor Ecosystem Restoration Study (USACE, 2004.), the U.S. Army Corps of Engineers (USACE) has contracted with MACTEC Engineering and Consulting (MACTEC) to identify and conduct a screening level evaluation of alternative potential measures to seasonally improve dissolved oxygen (DO) concentrations in Savannah Harbor. Low DO levels in Savannah Harbor are the subject of an EPA Region 4 Draft Total Maximum Daily Load (TMDL) for Dissolved Oxygen (EPA, 2004). According to EPA, the particular harbor segment for which DO improvement is needed is an approximate four mile length between Talmadge Bridge and Elba Island and the critical season of the year for such DO improvement is the three-month period from June 15th through September 15th.

The EPA TMDL modeling attributes an approximate 0.5 mg/L critical segment DO deficit to all point sources of BOD (combined) with roughly one half of this point source deficit resulting from upriver point source BOD loads reaching the upper end of the estuary and the other half resulting from point source BOD loads directly to the estuary. This EPA finding means that total elimination of all point source BOD loads between Thurmond Dam and the sea could improve critical segment DO concentrations in Savannah Harbor by only 0.5 mg/L. The Draft EPA TMDL, based on meeting newly recommended DO criteria, calls for an approximate 30-percent overall reduction of point source BOD loading from the overall point source BOD loading experienced during the summer critical period of 1999.

The types of potential measures identified in the current harbor DO improvement screening for the Army Corps include: directly adding air or oxygen to low DO waters in the critical harbor segment; mixing low DO waters on the bottom of the harbor with higher DO surface waters; seasonally increasing flow releases from upstream reservoirs; seasonally reducing BOD loads from industrial and municipal discharges to the harbor and upriver. A potential benefit to point source BOD dischargers of the Corps' DO mitigation and restoration projects

is that the federal government may fund a portion of the costs for design and construction of whatever DO improvement measures may be authorized.

For purposes of screening the potential for seasonal BOD load reductions, MACTEC is contacting the larger point-source BOD dischargers seeking their ideas as to what measures might be considered for such screening. The objective is to identify potential means and general order of costs for reducing BOD discharges by about 30 percent or more during the three month critical season (June 15th through September 15th). Potential alternatives might include added effluent storage capacity, critical season land application or wetlands polishing, supplemental or short-term enhanced treatment, plant process changes, coordinated plant shut-down/maintenance schedules during the critical season, water conservation measures, or (in the estuary) piping BOD discharges farther seaward. Considering the limited impact of point sources on the critical DO deficit (only 0.5 mg/L according to EPA) it seems unlikely that point source BOD load reduction measures would prove to be a cost efficient means for significantly improving DO. Nonetheless, consideration of BOD load reduction alternatives is a required component of this DO improvement screening project.

To accomplish the screening level evaluation of potential BOD point source load reductions, MACTEC requests information relating to the wastewater treatment process at your facility. Specifically, waste stream generation process flow diagrams, wastewater treatment process flow diagrams, and unit operations information. Additionally, MACTEC recognizes that this information may be sensitive and will not include specific plans or diagrams in the final report and will only use them to identify the potential "next steps" for BOD reduction. Representatives of MACTEC will be calling from February 2 through February 11 (or as necessary) to discuss this project and information with you for your facility.

Thank you for your cooperation.

Sincerely,

MACTEC Engineering and Consulting

Larry A. Neal, P.E.
Senior Principal Engineer
Vice President

Margaret E. Tanner
Senior Engineer

References:

USACE, 2005. Savannah Harbor Expansion Project website.
http://www.sysconn.com/harbor/

USACE, 2005. Savannah Harbor Ecosystem Restoration Dissolved Oxygen (DO) website.
http://www.sas.usace.army.mil/projects/projects/shdo.htm

March 15, 2005

FILE COPY

Rick Hamilton
Weyerhaeuser
P.O. Box 668
Savannah, GA 31402

Regarding: **Information request for the SHER and SHEP Projects**
Screening Level DO Improvement Alternatives for Savannah Harbor
USACE SHEP/SHER Project
Project Number: 6301-05-0001

Dear Mr. Hamilton:

As components of both the Savannah Harbor Expansion Project (USACE, 2004) and the Savannah Harbor Ecosystem Restoration Study (USACE, 2004.), the U.S. Army Corps of Engineers (USACE) has contracted with MACTEC Engineering and Consulting (MACTEC) to identify and conduct a screening level evaluation of alternative potential measures to seasonally improve dissolved oxygen (DO) concentrations in Savannah Harbor. Low DO levels in Savannah Harbor are the subject of an EPA Region 4 Draft Total Maximum Daily Load (TMDL) for Dissolved Oxygen (EPA, 2004). According to EPA, the particular harbor segment for which DO improvement is needed is an approximate four mile length between Talmadge Bridge and Elba Island and the critical season of the year for such DO improvement is the three-month period from June 15th through September 15th.

The EPA TMDL modeling attributes an approximate 0.5 mg/L critical segment DO deficit to all point sources of BOD (combined) with roughly one half of this point source deficit resulting from upriver point source BOD loads reaching the upper end of the estuary and the other half resulting from point source BOD loads directly to the estuary. This EPA finding means that total elimination of all point source BOD loads between Thurmond Dam and the sea could improve critical segment DO concentrations in Savannah Harbor by only 0.5 mg/L. The Draft EPA TMDL, based on meeting newly recommended DO criteria, calls for an approximate 30-percent overall reduction of point source BOD loading from the overall point source BOD loading experienced during the summer critical period of 1999.

The types of potential measures identified in the current harbor DO improvement screening for the Army Corps include: directly adding air or oxygen to low DO waters in the critical harbor segment; mixing low DO waters on the bottom of the harbor with higher DO surface waters; seasonally increasing flow releases from upstream reservoirs; seasonally reducing BOD loads from industrial and municipal discharges to the harbor and upriver. A potential benefit to point source BOD dischargers of the Corps' DO mitigation and restoration projects

is that the federal government may fund a portion of the costs for design and construction of whatever DO improvement measures may be authorized.

For purposes of screening the potential for seasonal BOD load reductions, MACTEC is contacting the larger point-source BOD dischargers seeking their ideas as to what measures might be considered for such screening. The objective is to identify potential means and general order of costs for reducing BOD discharges by about 30 percent or more during the three month critical season (June 15th through September 15th). Potential alternatives might include added effluent storage capacity, critical season land application or wetlands polishing, supplemental or short-term enhanced treatment, plant process changes, coordinated plant shut-down/maintenance schedules during the critical season, water conservation measures, or (in the estuary) piping BOD discharges farther seaward. Considering the limited impact of point sources on the critical DO deficit (only 0.5 mg/L according to EPA) it seems unlikely that point source BOD load reduction measures would prove to be a cost efficient means for significantly improving DO. Nonetheless, consideration of BOD load reduction alternatives is a required component of this DO improvement screening project.

To accomplish the screening level evaluation of potential BOD point source load reductions, MACTEC requests information relating to the wastewater treatment process at your facility. Specifically, waste stream generation process flow diagrams, wastewater treatment process flow diagrams, and unit operations information. Additionally, MACTEC recognizes that this information may be sensitive and will not include specific plans or diagrams in the final report and will only use them to identify the potential "next steps" for BOD reduction. Representatives of MACTEC will be calling from February 2 through February 11 (or as necessary) to discuss this project and information with you for your facility.

Thank you for your cooperation.

Sincerely,

MACTEC Engineering and Consulting

Larry A. Neal, P.E.
Senior Principal Engineer
Vice President

Margaret E. Tanner
Senior Engineer

References:

USACE, 2005. Savannah Harbor Expansion Project website.
http://www.sysconn.com/harbor/

USACE, 2005. Savannah Harbor Ecosystem Restoration Dissolved Oxygen (DO) website.
http://www.sas.usace.army.mil/projects/projects/shdo.htm

APPENDIX D

OXYGEN SUPPLEMENTATION TECHNOLOGIES

APPENDIX D

OXYGEN SUPPLEMENTATION TECHNOLOGIES

(3/29/05)

Section 1. TMDL Compliance

Allowable BOD Loading

Regulations requiring that treated effluents be discharged to receiving waters at elevated D.O. concentrations are specified in some discharge permits. Conventional aeration techniques may achieve these higher concentrations but usually entail prohibitively high unit energy consumption and are limited in the D.O. levels that can be achieved. Using standard aeration equipment to increase the D.O. from 0 to 7 mg/L in water at 25^{o}C would require approximately 2700 kwhr/ton of D.O. added, which is equivalent to over $200/ton of D.O. for electricity rates of $0.08/kwhr.

An efficient oxygenation system, on the other hand, can achieve the higher D.O. requirements both more easily and more economically. Technology is now available to produce heretofore impossibly high superoxygenation levels, allowing TMDL D.O. standards to be reached in many applications without the necessity for tertiary treatment.

TMDL Requirement Solutions

Reduction of pollutant loading, water augmentation in low flow situations and aeration are the methods traditionally used to reach TMDL levels. One aspect of the TMDL process mandated for surface waters is to establish the D.O. level appropriate for the resident fishery. This then leads to designation of the allowable BOD and/or nutrient-loading rate applicable to all entities discharging to the waterway. For impounded or slow flowing rivers with attendant low reaeration rate, k_2, as found in the relatively flat terrain, the allowable pollutant loading rates are accordingly quite low, resulting in the need to achieve especially high pollutant removal rates by the contributing entities. Such advanced removals cause exponential increases in wastewater treatment costs for relatively small incremental removal of pollutants. At present secondary treatment is mandated in all states for all wastewaters, resulting in more than 90% removals commonly being realized, but tertiary removals with their attendant high cost may also be necessary to meet the TMDL levels in many cases. However tertiary treatment may no longer be necessary in most cases when using a newer method which supplements D.O. in very high concentrations sufficient to achieve TMDL standards for D.O.. However, as presented in this paper, a newer method of supplementing superoxygenation directly to the river, promises significant advantages not achievable in the past.

The rate of reaeration of a river is shown in the following equation by Thackston:

$$k_2 = 0.000025[\ 1 + 9\ \{F\}^{0.25}][(h\ S_e\ g)^{0.5}]/h$$

Where: u = velocity – ft/sec

h = depth – ft

S_e = slope – ft/ft

Fig. __ depicts the k_2 corresponding to velocity and depth combinations.

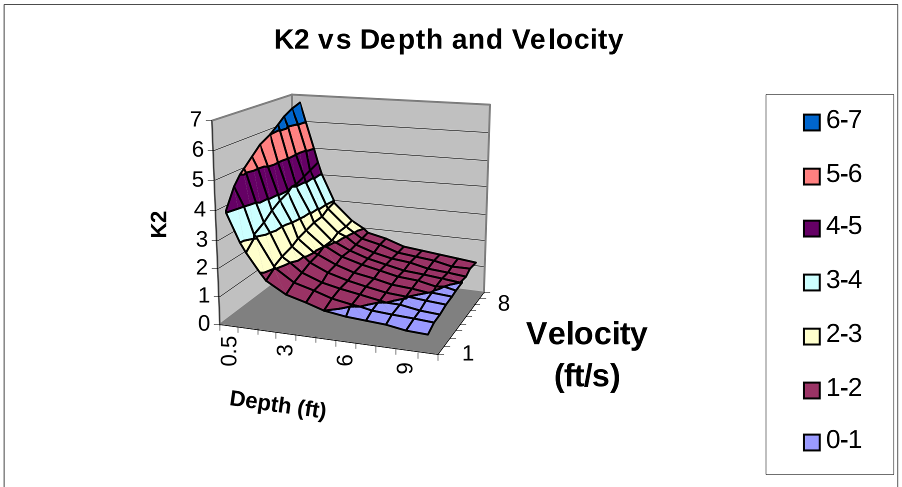
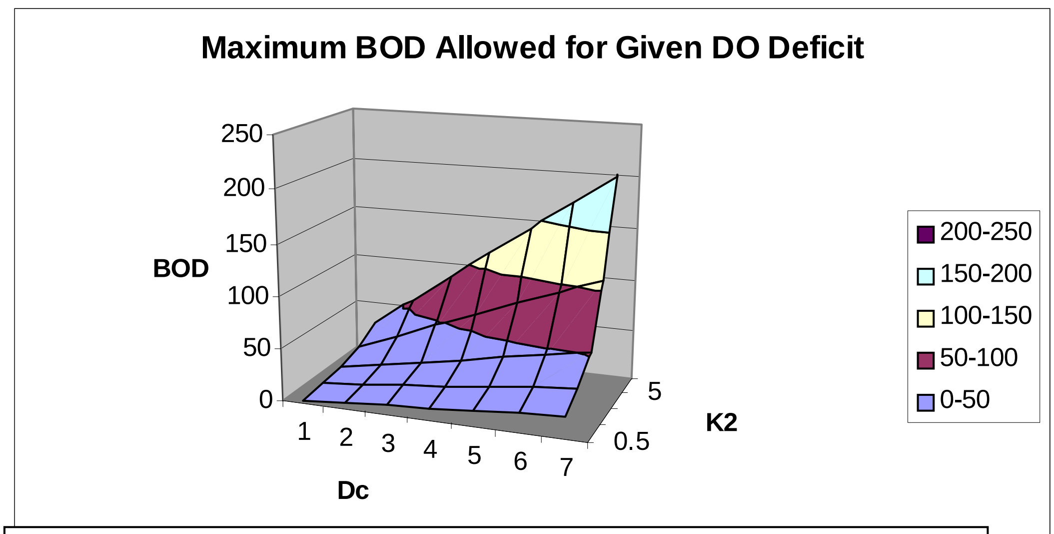


Fig. Reaeration rate vs velocity and depth



Maximum BOD Allowed for a Given D.O. Deficit at Sag Point

The allowable BOD loading in a segment of river is a function of the allowable D.O. deficit (or target D.O.) and the k_2 of that segment as shown in Fig. __

Strategy for D.O. Supplementation:

- Add D.O. equivalent to ultimate BOD in discharge so no oxygen resources in the harbor are consumed in metabolizing residual BOD.
- Higher D.O. from oxygenation station permits increased spacing between oxygenation stations.
    - This permits economy of scale.
    - Cost to bring in electrical power much reduced
    - Delivery of LOX
- Propeller pumps to assist in D.O. transport away from oxygenation station.

D.O. Supplementation Trading for Advanced BOD removal

The allowable BOD loading on a river is a function of k_r, k_d, and k_2. For example if River A has a depth of 10 ft and velocity of 1 ft/sec it will have a $k_2 = 0.65$/day while River B, with a depth of 2 ft and velocity of 4 ft/sec will have $k_2 = 2.3$/day. Thus the allowable BOD loading at 25 ^oC for a D.O. deficit of 3 mg/L and for River A is 10 mg/L. By comparison, the allowable BOD loading for River B is 28 mg/L.

Lower aeration rated rivers should not be penalized if successful reaeration rates are reached by means of superoxygenation. When water quality trading is implemented locally, then, supplemental oxygenation of the receiving water body will also be an acceptable solution for meeting TMDL standards.

On Jan 13, 2003 EPA announced a new Water Quality Trading Policy to provide guidance on how trading can occur under the Clean Water Act while implementing regulations. Water quality trading is a market-based approach that is intended to provide greater efficiency in achieving water quality goals and watersheds by allowing one source to meet its regulatory requirements by using pollutant reductions created by another source that has lower pollution control cost.

Supplemental oxygenation of a river as a trade-off for non-point source pollution control measures has been used successfully. A study performed to remediate Snake River D.O. deficiency related to TMDL (caused by non-point source phosphorous loading) established that oxygen could be supplemented directly to the river for 3 % of the cost to reduce phosphorous from non-point sources to achieve comparable D.O. standards.

Ruane has postulated how the South Fork Holston River in Tennessee point/nonpoint-source pollutant trading within a watershed might be implemented. Although several hundreds of millions of dollars were invested for waste treatment facilities in the 1970s, nevertheless D.O. levels in the South Fork Holston River dropped to 2 mg/L under low flow conditions. D.O. concentrations were even predicted to range from 0 to 1 mg/L if industrial and municipal facilities discharged to the limits of their permitted waste loads.

TVA investigators considered a number of options for improving D.O. conditions in the South Fork Holston River, including advanced waste treatment for the dischargers, turbine aeration at Fort Patrick Henry Dam, various levels of flow augmentation at the dam, and in stream aeration. The results of this exploratory analysis indicated that D.O. standards of 5 mg/L in the river could not be attained using the advanced effluent treatments that were being considered by the industrial and municipal dischargers, but a water quality trade off could meet the requirements. For example, it was predicted that state water quality standards could be met by augmenting flow releases from the dam, coupled with additional aeration by the hydroelectric project either at the dam or downstream. The annual cost of the trade off option would range from $298,000 to $395,000, compared to an estimated annual cost of $44,000,000 for the industrial and municipal dischargers to operate advanced (but insufficient) waste treatments.

Superoxygenation provides a significant advantage by increasing river D.O. without processing the entire river. Also much smaller sidestream flows and civil works are required for superoxygenation than for aeration. Compelling cost comparisons favor use of this newest type of technology to achieve TMDL standards since pure oxygen is available for only $60 to $100/ton, depending on the usage rate. Successful superoxygenation can dissolve oxygen into water with 90% oxygen absorption efficiency for a total cost of approximately $100/ton D.O. (which includes amortization of the capital cost @ $10/ton D.O., energy consumption of 400 kwhr/ton D.O. @ $0.05/kwhr = $20/ton D.O., and the cost of oxygen at $70/ton D.O.) while achieving 70 mg/L D.O. in a sidestream. When using pure oxygen vs aeration only about one tenth as much energy (300 kwhr/ton D.O.) is consumed per ton of D.O. supplemented than required for aeration yet D.O. concentrations in the river equivalent to air saturated D.O. can be easily achieved with these economies. The Chicago Canal sidestream aeration system, which moves the entire canal flow through the cascade aerators with an increase of only 1 to 3 mg/L D.O. involves energy consumption of over 3000 kwhr/ton of D.O. supplemented, which is ten times the energy requirement necessary for pure oxygen supplementation.

If the discharge has received secondary treatment there will be nil degradation of the river quality. Deep, slow moving rivers no longer need to be penalized in TMDL analyses when adopting superoxygenation technology. Advanced treatment will no longer be required.

Tertiary Removal of BOD

Tertiary treatment to lower the five-day BOD below 20 to 30 mg/L does little to improve the river habitat. The costs of tertiary treatment may exceed the cost of secondary biological treatment. If an increase in D.O. is a major need to improve the river habitat, then oxygen supplementation instead of tertiary removal of BOD should be implemented, especially with pooled rivers or harbors having very low aeration rates. For water quality limited harbors receiving secondary biologically treated industrial or domestic affluence. It is possible that an agreement could be reached with the state regulatory agency to allow oxygen to be supplemented directly to the harbor in order to maintain regulated D.O. concentrations.

As shown in the Figs. below, the health of a water body is directly correlated with the D.O. maintained therein.

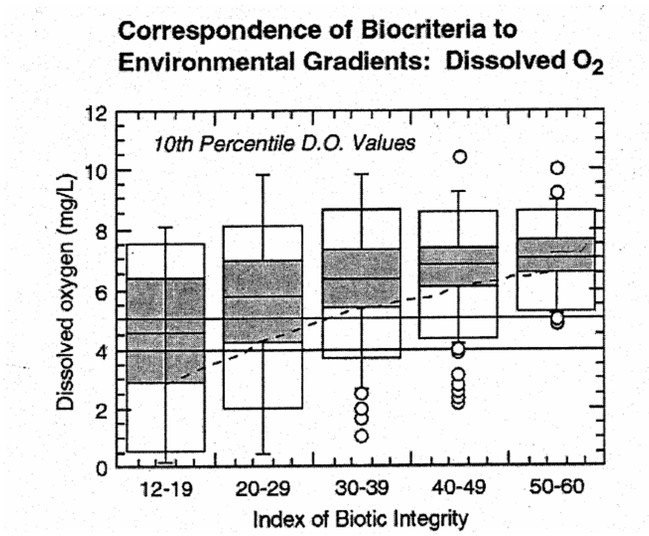
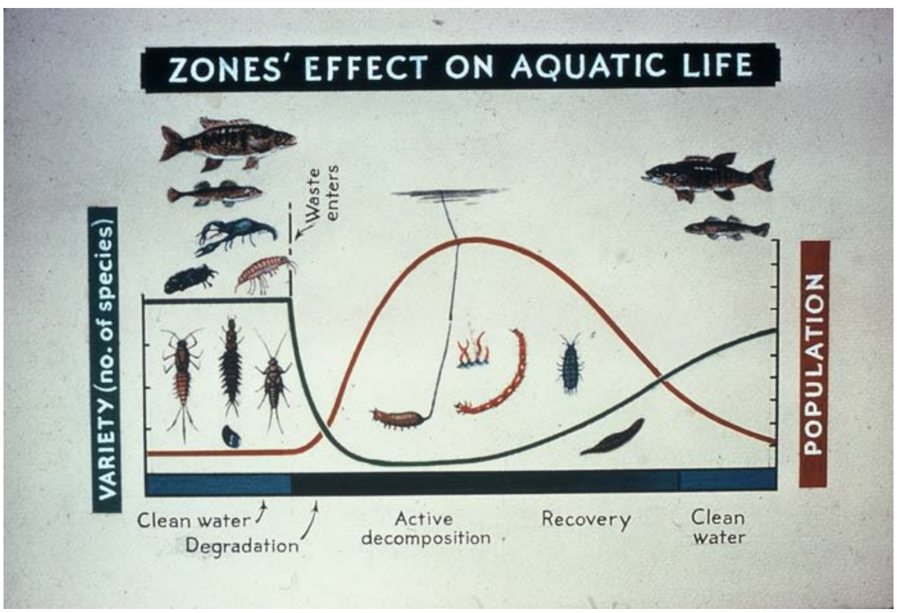
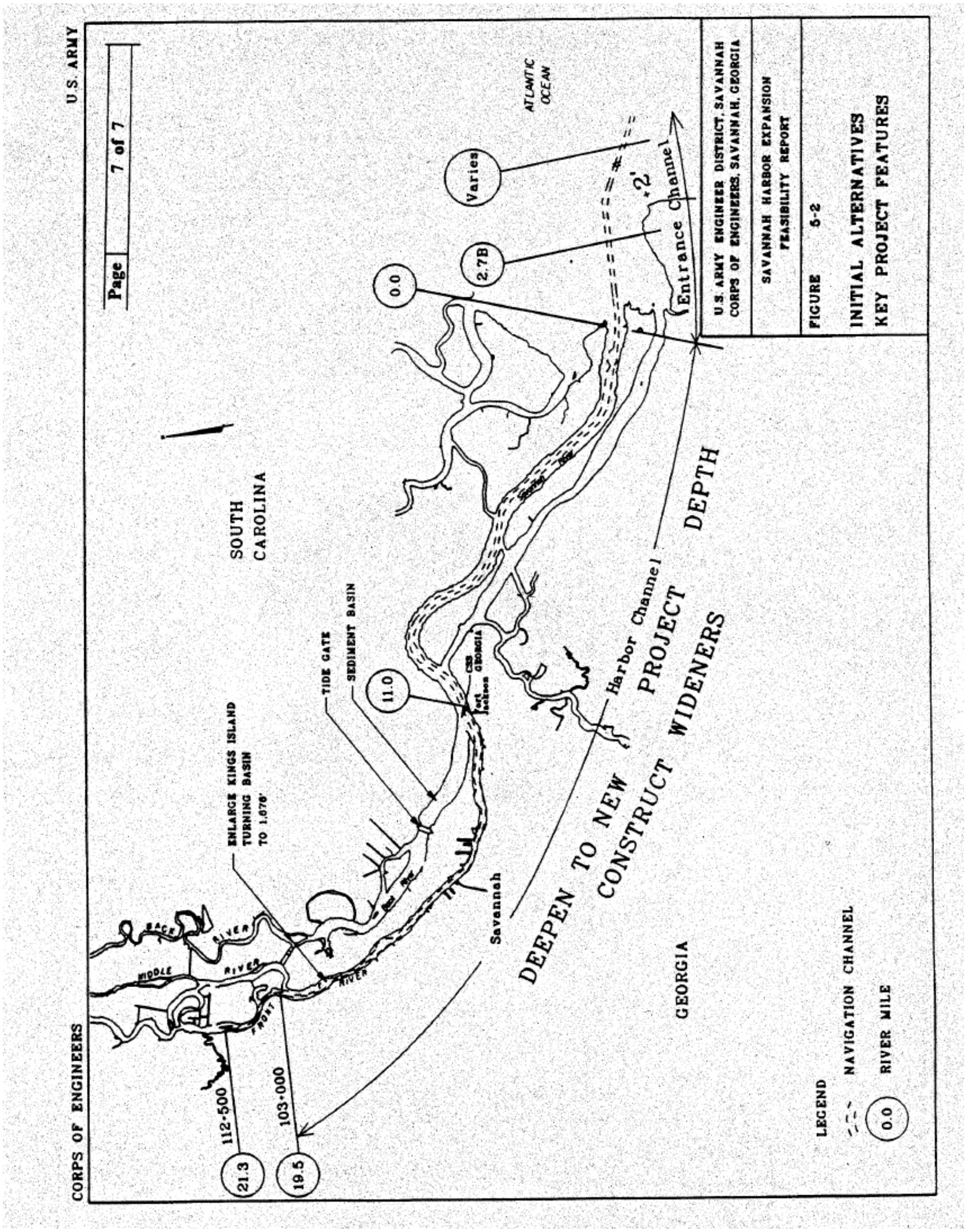
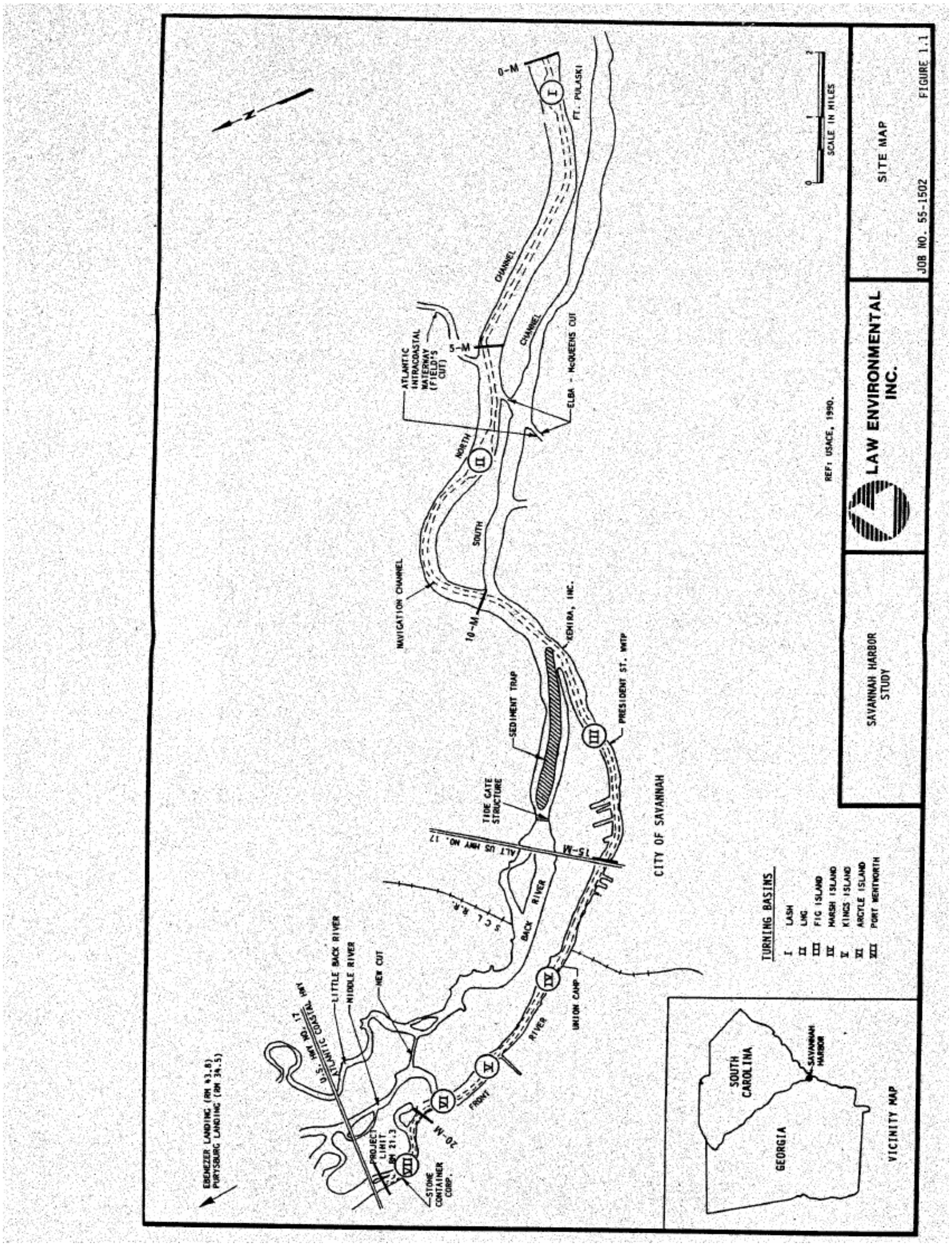


Fig. Correspondence of biocriteria to environmental gradients: dissolved oxygen



Aquatic Diversity as a Function of D.O. Recovery


CORPS OF ENGINEERS
U.S. ARMY
Page 7 of 7
SOUTH CAROLINA
ATLANTIC OCEAN
GEORGIA
Savannah
BACK RIVER
MIDDLE RIVER
FRONT RIVER
21.3
112+500
19.5
103+000
ENLARGE KINGS ISLAND TURNING BASIN TO 1,676'
TIDE GATE
SEDIMENT BASIN
11.0
CSS GEORGIA
Fort Jackson
0.0
2.7B
Varies
+2'
Entrance Channel
Harbor Channel
DEEPEN TO NEW PROJECT DEPTH
CONSTRUCT WIDENERS
LEGEND
NAVIGATION CHANNEL
0.0 RIVER MILE
U.S. ARMY ENGINEER DISTRICT, SAVANNAH
CORPS OF ENGINEERS, SAVANNAH, GEORGIA
SAVANNAH HARBOR EXPANSION FEASIBILITY REPORT
FIGURE 5-2
INITIAL ALTERNATIVES
KEY PROJECT FEATURES



SAVANNAH HARBOR STUDY
LAW ENVIRONMENTAL INC.
SITE MAP
JOB NO. 55-1502
FIGURE 1.1
REF: USACE, 1990.
SCALE IN MILES
VICINITY MAP
SOUTH CAROLINA
GEORGIA
SAVANNAH HARBOR
TURNING BASINS
I LASH
II LNG
III FIG ISLAND
IV MARSH ISLAND
V KINGS ISLAND
VI ARGYLE ISLAND
VII PORT WENTWORTH
CITY OF SAVANNAH
NAVIGATION CHANNEL
SEDIMENT TRAP
TIDE GATE STRUCTURE
PRESIDENT ST. WWTP
KEMIRA, INC.
ELBA - McQUEENS CUT
ATLANTIC INTRACOASTAL WATERWAY (FIELD'S CUT)
FT. PULASKI
UNION CAMP
STONE CONTAINER CORP.
PROJECT LIMIT RM 21.3
EBENEZER LANDING (RM 43.8)
PURYSBURG LANDING (RM 34.5)
LITTLE BACK RIVER
MIDDLE RIVER
NEW CUT
FRONT RIVER
BACK RIVER
NORTH CHANNEL
SOUTH CHANNEL
ALT US HWY NO. 17
U.S. HWY NO. 17 ATLANTIC COASTAL HWY
0-M
5-M
10-M
15-M
20-M

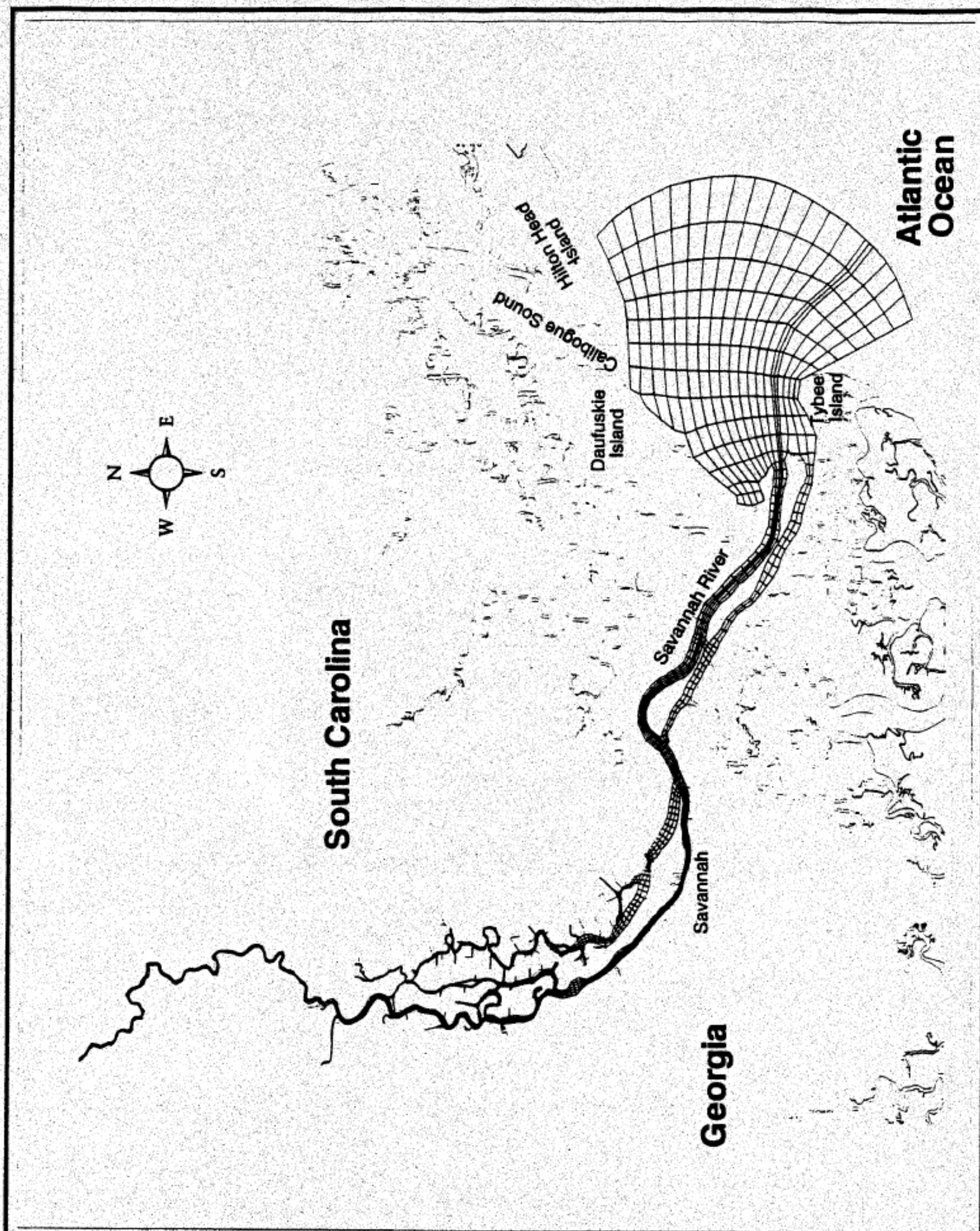
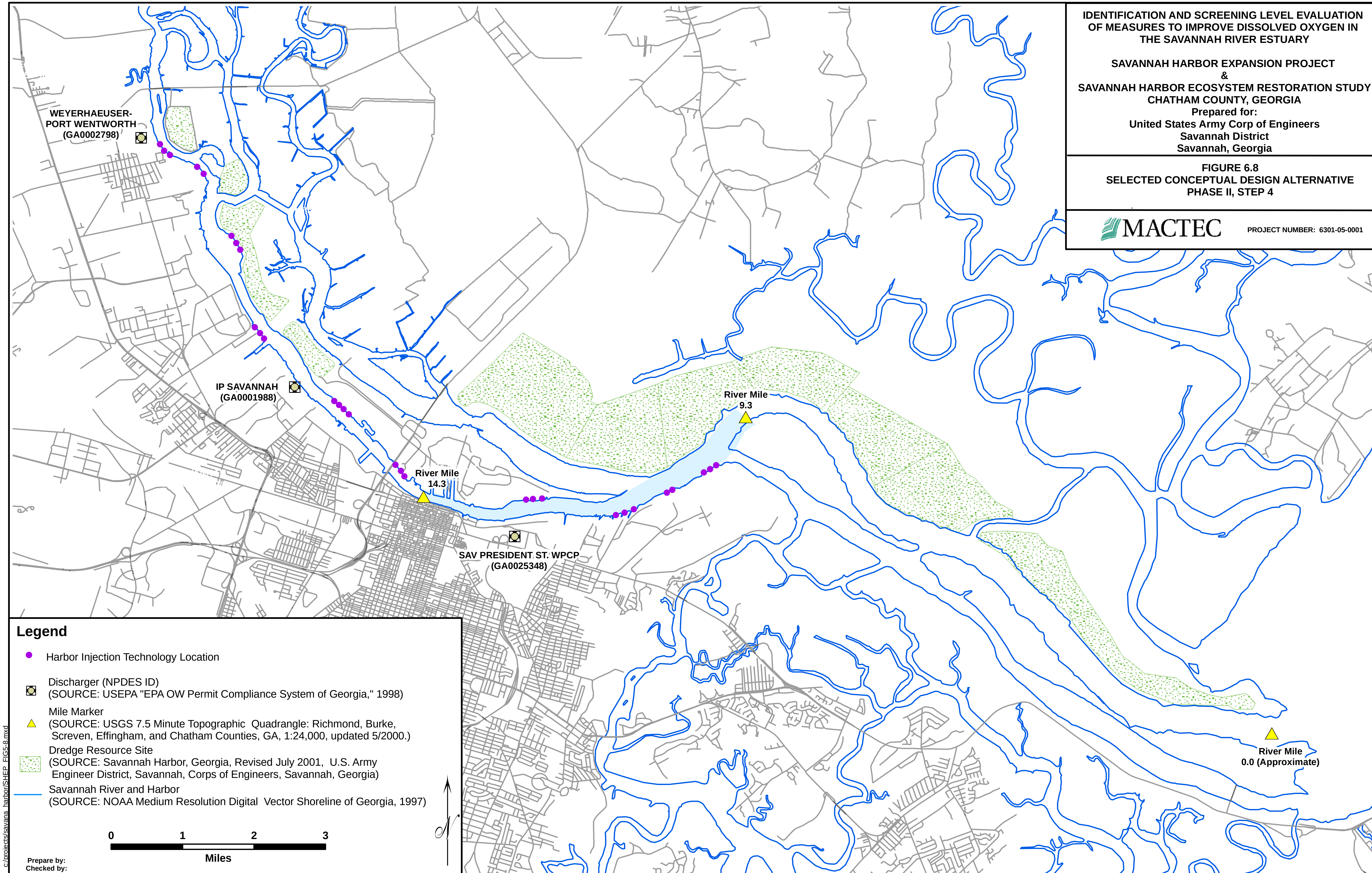


Figure 3-1
Model Grid

APPLIED TECHNOLOGY & MANAGEMENT, INC.



c:/projects/savana_harbor/SHEP_FIG5-8.mxd

APPENDIX A

USACE SCOPE OF WORK

SCOPE OF WORK

IDENTIFICATION AND SCREENIING LEVEL EVALUATION OF MEASURES TO IMPROVE DISSOLVED OXYGEN IN THE SAVANNAH RIVER ESTUARY

SAVANNAH HARBOR EXPANSION PROJECT & SAVANNAH HARBOR ECOSYSTEM RESTORATION STUDY CHATHAM COUNTY, GEORGIA

1.0 INTRODUCTION.

As components of both the Savannah Harbor Expansion Project and the Savannah Harbor Ecosystem Restoration Study, Savannah District needs to identify and conduct a screening level evaluation of potential measures that could improve dissolved oxygen in the Savannah River Estuary.

The Savannah Harbor Expansion Project is evaluating deepening the navigation channel in Savannah Harbor. Such deepening could reduce dissolved oxygen levels in some locations within the river during some periods of the year. The project desires to consider methods to reduce or eliminate that potential adverse effect. The project is also identifying cumulative impacts to the harbor's ecosystem that have resulted from previous developments.

The Savannah Harbor Ecosystem Restoration Study is examining ways to improve dissolved oxygen levels in the harbor. That study is focused on methods of improving existing levels of dissolved oxygen in the harbor during the critical summer months.

2.0 BACKGROUND.

Portion of Savannah Harbor has not met Georgia's water quality standards for dissolved oxygen in some locations during the summer months. The harbor is on Georgia's Section 303(d) list for waters that do not comply with water quality standards for dissolved oxygen. EPA Region 4 released a Draft TMDL for Dissolved Oxygen for the harbor in August 2004. That document identified a portion of the harbor which experiences low levels of dissolved oxygen during the summer months. The Draft TMDL calls for elimination of all point source waste loads exerted on the harbor, plus the addition of 90,000 lbs/day of oxygen to the harbor system during critical conditions. EPA's document indicates that the waste load from discharges within the harbor places a 99,000 lbs/day oxygen demand on the system, while the load from upriver discharges exerts an additional 100,000 lbs/day oxygen demand in the harbor. These combined loads equate to roughly a 0.4 mg/l of the oxygen deficit in the critical harbor segment. Roughly half of that load originates from discharges within the harbor, while the other half result from upriver discharges. EPA proposed an alternate TMDL consisting of a revised water quality standard and a 30 percent reduction in the total point source waste load to the harbor (a reduction of about 57,000 pounds/day TBODu to produce a remaining load of 132,000 pounds/day TBODu).

It is unlikely that the present Georgia water quality standard for dissolved oxygen will remain in place in its present form. EPA has stated that it is not effective and has proposed an alternate standard in the August 2004 Draft TMDL. The public comment period has not yet closed on EPA's proposal, so we cannot know if their proposal will be adopted as proposed. The effect of the deep-draft navigation channel on the system's ability to recover from the waste loadings is unknown at this time, but this factor is being investigated.

The Savannah Harbor Expansion Project has not determined the precise extent of its potential impact on dissolved oxygen levels. However, we believe it could reduce already low D.O. levels at the bottom by as much as 0.5 mg/L. The Expansion Project has identified several measures that could be used to improve dissolved oxygen within the harbor. Those measures are as follows:

- *Add air or oxygen to low dissolved oxygen waters*
  - Add air or oxygen upstream of the deep-draft harbor (Augusta to Savannah)
    - Floating aerators, air injection system, D.O. injection system
  - Add air or oxygen within the deep-draft harbor
    - Floating aerators, air injection system
    - D.O. injection system on bottom of river
    - D.O. injection system on Hutchinson Island
- Mix low dissolved oxygen waters on the bottom with higher D.O. surface waters
  - Inflatable weir
  - Pumps
- Increase releases from upstream reservoirs
- Reduce the BOD loads from industrial and municipal discharges in the harbor
- Reduce the BOD loads from industrial and municipal discharges further upriver

Other measures may also exist that are feasible and implementable. This initial study focuses on the potential improvements that are associated with BOD load reduction and addition of air or oxygen. The potential feasibility of other measures will be examined qualitatively. As part of its assessment of cumulative impacts, the Expansion Project is also identifying effects that past development of the harbor have produced on water quality.

3.0 OBJECTIVE. The objective of this study is to identify and conduct a screening level evaluation of potential measures that could improve dissolved oxygen in the Savannah River Estuary. This analysis will include an assessment of the engineering feasibility and cost effectiveness of potential improvement measures, as well as identification of implementation problems. This effort will be directed toward both the portion of the harbor and time of year that were identified in EPA's Draft TMDL for Dissolved Oxygen as having recurring low levels of D.O. The analysis will allow both Corps projects to consider alternate methods of improving dissolved oxygen from its present levels, as well as developing several increments of D.O. improvement.

4.0 METHODOLOGY. This study will be conducted in two phases, with multiple steps in each phase. Models currently exist for both the riverine portion of the Savannah River from Thurmond Dam to downstream of Clyo, Georgia (River Model) and for the Savannah Harbor from Clyo to the Atlantic Ocean (Harbor Models). These models need not be used in this screening level evaluation.

Phase I will be an assessment of potential D.O. improvement measures that could be used either singly or as a package to meet the Georgia water quality standard for dissolved oxygen. Since EPA has disapproved the present Georgia standard for D.O., this phase will include four steps. The first step will consider measures that would allow the harbor to comply with the present Georgia D.O. standard under existing waste loads. This would address the approximate 200,000 lbs/day excess oxygen demand presently in the harbor. The second step will consider measures that would allow the harbor to comply with the present Georgia D.O. standard under full permitted waste loads. This would address the discharged loads of approximate 367,000 lbs/day TBODu that are permitted in the harbor plus 75 percent of the 358,000 lbs/day TBODu that are permitted in the upriver areas. The third step will consider measures that would improve D.O. levels in the harbor to the extent that it meets the D.O. standard that EPA proposed for Georgia in its August 2004 Draft TMDL. This step would consider the effects of the existing waste loads. This step would develop plans that have the same effect as the 30 percent reduction in BOD loading proposed by EPA in its Alternate TMDL. The fourth step will also consider measures that would allow the harbor to comply with the D.O. standard that EPA proposed for Georgia in its August 2004 Draft TMDL. This step would consider the effects of full permitted waste loads -- 367,000 lbs/day TBODu permitted in the harbor area plus 75 percent of the 358,000 lbs/day TBODu that is permitted upriver. These steps can be summarized as follows:

Step	D.O. Standard	Point Source Loading
1	Present GA D.O. Standard	Present loading
2	Present GA D.O. Standard	Full permitted loads
3	EPA proposed standard	Present loading
4	EPA proposed standard	Full permitted loads

Phase II would consist of assessing potential measures that could be used either singly or as a package to further improve dissolved oxygen levels in the harbor. The improvements evaluated in this second phase could be larger scale designs of those identified in the first phase effort or could be a separate set of design solutions. This phase would also consist of four incremental steps, each improving bottom D.O. levels by 0.2 mg/L. Thus, this phase will develop four incremental designs for improving dissolved oxygen, the first capable of improving bottom D.O. levels by 0.2 mg/L, the second would improve D.O. levels by 0.4 mg/L, and the third would improve D.O. levels by 0.6 mg/L., and the fourth would improve D.O. levels by 0.8 mg/L. The work on this phase would assume the harbor already meets the D.O. standard the EPA proposed in August 2004.

5.0 WORK TO BE PERFORMED BY THE CONTRACTOR.

The scope of this study is to assess the feasibility and cost effectiveness of potential measures to improve dissolved oxygen (focusing on BOD load reduction and addition of air or oxygen) in the harbor during the summer months. Major steps within this study are:

1) Review the Draft TMDL for Dissolved Oxygen for the harbor that was proposed by EPA Region 4 in August 2004.
2) From EPA's Draft TMDL and the inputs to the computer models upon which it is based, conduct a screening level assessment of the potential contribution to the D.O. deficit from individual point source discharges along the river. This will include each of the discharges included in the TMDL models, whether they are located in Savannah, Augusta, or in between. Table 1 in EPA's Draft TMDL shows the permit loads calculated for dischargers in Savannah, while similar information for the upstream dischargers can be found in Appendix D of that report.
3) Develop a comprehensive list of potentially feasible measures to improve D.O. levels in Savannah Harbor during the summer months. This should include measures to address point source loads (upriver and in the harbor), non-point source loads, and storm water loads.
4) Identify and assess the largest contributors of BOD loads to the Savannah River. Develop a table ranking the BOD loads contributed by each source to identify the sources contributing the largest BOD loads. For the five largest point source contributors of BOD to the system, summarize their existing treatment systems. For each of those five sources, list the next two steps that would most traditionally be employed for additional BOD reductions and the estimated extent of reduction to be expected from each of those steps.
5) Assess the feasibility of each of the potentially feasible D.O. improvement measures identified above in step 3 in light of the conditions occurring in the Savannah River system. Briefly describe the conditions under which each measure would typically be most effective and the conditions that reduce its effectiveness.
6) For each step in Phase I, develop one suitable method for making the desired D.O. improvement. This will include a conceptual-level design for each alternative method. Coordination with either the point source dischargers or GA DNR-EPD may be necessary to obtain additional information on the physical and biological characteristics of each discharge. That information could be needed to assess the technical feasibility of potential improvement methods. This conceptual design will include description of the process to be employed and the size/scale of the major features. As part of the conceptual designs, identify problems or considerations that may limit the effectiveness of the measure or render it un-implementable. For Phase II, develop conceptual-level designs for making four incremental steps of improvement in D.O. in the harbor. Develop a conceptual design – as described above -- for each of those four levels of D.O. improvement. The conceptual designs are expected to be screening level design layouts and include major features and/or BOD load reductions. Modeling to assess the impact of the conceptual designs to D.O. in the harbor will not be performed in this study. As part of each conceptual design, include the reasoning for why the design identified would be the most cost effective approach.
7) Evaluate the cost-effectiveness of the four conceptual designs for improving D.O. levels that were developed in Phase I and the four designs developed in Phase II. This will include implementation (access, land, equipment, construction, etc.) and operation costs. Cost estimates provided will be feasibility level cost evaluations and will be used to assess the cost-effectiveness of each conceptual design.
8) Identify the most cost effective D.O. improvement measure for each of the four steps in Phase I.
9) For the most cost-effective D.O. improvement designs developed through Phase I and the designs developed through Phase II, provide the following information to aid in the description of those designs: (A) general location map, and (B) site map showing its

relation to nearby properties. Site maps will utilize readily available GIS/CADD tax parcel files. If files are unavailable, a figure showing predominant land use in the area may be substituted.

10) Prepare a report describing the procedures used, the measures that were considered, the conceptual designs that were developed, and the conclusions reached in the study.

6.0 MATERIALS TO BE FURNISHED BY SAVANNAH DISTRICT. Savannah District will provide no materials for this Delivery Order. However, the Savannah District may be able to research tax records in Savannah and surrounding areas.

7.0 DELIVERABLES. All deliverables should be provided to the U.S. Army Corps of Engineers, Attn: CESAS-PD-E (Mr. William Bailey), P O Box 889, Savannah, GA 31402.

7.1 MONTHLY PROGRESS REPORTS (Deliverable 1). Submit one (1) copy by the 10^{th} of each month documenting the previous month's efforts.

7.2 DRAFT SUMMARY REPORT (Deliverable 2). Submit ten (10) bound copies of a report describing the procedures used in this work, as well as the findings and conclusions. Submit ten (10) CDs containing the report developed through this work.

7.3 FINAL SUMMARY REPORT (Deliverable 3). Submit twenty (20) bound copies of a report describing the procedures used in this work, as well as the findings and conclusions. Submit twenty (20) CDs containing the report developed through this work. Submit one (1) CD containing the report in both Microsoft WORD and ADOBE Acrobat formats.

8.0 SCHEDULE. The Contractor shall adhere to the following project schedule.

Milestone	Due Date
Initiate work	1 week after issuance of the Delivery Order
Monthly Progress Reports	10^{th} of each month until completion of the D. Order
Draft Summary Report	12 weeks from issuance of the Delivery Order
Final Summary Report	3 weeks from receipt of comments on Draft Report

The Government expects to provide comments on the Draft Summary Report after a 30-day review period.

9.0 POINT OF CONTACT. Mr. William Bailey (CESAS-PD-E) will be the US Army Corps of Engineers' point of contact for this work. He can be reached at 912-652-5781 (FAX 912-652-5787) or at the following address:

Mr. William Bailey
ATTN: PD-E
US Army Corps of Engineers
Savannah District
P.O. Box 889
Savannah, GA 31406-0889

All billing invoices should be sent to Mr. William Bailey.

10.0 REFERENCES.

EPA, Region 4, August 2004. Draft Total Maximum Daily Load (TMDL) for Dissolved Oxygen in Savannah Harbor, Savannah River Basin, Chatham and Effingham Counties, Georgia. Report prepared by EPA Region 4, Atlanta, Georgia.

APPENDIX B

POINT SOURCE DISCHARGES

Appendix B

Point Source Dischargers[1]
Identification and Screening Level Evaluation of Measures to Improve Dissolved Oxygen in the Savannah River Estuary
Savannah Harbor Expansion Project & Savannah Harbor Ecosystem Restoration Project
Chatham County, Georgia

		Current Permit Limits				Oxygen Demanding Load Based on Current Permit Limits				
Facility Name	NPDES ID	Flow[a] (MGD)	BOD_5[b] (lbs/day)	NH_3 (mg/L)	NH_3 (lbs/day)	F-Ratio	$CBOD_U$ (lbs/day)	$NBOD_U$ (lbs/day)	$TBOD_U$ (lbs/day)	Permit Limit $TBOD_U$ (lbs/day)
Arcadian (PCS Nitrogen)	GA0002071	3.00	751		2,833			12,947	12,947	9,710[c]
City of Augusta (Butler Creek)	GA0037621	46.10	3,845	1.5	577	4	15,379	2,636	18,015	13,511[c]
City of Harlem	GA0020389	0.25	63			2	125		125	94[c]
City of Sardis	GA0020893	0.20	33	5.0	8	3	100	38	138	104[c]
City of Springfield	GA0020770	0.50	104	5.0	21	2	209	95	304	228
City of Sylvania	GA0021386	1.51	378	17.4	219	2	756	1,001	1,757	1,318[c]
City of Thomson	GA0020974	2.50	313	5.0	104	3.5	1,095	476	1,571	1,178[c]
City of Waynesboro	GA0038466	2.00	500	15.0	250	3.5	1,751	1,143	2,895	2,171[c]
Columbia County (Crawford Creek)	GA0031984	1.50	150	1.2	15	2	300	70	370	277[c]
Columbia County (Little River)	GA0047775	3.00	375	8.7	218	3.5	1,314	995	2,308	1,731[c]
Columbia County (Reed Creek)	GA0031992	4.60	384	2.0	77	4	1,535	351	1,885	1,414[c]
DSM Chemicals	GA0002160		250		6,000	3	750	27,420	28,170	21,128[c]
Fort Gordon	GA0003484	4.00	1,001	17.5	584	2	2,002	2,668	4,670	3502[c]
Fort James Paper (GA Pacific)	GA0046973		10,850			5	54,250		54,250	40,688[c]
Gracewood School and Hospital	GA0022161	0.50	125	17.4	73	2	250	332	582	436[c]
International Paper (Augusta)	GA0002801		30,000			6	180,000		180,000	135,000[c]
NIPRO			3,300		6,000	3	9,900	27,420	37,320	27,990[c]
Richmond County (Spirit Creek)	GA0047147	2.24	560	17.4	325	2	1,121	1,486	2,606	1955[c]
Engelhard	GA0048330				882			4,030	4,030	4,030
Garden City	GA0031038	2.00	500	17.4	290	2.4	1,201	1,325	2,526	2,526
International Paper (Savannah)	GA0001988	3.60	25,000			10.7	267,500		267,500	267,500
Kerr-McGee Pigments	GA0003646	0.60								
President Street	GA0025348	27.00	4,166	12.9	2,905	3.9	16,247	13,276	29,523	29,523
Travis Field	GA0020447	1.50	250	11.6	145	2.3	575	663	1,238	1,238
Weyerhaeuser-Port Wentworth	GA0002798	0.10	6,700			4.5	30,150		30,150	30,150
Wilshire	GA0020443	4.50	1,126	17.4	653	2.5	2,815	2,984	5,799	5,799
Georgia Power Co. Plant Votgle (Southern Nuclear)	GA0026786								0	0
Savannah Electric Plant Kraft	GA0003816								0	0
Savannah Electric Plant Riverside	GA0003751								0	0
Savannah Electric Plant McIntosh	GA0003883								0	0
City of Aiken (Horse Creek)	SC6641003	26.0	7,156	11.0	2,385	3	21,468	10,901	32,369	24,276[c]
Clariant Corporation-Martin Plant	SC0042803	1.8	564			3	1,692		1,692	1,269
Kimberly-Clark	SC0000582	11.2	4,031			3	12,093		12,093	9,070[c]
Savannah River Site										
SC Electric and Gas, Urquhart	SC0047431	142.9								0
Town of Allendale	SC0039918	4.0	834	20.0	667	3	2,502	3,048	5,550	4163c
Town of Hardeeville	SC0034584	1.0	253			2	506		506	380c

Notes:

Prepared By: ____________
Checked By: ____________

NPDES - National Pollutant Discharge Elimination System
MGD - million gallons per day
TMDL - Total Maximum Daily Load
BOD_5 - Biochemical Oxygen Demand
lbs/day - pounds per day
mg/L - milligrams per liter
$CBOD_U$ - Carbonaceous Ultimate Biochemical Oxygen Demand
$NBOD_U$ - Nitrogenous Ultimate Biochemical Oxygen Demand
$TBOD_U$ - Total Ultimate Biochemical Oxygen Demand
NA - Not Applicable
NH_3 - Ammonia
RM - River Mile
m^3/ton - cubic meters per ton

(1) Based on current permit limits as reported in USEPA EnviroFacts Database. For upstream dischargers 75% of the permitted load was used to complete the ranking.

Information not available

(a) As reported in the Draft TMDL (USEPA, 2004). Values for IP-Savannah, GAPAC, Weyerhaeuser are assumed to be erroneous. Permit limits and discharge monitoring report (DMR) data were used to provide flow information for design.

(b) USEPA, 2004. Draft Total Maximum Daily Load (TMDL) for Dissolved Oxygen in Savannah Harbor River Basin: Chatham and Effingham Counties, Georgia. U.S. Environmental Protection Agency. August 2004.

(c) Assumes 75% $TBOD_U$ reaches the Harbor.

APPENDIX C

CORRESPONDANCES

Subacz, Jonathan

From: Kinnard, Tanya
Sent: Wednesday, April 06, 2005 11:18 AM
To: Subacz, Jonathan
Subject: FW: Reuse system questions

From: Tanner, Margaret
Sent: Monday, March 21, 2005 3:40 PM
To: bob_scanlon@savannahga.gov
Cc: Neal, Larry; Kinnard, Tanya; Subacz, Jonathan; Latalladi, Monique
Subject: Reuse system questions

Here are our questions and information needs for the City of Savannah Reuse plan.

Current Water Reuse Plan

What were the costs to provide reuse water to the golf course on Hutchinson Island?
What is the average design flowrate to the golf course during the summer months?
What is the pipe diameter?
What is the BOD loading or BOD5 concentration in the reuse water?
What is the total golf course area currently being irrigated with the reuse water?

You mentioned that there was another golf course receiving reuse water. What is the name? Also, do you have information similar to the questions for the Hutchinson Island golf course? When did reuse start for this course (was it included in the flow estimates for the 1999 data)? Also, EPA is using DMR data to conduct the modeling from 1997-2003. When did the Hutchinson Island course go on line?

What is the total quantity of water currently designated for reuse?

Potential Future Water Reuse

On the City's website, we found information that suggested that there was some potential to provide reuse water to:

- Forsyth Park
- Daffin Park
- Paulsen Softball Complex
- Guy Minick Sports Complex
- County Soccer Complex

Can you provide addresses or (lat/lon data) for these sites?
Do you have the areas to be irrigated and the volume of reuse water to be provided for each of these sites?
Will each be supplied from the President's street facility? If not, what facility will supply the reuse water?
Has any type of cost analysis been done to assess the feasibility of this plan? If so, can this be provided?
Will the wastewater treatment plant need to be expanded to provide for increase reuse water usage? If so by what design flow? Have costs been developed for changes to the facility?

MARGARET E. TANNER – Senior Engineer
MACTEC Engineering and Consulting, Inc.
Kennesaw Technical Center
Office 770.421.7032 – **Mobile** 770.605.3957 – **Fax** 770.421.3486
Email metanner@mactec.com – **Web** www.mactec.com

Subacz, Jonathan

From: Whitlock.Steve@epamail.epa.gov
Sent: Thursday, February 10, 2005 6:02 PM
To: Bailey, William G SAS
Cc: greenfield.jim@epamail.epa.gov
Subject: RE: Question on Savannah RIV1 Model

Bill,
Preliminary results are in:
I ran scenarios with upper boundary DO at normal observed levels and then at 20% higher. At Clyo I saw no noticeable difference in DO. Also, since I did not change the BOD decay rate there was no difference in BOD. This means additions of DO at the Dam would only affect local DO and not the downstream reaches of the river or harbor.

....

Steve Whitlock
US EPA Region 4, Water Management Division
TMDL Modeling and Support Section
61 Forsyth Street, SW, Atlanta, GA 30303-3104
phone 404-562-9242, fax 404-562-9224
whitlock.steve@epa.gov

....

#37

INTERNATIONAL PAPER

Jeffrey S. Lynn
Manager of External Regulatory Affairs
Corporate Environment

International Place
6400 Poplar Ave.
Memphis, TN 38197
Phone 901-419-3956

Ms. Sibyl Cole
U.S. EPA Region IV
61 Forsyth St., S.W.
Atlanta, GA 30303

January 29, 2005

Re: Comments on the Savannah Harbor Draft TMDL for Dissolved Oxygen (DO) – August 2004

Dear Ms. Cole:

As the world's largest paper and forest products company with two major manufacturing operations in the Savannah River Basin, located in Augusta and Savannah, International Paper has a significant interest in the development and implementation of a scientifically defensible and equitable TMDL to mitigate the dissolved oxygen (DO) impairment for the Savannah River Harbor.

While International Paper recognizes that EPA was under a consent decree obligation to issue this proposed TMDL, the company strongly objects to finalizing the proposed TMDL or any alternative TMDL without further public notice and comment. As discussed in greater detail below, any final TMDL based upon the existing Georgia water quality standard or the modeling system underlying EPA's August 2004 proposal is scientifically unsound and without basis in fact or law. International Paper reserves its right to provide further comment on any revised or alternative TMDL.

Under the aforementioned objection and reservation of rights, International Paper submits the following comments on behalf of both International Paper mills.

INTRODUCTION

International Paper is vigilant in its efforts to protect water quality and is committed to assuring that water quality in the Savannah River Harbor is appropriately protected. We further recognize that water quality protection is critical to the viability of our multi-billion dollar assets in the Savannah River Watershed; hence it is critical that the TMDL accurately reflect the current hydrodynamic regime and physical setting of the Harbor and that the TMDL be based upon a water quality standard that defines the appropriate level of protection necessary for the Harbor.

It is furthermore essential that the final TMDL for the Savannah River Harbor be based on a water quality standard that is attainable and recognizes the level of water quality protection necessary for an industrial port, such as the Savannah Harbor. As highlighted in the draft TMDL, the Harbor, even under natural conditions with no inputs from point source dischargers, could not meet the existing water quality standard that was used to develop the draft. Use of this inappropriate water quality standard resulted in a totally unrealistic outcome for point source dischargers, that being "zero discharge." The concept of "zero discharge" is clearly unattainable, unachievable and wholly inappropriate. Neither municipal nor industrial point source dischargers can achieve such an impractical goal without significant social and economic disruption and the threat of abandoning continued operation. Another outcome MUST be achieved.

Prior to finalizing the TMDL, an appropriate water quality standard must be identified and incorporated into the TMDL. EPA's recognition that this critical point has not been met should, by itself, provide the foundation to withdraw the draft TMDL until such time that an appropriate standard is adopted and a revised TMDL can be recalibrated using an amended and more appropriate water quality standard. It is entirely inappropriate to advance the draft TMDL, as it cannot be practically implemented. Furthermore, the alternative TMDL is not appropriate and contains many of the same deficiencies as the draft TMDL – i.e., use of an insufficient model, etc.

NON-TECHNICAL COMMENTS

The TMDL Does Not Appropriately Account for Past and Potential Future Harbor Deepening Projects

In 1989, the Georgia's Environmental Protection Division (EPD) established the current Coastal Fishing DO standard for the Harbor. In 1989, the Harbor met that standard, with an authorized depth of 38 feet. The Harbor is currently authorized and dredged to a depth of 42 feet. In practice, this means that the Harbor can be anywhere from 44 to 46 feet deep in places where the COE overdredges to maintain the minimum 42 foot depth for ships to enter the port. The current depth of 42 feet was achieved in 1994. Since the deepening project in 1994, the Harbor has not met the DO standard. These past physical modifications (deepening events) have significantly impacted the water quality of the Savannah Harbor over the past several decades and are widely and logically believed to have had a specific impact on DO.

In addition, the Georgia Ports Authority and the US Army Corps of Engineers (COE) are reviewing yet another application to deepen the harbor an additional 6 feet which will further impact the Harbor's DO. There is an effort currently spearheaded by the COE to establish a re-aeration project to mitigate impacts of historic Harbor deepening events. This is a federal cost-shared project with participation by federal and state government agencies and local shareholders. The City of Savannah serves as the local sponsor for this project. NPDES permit holders in the Harbor, including International Paper, are also contributing time and resources to the project. The TMDL Project and the COE Restoration Project share a common goal - to quantify the oxygen deficit in the Harbor and determine options available for mitigation. A final plan of action has yet to be defined. However, at a minimum the Restoration Project must be coordinated and incorporated into the TMDL prior to its finalization and implementation. International Paper does not believe that public, nor for that matter private, funds should be used to alleviate a perceived water quality impairment based on a standard that is unattainable under present-day natural conditions.

The past and potential future deepening events are considered the "root cause" for the DO impairment of the Harbor. Point source dischargers are described as collectively contributing less than 0.5 ppm to the DO deficit in the Harbor. As such, it is completely inappropriate for point source dischargers to bear a 30% load reduction as suggested under the alternative TMDL scenario based on EPA's recommended DO standard. It is objectionable for point sources to bear such extreme costs associated with remedial actions to improve water quality when they are not the "primary" influence impacting DO levels in the Harbor.

Costs to Upgrade Wastewater Treatment Plants Exceed Point Source Contribution to the Impairment Problem

To further demonstrate the inequity of the 30% BOD load reduction proposed in the alternative TMDL we have conducted some preliminary engineering analyses to determine how the Augusta and Savannah Mills could achieve the proposed reductions. We also estimated the associated costs for these actions.

Both mills would have to significantly reconfigure their wastewater treatment systems to achieve the improved removal efficiencies mandated by the alternative TMDL. This action could only be achieved at a significant capital cost to each mill. Using standard engineering assumptions, the estimates to increase BOD removal efficiency at the Augusta and Savannah Mills, respectively, are $28,275,000 and $37, 492,000. These figures represent the total costs anticipated to increase BOD removal efficiencies and assure compliance with anticipated limitations based on the suggested alternative TMDL.

It is wholly inappropriate to expect point source dischargers that, in aggregate, only contribute 0.5 ppm to the DO sag in the Harbor, to this extraordinarily heavy expense. Any cost associated with achieving the final DO standard for the Harbor should be assumed proportionally by the entities contributing to the problem. The projected high costs associated with wastewater treatment system upgrades to meet a 30% BOD reduction brings into question the viability of both of these mills. It is inappropriate to propose such high cost remedies when point sources are not the predominant contributory factor to the problem.

EPA's Model Must Account for the Harbor Deepening Events

Prior to finalizing the TMDL for the Harbor, EPA must specifically evaluate the impact of the historic and proposed deepening events. As stated above, the Harbor was considered in compliance with its DO water quality standard prior to the deepening events that have modified the physical configuration of the Harbor, thus allowing greater tidal influence, reduced water velocity, and increased residence time for precursors to DO reductions. Each of these factors and others ultimately led to the Harbor's unique DO situation. It is necessary for the COE to continuously dredge the Harbor in order to maintain the currently approved depth. This is an ongoing activity that must also be addressed. Without these deepening and depth maintenance activities the Harbor would naturally return to a much shallower depth and it is logical that DO concerns would return to a more normal and water quality standard compliant situation, inclusive of the point source contributions.

The impact of Harbor deepening must be modeled to assure that any actions recommended in the final TMDL are focused on the primary contributing factors the TMDL seeks to remedy. International Paper strongly urges EPA to more fully model the Harbor based on historic depths versus the current and proposed depths in order to more fully understand the relationship these deepening events have on DO levels in the Harbor. In addition, the model must focus on the Harbor as a whole and not just the areas that have been deepened or undergone depth maintenance activities.

Recommended DO Standard

The draft TMDL proposed a "zero discharge" limitation for all point sources based upon an effort to protect the existing DO water quality standard. We support EPA's recognition of the Savannah Harbor's inability to meet the existing water quality standard under natural conditions. The inability to comply naturally with an overly restrictive water quality standard led the authors of the draft TMDL to recommend the need for development of a more realistic DO water quality standard. The authors suggested a revised site-specific marine DO criterion based on data from estuaries in the Virginian Province, which is defined as Cape Cod to Cape Hatteras.

It is unknown whether the recommended DO criterion is fully appropriate for the Savannah Harbor situation and as such, we would further encourage EPA to validate this alternative criterion as appropriate and applicable to the Savannah Harbor. International Paper supports EPA's effort to identify a suitable criterion and encourages EPA to continue this effort expeditiously. We do, however, caution EPA that whatever criterion is finally adopted for the Harbor it MUST recognize that this waterbody is an industrial port and the standard of protection MUST reflect that realization and the complexities associated with a heavily modified waterbody. Identification and selection of an appropriate water quality standard for the Harbor is critical to defining a TMDL that will be equitable to all stakeholders.

TECHNICAL COMMENTS

Model Comments

The model used to develop the existing draft TMDL significantly oversimplifies the dynamics of the Harbor and may not accurately portray the impact of point sources on DO concentrations in the harbor. The following technical comments and observations involving specific areas are offered:

Re-aeration
It is our understanding that EPA has efforts underway to enhance the model that was used to develop the draft TMDL by addressing re-aeration concerns. International Paper fully supports these efforts to advance the utility and validity of this model as a tool to reflect the Harbor regime more accurately and in its entirety. Full disclosure of the supporting data to construct the model is requested.

BOD Decay Rates
We further encourage EPA to reassess the BOD decay rates that were used in the model as they oversimplify the fate of BOD in the Harbor. Since the current model uses a single decay rate, the loadings for many point source dischargers are either overestimated or underestimated. The model should be refined so it reflects the Harbor system as a whole allowing for the differing decay rates from individual point sources. Incorporation of multiple decay rates into the model should vastly modify the results. BOD decay rates are available for all dischargers and the model has the capability to handle multiple decay rates. Full use of the model's capabilities is imperative so as to provide maximum model accuracy. The actual decay rates, as measured for each discharger, can be incorporated into the model and provide a much more realistic picture of the Harbor's DO situation. It is premature to finalize the TMDL until the modeling process is complete and can be used to characterize the Harbor with a much greater degree of rigor and precision.

The paper industry has conducted a considerable amount of research on decay dynamics of oxygen-demanding substances from pulp and paper mill effluents. The data collected shows that these dynamics are relatively complex and that much of the BOD in paper mill effluents decays relatively slowly, on the order of 0.02/day. Additional studies have also indicated that de-oxygenation kinetics of CBOD from pulp and paper mill effluents are in some cases poorly represented by single stage first order decay expressions. In the case of the Savannah Harbor there are multiple sources of BOD to the system including pulp and paper, other point sources and non-point sources. The Savannah Harbor model applies a first order decay model and a coefficient of 0.09/day for the modeled reach from Clyo to the ocean. This simplified decay rate constant has significant consequences for depicting an accurate model of BOD impacts on DO for the Harbor. Use of this overly simplified approach must be addressed. It is highly recommended that multiple rate decay coefficients be incorporated into another round of modeling prior to redrafting the TMDL so as to more accurately reflect the true decay dynamics of the system.

It is also unclear why the upstream river model uses a decay rate of 0.06/day until it enters the harbor and is reassigned a decay rate of 0.09/day. This may overstate the decay of upstream BOD in the harbor. This overestimate may need to be corrected by modeling it as a separate BOD component with a slower decay rate.

Deepening
As mentioned above, the harbor deepening events must be modeled to identify both pre-deepening and post-deepening impacts on the system as a whole. It is also recommended that a finer grid be used for the model prior to its use for developing a final TMDL.

Storm Water
The TMDL states that storm water is inconsequential as a contributing factor to the overall DO deficit as represented by the statement that storm water has "no measurable impact on DO levels in the critical areas of concern (p.13)." There is little to no data provided to support such a claim. However, it is noted that storm water did enter the system during data collection in 1999 and as such is implicitly included in the background data. This is a very important point and we suggest that storm water impacts be explicitly identified and incorporated into the TMDL. The State of Georgia has proposed new regulations for Industrial Storm Water Discharges that will impact business sites that discharge storm water to the Harbor. The TMDL needs to address how storm water dischargers will be impacted so as to maintain consistency between the TMDL and the requirements of the new General Industrial Storm Water Permit. We further reserve discussion on the allocation of storm water based on the insufficiency of data provided.

The draft TMDL describes the "vast majority" of non-NPDES loading of oxygen-demanding substances as derived from natural background sources, such as detritus and marsh outflow to the river. It is difficult to perceive how storm water, which would increase detritus inflow to the river and marsh outflow can be described as having "no measurable impact" on DO levels.

CONCLUSION

International Paper participates in two separate coalitions of dischargers representing the Savannah and Augusta areas. Respectively, these coalitions are the Savannah Harbor Committee and the Central Savannah River Area TMDL Group. Comments submitted by these individual coalitions are hereby incorporated by reference. The comments submitted by the American Forest & Paper Association are also incorporated by reference.

Although EPA's effort to expedite the development of this TMDL was predicated on achieving a judicially-driven timeline, we strongly recommend that EPA now take the necessary time to coordinate its efforts with stakeholders to determine an appropriate water quality standard and corresponding DO criterion for the Savannah River Harbor, redefine the TMDL based on the revised standard and resubmit the revised TMDL for review and comment. It is our understanding that EPA has initiated efforts to re-evaluate the model used to develop the initial draft TMDL and we fully support this action, however, the numerous activities described above must be coordinated with the model review in order to assure the final TMDL is appropriate, scientifically defensible and achievable.

International Paper encourages EPA to refocus its efforts to collectively, with stakeholders, revise and redraft the TMDL based on an appropriate water quality standard that recognizes the protections necessary for an industrial port. To this end, International Paper encourages EPA to adopt the above recommendations and actions as their own and fully commit to assuring the development of a practical and attainable TMDL. To discuss these comments further or answer any questions that may arise, please contact me at (901) 419-3956.

Sincerely,

Jeffrey S. Lynn
Manager External Regulatory Affairs

The above comments are submitted and endorsed on the behalf of International Paper's Augusta and Savannah Mills. Should you have additional mill-specific questions please contact either Jeremy Pearson (706-796-5363) at the Augusta Mill or Donna Katula (912-238-7054) at the Savannah Mill.

Respectfully Submitted,

Steve Bowden
Augusta Mill Manager

Timothy M. Kean
Savannah Mill Manager

January 31, 2005

FILE COPY

Bob Scanlon
City of Savannah
P.O. Box 1027
Savannah, GA 31402

Regarding: **Information request for the SHER and SHEP Projects**
Screening Level DO Improvement Alternatives for Savannah Harbor
USACE SHEP/SHER Project
Project Number: 6301-05-0001

Dear Mr. Scanlon:

As components of both the Savannah Harbor Expansion Project (USACE, 2004) and the Savannah Harbor Ecosystem Restoration Study (USACE, 2004.), the U.S. Army Corps of Engineers (USACE) has contracted with MACTEC Engineering and Consulting (MACTEC) to identify and conduct a screening level evaluation of alternative potential measures to seasonally improve dissolved oxygen (DO) concentrations in Savannah Harbor. Low DO levels in Savannah Harbor are the subject of an EPA Region 4 Draft Total Maximum Daily Load (TMDL) for Dissolved Oxygen (EPA, 2004). According to EPA, the particular harbor segment for which DO improvement is needed is an approximate four mile length between Talmadge Bridge and Elba Island and the critical season of the year for such DO improvement is the three-month period from June 15th through September 15th.

The EPA TMDL modeling attributes an approximate 0.5 mg/L critical segment DO deficit to all point sources of BOD (combined) with roughly one half of this point source deficit resulting from upriver point source BOD loads reaching the upper end of the estuary and the other half resulting from point source BOD loads directly to the estuary. This EPA finding means that total elimination of all point source BOD loads between Thurmond Dam and the sea could improve critical segment DO concentrations in Savannah Harbor by only 0.5 mg/L. The Draft EPA TMDL, based on meeting newly recommended DO criteria, calls for an approximate 30-percent overall reduction of point source BOD loading from the overall point source BOD loading experienced during the summer critical period of 1999.

The types of potential measures identified in the current harbor DO improvement screening for the Army Corps include: directly adding air or oxygen to low DO waters in the critical harbor segment; mixing low DO waters on the bottom of the harbor with higher DO surface waters; seasonally increasing flow releases from upstream reservoirs; seasonally reducing BOD loads from industrial and municipal discharges to the harbor and upriver. A potential benefit to point source BOD dischargers of the Corps' DO mitigation and restoration projects

is that the federal government may fund a portion of the costs for design and construction of whatever DO improvement measures may be authorized.

For purposes of screening the potential for seasonal BOD load reductions, MACTEC is contacting the larger point-source BOD dischargers seeking their ideas as to what measures might be considered for such screening. The objective is to identify potential means and general order of costs for reducing BOD discharges by about 30 percent or more during the three month critical season (June 15th through September 15th). Potential alternatives might include added effluent storage capacity, critical season land application or wetlands polishing, supplemental or short-term enhanced treatment, plant process changes, coordinated plant shut-down/maintenance schedules during the critical season, water conservation measures, or (in the estuary) piping BOD discharges farther seaward. Considering the limited impact of point sources on the critical DO deficit (only 0.5 mg/L according to EPA) it seems unlikely that point source BOD load reduction measures would prove to be a cost efficient means for significantly improving DO. Nonetheless, consideration of BOD load reduction alternatives is a required component of this DO improvement screening project.

To accomplish the screening level evaluation of potential BOD point source load reductions, MACTEC requests information relating to the wastewater treatment process at your facility. Specifically, waste stream generation process flow diagrams, wastewater treatment process flow diagrams, and unit operations information. Additionally, MACTEC recognizes that this information may be sensitive and will not include specific plans or diagrams in the final report and will only use them to identify the potential "next steps" for BOD reduction. Representatives of MACTEC will be calling from February 2 through February 11 (or as necessary) to discuss this project and information with you for your facility.

Thank you for your cooperation.

Sincerely,

MACTEC Engineering and Consulting

Larry A. Neal, P.E.
Senior Principal Engineer
Vice President

Margaret E. Tanner
Senior Engineer

References:

USACE, 2005. Savannah Harbor Expansion Project website.
http://www.sysconn.com/harbor/

USACE, 2005. Savannah Harbor Ecosystem Restoration Dissolved Oxygen (DO) website.
http://www.sas.usace.army.mil/projects/projects/shdo.htm

January 31, 2005

FILE COPY

Michelle Liotta
Georgia-Pacific
P.O. Box 828
Rincon, GA 31326-0828

Regarding: **Information request for the SHER and SHEP Projects**
Screening Level DO Improvement Alternatives for Savannah Harbor
USACE SHEP/SHER Project
Project Number: 6301-05-0001

Dear Ms. Liotta:

As components of both the Savannah Harbor Expansion Project (USACE, 2004) and the Savannah Harbor Ecosystem Restoration Study (USACE, 2004.), the U.S. Army Corps of Engineers (USACE) has contracted with MACTEC Engineering and Consulting (MACTEC) to identify and conduct a screening level evaluation of alternative potential measures to seasonally improve dissolved oxygen (DO) concentrations in Savannah Harbor. Low DO levels in Savannah Harbor are the subject of an EPA Region 4 Draft Total Maximum Daily Load (TMDL) for Dissolved Oxygen (EPA, 2004). According to EPA, the particular harbor segment for which DO improvement is needed is an approximate four mile length between Talmadge Bridge and Elba Island and the critical season of the year for such DO improvement is the three-month period from June 15th through September 15th.

The EPA TMDL modeling attributes an approximate 0.5 mg/L critical segment DO deficit to all point sources of BOD (combined) with roughly one half of this point source deficit resulting from upriver point source BOD loads reaching the upper end of the estuary and the other half resulting from point source BOD loads directly to the estuary. This EPA finding means that total elimination of all point source BOD loads between Thurmond Dam and the sea could improve critical segment DO concentrations in Savannah Harbor by only 0.5 mg/L. The Draft EPA TMDL, based on meeting newly recommended DO criteria, calls for an approximate 30-percent overall reduction of point source BOD loading from the overall point source BOD loading experienced during the summer critical period of 1999.

The types of potential measures identified in the current harbor DO improvement screening for the Army Corps include: directly adding air or oxygen to low DO waters in the critical harbor segment; mixing low DO waters on the bottom of the harbor with higher DO surface waters; seasonally increasing flow releases from upstream reservoirs; seasonally reducing BOD loads from industrial and municipal discharges to the harbor and upriver. A potential benefit to point source BOD dischargers of the Corps' DO mitigation and restoration projects

is that the federal government may fund a portion of the costs for design and construction of whatever DO improvement measures may be authorized.

For purposes of screening the potential for seasonal BOD load reductions, MACTEC is contacting the larger point-source BOD dischargers seeking their ideas as to what measures might be considered for such screening. The objective is to identify potential means and general order of costs for reducing BOD discharges by about 30 percent or more during the three month critical season (June 15th through September 15th). Potential alternatives might include added effluent storage capacity, critical season land application or wetlands polishing, supplemental or short-term enhanced treatment, plant process changes, coordinated plant shut-down/maintenance schedules during the critical season, water conservation measures, or (in the estuary) piping BOD discharges farther seaward. Considering the limited impact of point sources on the critical DO deficit (only 0.5 mg/L according to EPA) it seems unlikely that point source BOD load reduction measures would prove to be a cost efficient means for significantly improving DO. Nonetheless, consideration of BOD load reduction alternatives is a required component of this DO improvement screening project.

To accomplish the screening level evaluation of potential BOD point source load reductions, MACTEC requests information relating to the wastewater treatment process at your facility. Specifically, waste stream generation process flow diagrams, wastewater treatment process flow diagrams, and unit operations information. Additionally, MACTEC recognizes that this information may be sensitive and will not include specific plans or diagrams in the final report and will only use them to identify the potential "next steps" for BOD reduction. Representatives of MACTEC will be calling from February 2 through February 11 (or as necessary) to discuss this project and information with you for your facility.

Thank you for your cooperation.

Sincerely,

MACTEC Engineering and Consulting

Larry A. Neal, P.E.
Senior Principal Engineer
Vice President

Margaret E. Tanner
Senior Engineer

References:

USACE, 2005. Savannah Harbor Expansion Project website.
http://www.sysconn.com/harbor/

USACE, 2005. Savannah Harbor Ecosystem Restoration Dissolved Oxygen (DO) website.
http://www.sas.usace.army.mil/projects/projects/shdo.htm

January 31, 2005

FILE COPY

Jeremy Pearson
International Paper–Augusta Mill
P.O. Box 1425
Augusta, GA 30903

Regarding: **Information request for the SHER and SHEP Projects**
Screening Level DO Improvement Alternatives for Savannah Harbor
USACE SHEP/SHER Project
Project Number: 6301-05-0001

Dear Mr. Pearson:

As components of both the Savannah Harbor Expansion Project (USACE, 2004) and the Savannah Harbor Ecosystem Restoration Study (USACE, 2004.), the U.S. Army Corps of Engineers (USACE) has contracted with MACTEC Engineering and Consulting (MACTEC) to identify and conduct a screening level evaluation of alternative potential measures to seasonally improve dissolved oxygen (DO) concentrations in Savannah Harbor. Low DO levels in Savannah Harbor are the subject of an EPA Region 4 Draft Total Maximum Daily Load (TMDL) for Dissolved Oxygen (EPA, 2004). According to EPA, the particular harbor segment for which DO improvement is needed is an approximate four mile length between Talmadge Bridge and Elba Island and the critical season of the year for such DO improvement is the three-month period from June 15th through September 15th.

The EPA TMDL modeling attributes an approximate 0.5 mg/L critical segment DO deficit to all point sources of BOD (combined) with roughly one half of this point source deficit resulting from upriver point source BOD loads reaching the upper end of the estuary and the other half resulting from point source BOD loads directly to the estuary. This EPA finding means that total elimination of all point source BOD loads between Thurmond Dam and the sea could improve critical segment DO concentrations in Savannah Harbor by only 0.5 mg/L. The Draft EPA TMDL, based on meeting newly recommended DO criteria, calls for an approximate 30-percent overall reduction of point source BOD loading from the overall point source BOD loading experienced during the summer critical period of 1999.

The types of potential measures identified in the current harbor DO improvement screening for the Army Corps include: directly adding air or oxygen to low DO waters in the critical harbor segment; mixing low DO waters on the bottom of the harbor with higher DO surface waters; seasonally increasing flow releases from upstream reservoirs; seasonally reducing BOD loads from industrial and municipal discharges to the harbor and upriver. A potential benefit to point source BOD dischargers of the Corps' DO mitigation and restoration projects

is that the federal government may fund a portion of the costs for design and construction of whatever DO improvement measures may be authorized.

For purposes of screening the potential for seasonal BOD load reductions, MACTEC is contacting the larger point-source BOD dischargers seeking their ideas as to what measures might be considered for such screening. The objective is to identify potential means and general order of costs for reducing BOD discharges by about 30 percent or more during the three month critical season (June 15th through September 15th). Potential alternatives might include added effluent storage capacity, critical season land application or wetlands polishing, supplemental or short-term enhanced treatment, plant process changes, coordinated plant shut-down/maintenance schedules during the critical season, water conservation measures, or (in the estuary) piping BOD discharges farther seaward. Considering the limited impact of point sources on the critical DO deficit (only 0.5 mg/L according to EPA) it seems unlikely that point source BOD load reduction measures would prove to be a cost efficient means for significantly improving DO. Nonetheless, consideration of BOD load reduction alternatives is a required component of this DO improvement screening project.

To accomplish the screening level evaluation of potential BOD point source load reductions, MACTEC requests information relating to the wastewater treatment process at your facility. Specifically, waste stream generation process flow diagrams, wastewater treatment process flow diagrams, and unit operations information. Additionally, MACTEC recognizes that this information may be sensitive and will not include specific plans or diagrams in the final report and will only use them to identify the potential "next steps" for BOD reduction. Representatives of MACTEC will be calling from February 2 through February 11 (or as necessary) to discuss this project and information with you for your facility.

Thank you for your cooperation.

Sincerely,

MACTEC Engineering and Consulting

Larry A. Neal, P.E.
Senior Principal Engineer
Vice President

Margaret E. Tanner
Senior Engineer

References:

USACE, 2005. Savannah Harbor Expansion Project website.
http://www.sysconn.com/harbor/

USACE, 2005. Savannah Harbor Ecosystem Restoration Dissolved Oxygen (DO) website.
http://www.sas.usace.army.mil/projects/projects/shdo.htm

MACTEC

January 31, 2005

FILE COPY

Brittany Robinson
International Paper–Savannah
P.O. Box 570
Savannah, GA 31402

Regarding: **Information request for the SHER and SHEP Projects**
Screening Level DO Improvement Alternatives for Savannah Harbor
USACE SHEP/SHER Project
Project Number: 6301-05-0001

Dear Ms. Robinson:

As components of both the Savannah Harbor Expansion Project (USACE, 2004) and the Savannah Harbor Ecosystem Restoration Study (USACE, 2004.), the U.S. Army Corps of Engineers (USACE) has contracted with MACTEC Engineering and Consulting (MACTEC) to identify and conduct a screening level evaluation of alternative potential measures to seasonally improve dissolved oxygen (DO) concentrations in Savannah Harbor. Low DO levels in Savannah Harbor are the subject of an EPA Region 4 Draft Total Maximum Daily Load (TMDL) for Dissolved Oxygen (EPA, 2004). According to EPA, the particular harbor segment for which DO improvement is needed is an approximate four mile length between Talmadge Bridge and Elba Island and the critical season of the year for such DO improvement is the three-month period from June 15th through September 15th.

The EPA TMDL modeling attributes an approximate 0.5 mg/L critical segment DO deficit to all point sources of BOD (combined) with roughly one half of this point source deficit resulting from upriver point source BOD loads reaching the upper end of the estuary and the other half resulting from point source BOD loads directly to the estuary. This EPA finding means that total elimination of all point source BOD loads between Thurmond Dam and the sea could improve critical segment DO concentrations in Savannah Harbor by only 0.5 mg/L. The Draft EPA TMDL, based on meeting newly recommended DO criteria, calls for an approximate 30-percent overall reduction of point source BOD loading from the overall point source BOD loading experienced during the summer critical period of 1999.

The types of potential measures identified in the current harbor DO improvement screening for the Army Corps include: directly adding air or oxygen to low DO waters in the critical harbor segment; mixing low DO waters on the bottom of the harbor with higher DO surface waters; seasonally increasing flow releases from upstream reservoirs; seasonally reducing BOD loads from industrial and municipal discharges to the harbor and upriver. A potential benefit to point source BOD dischargers of the Corps' DO mitigation and restoration projects

is that the federal government may fund a portion of the costs for design and construction of whatever DO improvement measures may be authorized.

For purposes of screening the potential for seasonal BOD load reductions, MACTEC is contacting the larger point-source BOD dischargers seeking their ideas as to what measures might be considered for such screening. The objective is to identify potential means and general order of costs for reducing BOD discharges by about 30 percent or more during the three month critical season (June 15th through September 15th). Potential alternatives might include added effluent storage capacity, critical season land application or wetlands polishing, supplemental or short-term enhanced treatment, plant process changes, coordinated plant shut-down/maintenance schedules during the critical season, water conservation measures, or (in the estuary) piping BOD discharges farther seaward. Considering the limited impact of point sources on the critical DO deficit (only 0.5 mg/L according to EPA) it seems unlikely that point source BOD load reduction measures would prove to be a cost efficient means for significantly improving DO. Nonetheless, consideration of BOD load reduction alternatives is a required component of this DO improvement screening project.

To accomplish the screening level evaluation of potential BOD point source load reductions, MACTEC requests information relating to the wastewater treatment process at your facility. Specifically, waste stream generation process flow diagrams, wastewater treatment process flow diagrams, and unit operations information. Additionally, MACTEC recognizes that this information may be sensitive and will not include specific plans or diagrams in the final report and will only use them to identify the potential "next steps" for BOD reduction. Representatives of MACTEC will be calling from February 2 through February 11 (or as necessary) to discuss this project and information with you for your facility.

Thank you for your cooperation.

Sincerely,

MACTEC Engineering and Consulting

Larry A. Neal, P.E.
Senior Principal Engineer
Vice President

Margaret E. Tanner
Senior Engineer

References:

USACE, 2005. Savannah Harbor Expansion Project website.
http://www.sysconn.com/harbor/

USACE, 2005. Savannah Harbor Ecosystem Restoration Dissolved Oxygen (DO) website.
http://www.sas.usace.army.mil/projects/projects/shdo.htm

MACTEC Engineering and Consulting, Inc.
3200 Town Point Drive NW, Suite 100 • Kennesaw, GA 30144
770-421-3400 • Fax: 770-421-3486

MACTEC

March 15, 2005

FILE COPY

Rick Hamilton
Weyerhaeuser
P.O. Box 668
Savannah, GA 31402

Regarding: **Information request for the SHER and SHEP Projects**
Screening Level DO Improvement Alternatives for Savannah Harbor
USACE SHEP/SHER Project
Project Number: 6301-05-0001

Dear Mr. Hamilton:

As components of both the Savannah Harbor Expansion Project (USACE, 2004) and the Savannah Harbor Ecosystem Restoration Study (USACE, 2004.), the U.S. Army Corps of Engineers (USACE) has contracted with MACTEC Engineering and Consulting (MACTEC) to identify and conduct a screening level evaluation of alternative potential measures to seasonally improve dissolved oxygen (DO) concentrations in Savannah Harbor. Low DO levels in Savannah Harbor are the subject of an EPA Region 4 Draft Total Maximum Daily Load (TMDL) for Dissolved Oxygen (EPA, 2004). According to EPA, the particular harbor segment for which DO improvement is needed is an approximate four mile length between Talmadge Bridge and Elba Island and the critical season of the year for such DO improvement is the three-month period from June 15th through September 15th.

The EPA TMDL modeling attributes an approximate 0.5 mg/L critical segment DO deficit to all point sources of BOD (combined) with roughly one half of this point source deficit resulting from upriver point source BOD loads reaching the upper end of the estuary and the other half resulting from point source BOD loads directly to the estuary. This EPA finding means that total elimination of all point source BOD loads between Thurmond Dam and the sea could improve critical segment DO concentrations in Savannah Harbor by only 0.5 mg/L. The Draft EPA TMDL, based on meeting newly recommended DO criteria, calls for an approximate 30-percent overall reduction of point source BOD loading from the overall point source BOD loading experienced during the summer critical period of 1999.

The types of potential measures identified in the current harbor DO improvement screening for the Army Corps include: directly adding air or oxygen to low DO waters in the critical harbor segment; mixing low DO waters on the bottom of the harbor with higher DO surface waters; seasonally increasing flow releases from upstream reservoirs; seasonally reducing BOD loads from industrial and municipal discharges to the harbor and upriver. A potential benefit to point source BOD dischargers of the Corps' DO mitigation and restoration projects

is that the federal government may fund a portion of the costs for design and construction of whatever DO improvement measures may be authorized.

For purposes of screening the potential for seasonal BOD load reductions, MACTEC is contacting the larger point-source BOD dischargers seeking their ideas as to what measures might be considered for such screening. The objective is to identify potential means and general order of costs for reducing BOD discharges by about 30 percent or more during the three month critical season (June 15th through September 15th). Potential alternatives might include added effluent storage capacity, critical season land application or wetlands polishing, supplemental or short-term enhanced treatment, plant process changes, coordinated plant shut-down/maintenance schedules during the critical season, water conservation measures, or (in the estuary) piping BOD discharges farther seaward. Considering the limited impact of point sources on the critical DO deficit (only 0.5 mg/L according to EPA) it seems unlikely that point source BOD load reduction measures would prove to be a cost efficient means for significantly improving DO. Nonetheless, consideration of BOD load reduction alternatives is a required component of this DO improvement screening project.

To accomplish the screening level evaluation of potential BOD point source load reductions, MACTEC requests information relating to the wastewater treatment process at your facility. Specifically, waste stream generation process flow diagrams, wastewater treatment process flow diagrams, and unit operations information. Additionally, MACTEC recognizes that this information may be sensitive and will not include specific plans or diagrams in the final report and will only use them to identify the potential "next steps" for BOD reduction. Representatives of MACTEC will be calling from February 2 through February 11 (or as necessary) to discuss this project and information with you for your facility.

Thank you for your cooperation.

Sincerely,

MACTEC Engineering and Consulting

Larry A. Neal, P.E.
Senior Principal Engineer
Vice President

Margaret E. Tanner
Senior Engineer

References:

USACE, 2005. Savannah Harbor Expansion Project website.
http://www.sysconn.com/harbor/

USACE, 2005. Savannah Harbor Ecosystem Restoration Dissolved Oxygen (DO) website.
http://www.sas.usace.army.mil/projects/projects/shdo.htm

MACTEC Engineering and Consulting, Inc.
3200 Town Point Drive NW, Suite 100 • Kennesaw, GA 30144
770-421-3400 • Fax: 770-421-3486

APPENDIX D

OXYGEN SUPPLEMENTATION TECHNOLOGIES

APPENDIX D

OXYGEN SUPPLEMENTATION TECHNOLOGIES

(3/29/05)

Section 1. TMDL Compliance

Allowable BOD Loading

Regulations requiring that treated effluents be discharged to receiving waters at elevated D.O. concentrations are specified in some discharge permits. Conventional aeration techniques may achieve these higher concentrations but usually entail prohibitively high unit energy consumption and are limited in the D.O. levels that can be achieved. Using standard aeration equipment to increase the D.O. from 0 to 7 mg/L in water at 25^oC would require approximately 2700 kwhr/ton of D.O. added, which is equivalent to over $200/ton of D.O. for electricity rates of $0.08/kwhr.

An efficient oxygenation system, on the other hand, can achieve the higher D.O. requirements both more easily and more economically. Technology is now available to produce heretofore impossibly high superoxygenation levels, allowing TMDL D.O. standards to be reached in many applications without the necessity for tertiary treatment.

TMDL Requirement Solutions

Reduction of pollutant loading, water augmentation in low flow situations and aeration are the methods traditionally used to reach TMDL levels. One aspect of the TMDL process mandated for surface waters is to establish the D.O. level appropriate for the resident fishery. This then leads to designation of the allowable BOD and/or nutrient-loading rate applicable to all entities discharging to the waterway. For impounded or slow flowing rivers with attendant low reaeration rate, k_2, as found in the relatively flat terrain, the allowable pollutant loading rates are accordingly quite low, resulting in the need to achieve especially high pollutant removal rates by the contributing entities. Such advanced removals cause exponential increases in wastewater treatment costs for relatively small incremental removal of pollutants. At present secondary treatment is mandated in all states for all wastewaters, resulting in more than 90% removals commonly being realized, but tertiary removals with their attendant high cost may also be necessary to meet the TMDL levels in many cases. However tertiary treatment may no longer be necessary in most cases when using a newer method which supplements D.O. in very high concentrations sufficient to achieve TMDL standards for D.O.. However, as presented in this paper, a newer method of supplementing superoxygenation directly to the river, promises significant advantages not achievable in the past.

The rate of reaeration of a river is shown in the following equation by Thackston:

$$k_2 = 0.000025[\ 1 + 9\ \{F\}^{0.25}][(h\ S_e\ g)^{0.5}]/h$$

Where: u = velocity – ft/sec
h = depth – ft
S_e = slope – ft/ft

Fig. __ depicts the k_2 corresponding to velocity and depth combinations.

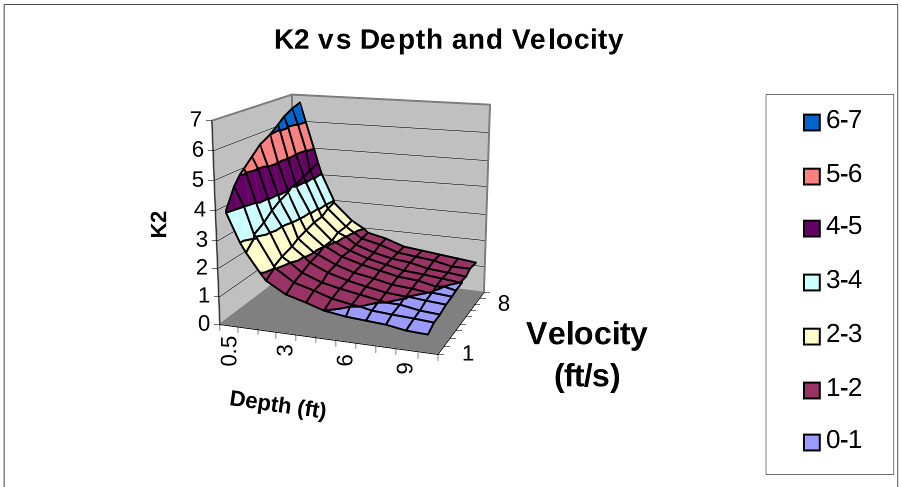
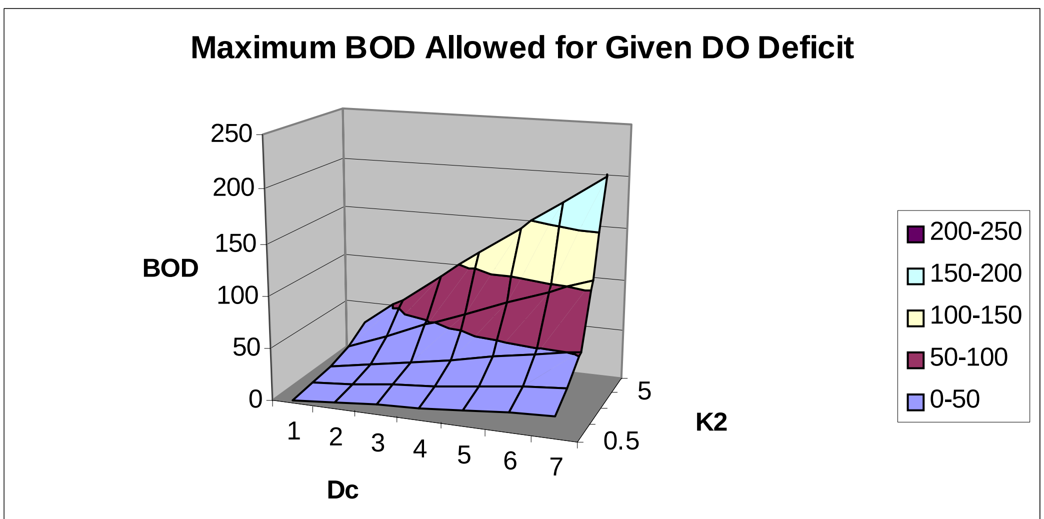


Fig. Reaeration rate vs velocity and depth



Maximum BOD Allowed for a Given D.O. Deficit at Sag Point

The allowable BOD loading in a segment of river is a function of the allowable D.O. deficit (or target D.O.) and the k_2 of that segment as shown in Fig. __

Strategy for D.O. Supplementation:

- Add D.O. equivalent to ultimate BOD in discharge so no oxygen resources in the harbor are consumed in metabolizing residual BOD.
- Higher D.O. from oxygenation station permits increased spacing between oxygenation stations.
    - This permits economy of scale.
    - Cost to bring in electrical power much reduced
    - Delivery of LOX
- Propeller pumps to assist in D.O. transport away from oxygenation station.

D.O. Supplementation Trading for Advanced BOD removal

The allowable BOD loading on a river is a function of k_r, k_d, and k_2. For example if River A has a depth of 10 ft and velocity of 1 ft/sec it will have a $k_2 = 0.65$/day while River B, with a depth of 2 ft and velocity of 4 ft/sec will have $k_2 = 2.3$/day. Thus the allowable BOD loading at 25 ^oC for a D.O. deficit of 3 mg/L and for River A is 10 mg/L. By comparison, the allowable BOD loading for River B is 28 mg/L.

Lower aeration rated rivers should not be penalized if successful reaeration rates are reached by means of superoxygenation. When water quality trading is implemented locally, then, supplemental oxygenation of the receiving water body will also be an acceptable solution for meeting TMDL standards.

On Jan 13, 2003 EPA announced a new Water Quality Trading Policy to provide guidance on how trading can occur under the Clean Water Act while implementing regulations. Water quality trading is a market-based approach that is intended to provide greater efficiency in achieving water quality goals and watersheds by allowing one source to meet its regulatory requirements by using pollutant reductions created by another source that has lower pollution control cost.

Supplemental oxygenation of a river as a trade-off for non-point source pollution control measures has been used successfully. A study performed to remediate Snake River D.O. deficiency related to TMDL (caused by non-point source phosphorous loading) established that oxygen could be supplemented directly to the river for 3 % of the cost to reduce phosphorous from non-point sources to achieve comparable D.O. standards.

Ruane has postulated how the South Fork Holston River in Tennessee point/nonpoint-source pollutant trading within a watershed might be implemented. Although several hundreds of millions of dollars were invested for waste treatment facilities in the 1970s, nevertheless D.O. levels in the South Fork Holston River dropped to 2 mg/L under low flow conditions. D.O. concentrations were even predicted to range from 0 to 1 mg/L if industrial and municipal facilities discharged to the limits of their permitted waste loads.

TVA investigators considered a number of options for improving D.O. conditions in the South Fork Holston River, including advanced waste treatment for the dischargers, turbine aeration at Fort Patrick Henry Dam, various levels of flow augmentation at the dam, and in stream aeration. The results of this exploratory analysis indicated that D.O. standards of 5 mg/L in the river could not be attained using the advanced effluent treatments that were being considered by the industrial and municipal dischargers, but a water quality trade off could meet the requirements. For example, it was predicted that state water quality standards could be met by augmenting flow releases from the dam, coupled with additional aeration by the hydroelectric project either at the dam or downstream. The annual cost of the trade off option would range from $298,000 to $395,000, compared to an estimated annual cost of $44,000,000 for the industrial and municipal dischargers to operate advanced (but insufficient) waste treatments.

Superoxygenation provides a significant advantage by increasing river D.O. without processing the entire river. Also much smaller sidestream flows and civil works are required for superoxygenation than for aeration. Compelling cost comparisons favor use of this newest type of technology to achieve TMDL standards since pure oxygen is available for only $60 to $100/ton, depending on the usage rate. Successful superoxygenation can dissolve oxygen into water with 90% oxygen absorption efficiency for a total cost of approximately $100/ton D.O. (which includes amortization of the capital cost @ $10/ton D.O., energy consumption of 400 kwhr/ton D.O. @ $0.05/kwhr = $20/ton D.O., and the cost of oxygen at $70/ton D.O.) while achieving 70 mg/L D.O. in a sidestream. When using pure oxygen vs aeration only about one tenth as much energy (300 kwhr/ton D.O.) is consumed per ton of D.O. supplemented than required for aeration yet D.O. concentrations in the river equivalent to air saturated D.O. can be easily achieved with these economies. The Chicago Canal sidestream aeration system, which moves the entire canal flow through the cascade aerators with an increase of only 1 to 3 mg/L D.O. involves energy consumption of over 3000 kwhr/ton of D.O. supplemented, which is ten times the energy requirement necessary for pure oxygen supplementation.

If the discharge has received secondary treatment there will be nil degradation of the river quality. Deep, slow moving rivers no longer need to be penalized in TMDL analyses when adopting superoxygenation technology. Advanced treatment will no longer be required.

Tertiary Removal of BOD

Tertiary treatment to lower the five-day BOD below 20 to 30 mg/L does little to improve the river habitat. The costs of tertiary treatment may exceed the cost of secondary biological treatment. If an increase in D.O. is a major need to improve the river habitat, then oxygen supplementation instead of tertiary removal of BOD should be implemented, especially with pooled rivers or harbors having very low aeration rates. For water quality limited harbors receiving secondary biologically treated industrial or domestic affluence. It is possible that an agreement could be reached with the state regulatory agency to allow oxygen to be supplemented directly to the harbor in order to maintain regulated D.O. concentrations.

As shown in the Figs. below, the health of a water body is directly correlated with the D.O. maintained therein.

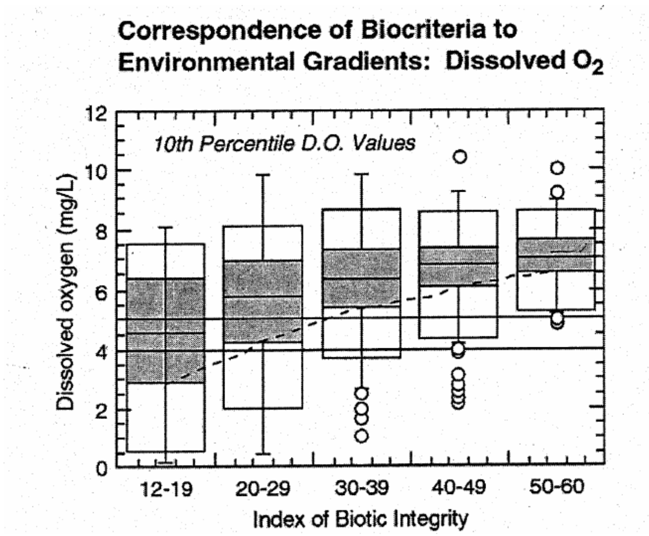
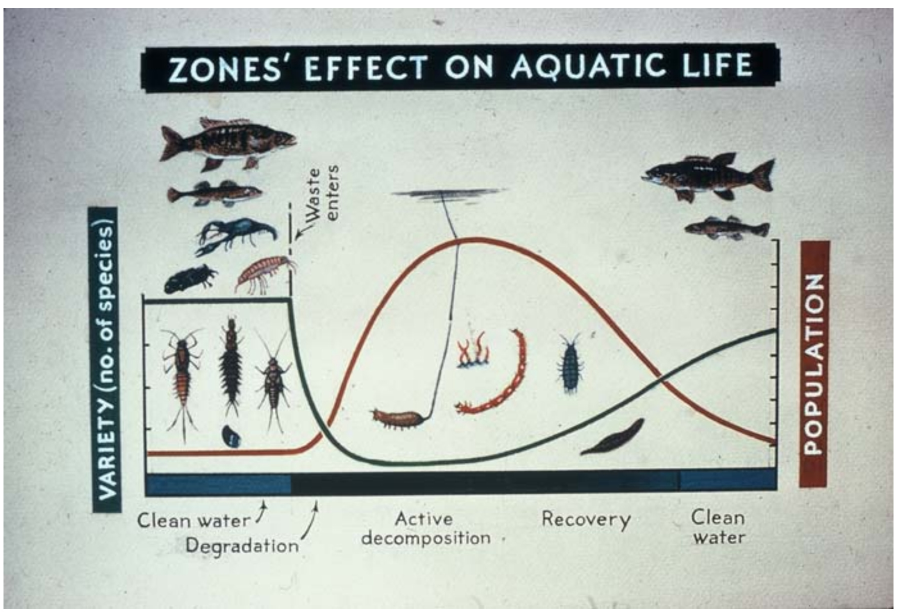
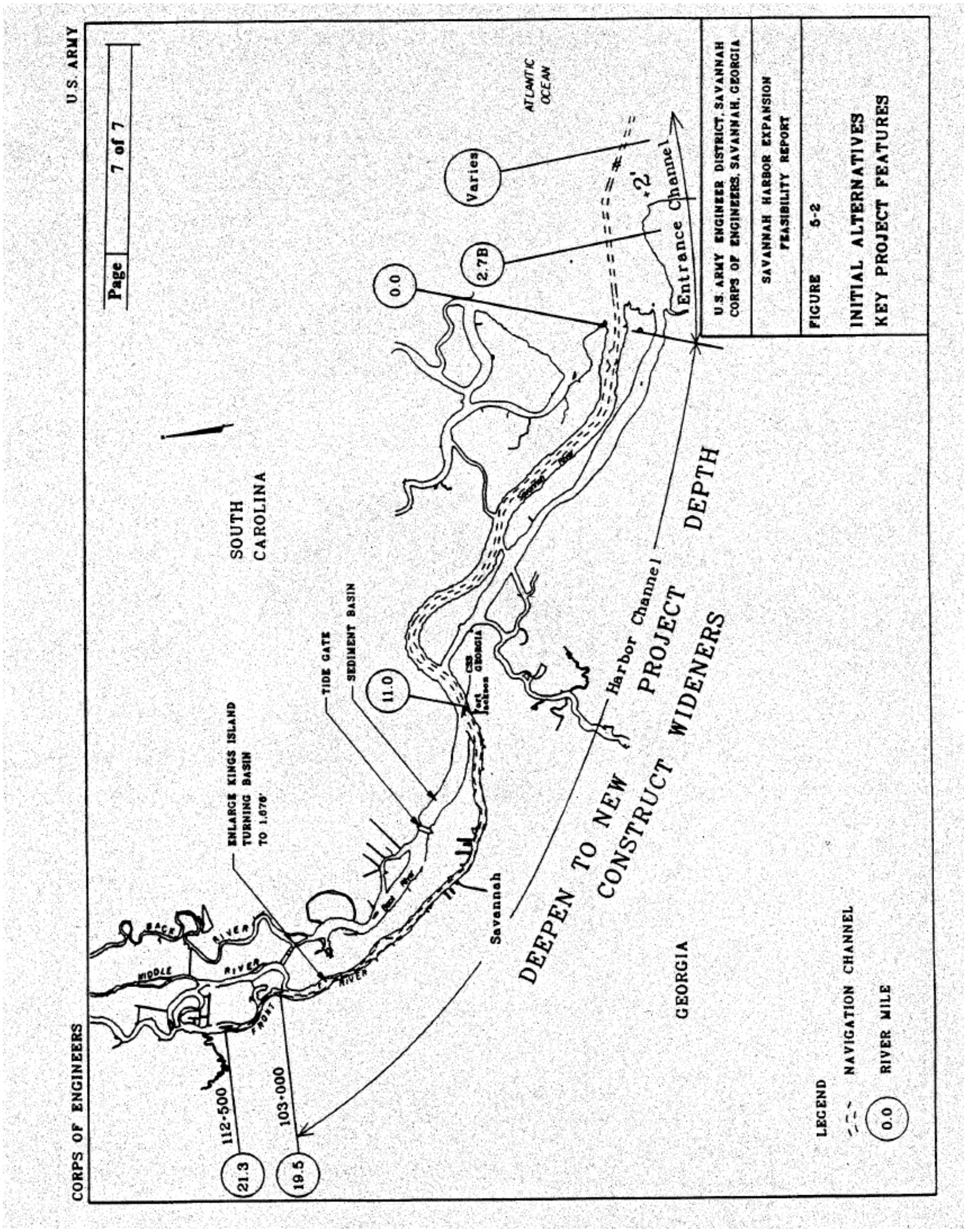
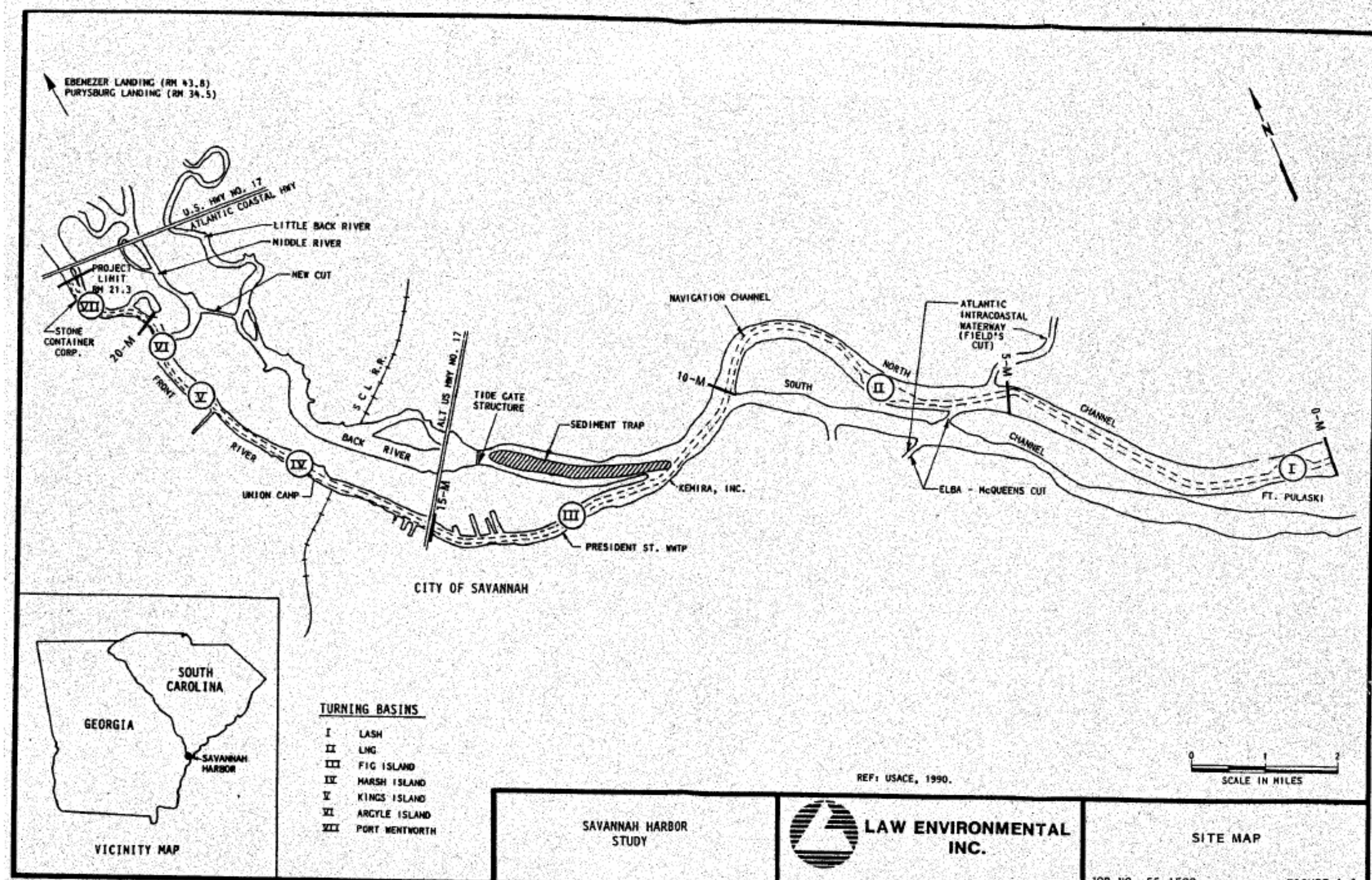


Fig. Correspondence of biocriteria to environmental gradients: dissolved oxygen



Aquatic Diversity as a Function of D.O. Recovery


CORPS OF ENGINEERS
U.S. ARMY
Page 7 of 7
SOUTH CAROLINA
GEORGIA
ATLANTIC OCEAN
Savannah
BACK RIVER
MIDDLE RIVER
FRONT RIVER
ENLARGE KINGS ISLAND TURNING BASIN TO 1,676'
TIDE GATE
SEDIMENT BASIN
CSS GEORGIA
Fort Jackson
21.3
112+500
19.5
103+000
11.0
0.0
2.7B
Varies
+2'
Entrance Channel
Harbor Channel
DEEPEN TO NEW PROJECT DEPTH
CONSTRUCT WIDENERS
LEGEND
NAVIGATION CHANNEL
0.0 RIVER MILE
U.S. ARMY ENGINEER DISTRICT, SAVANNAH
CORPS OF ENGINEERS, SAVANNAH, GEORGIA
SAVANNAH HARBOR EXPANSION FEASIBILITY REPORT
FIGURE 5-2
INITIAL ALTERNATIVES
KEY PROJECT FEATURES


EBENEZER LANDING (RM 43.8)
PURYSBURG LANDING (RM 34.5)
N
U.S. HWY NO. 17
ATLANTIC COASTAL HWY
LITTLE BACK RIVER
MIDDLE RIVER
NEW CUT
PROJECT LIMIT RM 21.3
STONE CONTAINER CORP.
20-M
FRONT
RIVER
UNION CAMP
BACK
RIVER
S C L R.R.
ALT US HWY NO. 17
15-M
TIDE GATE STRUCTURE
SEDIMENT TRAP
CITY OF SAVANNAH
PRESIDENT ST. WWTP
KEMIRA, INC.
NAVIGATION CHANNEL
10-M
SOUTH
NORTH
ATLANTIC INTRACOASTAL WATERWAY (FIELD'S CUT)
5-M
CHANNEL
CHANNEL
ELBA - McQUEENS CUT
0-M
FT. PULASKI
SOUTH CAROLINA
GEORGIA
SAVANNAH HARBOR
VICINITY MAP
TURNING BASINS
I LASH
II LNG
III FIG ISLAND
IV MARSH ISLAND
V KINGS ISLAND
VI ARGYLE ISLAND
VII PORT WENTWORTH
REF: USACE, 1990.
0 1 2
SCALE IN MILES
SAVANNAH HARBOR STUDY
LAW ENVIRONMENTAL INC.
SITE MAP
JOB NO. 55-1502
FIGURE 1.1

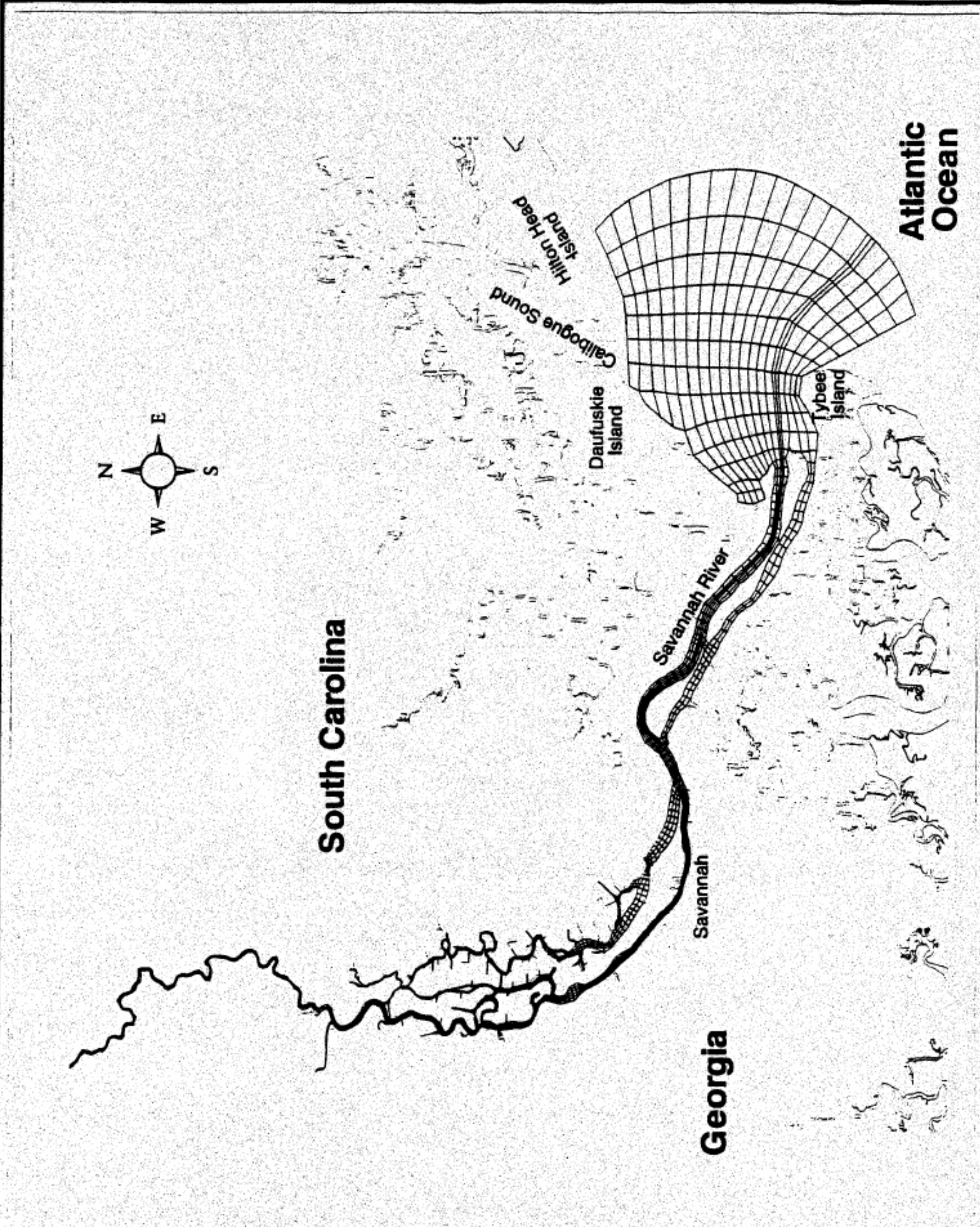


Figure 3-1
Model Grid

ATM
APPLIED TECHNOLOGY & MANAGEMENT, INC.