Engineering Services Committee Meeting Committee Room- 9/8/2008- 1:00 PM

ENGINEERING SERVICES

1. Approve award of the contract to I&E Specialties for roof replacement and repairs on the Planning and Zoning building in the amount of $89,306 which is to be funded from SPLOST Phase III funds for the Municipal Building. Attachments

2. Report from the Cedar Grove Cemetery Sub-Committee. Attachments

3. Motion to approve a Deed of Dedication and Maintenance Agreement for the water distribution system in Magnolia Villas, Phase II. Attachments

4. Approve funding of an extension of the Southeastern Natural Sciences Academy (SNSA) Savannah River at Risk study. Attachments

5. Motion to authorize condemnation to acquire title of a portion of property, designated as Butler Creek Upgrade East Project, 3491 Peach Orchard for permanent and temporary construction easements. Attachments

6. Approve an Option for Right-of-Way between Deborah P. Thomas and Brenda T. Tharpe, as owners, and Augusta, Georgia, for the property located at 1046 Alexander Drive for a purchase price of $42,100.00. 0.105 acre (4,571.61 sq. ft.) in fee and 0.038 acre (1,666.96 sq. ft.) of permanent construction & maintenance easement. Attachments

Augusta
GEORGIA

Engineering Services Committee Meeting
9/8/2008 1:00 PM
Award Contract for Replacement of Planning and Zoning Roof

Department:	Public Services - Facilities Management Division
Caption:	Approve award of the contract to I&E Specialties for roof replacement and repairs on the Planning and Zoning building in the amount of $89,306 which is to be funded from SPLOST Phase III funds for the Municipal Building.
Background:	The shingle roof on the Planning a Zoning building needs to be replaced. There is also damage to the eaves and fascia that needs to be repaired.
Analysis:	A Request for Bids (RFB), Bid Item 08-170, was issued for this scope of work. Specifications were sent out and six (6) prospective vendors attended the mandatory pre-bid conference. A single bid received was from I&E Specialties in the amount of $89,306. Staff has reviewed the numbers and found the bid to be in line with the anticipated costs. I&E Specialties has satisfactorily completed work for Augusta in the past. The scope of work includes removal and replacement of the roof shingles, as well as replacement of a specified amount of roof deck, fascia and soffit at a unit cost determined in the bid. The final contract amount will be adjusted, up or down, in accordance with the predetermined unit rates. Painting of the fascia and soffit are included as part of this contract.
Financial Impact:	The cost of the contract which is $89,306 is to be funded from SPLOST Phase III, Account #323-04-6211/296-05-0050.
Alternatives:	1. Approve award of the contract to I&E Specialties, for roof replacement and repairs on the Planning and Zoning building, in the amount of $89,306 which is to be funded from SPLOST Phase III funds for the Municipal Building. 2. Do not approve the award.
Recommendation:	#1. Approve award of the contract to I&E Specialties, for roof replacement and repairs on the Planning and Zoning building, in the amount of $89,306 which is to be funded from SPLOST Phase III funds for the Municipal Building.
Funds are Available in the Following Accounts:	The cost of the contract which is $89,306 is to be funded from SPLOST Phase III, Account #323-04-6211/296-05-0050.

Cover Memo

REVIEWED AND APPROVED BY:

Finance.
Administrator.
Clerk of Commission

Cover Memo

Item # 1

Engineering Services Committee Meeting
9/8/2008 1:00 PM
Cemetery Sub Committee Report

Department: Clerk of Commission

Caption: Report from the Cedar Grove Cemetery Sub-Committee.

Background:

Analysis:

Financial Impact:

Alternatives:

Recommendation:

Funds are Available in the Following Accounts:

REVIEWED AND APPROVED BY:

Clerk of Commission

Engineering Services Committee Meeting
9/8/2008 1:00 PM
Deed of Dedication and Maintenance Agreement for Water Distribution System - Magnolia Villas Phase II

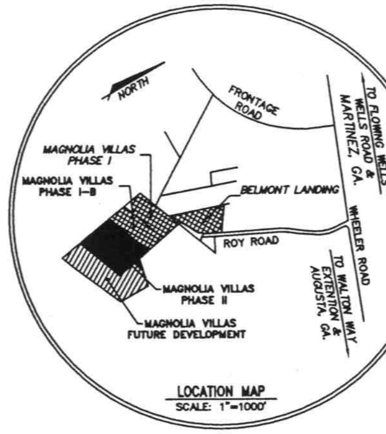
Department:	Augusta Utilities Department
Caption:	Motion to approve a Deed of Dedication and Maintenance Agreement for the water distribution system in Magnolia Villas, Phase II.
Background:	Malane Properties, LLC, has developed a tract of land, Magnolia Villas, Phase II, and wishes to dedicate the water distribution system to Augusta.
Analysis:	The water system has been inspected and approved by the Augusta Utilities Department.
Financial Impact:	None
Alternatives:	
Recommendation:	Approve motion to accept the Deed of Dedication and Maintenance Agreement, for the water distribution system in Magnolia Villas, Phase II.
Funds are Available in the Following Accounts:	N/A

REVIEWED AND APPROVED BY:

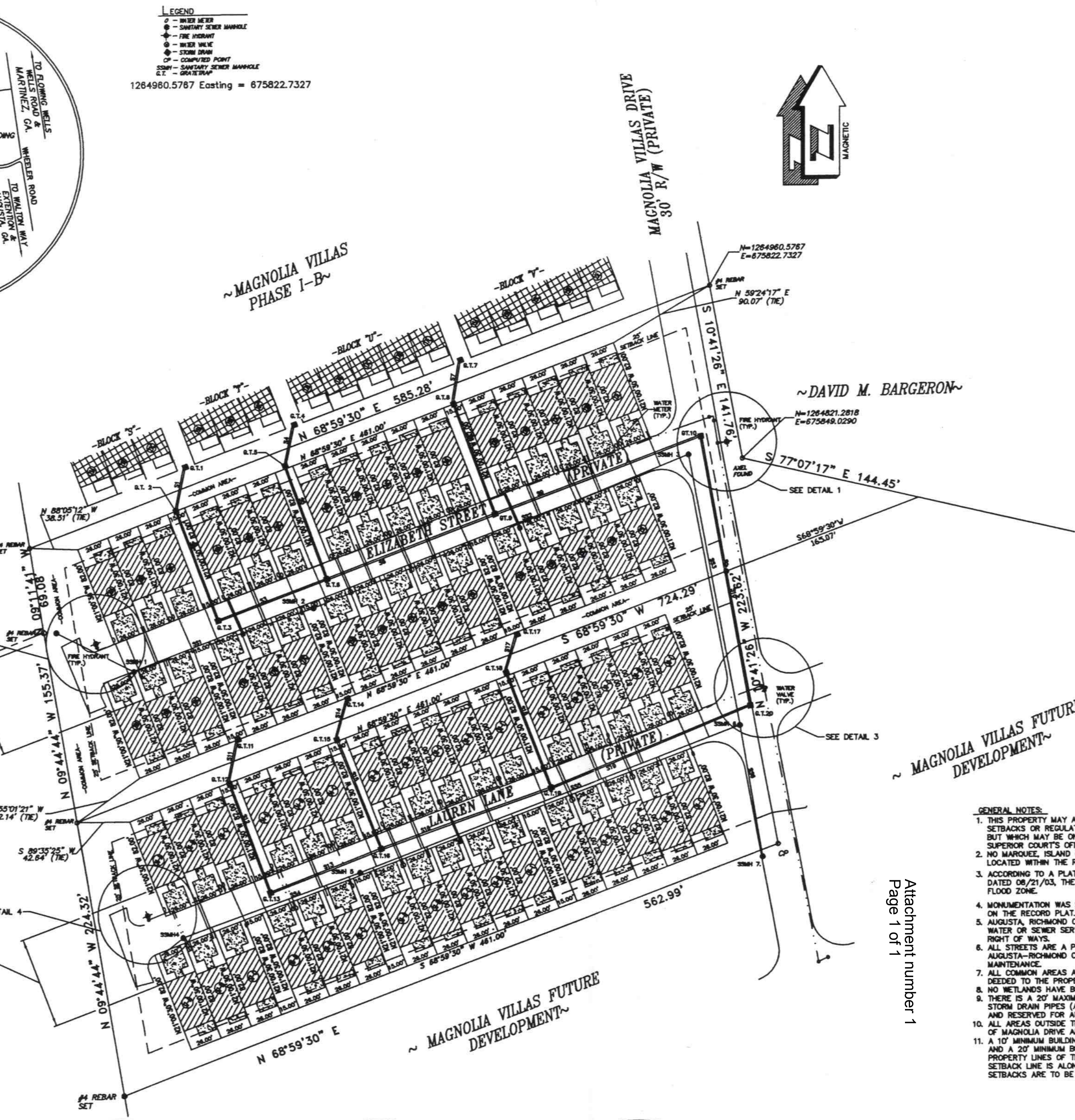
Finance.
Procurement.
Administrator.
Clerk of Commission

UTILITY INFORMATION - PHASE I

LOT No.	WATER: LEFT PROPERTY LINE	WATER: RIGHT PROPERTY LINE	SEWER: LEFT PROPERTY LINE	SEWER: RIGHT PROPERTY LINE
22A	2.72'	23.28'	23.77'	2.27'
22B	24.98'	1.02'	0.29'	26.23'
22C	3.14'	22.86'	23.32'	2.68'
22D	24.25'	1.75'	0.70'	26.69'
22E	1.93'	24.07'	24.77'	1.23'
23A	0.15'	25.85'	25.09'	0.76'
23B	24.78'	1.38'	1.35'	24.65'
23C	2.04'	24.00'	25.36'	0.64'
23D	23.92'	2.08'	2.76'	23.24'
23E	2.00'	24.00'	26.77'	0.77'
24A	2.48'	23.52'	24.33'	1.67'
24B	24.11'	1.89'	0.32'	25.68'
24C	1.48'	24.52'	26.41'	0.41'
24D	25.47'	0.53'	2.40'	23.60'
24E	1.92'	24.08'	0.34'	26.34'
25A	0.62'	25.38'	22.87'	3.13'
25B	24.83'	1.17'	2.22'	28.22'
25C	0.49'	25.51'	21.79'	4.22'
25D	24.56'	1.44'	2.82'	28.82'
25E	1.26'	24.74'	21.19'	4.81'
26A	3.29'	22.71'	25.48'	0.53'
26B	24.66'	1.34'	1.46'	24.54'
26C	1.39'	24.61'	0.45'	0.45'
27A	0.01'	26.00'	24.23'	1.77'
27B	24.53'	1.49'	1.80'	24.20
27C	1.25'	24.75'	25.81'	0.19'
28A	0.93'	25.07'	25.39'	0.61'
28B	23.77	2.23'	1.38'	24.62'
28C	0.86'	25.28'	26.98'	0.98'
29A	4.18'	21.82'	14.44'	11.56'
29B	21.27'	4.73'	0.29'	26.24'
29C	0.87'	25.13'	23.77'	2.27'
30A	2.52'	23.48'	5.64'	5.64'
30B	24.71'	1.29'	18.37'	18.37'
30C	0.11'	25.89'	15.83'	10.17'
30D	25.40'	0.60'	8.18'	34.18'
30E	1.73'	24.27'	22.69'	3.31'
31A	0.91'	25.09'	21.22'	4.78'
31B	24.77'	1.28'	3.28'	29.28'
31C	1.21'	24.83'	20.73'	5.53'
31D	25.10'	1.21'	2.67'	23.33'
31E	0.13'	0.13'	26.68'	0.68'
32A	2.86'	23.14'	24.73'	1.27'
32B	25.70'	0.30'	0.72'	25.28'
32C	1.41'	24.59'	6.32'	6.32'
32D	24.59'	1.41'	17.69'	17.69'
32E	0.06'	25.94'	26.37'	0.37'
33A	0.55'	25.45'	23.19'	2.81'
33B	24.63'	1.37'	4.66'	21.34'
33C	2.16'	23.84'	28.67'	2.67'
33D	26.87'	0.86	4.50'	30.50'
33E	7.62'	18.38'	19.51'	6.49'
34A	1.22'	24.78'	30.45'	4.45'
34B	24.05'	1.95'	6.44'	19.56'
34C	1.71'	24.29'	26.78'	0.78'
35A	1.73'	24.27'	22.36'	3.64'
35B	24.82'	1.18'	2.04'	28.04'
35C	2.55'	23.44'	21.97'	4.03'
36A	0.89'	25.11'	27.66'	1.66'
36B	23.79'	2.21'	3.65'	22.35'
36C	0.86'	25.32'	24.13'	1.87'
37A	1.04'	27.04'	20.24'	5.76'
37B	23.35'	2.65'	2.57'	23.43'
37C	0.23'	25.77'	26.58'	0.58'

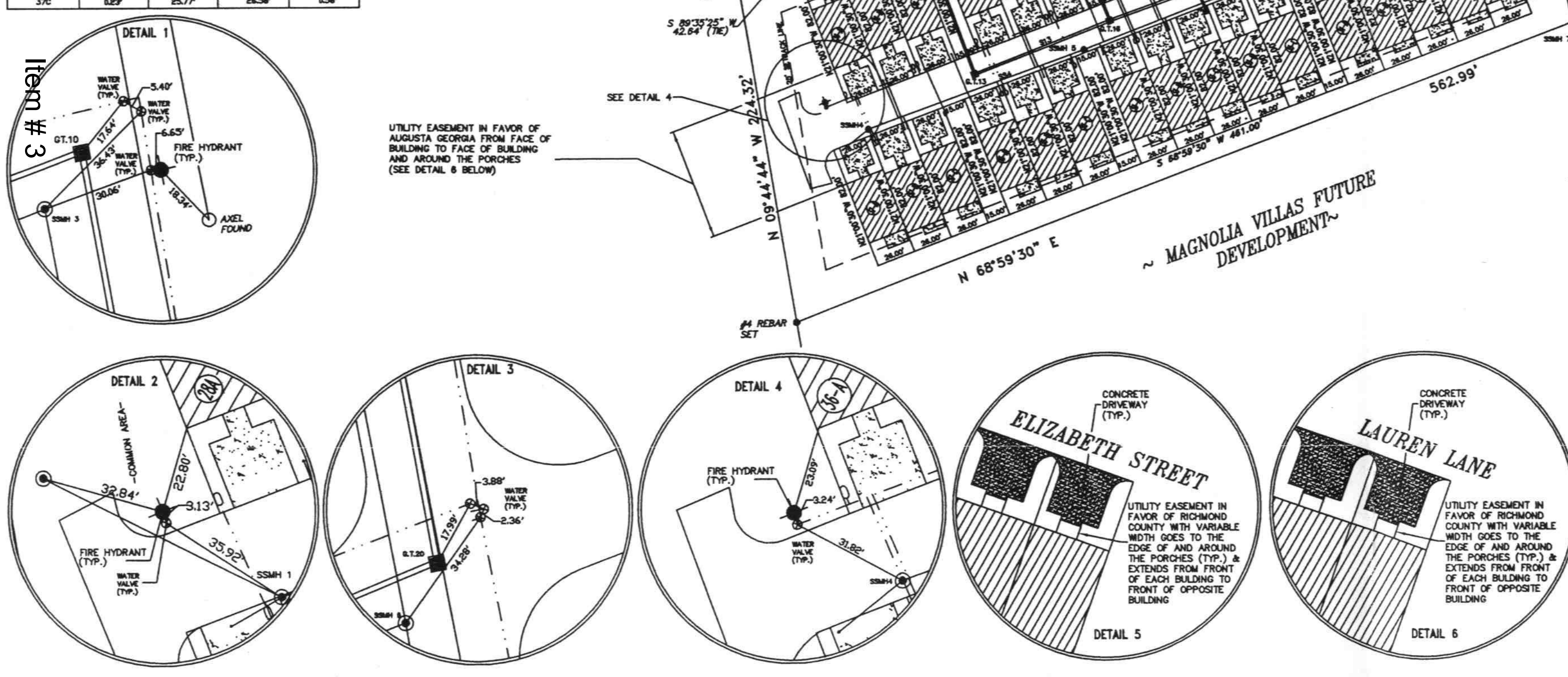


LOCATION MAP
SCALE: 1"=1000'



UTILITY EASEMENT IN FAVOR OF AUGUSTA GEORGIA FROM FACE OF BUILDING TO FACE OF BUILDING AND AROUND THE PORCHES (SEE DETAIL 5 BELOW)

UTILITY EASEMENT IN FAVOR OF AUGUSTA GEORGIA FROM FACE OF BUILDING TO FACE OF BUILDING AND AROUND THE PORCHES (SEE DETAIL 6 BELOW)



STORM WATER INFORMATION

STRUCTURE / PIPE	TYPE OF STRUCTURE / PIPE LENGTH	TOP ELEV. / GRADE	I.E. IN	I.E. OUT / TYPE OF PIPE
G.T.1	GRATE TRAP	391.96	N/A	387.86
S1	32.75	13.58%		18"CPP
G.T.2	GRATE TRAP	387.52	383.42	383.42
S2	91.00	0.93%		18"CPP
G.T.3	GRATE TRAP	387.37	382.57	382.57
STORM LINE S3 SEE BELOW				
G.T.4	GRATE TRAP	390.50	N/A	386.30
S4	30.16	10.44%		18"CPP
G.T.5	GRATE TRAP	386.35	383.15	382.15
S5	93.45	1.08%		18"CPP
G.T.6	GRATE TRAP	386.24	381.14	381.14
STORM LINE S6 SEE BELOW				
G.T.7	GRATE TRAP	390.75	N/A	386.55
S7	31.49	18.39%		18"CPP
G.T.8	GRATE TRAP	384.09	380.79	379.89
S8	90.97	0.92%		18"CPP
G.T.9	GRATE TRAP	384.35	379.05	378.65
STORM LINE S9 SEE BELOW				

STORM WATER INFORMATION

STRUCTURE / PIPE	TYPE OF STRUCTURE / PIPE LENGTH	TOP ELEV. / GRADE	I.E. IN	I.E. OUT / TYPE OF PIPE
G.T.11	GRATE TRAP	383.86	N/A	379.96
S11	32.18	8.89%		18"CPP
G.T.12	GRATE TRAP	381.10	377.10	377.10
S12	89.91	0.73%		18"CPP
G.T.13	GRATE TRAP	380.44	376.44	376.44
STORM LINE S13 SEE BELOW				
G.T.14	GRATE TRAP	386.15	N/A	380.75
S14	30.16	11.77%		18"CPP
G.T.15	GRATE TRAP	379.40	377.20	376.60
S15	91.35	1.38%		18"CPP
G.T.16	GRATE TRAP	379.37	375.37	375.17
STORM LINE S16 SEE BELOW				
G.T.17	GRATE TRAP	384.16	N/A	378.56
S17	27.66	20.30%		18"CPP
G.T.18	GRATE TRAP	377.23	373.43	373.33
S18	95.59	0.70%		18"CPP
G.T.19	GRATE TRAP	377.76	372.66	372.46
STORM LINE S19 SEE BELOW				

G.T.3	GRATE TRAP	387.37	382.57	382.57
S3	89.00	1.61%		18"CPP
G.T.6	GRATE TRAP	386.24	381.14	381.14
S6	141.00	1.62%		18"CPP
G.T.9	GRATE TRAP	384.35	378.86	378.65
S9	171.94	2.84%		24"CPP
G.T.10	GRATE TRAP	381.97	373.77	373.67
STORM LINE S10 SEE BELOW				

G.T.13	GRATE TRAP	380.44	376.44	376.44
S13	91.42	1.20%		18"CPP
G.T.16	GRATE TRAP	379.37	375.37	375.17
S16	140.82	1.50%		18"CPP
G.T.19	GRATE TRAP	377.76	373.08	372.46
S19	169.16	0.82%		24"CPP
G.T.20	GRATE TRAP	375.71	371.41	N/A
STORM LINE S10 SEE BELOW				

STORM WATER INFORMATION

STRUCTURE / PIPE	TYPE OF STRUCTURE / PIPE LENGTH	TOP ELEV. / GRADE	I.E. IN	I.E. OUT / TYPE OF PIPE
G.T.10	GRATE TRAP	381.97	373.77	373.67
S10	218.98	1.00%		30"CPP
G.T.20	GRATE TRAP	375.71	371.51	N/A

SANITARY SEWER INFORMATION

STRUCTURE / PIPE	TYPE OF STRUCTURE / PIPE LENGTH	TOP ELEV. / GRADE	I.E. IN	I.E. OUT / TYPE OF PIPE
SSMH 1	MANHOLE	388.48	378.18	378.18
SS1	153.28	0.84%		8" SDR
SSMH 2	MANHOLE	386.18	376.88	376.88
SS2	324.77	1.19%		8" SDR
SSMH 3	MANHOLE	381.52	373.02	373.02
SANITARY SEWER LINE SS3 SEE BELOW				

SANITARY SEWER INFORMATION

STRUCTURE / PIPE	TYPE OF STRUCTURE / PIPE LENGTH	TOP ELEV. / GRADE	I.E. IN	I.E. OUT / TYPE OF PIPE
SSMH 4	MANHOLE	380.85	N/A	372.85
SS4	151.19	0.88%		8" SDR
SSMH 5	MANHOLE	379.31	371.31	371.31
SS5	326.88	0.41%		8" SDR
SSMH 6	MANHOLE	375.78	368.98	368.98
SANITARY SEWER LINE SS3 SEE BELOW				

SANITARY SEWER INFORMATION

STRUCTURE / PIPE	TYPE OF STRUCTURE / PIPE LENGTH	TOP ELEV. / GRADE	I.E. IN	I.E. OUT / TYPE OF PIPE
SSMH 3	MANHOLE	381.52	373.02	373.02
SS3	222.15	1.37%		8" SDR
SSMH 6	MANHOLE	375.78	368.98	368.98
SS6	107.72	[illegible]		8" SDR
SSMH 7	MANHOLE	374.01	[illegible]	[illegible]
SANITARY SEWER LINE SS3 SEE BELOW				

TECHNICAL DATA:
INSTRUMENT USED - TOPCON GPT-1003
ANGULAR ERROR - 5" PER POINT
TRAVERSE CLOSURE - 1/18,500'
ADJUSTMENT BY NO RULE

GENERAL NOTES:
1. THIS PROPERTY MAY ALSO BE SUBJECT TO EASEMENTS, SETBACKS OR REGULATIONS, NOT SHOWN ON THIS PLAT, BUT WHICH MAY BE ON RECORD IN THE CLERK OF SUPERIOR COURT'S OFFICE.
2. NO MARQUEE, ISLAND OR SPRINKLER SYSTEMS MAY BE LOCATED WITHIN THE RIGHT OF WAYS.
3. ACCORDING TO A PLAT BY SOUTHERN PARTNERS, INC. DATED 08/21/03, THESE LOTS ARE NOT IN A 100 YEAR FLOOD ZONE.
4. MONUMENTATION WAS SET AT PROPERTY CORNERS AS SHOWN ON THE RECORD PLAT.
5. AUGUSTA, RICHMOND COUNTY WILL NOT REPAIR OR MAINTAIN WATER OR SEWER SERVICES LOCATED OUTSIDE EASEMENTS OR RIGHT OF WAYS.
6. ALL STREETS ARE A PERMANENT INGRESS AND EGRESS TO AUGUSTA-RICHMOND COUNTY FOR UTILITY REPAIR AND MAINTENANCE.
7. ALL COMMON AREAS AND LANDSCAPE AREAS ARE TO BE DEEDED TO THE PROPERTY OWNERS ASSOCIATION.
8. NO WETLANDS HAVE BEEN IDENTIFIED ON THIS PROPERTY.
9. THERE IS A 20' MAXIMUM EASEMENT CENTERED OVER ALL STORM DRAIN PIPES (ALONG MAGNOLIA DRIVE AS SHOWN) AND RESERVED FOR AUGUSTA, RICHMOND COUNTY.
10. ALL AREAS OUTSIDE THE AREA FOR LOTS AND RIGHT OF WAY OF MAGNOLIA DRIVE ARE TO BE COMMON AREAS.
11. A 10' MINIMUM BUILDING LINE IS ALONG ALL REAR LOT LINES AND A 20' MINIMUM BUILDING LINE IS ALONG THE OUTSIDE PROPERTY LINES OF THE DEVELOPMENT BOUNDARY AND A 15' SETBACK LINE IS ALONG MAGNOLIA DRIVE. ANY OTHER SETBACKS ARE TO BE REFERED TO DETAIL 1 OF SHEET 2.

GEORGIA REGISTERED No. 1725 PROFESSIONAL LAND SURVEYOR BENNIE C. HARBIN

IN MY OPINION, THIS PLAT IS A CORRECT REPRESENTATION OF THE LAND PLATTED AND HAS BEEN PREPARED IN ACCORDANCE WITH THE MINIMUM STANDARDS OF LAW.

NOTES
1. WATER LINE IS 8" C-900, CLASS 200 P.V.C..
2. SEWER MAIN IS 8" SDR 35 8" SERVICES.

CONTRACTOR'S CERTIFICATION
I HEREBY CERTIFY THAT THE MATERIALS AS SHOWN ON THIS MAP ARE CONSTRUCTED.

NAME TITLE

SURVEYOR'S CERTIFICATION
IT IS HEREBY CERTIFIED THAT THIS PLAT IS TRUE AND CORRECT AND WAS PREPARED FROM AN ACTUAL SURVEY OF THE PROPERTY BY ME OR UNDER MY SUPERVISION, THAT ALL MONUMENTS SHOWN HERON ARE CORRECTLY SHOWN AND THAT ALL ENGINEERING REQUIREMENTS OF COLUMBIA COUNTY, GEORGIA HAVE BEEN COMPLIED WITH FULLY.

BENNIE C. HARBIN GA. R.L.S. NO. 1725

AS-BUILT OF
PHASE II
OF
MAGNOLIA VILLAS
FOR
PAUL McELMURRAY
1496 ATOMIC RD. N. AUGUSTA, SC. 29841 (706)-831-9946
AUGUSTA-RICHMOND COUNTY, GEORGIA
SCALE: 1" = 50' (50' 25' 0 50' 100' SCALE IN FEET) JULY 9, 2008
PREPARED BY
SOUTHERN LAND SURVEYORS, INC.
4571-C COX ROAD PHONE (706)855-5700 EVANS, GEORGIA 30809

C.O.R. H08133-AB

Attachment number 1
Page 1 of 1

Item # 3

STATE OF GEORGIA

COUNTY OF RICHMOND

DEED OF DEDICATION
[Utilities only-Private Streets]

WHEREAS, _Malane Properties, LLC____(hereinafter known as "**DEVELOPER**") owns a tract of land in Richmond County, Georgia known as _Magnolia Villas, Phase II___ (Subdivision Name) and in the building of a housing subdivision on said tract, it has laid out a water distribution system and gravity sanitary sewerage system, in said subdivision; and

WHEREAS, it is the desire of **DEVELOPER**, to deed water distribution system, the sanitary sewer and apparatuses to remain private, to **AUGUSTA, GEORGIA**, (hereinafter known as "**AUGUSTA**"), a political subdivision acting by and through the Augusta-Richmond County Commission for maintenance and control, reserving unto itself the maintenance and control of the storm drainage system and the road and street system; and

WHEREAS, a plat of the above stated subdivison has been prepared by __Magnolia Villas, Phase II__, dated _July 9, 2008_ and said plat has been recorded in the Office of the Clerk of Superior Court of Richmond County, Georgia in Reel _____, page(s) _______ and to which reference is hereby made to said plat for a more complete and accurate description as to the land herein described; and

WHEREAS, **AUGUSTA,** by and through the Augusta-Richmond County Commission, has consented and agreed to accept and maintain said water distribution system and gravity sanitary sewerage system; and

WHEREAS, DEVELOPER has agreed that neither **AUGUSTA**, nor any of its departments, shall maintain individual force mains and/or grinder pumps and that said individual force mains and/or grinder pumps shall remain private.

NOW, THEREFORE, this indenture made this _____ day of ___________, 20____ between **DEVELOPER** and **AUGUSTA**,

W I T N E S S E T H:

That **DEVELOPER**, for and in consideration of the sum of Ten and no/100 ($10.00) Dollars, to it in hand well and truly paid by **AUGUSTA**, at and before the sealing and delivery of these presents, the receipt of which is hereby acknowledged and for the further consideration of the benefits to its property by the maintenance of said water distribution system and gravity sanitary sewerage system, by **AUGUSTA**, has and does by these presents, grant, bargain, sell and confirm unto **AUGUSTA**, its successors and assigns, the following, to-wit:

> Exclusive easement(s) in perpetuity over the water distribution system and the gravity sanitary sewerage system, as shown on the aforementioned plat.
>
> Together with all of the necessary rights of ingress and egress for the purpose of maintaining the described water distribution system and gravity sanitary sewerage system.

DEVELOPER, having elected to maintain the roads and streets as private streets, covenants that its (her/his) heirs, legal representatives, and successors and assigns, shall repair, pave, or replace any private parking lot, road or street, or any portion thereof, through which **AUGUSTA** may excavate or perform other work in connection with repairs, construction, maintenance, or extension of its water distribution system and sanitary sewerage system, and shall grant to the **AUGUSTA** the necessary easement(s) in connection with such construction or extension.

DEVELOPER also grants **AUGUSTA** the right, but not the duty, to clear and keep clear, all trees, undergrowth and other obstructions from said permanent easement, along with the right of free ingress and egress to and from said permanent easement for this purpose.

DEVELOPER further agrees that no trees or other vegetation that may interfere with the laying, relaying, installing, extending, operating, repairing and maintaining of pipelines transporting and carrying utility services shall be planted on said easement(s) and that no buildings, structures, or other permanent improvements shall be erected, constructed, or maintained thereon.

TO HAVE AND TO HOLD said water distribution system and gravity sanitary sewerage system, together with all and singular, the rights, members, appurtenances thereof to the same being, belonging, or in anywise appertaining to the only proper use, benefit and behoof of **AUGUSTA**, its successors and assigns forever in fee simple.

AND DEVELOPER, its (her/his) heirs, legal representatives, successors and assigns, will warrant and defend the right and title to the above described property, to **AUGUSTA**, its successors and assigns, against all claims of all persons whosoever.

IN WITNESS WHEREOF, DEVELOPER has hereunto set its (her/his) hand and affixed its seal the day and year first above written.

DEVELOPER:

Signed, sealed and delivered in

By: _Malane Properties, LLC_

PRINTED NAME: Paul McElmurray

8-1-08

As its _Operating Manager_____

Witnessed By: ______________
8-1-08

Lerha Thompson
Notary Public, State of _______________
My Commission Expires: _____________

LERHA THOMPSON
NOTARY PUBLIC, RICHMOND COUNTY, GEORGIA
MY COMMISSION EXPIRES JUNE 22, 2012

Attest: ____________________________

As Its: ____________________________

(SEAL)

ACCEPTED BY:

AUGUSTA, GEORGIA

By: __________________________
As its Mayor

Attest: ________________________
Clerk

(SEAL)

STATE OF GEORGIA
COUNTY OF RICHMOND

MAINTENANCE AGREEMENT

FOR Magnolia Villas, Phase 2 (Utility Water & Sewer)

THIS AGREEMENT, entered into this ____ day of_________________, 2008, by and between the **Malane Properties, LLC, Magnolia Villas, Phase 2** hereinafter referred to as the **"DEVELOPER"**, and **AUGUSTA, GEORGIA,** a political subdivision of the State of Georgia, hereinafter referred to as the **"CITY."**

WHEREAS, the **DEVELOPER** requested that the **Augusta, Georgia** accept certain sewer lines, water lines and mains or mains, pipes, valves, and connections, and appurtenances for the subdivision, as shown by deed contemporaneously tendered and recorded in the office of the Clerk of the Superior Court of Richmond County, Georgia, in Realty Reel __________ Page__________ ; and

WHEREAS, the **CITY** has adopted a policy requiring the **DEVELOPER** to maintain all installations laid or installed in the subdivision for a period of eighteen months, which the **CITY** accepts by deed;

NOW, THEREFORE, in consideration of the premises, the expense previously incurred by the **DEVELOPER** and the mutual agreement hereinafter set out, **IT IS AGREED** that:

(1) The **CITY** accepts certain sewer lines, water lines and mains or mains, pipes, valves, and connections, and appurtenances for the subdivision, respectively described in the deed contemporaneously tendered herewith to the Augusta-Richmond County Commission, recorded in the office of the Clerk of the Superior Court of Richmond County, Georgia, in Realty Reel__________ Page __________ .

(2) The **DEVELOPER** agrees to maintain all the installations laid or installed in said subdivision as described in said deed for a period of eighteen months from the date herein.

(3) The **DEVELOPER** agrees that, if during said eighteen month period there is a failure of the installations laid or installed in said subdivision described in the deed due to failure or poor workmanship, the **DEVELOPER** shall be responsible for adequate maintenance and repair.

(4) In the event of such failure of the improvements, the **CITY** shall notify the **DEVELOPER** and set forth in writing the items in need of repair. The **DEVELOPER** shall present, within fifteen business days, its proposed plan of repair and shall have the repairs completed in a reasonable time, as determined by the **CITY**.

(5) If, in the event of an emergency, as determined by the **CITY**, the **DEVELOPER** is unable to respond in a timely manner, the **CITY** shall be authorized to erect barricades, traffic direction devices and such other temporary measures as are necessary to remedy the emergency nature of the problem at the **DEVELOPER'S** expense and allow the **DEVELOPER** time to make the needed repairs.

(6) In the event the **DEVELOPER** fails to comply with the terms of this agreement, then the **CITY** shall proceed to have the necessary corrective work done, and the **DEVELOPER** agrees to be responsible to the **CITY** for payment in full of costs of repairing the improvements due to failure of material or poor workmanship as liquidated damages.

IN WITNESS WHEREOF, the **DEVELOPER** has hereunto set his hand and seal and the **CITY** has caused the execution of this agreement by and through its duly authorized officers and agents, with its seal affixed, the day and year first above written.

SIGNED, SEALED, AND DELIVERED DEVELOPER in our presence:

Malane Properties, LLC
Magnolia Villas, Phase2

AS it's

Paul McElmurray

Witness 8-1-08

Operating Manager 8-1-08

Notary Public

My Commission Expires ______________

LERHA THOMPSON
NOTARY PUBLIC, RICHMOND COUNTY, GEORGIA
MY COMMISSION EXPIRES JUNE 22, 2012

Accepted By:

Augusta, Georgia

By:______________________________

As Its Mayor

Attest:__________________________

Administrator

Engineering Services Committee Meeting
9/8/2008 1:00 PM
Extended funding for the Southeastern Natural Sciences Academy Savannah River at Risk Study.

Department:	Utilities
Caption:	Approve funding of an extension of the Southeastern Natural Sciences Academy (SNSA) Savannah River at Risk study.
Background:	The Southeastern Natural Sciences Academy (SNSA) began a 24 month study of the middle Savannah River in January 2006. This study, known as Savannah River at Risk, was funded by multiple entities including Augusta. The study identified additional issues that need to be investigated in order to fully understand the complex nature of the Savannah River system from Thurmond Dam to the Savannah Harbor. Augusta previously contributed $300,000 to the original study. The SNSA has presented the attached proposal for continuation and expansion of the study to include data collection in the Savannah Harbor. We would like to offer additional funding to SNSA for this work in the amount of $150,000 per year for two years for a total additional participation of $300,000.
Analysis:	The information obtained from the original SNSA study has been very helpful to Augusta as we have worked with regulators in developing a new dissolved oxygen standard for the Savannah Harbor. This new standard will require the revision of the Total Maximum Daily Load (TMDL) determination for the harbor. The new TMDL will have a significant impact on the Augusta area as decreases in the allowable wasteload contributions to the river are expected. The data collected to date and the additional data to be collected will be extremely valuable to Augusta area users of the river. It is imperative that decisions regarding the use of the river for wasteload assimilation be based on the most accurate and scientifically valid data to insure that wasteload allocation reductions are truly necessary for the health of the river system. This data will be valuable during the development of the revised TMDL and during discussions with regulators about future individual permit requirements.
Financial Impact:	$150,000 from the 2008 budget and $150,000 from the 2009 budget for a total additional participation of $300,000
Alternatives:	1) Rely on the limited and restricted data currently available to inform regulatory decision makers (not recommended). 2) Continue Augusta's participation in the SNSA study through a commitment of $150,000 per year for two years.
Recommendation:	Continue Augusta's participation in the SNSA study through a commitment of $150,000 from the 2008 budget and $150,000 from the 2009 budget for a

Cover Memo

Item # 4

total additional participation of $300,000.

Funds are Available in the Following Accounts:	507043490-5212115 / 80500010-5212115

<u>REVIEWED AND APPROVED BY</u>:

Finance.
Procurement.
Administrator.
Clerk of Commission

Executive Summary

Southeastern Natural Sciences Academy is pleased to offer this research proposal to continue the Savannah River study which began in January 2006. The current issue surrounding water quality within the Savannah River stems from dissolved oxygen (DO) concentrations within the river and the Savannah harbor. However, the current drought condition and increasing population within the southeastern United States adds another level of uncertainty for the fate of water quality and water quantity within the Savannah River basin as well. Each stress, low DO concentrations, impact of drought, and increasing population will require sensible and equitable management solutions. Those solutions, which need to provide a dynamic balance between natural resource protection and increasing anthropogenic pressures, can only be based upon a holistic and sound scientific database. The Academy began such a database in 2006 and proposes to continue this important database for an additional 2 years. This proposal however expands the current database to include specific parameters that will fill significant data gaps in the debate over the impact of the CSRA discharges on DO concentrations within the river and harbor. Data collected and analyzed by the Academy within the first two years provided sufficient evidence to draw into question some of EPA's conclusions regarding the impact of the CSRA discharges on DO concentrations, but a more detailed study is required to strengthen that argument. This executive summary is meant to give a brief overview of the significantly more detailed formal proposal (attached).

The Environmental Protection Agency acknowledges that the DO water quality standard for the lower Savannah River is not appropriate and needs to be revised. Until that revision is implemented however, EPA is forced to meet the current water quality standard. In order to meet that standard, EPA is requiring that no additional loadings of oxygen demanding substances (predominantly organic matter and dissolved ammonia) take place within the middle and lower Savannah watersheds since the harbor cannot assimilate any loads above those provided by the natural background condition. This means that all industrial and municipal effluents that empty into the Savannah River within the Central Savannah River Area (CSRA) cannot contain oxygen demanding substances. EPA has suggested that nearly half of the oxygen demanding substances, which lead to violation of the DO standard within the Savannah harbor, originate from those CSRA point source discharges. Meeting this organic matter and ammonia removal requirement may be impossible and may require industries and municipalities to cease operations. As a result of marketplace globalization, local industries may be more apt to move out of the area under such regulatory constraint. Clearly, this would result in significant job loss and economic impact to the CSRA. Municipalities on the other hand, have no option but to continue operations and would most likely face financial penalties for violation of the loadings rule.

The science supporting EPA's loadings argument may be founded on too few river data sampling events, too few river sampling locations, and an oversimplified view of how the ecology of the Savannah River functions. Furthermore, EPA's argument is bolstered by a false sense of validation due to a heavy reliance upon conclusions generated through ecological modeling efforts. Results from ecological models are only as good as the overall understanding of the system and the ability to create an appropriate data collection scheme that fits the goals of the model. Neither modeling criteria have been sufficiently met for the Savannah River. Proof that the loadings argument is not sufficient and that the modeling efforts have provided faulty conclusions comes from a high frequency, empirical data set collected during the

Academy's two year study on the Savannah River. As will be discussed briefly below, and in more detail within the formal proposal, current modeling results are in significant opposition to actual, measured data results.

The Academy's two year study showed that the CSRA dischargers were not the only sources of oxygen demanding substances (organic material) to the river; Thurmond Lake, CSRA dischargers, and the floodplain below the CSRA all contributed to the total load. In the cooler months, organic load increased steadily along the entire river study reach, proving that organic material was added along the entire river from both human impacts and natural background contributions. During the warmer, summer months, the organic load increased from the dam, through the CSRA, but often decreased within the floodplain. In fact, results from the July 2007 sampling excursion showed that the same amount of organic material added through the CSRA was removed within the floodplain, most likely due to bacterial degradation. Although the study was not designed to show which organic load source was preferentially used by the bacteria, stable isotope data on organic matter particles showed that the overall river particulate matter "signature" was more similar to a bottomland hardwood floodplain source than wastewater treatment plant effluent and pulp and paper mill effluent. One of the goals of this research proposal is to more clearly define the sources of organic material to the Savannah River system and to determine the extent to which each source is used by bacteria within the river to determine if the CSRA effluents reach the harbor or are used by bacteria before they reach the harbor.

The Academy's study also found that DO at each location within the study reach was 70%-120% saturated throughout most of the study period. GAEPD/EPA modeling efforts, calibrated to the Academy's 2006 data, showed that there should have been no DO at Clyo in the summer of 2007. Actual data collected during that time period showed that Clyo was nearly 100% saturated during that time. Similarly, data collected from the USGS gauge at the USACE dock within the Savannah harbor showed that the harbor DO standard of 3.0 mg O_2/L was violated a total of 7.75 cumulative hours from August 2007 through December 2007; those hours were not contiguous. EPA's Final Total Maximum Daily Load (TMDL) for DO (EPA, 2006) states, "The dissolved oxygen criteria is no less that 3.0 mg/L in June, July, August, September, and October; no less than 3.5mg/L in May and November; and no less than 4.0 mg/L in December, January, February, March, and April. Based upon the [EPA] modeling results, these criteria cannot be attained even if all continuous discharges of the oxygen-demanding substances are eliminated". Actual data collected by USGS within the harbor showed that the standard was met 99.8% of the time from August 2007 through December 2007. These discrepancies call into question the validity, and sole reliance, upon modeling for decision making and point to the importance of, and increased need for, continued empirical data collection.

The model used for the Savannah River DO issue is a dynamic model which means that the model was intended to predict the impact of oxygen demanding substances on river and harbor DO levels. In order to achieve that goal, the model simulates what happens to oxygen as the wastes leave the CSRA discharge points (i.e. industries and municipalities) and are transported along the entire length of the river to the harbor. The modeler, armed with a general understanding of river dynamics, defines the important parameters which are thought to most accurately determine the impact of the waste on DO in the river and harbor. Two significant problems exist regarding the Savannah River harbor DO modeling effort; 1) the model under simplifies and negates some important river processes, and 2) the empirical data used as input to the dynamic model was not collected dynamically. Both issues decrease the validity of the model results. Water samples collected by the Academy since 2006 have included a dynamic sampling scheme. As a result, the Academy's dataset is the only dataset robust enough to validate the TMDL modeling efforts. This proposal will not only allow for continuation of that database but will also offer a unique opportunity to validate the dynamic model output by conducting several continuous sampling events which start in the CSRA and end at the head of the Savannah harbor. This empirical dataset can be compared time-for-time to EPA model data.

The Academy's data is the only existing contemporary, continuous, and empirical dataset representing the middle and lower Savannah River basins. Other databases exist but historic data does not reliably represent contemporary conditions nor do monthly, synoptic sampling events represent continuous conditions. The Academy's dataset is the only one able to calibrate and validate EPA and GAEPD modeling efforts. In addition, the Academy is working with USACE and both SC and GA regulators to determine optimal river management strategies for maintaining river water quality as Thurmond Lake levels approach unprecedented lows. The Academy's research and dataset is the scientific foundation upon which decisions regarding the Savannah River will be made. The Academy endeavors to shed new light on the ecological function of the Savannah River which will offer new insight into optimization of regulated river management strategies not only for the Savannah River but for other regulated rivers as well. We hope that you see the value in funding this proposed research project.

Determination of sources and in-stream dynamics of oxygen demanding substances along the entire length of the middle and lower Savannah River basin

"Understanding the ecological structure and function of natural and/or altered lotic ecosystems is a common goal of many stream and river ecologists. This has spurred development of numerous conceptual models, shaped empirical research and funding, and occasionally altered government policies on river conservation, management, and rehabilitation. **Formation of conceptual theories can expand our knowledge of factors regulating river networks as *long as popular theories are viewed as the "latest best approximations" rather than iron*-clad truths and if ecologists seek to test theories and comprehend why concordance or incongruity emerge"** ***(Thorp et al., 2006).***

Some confusion in the perception of how the Savannah River functions may stem from the lack of a consistent theory regarding how rivers, in general, function. Lorenz et al (1997) presented a good overview of the predominant theoretical concepts which describe ecological processes within rivers. One of the original, and still most popular, concepts in river ecology is the River Continuum Concept (Vannote et al 1980). This concept argues that macroinvertebrate assemblages are structured along a continuous gradient from the headwaters to the river mouth and the spatial positioning of those organisms reflects the functionality of those organisms in terms of organic matter processing, from course to particulate, along the gradient. This view implies that the majority of organic material within river systems results from headwater inputs. Since this foundational concept is based upon studies conducted within low order (headwater) streams it most likely does not apply to higher order streams. This concept does not consider additional inputs along the river length nor does it consider in-stream (autochthonous) production of organic material (phytoplankton), or carbon quality. Such a "headwater dominated view" does not apply to more complex, higher order systems and should not be the basis for modeling higher order river system dynamics.

Dynamics surrounding the sources and fate of material in rivers often requires extensive evaluation of the entire river system with special consideration for spatial and temporal scales. Such wide ranging view of the system is required because rivers are a dynamic interplay between physical, chemical, biological, and geological elements. At discrete river locations, these elements do not remain static. Thus, it is necessary to view, sample, and model these systems dynamically. For example, a static-view sampling approach of several river locations spaced several miles apart might include taking samples without reference to travel time between those samples. The dynamic-view approach accounts for travel time and thus accounts for antecedent dynamics (physical, chemical, and biological) that occur between successive locations. Data collected in static-view will lead to completely different conclusions from data collected in dynamic-view. A better understanding of a dynamic system requires a dynamic view. Furthermore, dynamic modeling should only be calibrated with dynamic-view sampling protocols. Therefore, a more logical approach to understanding the complex dynamics of material source, fate, and transport within rivers, would be to account for upstream, lateral, and in-stream sources and also take into account quality of material entering the system in terms of its utility to the biota. Such parameters have been taken into account in more recent river concepts (e.g. Patch Dynamic Concept: Pringle et al., 1988; Townsend, 1989), and are more in line with the philosophical foundation of the research proposed here.

1 Introduction

It has been suggested that nearly half of the oxygen demanding substances, which lead to violation of the dissolved oxygen standard within the Savannah harbor, originate from the CSRA point source discharges. This hypothesis has been reached as a result of reliance upon years of modeling the system with data calibrated and validated with a static-view sampling approach instead of a dynamic-view sampling approach and possibly a flawed understanding of how this highly regulated river functions, which results from a foundational philosophy grounded in the River Continuum Concept.

Several limitations to the CSRA load hypothesis exist:

- Sources of oxygen demanding substances exist from Thurmond Dam to the ocean and are not just limited to point source discharges. It seems necessary to determine the relative magnitude of all sources including natural background contributions that do not just emanate from easily observable tributaries but also emanate from small but continuous sources. In addition, it seems necessary to determine the relative value of each source to bacterial respiration and hence dissolved oxygen loss.
- The approved method for determining the magnitude of oxygen demanding substances in a wastewater, industrial effluent, or tributary is Biochemical Oxygen Demand (BOD). The preferred incubation time is 90 days (uBOD) for DO TMDL modeling but results from 5 day incubations (BOD_5) are often extrapolated to 90 days. Since this test is a static bottle test, it may not fully characterize the sources nor accurately predict the rates that actually occur once introduced to a dynamic river system. However, this test may accurately predict oxygen demand in stagnant systems. It seems necessary to compare static uBOD bottle rates to in-situ rates below point sources (tributaries and effluent pipes) because the compared results may not agree with point source theory and those dynamics will not be completely understood for the Savannah River unless evaluated.
- Models have been used extensively over the years as a tool for both understanding and predicting system dynamics. However, modeling gives a simplified picture of reality. Advances in instrumentation technology have resulted in significant cost reductions

associated with continuous data collection. This has allowed for the development of continuous monitoring networks which more accurately reflect reality. Since the goal of model validation is to predict data collected from continuous monitors, it may be time to evaluate the uncertainty associated with modeling efforts and the ramifications of decision making based upon models versus real-time data when model output doesn't agree with the continuous data. It also seems necessary to validate model output with continuous data sets, collected with uninterrupted Lagrangian river sampling cruises, in order to validate the sources, characterization, fate, and transport of oxygen demanding substances from the Thurmond Dam to the Savannah Harbor.

- The CSRA **receives** organic material from Thurmond Dam. This fact has never been taken into account since most of the synoptic samplings conducted by the regulatory agencies were initially conducted below Augusta (RM 185), from ~RM 61 to the harbor and have only recently been conducted within the CSRA. On average, the CSRA received 2.3 mg/L of dissolved organic material from the lake and average concentrations at RM 61 were 4.0 mg/L throughout the first two years of the Academy's study. In addition, sustained drought conditions and increasing human population in the southeast are stressing water supplies. As a result of sustained drought, the Savannah Basin USACE is nearing the Level 4 drought plan which results in "flow-in flow-out" discharges to the middle and lower Savannah River. Furthermore, Level 4 also requires the Corps to switch from discharges originating from the mid depths of Thurmond Lake to sluices in the lower depths of the lake. It seems necessary, not only to continue monitoring conditions relating to reduced river discharges and the harbor DO TMDL issue but also to evaluate the potential increased load of oxygen demanding substances that the CSRA will receive as a result of water management decisions at the Level 4 drought condition. In addition, since Level 4 flows have never been necessary since establishment of the Thurmond Dam, a new low flow condition will be established for the Savannah River since the 1950s.

EPA recognizes that the current water quality standard for the harbor may not be appropriate and revision of that standard is underway (EPA, 2006). Since EPA has relatively good data for the marsh loadings as a result of extensive studies conducted by ATM, EPA and others within the harbor and estuary, it is imperative that a similarly detailed study be conducted from Thurmond Dam to the harbor in order to characterize the natural background contributions to the middle and lower Savannah basin.

The question still remains however, does the CSRA supply 50% of the oxygen demanding load that leads to violation of the harbor DO standard? The only way to answer this question is through a multiple parameter source tracking methodology, along with a dynamic-view sampling approach, which includes stable isotopes, lignin component characterization, C:N ratios, and other parameters which allow for determination of complex organic matter mixing and processing dynamics. In fact in California, USGS is conducting a similar study as the one being proposed here, including Lagrangian sampling, to determine sources of oxygen demanding substances which lead to low DO in the San Joaquin harbor (Carol Kendall, personal comm.). In an effort to answer the question for the Savannah system, Southeastern Natural Sciences Academy is proposing to determine the sources, fate, and transport of oxygen demanding material from Thurmond Dam to the Savannah harbor and to compare in-stream respiration rates to uBOD bottle rates. In addition, in-stream rates along with other parameters will allow for determination of river metabolism (photosynthesis and respiration) for the Savannah River system. In order to determine sources, fate, and transport, the Academy will "fingerprint" those sources (natural and anthropogenic) that are thought to contribute significantly to the oxygen demanding material load to the river and compare those same constituents at each Lagrangian river sampling station in order to determine the fate and transport dynamics of those sources. In addition, the Academy will conduct at least two continuous river cruises per year from the CSRA to the harbor collecting continuous data for the entire study reach length. The Academy will add three permanent stations to the existing continuous monitoring network, at RM 27 (I-95 bridge), Brier Creek, and possibly Ebeneezer Creek, as well as develop a real-time data collection network through a cooperative agreement with Clemson University. Since USGS and USACE have a permanent station at the Corps dock in the harbor, we will develop a cooperative agreement with them or another harbor/estuary research team as well to extend the same study parameters to the harbor.

2 Important findings from the Academy's 2006-2007 study

2.1 How is the DO situation in the Savannah now?

Figure 1 shows DO saturation data from each permanent river station from 2006-2007. The data indicate that DO saturation was variable at RM 215 due to lake stagnation, the shoals and NSBL&D created supersaturated conditions (>100%) (RM 202 and RM185, respectively), and saturation at Clyo (RM 61) was constantly maintained between 80 and 105%, with consistently higher saturation values during the low flow period of 2007.

DO TMDL modeling efforts over the past year by GAEPD, calibrated to 2006 SNSA data, continue to predict near zero DO concetrations at Clyo. As shown below, nearly all of the data collected over the past two years showed that saturation at Clyo was ~80-105% with 2007 being saturated much of the time.

EPA's Final DO TMDL (2006) states, *"The dissolved oxygen criteria is no less that 3.0* mg/L in June, July, August, September, and October; no less than 3.5mg/L in May and November; and no less than 4.0 mg/L in December, January, February, March, and April. **Based upon the modeling results, these criteria cannot be attained even if all continuous discharges of the oxygen-demanding substances are eliminated**". Figure 2 shows the empirical data collected from the Corps dock within the harbor from July 2007 through February 2008 (data source: USGS, chart provided by GAEPD).

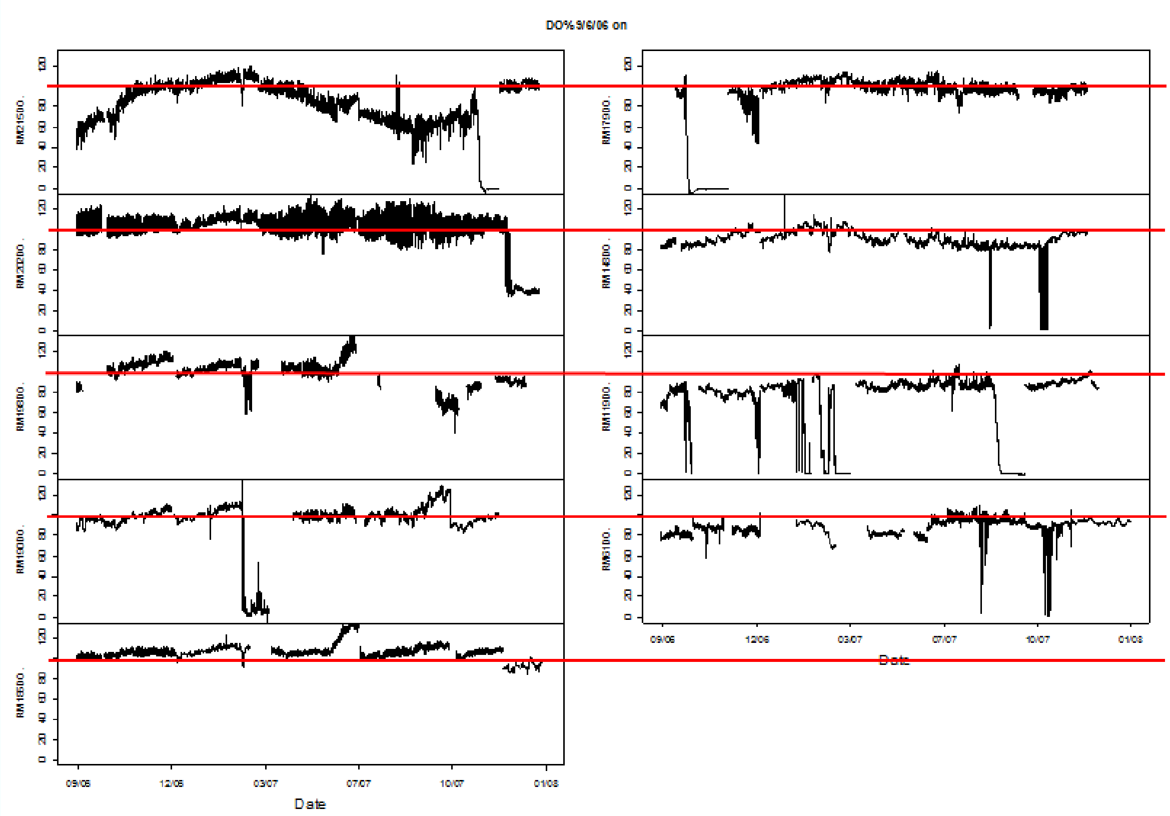


Figure 1. Dissolved oxygen saturation values at each permanent station from 2006-2007. Column 1 from top to bottom: RM 215, RM 202, RM 198, RM 190, RM 185; column 2 from top to bottom: RM 179, RM 148, RM 119, RM 61. Red line is a reference and is equal to 100% sat. on each graph.

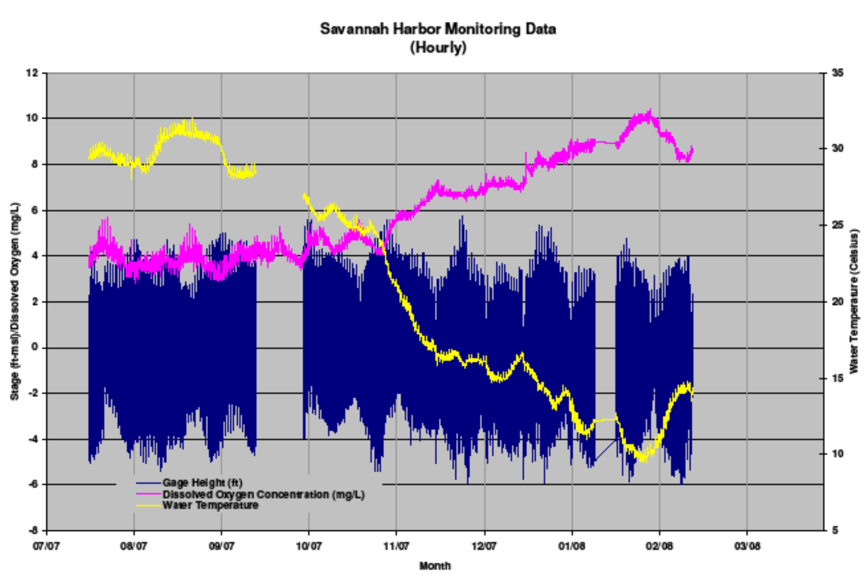


Figure 2. Empirical data from the USACE dock within the Savannah harbor (data source: USGS; chart provided by GAEPD).

As shown in Figure 2, data collected from the USACE/USGS sonde within the harbor from August 2007 through December 2007 indicated that the DO standard of 3.0 mg O_2/L was violated a total of 31/13,339 readings (0.2%) or 7.75 cumulative hours; these hours were not contiguous. The maximum exceedance during that time, 0.2 mg O_2/L (2.8 mg O_2/L), was near the error of the YSI 6600EDS instrument (0.1 mg O_2/L or 1% of the reading, whichever is greater). Similar exceedance events occurred in July 2007 but data from those events were not available at the time of this analysis. These comparisons indicate that reliance upon modeled data versus empirical data should be questioned.

2.2 How does the amount of organic material in the Savannah River compare to other rivers? To other rivers in Georgia?

TOC concentrations in natural systems typically range from 0.5 mg/L in groundwater and seawater to 30 mg/L in "blackwater" swamps with average river concentrations of ~7.0 mg/L; 5 mg/L as DOC and 2 mg/L as Particulate Organic Carbon (POC) (Thurman, 1985). On average, the Savannah had less Total Organic Carbon (TOC) when compared to literature values of other rivers, with Dissolved Organic Carbon (DOC) comprising all of the TOC in 92% of the samples. Average DOC concentrations in Savannah River's mainstem ranged from 2.3 to 4.1 mg/L at RM 215 and RM 179, respectively while concentrations ranged from ~3.1 to 6.5 mg/L in Horse Creek and Butler Creek, respectively (Fig. 3).

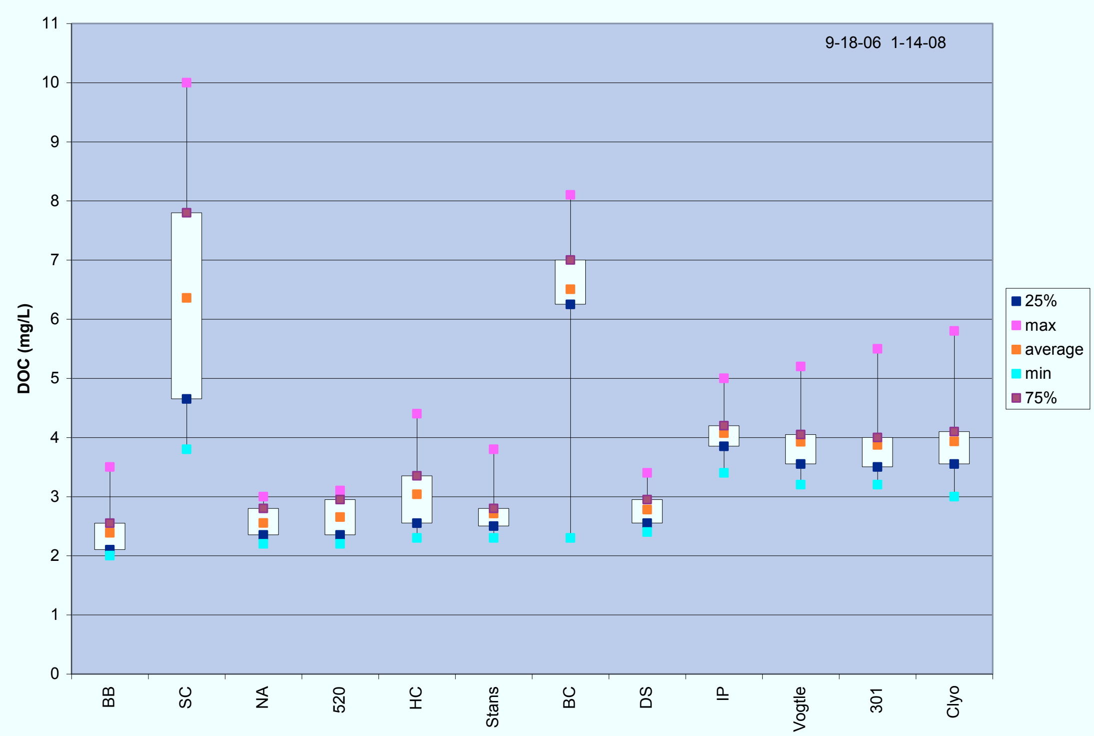


Figure 3. Monthly DOC concentrations from each permanent station from SEPT06-JAN08. X-axis nomenclature: BB= RM215, SC = Stevens Creek, NA= RM202, 520= RM198, HC = Horse Creek, Stans= RM190, BC = Butler Creek, DS= RM185, IP= RM179, Vogtle= RM148, 301= RM119, Clyo= RM61.

Compared to other rivers in Georgia, TOC concentrations within the Savannah are either similar (rivers originating in the Piedmont) or significantly below (rivers originating in the Coastal Plain) those of other rivers in the state. Cai et al. (1998) showed DOC concentrations of ~9 mg/L in the Altamaha (Piedmont river) and ~26 mg/L in the Satilla (a Coastal Plain river); at the time of sampling (1995), concentrations within the Savannah were ~4.5 mg/L at the river/estuary interface. Moran, et al. (1999) sampled the Savannah, Ogeechee, Altamaha, Satilla, and St. Marys rivers in March 1996 at the river/estuary interface and reported concentrations of 4.3, 3.8, 3.2, 4.0, 4.2 mg/L, respectively. They sampled the Savannah, Altamaha, and Satilla again in May 1996 and reported concentrations of 3.2, 3.0, and 3.6 mg/L, respectively. Finally, they reported concentrations of 25.4 and 29.9 mg/L in their samplings of the Satilla in March 1997 and August 1997, respectively.

TOC concentrations at Clyo (RM 61) compared to the USGS station at Port Wentworth over the same time period showed that the concentrations were similar from April 2006 through April 2007 (Fig. 4). Although the concentrations were similar between these two sites, the significant difference may be the organic carbon mass between the sites when accounting for discharge. USGS does not supply discharge data for this site but the specific conductance data from this site indicated that it was well within the tidal portion of the harbor (spec. cond. >>1 mS). If the concentrations were the same but the discharges varied by 10x at some points during high tide, then the carbon mass at the Port Wentworth site was 10x higher as well. This logic may indicate that the riverine carbon load contributed only ~10% of the total carbon load to the harbor at that time.

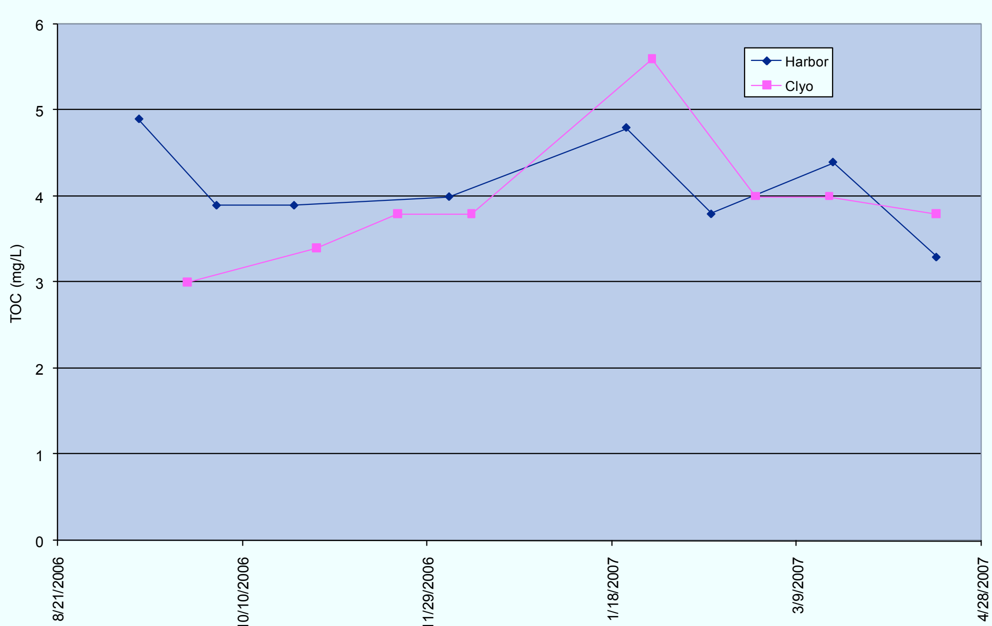


Figure 4. TOC concentrations at Clyo and Port Wentworth (source data:USGS) stations.

Figure 5 shows the Lagrangian mass flux results from January 2007 through January 2008. Overall trends indicated a seasonal trend where the cooler months exported significantly more carbon than the warmer months (>1E^6 mg C/s versus >8E^5 mg C/s). During the cooler months, presumably due to decreased respiration rates, carbon mass increased steadily with decreasing river mile, even through the floodplain section of the study reach. However in the warmer months, DOC mass often decreased through the section of river with adjacent floodplains. This trend most likely indicated that significant respiration was ongoing especially in July 2007 when a loss of ~ 2E^5 mg DOC/s was observed from RM 179 to RM 61; this loss decreased carbon mass to levels observed within the CSRA pool for that time period and may indicate that a significant amount of CSRA effluent material may be respired within river, prior to the harbor.

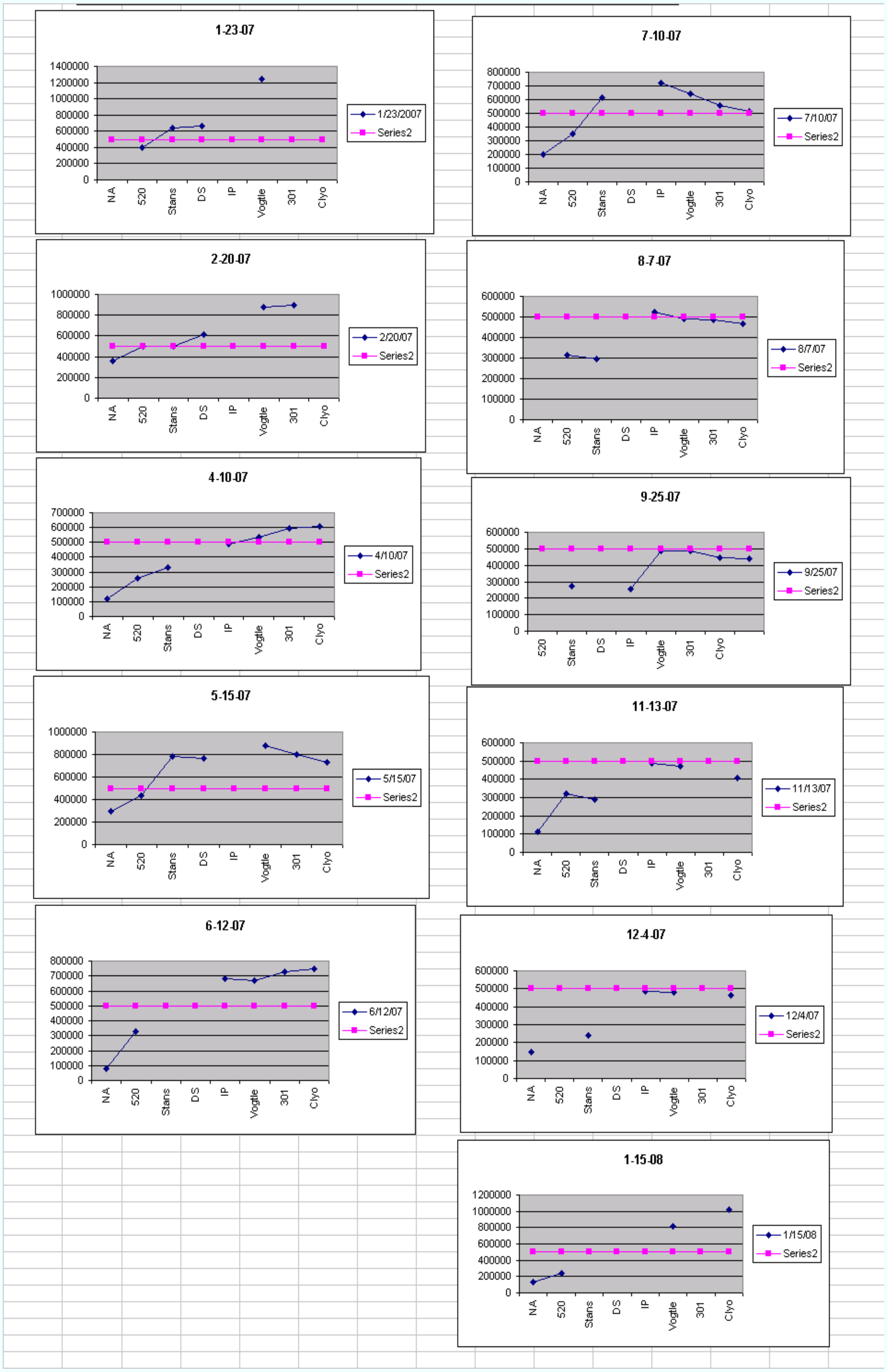


Figure 5. Lagrangian DOC mass flux results from Jan2007 through Jan2008. Y-axis units are mg DOC/s. Pink line on each graph is a reference line and is the same magnitude ($5E^5$ mg DOC/s) on each graph. X-Axis nomenclature: NA= RM202, 520= RM198, Stans= RM190, DS= RM185, IP= RM179, Vogtle= RM148, 301= RM119, Clyo= RM61.

2.3 TOC:DOC dynamics, indicator of sources?

Throughout the first 2 years of the Savannah River study, concentrations of TOC and DOC have been virtually equal. However, measurement error may account for some of this similarity. Both TOC and DOC are determined, by Shealy Environmental Services (Cayce, SC), on a Shimadzu TOC 5000 analyzer. This is the most cited instrument for this analysis and is an EPA approved method with a standard error of 1-3% for DOC and 5-10% for TOC. That potential error results from the possible limitation of the instrument to sample larger particulate matter upon analysis (Ron Benner, personal communication; APHA, 1985). If the sampled river system is typically depleted of large particulate matter, then the measurement error for TOC would be minimal. With that in mind, 92% of the TOC data was within 10% of the DOC data (n=309) (Fig. 6). Of the remaining 8%, only half of the data showed TOC>DOC whereas the other half showed DOC>TOC.

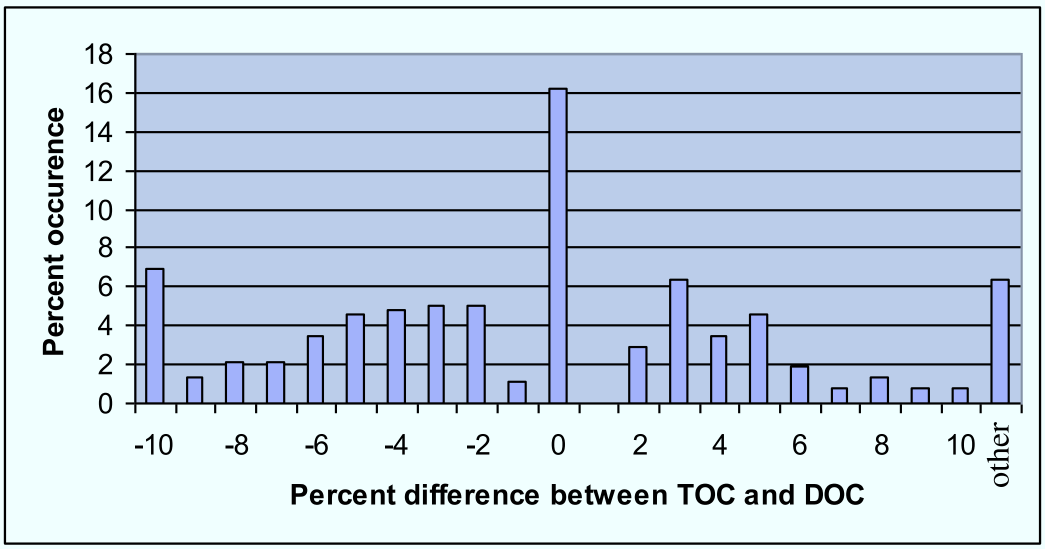


Figure 6. Histogram of percent difference between TOC and DOC (n=309).

Of all instances where TOC > DOC (all data included, n=309), 26% occurred within the sampled creeks (Stevens Creek, Horse Creek, and Butler Creek), 16% occurred above New Savannah Bluff Lock & Dam (NSBL&D), and 58% occurred below NSBL&D. Of the instances where TOC exceed DOC by more than 10% (n=24), 54% occurred in the sampled creeks, 25% occurred upstream of NSBL&D, and 21% occurred downstream of NSBL&D.

The apparent discrepancy for the Savannah River TOC/DOC dynamics stems from the fact that it is a highly regulated river. Natural (unregulated) rivers typically contain organic matter from many sources which can be grouped into two main categories, autochthonous and allochthonous. Autochthonous sources originate in-stream and mostly result from bacterial, algal, and aquatic vegetative growth. Allochthonous sources originate from watershed sources outside the river and can come from headwaters, tributaries, floodplain and riparian wetlands, groundwater, and anthropogenic point sources. Since the Savannah is completely disconnected from its headwaters by three reservoirs (Hartwell, Russell, and Thurmond), the typical carbon additions from that source is reduced compared to the amount that could possibly be transported from the headwaters. In addition, the TOC/DOC ratio is significantly altered as a result of the reservoirs. Steep upland catchments typically release more Particulate Organic Carbon (POC; POC=TOC-DOC) material than lowlands. POC released from the reservoirs is negligible because there is extensive bacterial processing and settling of the upland POC within the reservoirs. Water feeding the middle and lower Savannah originates from the mid-depths of Thurmond Lake, so most of the TOC is in the dissolved form. These reservoir effects typically kept the DOC concentrations fairly low and constant at 2.33 mg/L (SD = 0.396 mg/L; n=15) throughout the 2006-2007 study. The three additional impoundments within the middle Savannah (Stevens Creek Dam, Augusta Diversion Dam, and NSBL&D), in addition to the pooling effect of NSBL&D, had a similar effect on TOC/DOC ratio as well.

Downstream of NSBL&D, river meandering and bank erosion was possible from ~RM 185 on. However, POC transport was still minimal because the middle and lower reaches of the Savannah are within the relatively moderate to flat catchments of the Coastal Plain. This resulted in a predominance of DOC export from the watersheds within the middle and lower reaches. Newman (1986) conducted biweekly sampling of organic material for 18 months within the Four Mile Branch watershed (on Savannah River Site property; ~RM148) and found average TOC concentrations of 7.1 mg/L with DOC accounting for 75% of TOC. Mulholland and Keunzler (1979) found that watersheds in North Carolina that had considerable swamp drainage exported 7x more organic carbon than upland watersheds, with >80% being exported as DOC.

Streams and rivers drain varying loads of carbon from watersheds to the ocean. The load typically depends upon the climate where biomes in cooler climates generate more carbon flux to rivers than those in warmer climates and biomes in drier climates generate less carbon flux than wetter biomes with swamp forests generating one of the highest fluxes (9.913 g C m^{-2} yr^{-1}) (Table 1). For the Savannah, Dosskey and Bertsch (1994) found that 93% of all carbon entering Four Mile Branch (an SRS tributary; ~RM148) resulted from only 6% of the watershed area which was floodplain wetland forest and that the study watershed (12.6 km^2) exported 26.9 tons C/yr to the Savannah River.

Table 1. Annual riverine DOC flux from different soils and vegetation habitat.

Biome	*Soil C:N*	*Observed DOC flux ($g\ C\ m^{-2}\ yr^{-1}$)[b]*
Cool grasslands	13.5	0.386
Tropical savannah	13.6	1.090
Taiga	13.8	0.700
Siberian steppe	14.7	1.290
Warm deciduous forests	15.3	1.410
Warm mixed woodlands	16.7	1.714
Cool deciduous forests	17.1	1.927
Warm conifer forests	21.0	3.684
Cool conifer forests	21.0	4.226
Northern mixed forests	23.2	5.260
Heath/moorlands	24.6	5.650
Tropical forests	25.0	6.336
Boreal/peat mix	25.7	6.349
Peatlands	30.1	8.567
Swamp forests	32.4	9.913

[a] From data reviewed by Aitkenhead and McDowell (2000).
[b] $\times 10 = kg\ C\ ha^{-1}\ yr^{-1}$.

from Wetzel, 2001.

2.4 BOD_5 results; all that oxygen demanding waste?

The total number of BOD_5 samples that were analyzed from 2006-2007 was 305. Of the total, 35 samples (11.5%) had results higher than the Practical Quantitation Limit (PQL) of 2 mg/L. Of the 35 samples >2.0 mg/L, 13 (37.1%) were considered storm water samples. Of the samples with results >PQL, 63% were from the sampled creeks (Stevens Creek, Horse Creek, Butler Creek), with sites above and below NSBL&D comprising 17% and 20%, respectively. Of samples >PQL, Butler Creek comprised nearly half of the total with 49% with Stevens Creek and RM 202 comprising ~ 10% each (Fig. 6). Box plots of the results are shown in Figure 7. These results are similar to data collected by SCDHEC from 1999 through 2006 for the Savannah River. Their data showed 232/829 (28%) samples with results >PQL. In addition, their results showed that 595/829 (71%) samples had results <PQL but >0. Their average concentration from all data was 1.65 mg/L.

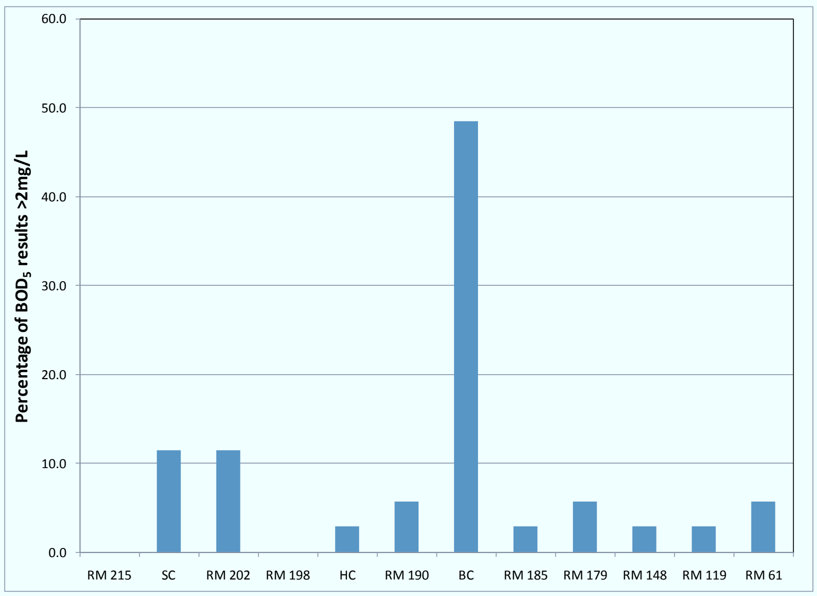


Figure 6. Percentage of BOD_5 results >2.0 mg/L by site from 2006-2007 (n=305).

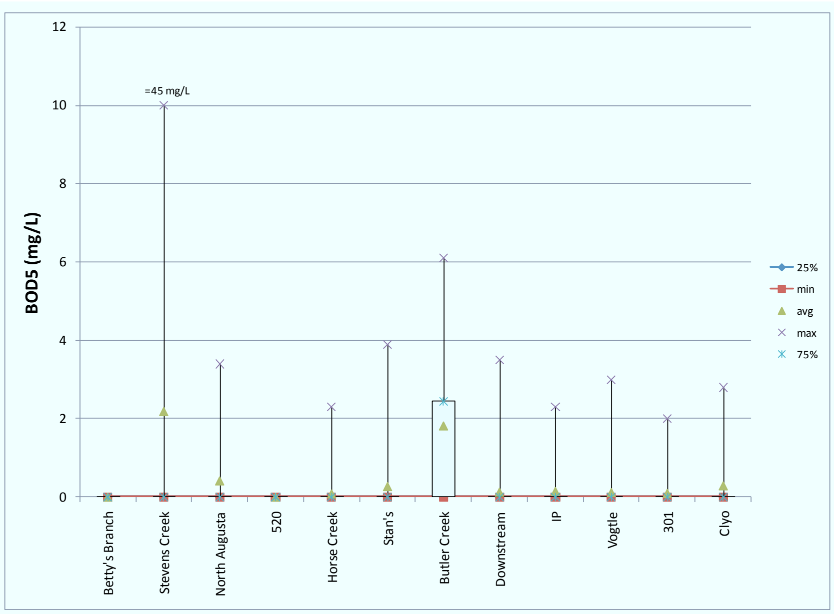


Figure 7. BOD_5 results from 2006-2007 (note: SC max =45 mg/L).

2.4.1 Stable isotope results for Savannah River

Stable isotopes have been used extensively over the past 30 years as a tool to increase knowledge of food web connectivity in aquatic systems. Stable isotopes allow for determination of connectivity because organisms nearly take on the isotope values of those foods upon which an organism feeds, hence the origination of the phrase, "You are what you eat". Nearly in the previous sentence refers to slight shifts in isotope values as predator-prey relationships move up the food chain. For example, carbon isotopes shift by ~1‰ in the more positive direction, and nitrogen isotopes shift by ~3.5‰ in the more positive direction as successive trophic level jumps are made (Peterson and Fry, 1987). Another reliable trend that stable isotopes adhere to pertain to small scale processes such as respiration, photosynthesis, and chemical reactions; lighter isotopes are favored over heavier isotopes (Fry, 2006). For instance, if DOC is processed within a river by bacteria, the bacteria will preferentially choose $\delta\,^{12}C$ over $\delta\,^{13}C$ and the overall remaining DOM in the river water will be mostly $\delta\,^{13}C$ and will appear as a "heavier" signature (more negative) in successive samples. General trends for $\delta^{15}N$, $\delta^{13}C$, and $\delta^{34}S$ are shown in Figure 8.

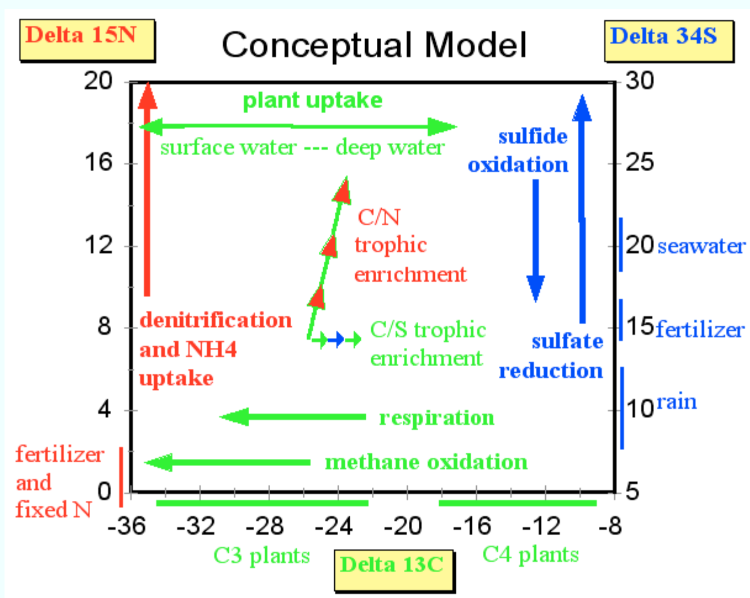


Figure 8. Conceptual model of $\delta^{15}N$, $\delta^{13}C$, and $\delta^{34}S$ stable isotope dynamics in food web studies (from, Kendall et al., http://sofia.usgs.gov/publications/posters/atl-mtg/print.html).

Another method for understanding food web relationships and biological effects on organic material in aquatic systems is to use $\delta^{13}C$-vs- C:N plots. The same trends apply for $\delta^{13}C$ as above, but the C:N of organic material changes with sources and processing as well. In general, as bacteria process organic material they selectively utilize the nitrogen and labile carbon components within the POM or DOM molecules, leaving highly refractory carbon and high C:N . Although C:N vary widely according to individual sources, a few examples of C:N in nature are as follows: humic substances (recalcitrant organic material) >30:1, algae ~6.6:1, allochthonous material >45:1, allochthonous material 12:1 (Wetzel, 2001). Figure 9 shows general trends for $\delta^{13}C$-vs-C:N plots.

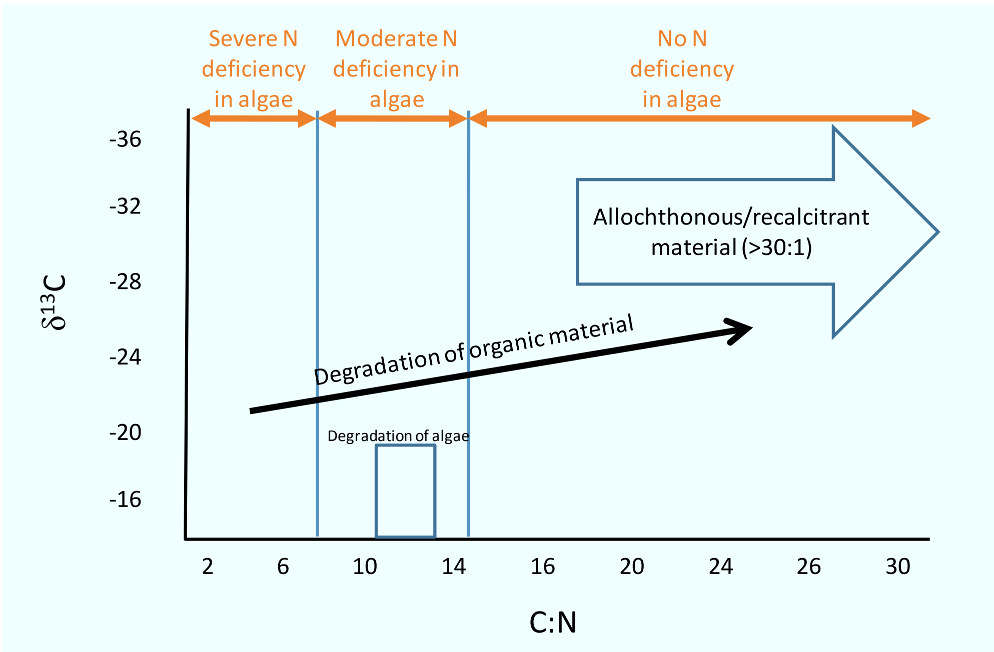


Figure 9. General trends of carbon degradation in aquatic systems as shown in $\delta^{13}C$-vs- C:N plots.

When viewed together, these plots provide powerful data analysis tools for source tracking and ecological studies of the fate and transport of organic material in aquatic systems. The source tracking approach usually starts with an understanding of the major sources of material to the system. For the Savannah River, EPA suggests that International Paper and the CSRA wastewater treatment facilities provide the bulk of material from the CSRA that impacts the harbor. Therefore, it is necessary to characterize those effluents, along with other sources that are deemed to be important (i.e. floodplain wetlands, phytoplankton, etc) and view the Lagrangian river samples with reference to those sources. Figure 10 shows $\delta^{13}C$-vs- C:N and $\delta^{13}C$-vs- $\delta^{15}N$ plots from seston (material collected on a filter with a nominal pore size <0.7 um) samples collected in November 2006.

EPA argues that the wastewater treatment plants and International Paper contribute the bulk of the material from CSRA; those sources are shown within the figure below (BCW and IPeff, respectively). Other, more overlooked, organic material sources which may play significant roles are Thurmond Lake and bottomland hardwood swamps, located along the river below NSBL&D. The Thurmond signature is shown as RM 215 and the bottomland swamp signature was assumed as a sample from the Phinizy swamp, located behind SNSA.

If seston within the river was influenced by either IP effluent or Messerly's WWTP, the mainstem river stations would have converged toward those source signatures. As shown, RM 179, which is ~ 2 river miles below the IP effluent, maintained a signature closest to that of the lake (RM 215) for C:N and ^{13}C but was close to IPeff in terms of ^{15}N. The Lagrangian samples showed a trend away from the RM179/lake signature toward the bottomland hardwood signature (BCP). Those samples were the last three stations within the study reach and have extensive bottomland hardwood swamps adjacent to the river. The trends of increasing C:N, increasing ^{15}N, and slight decrease in ^{13}C indicate microbial processing of the organic material. Although this data is on seston particles, some conjecture can be made regarding the dynamics between the dissolved CO_2 signature and the ^{13}C signature in terms of bacterial and algal dynamics. As organic material is cycled downstream and transformed from organic C to CO_2 by bacteria, the CO_2 signature becomes more and more depleted in the lighter isotope (more negative). As algae utilize the depleted CO_2 for photosynthesis, the organic signature of the algal cells becomes more depleted too. Therefore, the seston signature may be indicative of the algal signature because the algal cells would have been trapped on the filter which was analyzed for the isotope analysis. Another hypothesis is that particulate material contributions from the vegetation within the RM148-RM61 study reach contributed significantly to the analyzed sample. The data collected within the two year study were not enough to make definitive determinations between those two hypotheses but it was quite clear that the mainstem stations did not wholly trend toward either the Messerly WWTP or IPeff signatures. Not all of the isotope data collected within the first two years of the study has been analyzed but findings to date are consistent with those presented here. As shown, the dual isotope approach can be quite powerful evidence of sources, fate, and transport of material within river systems but the use of other parameters to more definitively characterize sources can only increase clarity of the system dynamics.

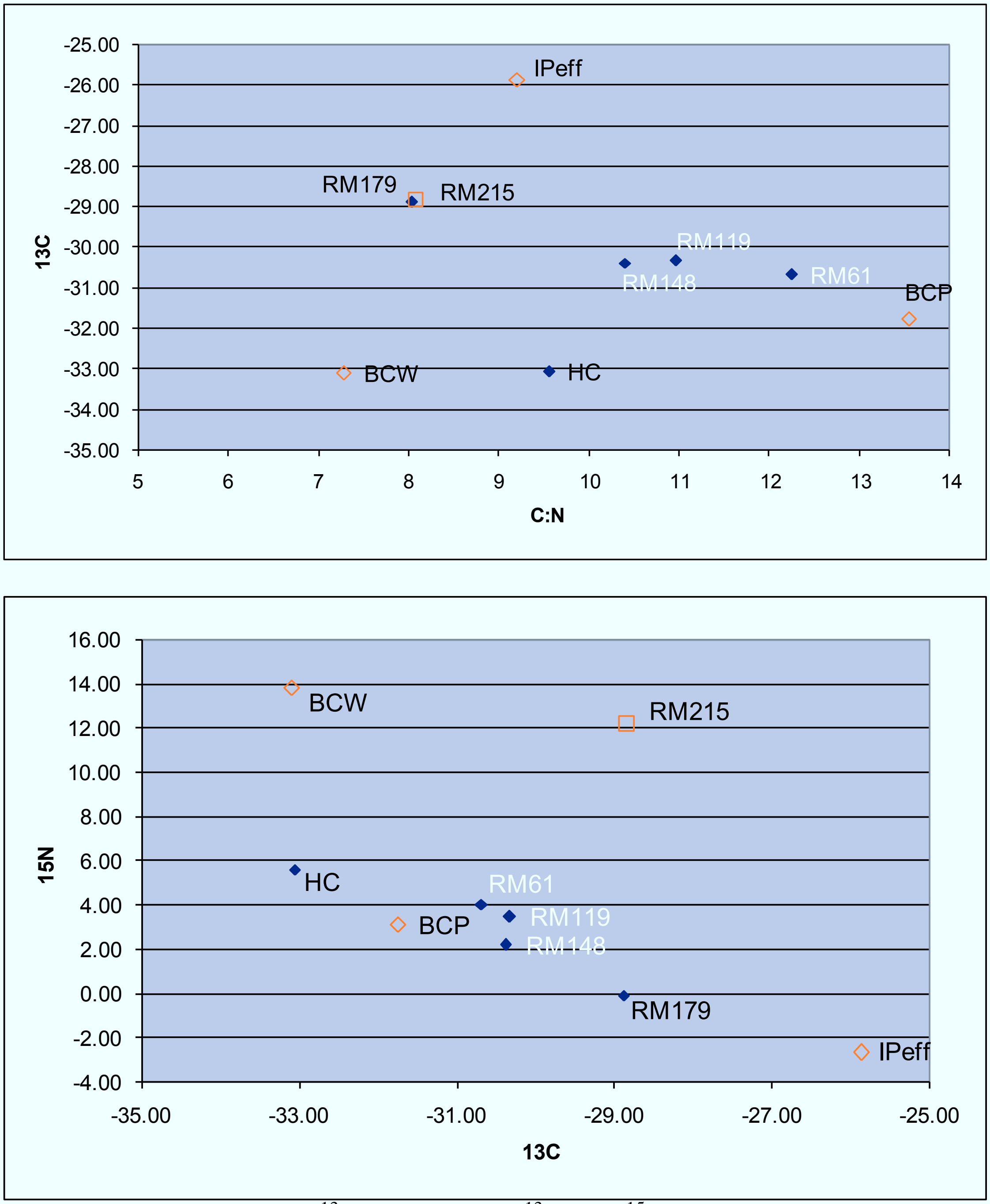


Figure 10. Plots of seston δ^{13}C-vs- C:N and δ^{13}C-vs- δ^{15}N values. Assumed sources are shown as orange symbols (BCW= Messerly wastewater effluent after constructed wetlands; RM215= 7 miles below Thurmond Dam-assumed to be signature for lake water; BCP= Phinizy swamp- assumed to be signature for bottomland hardwood swamp; IPeff= International Paper's effluent. Lagrangian mainstem stations are shown with white letters (RM148-near Plant Vogtle; RM119-near GA/SC 301 bridge; RM61-near Clyo, GA) and non-Lagrangian mainstem stations are shown with black letters (RM 179- 2 miles below International Paper effluent; HC= Horse creek).

3 Study Proposal

As stated, the only way to determine the sources and fate or organic material and to determine the CSRA load, relative to the harbor load is through a multiple parameter source tracking methodology, along with a dynamic-view sampling approach, which includes stable isotopes, lignin component characterization, C:N ratios, and other parameters which allow for determination of complex organic matter mixing and processing dynamics. A discussion of the procedures for making those determinations follows.

3.1 Continuous data collection

Continuous data will continue to be collected at 15 minute intervals. Some changes from the original study will be made to improve the study's focus on oxygen demanding substances, to extend the study to the harbor, and to reallocate funds to more important parameters.

Proposed permanent location changes to Year 3 study

- At least one of the stations within the pooled section (RM 202 to RM 190) will be removed
- One permanent station will be added near RM 27
- One permanent station will be added in Brier Creek
- Final continuous data collection site locations for year 3:
  - RM 215
  - Stevens Creek
  - RM 202
  - Horse creek
  - RM 190
  - Butler Creek
  - RM 185
  - RM 179
  - RM 148
  - RM 119
  - Brier Creek
  - RM 61
  - RM 27
  - RM 11 (possible cost share with USACE, SCDNR, USGS, and/or Skidaway)

As in the first two years, data will be collected with YSI 6600EDS sondes and will collect temperature, pH, DO, specific conductance, redox, and turbidity data. All DO probes will be upgraded to YSI's optical DO sensor technology (ROX) for the 2008 study through a Cyber-Infrastructure grant from Clemson University. These new probes have been tested side-by-side with the current rapid pulse DO (modified Clark-type cell) probe technology at one of the Savannah stations and have been found to be just as accurate and more reliable since there is no need for changing membranes and potential for fouling is eliminated. Discharge data will continue to be obtained from permanent USGS stations located at RM 185 (NSBL&D), RM 150 (Plant Vogtle), RM 119 (GA-301), and RM 61 (Clyo). Discharge and stage height are collected at 15-minute intervals except at the RM 150 station which is collected at hourly intervals. Three Acoustic Doppler Current Profilers (ADCPs) will be deployed above, within, and below the pool in order to more easily determine discharge within those reaches where a USGS gauge is absent, and one additional ADCP will be used to create discharge/stage height correlations for all monitored creeks along the study reach. The four ADCPs will be supplied through a Cyber-infrastructure grant from Clemson University.

3.2 Continuation of monthly river sampling events

Monthly sampling events will continue along with two storm event samplings. Information gathered from the first two years of the study showed that non-Lagrangian samples did not add significantly to the overall understanding of the study. Therefore, for this proposed research, we will limit the number of samplings to 8 samples per month, 7 of which will be within the Lagrangian scheme. In addition, due to the complex hydrological dynamics and confounding issues related to determining Lagrangian dynamics (i.e. Stevens Creek "tidal" activity due to power generation, Augusta Canal diversion, etc) within the pooled section of the river (from Thurmond Dam to NSBL&D), we propose to limit our monthly Lagrangian samples to at least one CSRA pool station and leave the remaining samples to those stations below NSBL&D. RM 215 will still be sampled monthly but again cannot be considered a Lagrangian sample due to the aforementioned dynamics. Table 2 shows the list of monthly parameters and the laboratories that will run those analyses.

Table 2. List of proposed monthly parameters by laboratory.

Shealy	UGA (CAIS)	UGA (IESIL)	ISL	SNSA
TOC	lignophenol analyses	DOC/DIC-15N, 13C, C:N	15N, 18O in nitrate	BOD5
DOC	13C, N15, C:N seston		32S in sulfate	uBOD
TIC	13C, N15, C:N periphyton			ash free dry mass
ALK	13C, N15, C:N macroinvertebrates			SUVA
TKN	14C (dissolved inorganic and organic)			chlorophyll a
NO_3	13C (CO2)			TOC
NH_4				DOC
Total Phosphorous				Total Nitrogen
Ortho Phosphorous				pCO2
ICP metals**				total alkalinity
SO_4				total inorganic carbon
Cl				organic acid pKa
Fe (dissolved)				meterological data

**Al, As, Cd, Ca, Cr, Cu, Fe, Pb, Mg, Mn, Ni, K, Se, Si, Na, Zn

- PCB, herbicides, pesticides, and mercury will no longer be analyzed
- Only total concentrations will be analyzed except for iron (for redox calculations) and DOC

As with the first study, mass fluxes of material will be one of the primary focus areas for the monthly sampling events. They will be assessed based upon Lagrangian sampling and discharge data.

3.3 Lagrangian river cruises

In order to determine the dynamics between carbon, nitrogen, and oxygen in a river system, it is necessary to apply a Lagrangian scheme. During the first two years of study such a scheme was employed and offered valuable insights into this interplay for the Savannah River. That scheme, although highly valuable and more effective than a simple Eulerian or static-view sampling scheme can be improved upon. An improvement upon this sampling scheme would be to incorporate a continuous Lagrangian sampling scheme. The proposed approach is to equip a research vessel with continuous sampling analytical instrumentation and float downstream behind a Swallow float drifter which will validate true river velocities. This approach seems considerably more robust and, in essence, would generate a highly unique empirical data set that could be compared to CE-QUAL-RIV1 modeling scenarios over the same time period.

The most accurate information from river cruises will come from data collected from ~ RM 202 to the recreational boating restricted zone of the Savannah harbor (~RM 20?) because there is only one impoundment along that study reach and it is fairly simple to circumvent in short time. Disruption of the continuity of the study is expected to be minimal because the drifter can be replaced by neutrally buoyant objects (e.g. oranges) that can go through the New Savannah Bluff Lock and Dam and be easily detected on the downstream side. It is clear that beginning cruises at RM 202 limit determinations of the importance of loads and processes from Thurmond Lake during power generating pulses, from Stevens Creek reservoir dynamics, and from the shoals but those dynamics could be assessed with smaller, discontinuous cruises as well as continuous Eulerian sampling at discrete locations within those sections.

The drawback to river cruises from RM 202 to ~RM 20? is that each cruise may take 2-3 weeks to complete so they will be limited in number. Since this study's focus is to determine the impact of Augusta on the harbor, cruises will be conducted during the critical period of the year, as determined by EPA, which typically occurs in the summer. In addition, unprecedented low flows (post Thurmond Dam) may also create a new critical situation as well; therefore at least one cruise (RM 202 to RM 20?) will be conducted during a summertime low flow period. At least one additional cruise (RM 202 to RM 20?) may be conducted in winter for comparative purposes since colder temperatures typically minimize photosynthesis and respiration in all aquatic systems including the Savannah River.

As mentioned, several smaller cruises will be conducted in areas not covered by the long reach cruises in order to characterize those areas as well. The smaller cruises will be conducted during the same time of year as the longer cruises.

Parameters proposed to be conducted on each cruise are shown in Table 3. Not all instrumentation within the table below can be done on the boat during the cruises, however, samples can be collected at relatively small (1-5 river miles), regularly spaced intervals during the cruises and analyzed at the lab. Since GPS coordinates will be collected continuously, all data will be referenced to river mile locations.

Table 3. Parameters that will be analyzed during river cruises

Continuous parameters	Instrument
CO_2 partial pressure	TIC/ALK/pCO2 analyzers
Total inorganic carbon	
Alkalinity	
pKa's of weak acids	
pH	YSI 6600 EDS sonde with continuous flow through cap
turbidity	
water temperature	
dissolved oxygen (optical probe)	
specific conductance	
chlorophyll a concentration	
total nitrogen	Shimadzu TOC-V Combustion analyzer
total organic carbon	
dissolved organic carbon	
Specific UV absorption (SUVA)	Shimadzu UV/VIS-2450 spectrophotometer
chlorophyll a concentration	
GPS location and boat speed	Garmin
wind speed	RainWise weather station
wind direction	
air temperature	
relative humidity	
precipitation	
tagged fish location	

3.4 Determination of sources and fate of oxygen demanding material within the middle and lower Savannah River basin

- Sources of oxygen demanding substances exist from Thurmond Dam to the ocean and are not just limited to point source discharges. It seems necessary to determine the relative magnitude of all sources including natural background contributions that do not just emanate from easily observable tributaries but also emanate from small but continuous sources. In addition, it seems necessary to determine the relative value of each source to bacterial respiration and hence dissolved oxygen loss.

Determination of sources of oxygen demanding substances requires strict characterization of the major sources and a dynamic-view sampling protocol of river water samples. Determination of the fate of organic material requires a strict characterization of the sources and end products of organic matter respiration, mostly

CO_2 and its isotopic signature, $^{13}CO_2$, thorough resolution of Lagrangian dynamics with respect to the characterized sources, and determination of in-stream metabolic rates.

3.4.1 Source characterization

Source material and monthly river samples, will be characterized by several chemical parameters. Those parameters are shown in Table 4 followed by brief descriptions of several key parameters.

Table 4. List of proposed parameters for source characterization.

Constituent	Signature for:
^{15}N-NO_3	MWWTP, agricultural runoff, denitrification
^{34}S-SO_4	pulp and paper mills, MWWTP
^{13}C-CO_2	unique to individual sources and species
^{13}C-POM and DOM	unique to individual sources and species
^{15}N-POM and DOM	unique to individual sources and species
^{14}C-DOM and DIC	unique to individual sources and species
C:N (POM and DOM)	unique to individual sources and species
lignophenols	unique to individual sources and angiosperm species
Total Alkalinity	acid neutralizing capacity; unique to individual sources
Specific UltraViolet Absorption (SUVA)	indicates carbon recalcitrance; unique to individual sources
Dissolved/Total chloride	unique to individual sources
TOC/DOC	unique to individual sources
organic acid pKa determination	unique to individual sources
BOD_5 and uBOD	unique to individual sources
conservative ions (i.e. Cl, Na, Mg)	used as conservative tracers for determining extent of mixing

- **^{15}N-NO_3** – Nitrate can originate from many sources but the isotopic signature of the oxygen and nitrogen molecules can be quite important in distinguishing between agricultural runoff and wastewater because fertilizer is produced by nitrogen fixation from the atmosphere and atmospheric nitrogen is the isotopic reference. Therefore, fertilizer nitrate has a near zero signature while processed nitrate from wastewaters typically have enriched nitrate signatures (high ^{15}N values) (Fig. 11).
- **^{34}S-SO_4** – As shown within the first two years of the river study, sulfate concentrations continued to increase within the river above those concentrations added by anthropogenic sources. Individual sources may have significantly different signatures and will be used to parse sources and downstream dynamics if reasonable differences in isotopic signals occur between sources.

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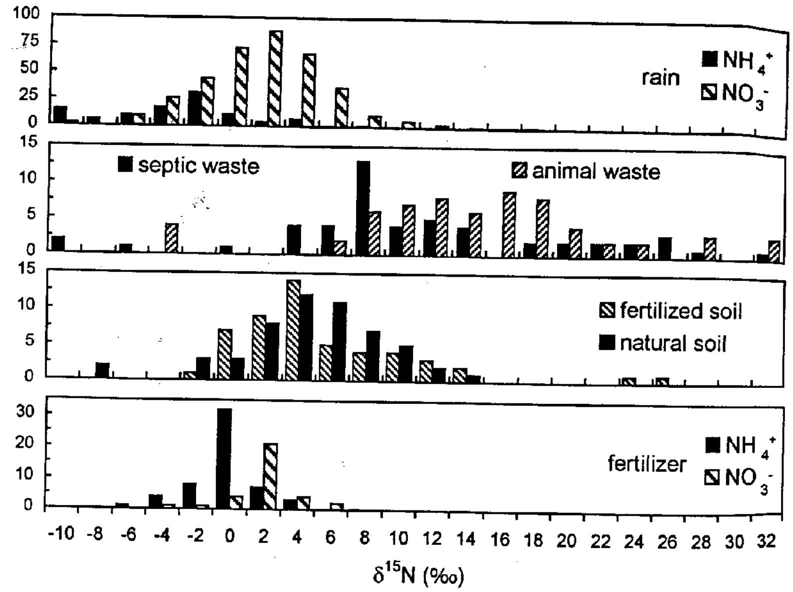

Summary of the range of $\delta^{15}N$ values for the major sources of nitrogen in the hydrosphere. The labels on the x-axis are for the high-end of the range plotted within the cell. Precipitation data from: Hoering (1957), Moore (1977), Heaton, (1986, 1987), Freyer (1978, 1991), Garten (1992, 1995), Paerl and Fogel (1994), Heaton et al. (1997), and the other sources listed in caption of Figure 16.8. Soil nitrate data from the compilation of Fogg et al. (1998) from the following sources: Bremner and Tabatabai (1973), Kreitler (1975, 1979), Rennie et al. (1976), Black and Waring (1977), Shearer et al. (1978), Gormly and Spalding (1979), and Wolterink et al. (1979). Fertilizer data are from: Kohl et al. (1971), Aly et al. (1981), Shearer et al. (1974b), and Rennie et al. (1976).

Figure 11. Ranges of ^{15}N values for several sources to aquatic systems (from Kendall, 2006).

- **^{13}C-CO_2** – This analysis will allow for determination of the carbon that is being respired within the river. For example, ^{13}C-CO_2 signatures within the Lagrangian river samples may trend toward the DOC/DIC signatures of anthropogenic sources below confluences. This would be evidence that those sources are preferentially selected for respiration over advective sources. In addition, measurement of pCO_2 at each location, coupled with the ^{13}C-CO_2 information will allow for mass balance calculations on organic carbon respiration. These empirically derived, in-situ values can then be compared to uBOD bottle rates.
- **$\delta^{13}C$, $\delta^{15}N$, C:N (POM and DOM)** – The ability of these analyses to parse sources and determine river dynamics was shown above. These analyses will continue on a monthly basis but will be extended to include DOM as well for Year 3.
- **^{14}C-DOC and DIC** – Several studies have shown the utility of coupled ^{14}C and ^{13}C analyses in determining the preferential selection of older or younger organic matter by bacteria in river systems. Using ^{14}C and ^{13}C in the Amazon River for example, Mayorga et al (2005) showed that bacteria preferentially selected, from the entire DOC pool, modern carbon substrates (less than 5 years old) over older substrates (tens to thousands

of years in age). Studies within the York River also showed that young organic matter was preferentially selected over older DOM (Raymond and Bauer, 2001). However, Cole and Caraco (2001) showed that up to 70% of the terrestrial organic matter, which was found to be centuries old, was respired within the river. Since the Savannah River is significantly regulated, it may not be possible to parse old carbon from young so these analyses, although powerful if the DOM pool is found to have a variety of ages, will be limited to fewer sampling events. Analysis of ^{14}C-DIC is also necessary since DIC age from ancient carbonate sources can confound ^{14}C-DOC results.

- **Lignophenols** – Lignin is a molecular component of land plants and several lignophenolic compounds have been used as natural tracers for determining sources of organic matter which contribute to the overall riverine DOM pool (Ertel et al., 1986). Specific lignophenol ratios have been used to source track individual types of land plants to assess their overall contributions (Ertel et al., 1986). For instance, gymnosperms (open seed bearing plants; e.g. coniferous trees) produce vanillyl but no syringyl phenols whereas angiosperms (plants that produce seeds within flowers and fruit) produce both, nonwoody plants produce cinnamyl phenols whereas woody plants do not (Hedges and Mann, 1979; Hedges and Ertel, 1982). For the Savannah, it is hypothesized that lignophenol signatures will add considerably to the understanding of the study. As shown in Table 5, lignophenols, specifically the guaiacol:syringyl ratio, will most likely aid significantly in determining the contribution of bottomland hardwoods versus softwoods such as pines to the river. In addition, these phenols, in addition to the Lagrangian sampling scheme, will be able to show additional contributions

Table 5. The basic composition of wood (from LaFleur, 1996)

	Percent composition	
	Hardwoods	Softwoods
Polysaccharides		
Alpha-cellulose	42-47%	51-55%
Hemicellulose	20-30%	15-20%
Lignin		
p-Hydroxyl propyl	trace	trace
guaiacol propyl	29-35%	>95%
syringyl propyl	40-46%	1%

- **Specific UV Absorption (SUVA) -** One simple method, using the absorption properties of chemical bonds, has been shown to be a good first approximation for more specialized chemical analyses of organic material. The inexpensive method is used on whole water samples (filtered through 0.2um filters) with a UV/VIS spectrophotometer (Chin et al., 1994; Peuravuori and Pihlaja, 1997). A high 280 nm (or 254 nm according to some researchers) absorptivity indicates a high degree of aromaticity (Chin et al., 1994) and a high degree of aromaticity may indicate a more recalcitrant carbon composition. High absorptivity at the 400 nm wavelength may be used to assess the extent of humification and may be used to determine sources of aquatic carbon (Thurman, 1985). Absorption ratios of 460 nm and 660 nm wavelengths (E_{460}/E_{660}) have been used to assess molecular weight and degree of humification in samples and in general, E_4/E_6 ratios in the 8-10 range indicate soil fulvic acids and ratios in the 2-5 range indicate soil humic acids (Thurman, 1985). The E_{250}/E_{365} quotient has been shown to correlate well with the aromaticity and molecular size of aquatic humic substances as well (Peuravuori and Pihlaja, 1997) and could potentially be used as a method of source tracking. These analyses are important to the Savannah River study because it may aid in determining the extent to which the carbon within samples is degradable and offer a simple, low cost analysis for tracking natural and anthropogenic sources to the river. In anticipation of the Savannah study leading to a more robust emphasis on carbon dynamics, some samples have already been analyzed using the UV/VIS spectroscopy method (Fig. 12).

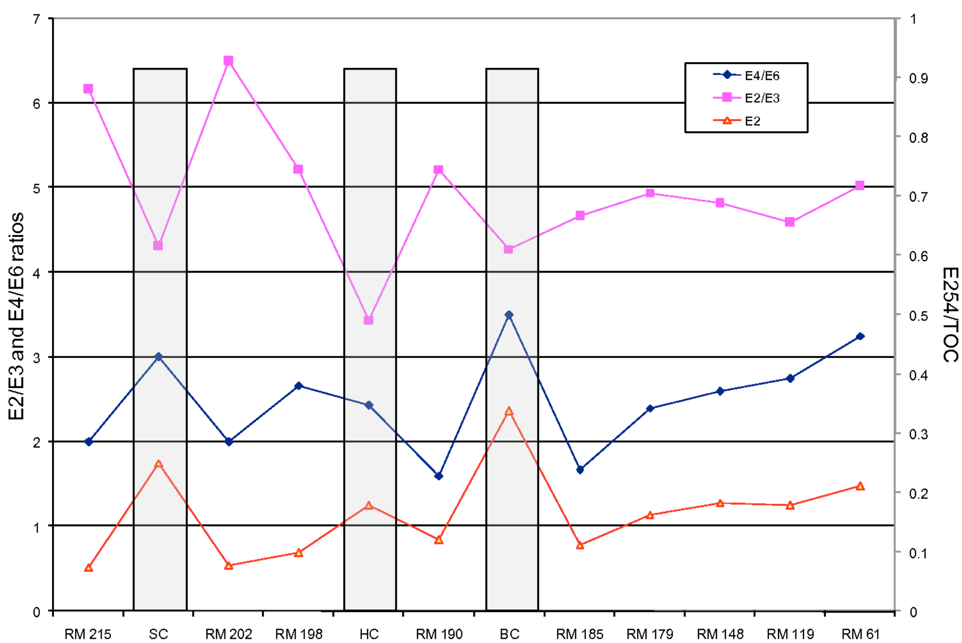

Figure 12. UV/VIS spectroscopic results for the same month from each station.

A few trends from the literature are given here as a guide for the spectrophotometric results:

- Several ranges of E_4/E_6 ratios have been given in the literature: soil humic acids range between 2-5 and E_4/E_6 ratios for soil fulvic acids range between 8-10 (Thurman, 1985); E_4/E_6 ratios for soil humic acids range from 3.8-5.8 and E_4/E6 ratios for soil fulvic acids range from 7.6-11.5 (Schnitzer, 1977).
- As E_2/E_3 ratio increases, the aromaticity and molecular size of aquatic humic substances decreases (Peuravuori and Pihlaja, 1997).

- Low E_2/E_3 values may indicate highly condensed, allochthonous carbon (terrestrially derived) whereas high E_2/E_3 values may indicate aliphatic, autochthonous carbon (algae).
- E_{280} absorbance indicates the degree of C=C bonding and indicates the extent of aromaticity within the sample; increasing E_{280} indicates increasing aromaticity.
- As shown, E_{254}/TOC values and the E_4/E_6 ratios (both indicate the degree of aromaticity) were highest within SC and BC, while the mainstem river locations increased steadily from RM 215 to RM 61, approaching values observed within the creeks. E_2/E_3 ratios were highest at RM 202 and lowest within the creeks; mainstem river locations varied considerably but decreased slightly from RM 215 to RM 61. These results are promising when viewed in terms of allochthonous and autochthonous carbon contributions as well as aromaticity/lability and will add considerably to the overall carbon study. The carbon lability/recalcitrance of all major influents to the river need to be assessed in order to determine the true influence of each discharge to the river. For example, recalcitrant carbon fractions may be transported to the ocean as a result of preferential utilization of labile carbon sources throughout the river study corridor.

3.4.2 Fate of source material

In order to determine the fate of effluent water it will be necessary to "fingerprint" or chemically characterize the major influents (natural and anthropogenic) to the river that would possibly change the chemical characteristics of water flowing from the ultimate middle and lower Savannah source, Thurmond Lake. The fate of each effluent would then be determined by developing mixing models from effluent signature data and the same suite of analyses sampled within the river Lagrangian sampling scheme. The simplest model type is a two source, mass balance mixing model where the weighted constituent value of a sample is the summation of two weighted constituent values from known sources, below is an example of how this approach is applied to stable isotope data:

$$\delta_{sample} * mass_{sample} = \delta_{source1} * mass_{source1} + \delta_{source2} * mass_{source2}.$$

Application of this approach within this study will be to use river data upstream of an influent (source 1) and influent data (source 2) to predict the values at the next sequential river station (sample). The Lagrangian sampling scheme that has been employed, and will continue in this study, presents a unique perspective for validating this application. Stable isotope mixing models have been used with some success in developing food webs but can be hampered by too many sources having the same or similar signatures (Fry, 2006). However, if sources have distinct enough fingerprints this approach can be quite successful using only stable isotopes of carbon and nitrogen. In order to bolster the success of this approach, it will be necessary to choose a suite of constituents that are unique to individual influents (natural and anthropogenic) and apply the mixing model approach to all constituents. Carbon and nitrogen are not conservative so if these are the constituents of concern for the DO TMDL issue, it will be necessary to apply this modeling approach to conservative constituents as well. The complexity of the two source approach can be increased as needed however, the inability to close the mass balance from two known sources is informative in itself and speaks to the point of this study.

In addition to the mixing model approach, the fate of organic material also has to include the link between organic material and the inorganic carbon system. Particulate and dissolved organic matter drives aquatic food web energetics. Since respiration of organic material is tightly coupled to the inorganic carbon cycle (generation of CO_2 and concomitant influence on the carbonate buffer system), stoichiometric evaluations are possible. In order to begin to understand these complex dynamics, researchers have increasingly turned to the use of specialized chemical analyses such as stable isotopes and identification of the chemical composition of bulk organic matter in aquatic ecological studies. However, since carbon mass is conserved during respiration, a baseline "accounting" or mass balance is still necessary. The stoichiometry is simple, 1 organic carbon respired: 1 CO_2 molecule formed:

$$CH_2O + O_2 \xrightarrow{\text{respiration}} CO_2 + H_2O$$

where CH_2O represents the generalized form for organic material. In addition, the above equation also indicates that for each mole of organic carbon respired, one mole of dissolved oxygen is consumed. An often used molar conversion for oxygen consumption as a result of organic carbon respiration is 2.67 (32g per mole O_2:12g per mole C) which means that for every milligram of carbon consumed, 2.67 mg O_2 will be consumed. Although this mass accounting is fairly straightforward, numerous confounders, such as other DO loss and gain mechanisms, are encountered when trying to apply this single relationship to a real system. For example in the July 2007 Lagrangian sampling results, a mass balance approach was applied to DO and DOC masses from RM 179 (below IP) to RM 148 (below Vogtle). Only 64% of the total DO loss between the two sites could be accounted for by respiration using the 2.67 conversion as described above. Of the remaining 26%, groundwater dilution may have accounted for up to 8%, the water temperature change within the reach (decreased DO saturation effect) may have accounted for 2.5%, and iron oxidation may have accounted for less that 1% which leaves the bulk of the remainder (~15.4%) to an unresolved mechanism, such as photooxidation of organic matter (Xie, et al., 2004). In addition, this mass balance approach has been applied to several of the monthly data sets however, the ability to complete the calculations on the entire data set is often confounded by an increase in DO mass with decreasing river mile, even in the summer months. This may indicate that photosynthesis plays a significant role in the oxygen budget, which has been overlook previously for the Savannah River since phytoplankton influence was assumed to be minimal and has been negated in GAEPD modeling scenarios.

In order to appropriately assess respiration (and photosynthesis) in real systems predominantly buffered by carbonate, several parameters have to be measured (Fig. 13). As shown, DOC, DO, pCO_2, pH, total inorganic carbon, and total alkalinity need to be measured in order to appropriately account for respiration of organic matter. Since photosynthesis is the opposite reaction of respiration, simultaneous assessment of primary productivity will be possible as well. Furthermore, in-situ river rates of these important processes can be assessed. Those results can be compared directly to uBOD rates. We propose to measure each parameter as part of the monthly sampling program for the Year 3 study (except for $B(OH)_4^-$ and the sulfide species within the Alk_T parameter). In addition, we propose to assess the dynamics between oxygen depletion and respiration during the proposed continuous sampling river cruises from Augusta to the harbor and at several of the permanent sampling locations throughout the year.

DOC conc. DO conc.

$$CH_2O + O_2 \xrightarrow{\text{respiration}} CO_2 + H_2O$$

pCO_2

$$CO_2 + H_2O \Leftrightarrow H_2CO_3 \Leftrightarrow HCO_3^- + H^+ \Leftrightarrow CO_3^{2-} + H^+$$

pH

$$\boxed{TIC = CO_2 + H_2CO_3 + HCO_3^- + CO_3^{2-}}$$

$$\begin{aligned} Alk_T &= HCO_3^- + 2(CO_3^{2-}) + NH_3 + HS^- + 2(S^{2-}) \\ &+ H_3SiO_4^- + 2(H_2SiO_4^{2-}) + B(OH)_4^- + HPO_4^{2-} \\ &+ 2PO_4^{3-} - H_3PO_4 + OH^- - H^+ + \text{organic acids}^- \end{aligned}$$

Figure 13. Connection between organic matter respiration and carbonate buffer system. Boxes indicate necessary measured parameters. DOC=dissolved organic carbon, DO= dissolved oxygen, pCO_2+ partial pressure of CO_2, TIC=total inorganic carbon, Alk_T=total alkalinity.

3.5 Determination of uBOD for CSRA group effluents and river stations

- The approved method for determining the magnitude of oxygen demanding substances in a wastewater, industrial effluent, or tributary is Biochemical Oxygen Demand (BOD). The preferred incubation time is 90 days (uBOD) for DO TMDL modeling but results from 5 day incubations (BOD_5) are often extrapolated to 90 days. Since this test is a static bottle test, it may not fully characterize the sources nor accurately predict the rates that actually occur once introduced to a dynamic river system. However, this test may accurately predict oxygen demand in stagnant systems. It seems necessary to compare static uBOD bottle rates to in-situ rates below point sources (tributaries and effluent pipes) because the compared results may not agree with point source theory and those dynamics will not be completely understood for the Savannah River unless evaluated.

TMDL model input of oxygen demanding substances is often solely reliant upon either Biochemical Oxygen Demand (BOD) or Ultimate Biochemical Oxygen Demand (uBOD) data. Both are static bottle tests of stream, effluent, and waste waters to determine rates and ultimate capacity of those waters to deplete oxygen in receiving rivers. This static bottle test may not fully represent actual dynamics that occur when those waters enter the stream. Bergstedt et al. (2004) showed that the introduction of small scale turbulence increased the following: oxygen depletion rates, bacterial abundance, bacterial respiration, bacterial growth rate, and nutrient uptake rates. In addition, they showed that in side-by-side static versus turbulent BOD_5 experiments, BOD_5 was underestimated in the static test which indicated that increased turbulence may have been acting on more of the available substrate (uBOD) within the samples. In fact, Shrivastava and Charan Dixit (1970) attributed the observed increase of BOD_5 with turbulence (compared to the standard static method) to the ultimate CBOD of the sample. Al-Homoud et al (2007) also found that small-scale fluid motion increased microbial growth and BOD when compared to the stagnant condition. Morrissette and Mavinic (1978) found that several in-situ stream variables (turbulence, light, and turbidity) had varying effects on BOD_5 when compared to results obtained from the static bottle test and indicated the standard test yields questionable results and that inclusion of physical characteristics of the stream may help obtain more meaningful results. Thomann and Mueller (1987), authors of the often cited modeling book, Principles of Surface Water Quality Modeling and Control indicated, "… the "bottle rate", K_1, in general is not equal to the deoxygenation rate for the BOD that occurs in natural waters". They stated, "… the estimation of K_d cannot usually be made from incubation of effluent to determine the BOD bottle rate, because the oxidation of BOD in a natural body of water includes phenomena that are not part of the BOD bottle rate". They cited biological slime, stream turbulence and roughness, and the density of attached organisms as causative factors for the discrepancy and suggested it was for this reason that attempts had been made to correlate K_d to receiving stream characteristics (depth, flow, and wetted perimeter).

As shown above, the Academy's data set did include BOD_5 as a sample variable for each sampling event. BOD_5 results showed that only 11.5% of the samples were >2.0 mg/L (PQL for the method). BOD_5 Savannah River data obtained from SCDHEC from 1999-2006 showed similar results, with only 28% of the samples having detections above 2 mg/L. The Academy's data set did not include uBOD data, which is the actual input variable to the model. Where uBOD data is not available it can be estimated from BOD_5 data according to the following equation:

$$Amount\ of\ oxidizable\ organic\ matter\ \left(mg\ \frac{O^2}{L}\right) = \frac{BOD_5}{1 - e^{-k(5)}}$$

(Thomann and Mueller, 1987; Chapra, 1997). In light of the possible error associated with the BOD_5 test, validity of this approach to estimate uBOD should be questioned too.

In addition to limitations of the test itself, all of the uBOD samples which were used as input data for the Savannah River DO TMDL modeling were most likely collected with the static-view approach. According to the DO TMDL modeling group, input to the model regarding CSRA group uBOD effluent data was based upon 1997 data. Jim

Greenfield advised the group to collect and analyze effluent uBOD data in order to update model input values. One additional sampling event (as far as SNSA is aware) took place in August 2007 in order to satisfy EPA's request. That event included CSRA group analysis of effluent data as well as a single day sampling excursion conducted by EPA in order to characterize uBOD results for the Savannah River. Although those data will most likely be significantly different compared to 1997 data, a one-time analysis of effluent and river data may not completely characterize effluent or river dynamics. It seems necessary to characterize uBOD dynamics within effluents and the river over time scales which more appropriately bracket significant time scale changes within those waters. For example on an annual scale, the current study has shown that seasonal dynamics within the river occur as a result of seasonal dynamics within Lake Thurmond. On a travel time scale, it takes nearly 1 week for SNSA to sample the river from RM 202 through RM 61 according to a Lagrangian sampling scheme: sampling the same stretch of river in one day assumes that the river is a static system and that samples collected at the same location will yield the same results every time. Time scale variability within industry effluents, most likely occurs as well. For example, uBOD characterization of effluent samples will be significantly different for those industries that have components of their system that are open to the atmosphere. On a seasonal basis, algal growth and aquatic vegetation in the spring and summer could potentially add a significant fraction of rapidly degradable carbon to uBOD results that may not be present in winter samples. In addition, process related activities (i.e. preventative maintenance procedures) may increase or decrease uBOD rates significantly on a stochastic time scale. Not accounting for various time scale dynamics could considerably skew river and effluent uBOD results which would seemingly impact DO TMDL model results and ramifications.

SNSA proposes to sample the Savannah River at each monthly Lagrangian station, with regard to travel time, seasonality, and CSRA group effluent locations in order to assess uBOD dynamics over a one year period. This sampling scheme will not only account for Lagrangian time scale dynamics but will also account for seasonal dynamics which are known to occur but are not usually accounted for in a one-time sampling excursion approach. SNSA proposes to analyze all uBOD river and effluent samples in order to standardize methodology and decrease analytical error inherent to multiple researcher precision. Jim Greenfield has offered SNSA scientists an opportunity to be trained at the EPA laboratory regarding proper uBOD methodologies which ensures reliability of results for all parties. SNSA's approach will be to offer one of our scientists an opportunity to receive an advanced degree within the purview of this proposed study. This approach will increase attention to detailed results. The research focus will be on Savannah River carbon dynamics with a constructive focus on uBOD and its use as a model input master variable. SNSA will focus on the following:

- Natural (background) seasonal variability of uBOD within the river
- Seasonal or process related variability of uBOD from industry
- Dynamic-view sampling of uBOD
- Establish 5d/90d BOD relationships

3.6 Model validation

- Models have been used extensively over the years as a tool for both understanding and predicting system dynamics. However, modeling gives a simplified picture of reality. Advances in instrumentation technology have resulted in significant cost reductions associated with continuous data collection. This has allowed for the development of continuous monitoring networks which more accurately reflect reality. Since the goal of model validation is to predict data collected from continuous monitors, it may be time to evaluate the uncertainty associated with modeling efforts and the ramifications of decision making based upon models versus real-*time data when model output doesn't* agree with the continuous data. It also seems necessary to validate model output with continuous data sets, collected with uninterrupted Lagrangian river sampling cruises, in order to validate the sources, characterization, fate, and transport of oxygen demanding substances from the Thurmond Dam to the Savannah Harbor.

Modeling ecological systems 10-20 years ago was necessary because the costs of autonomous continuous monitoring networks were prohibitive. However, the costs of monitoring equipment and analytical instrumentation are significantly more affordable today. The role of modeling in the age of continuous data collection networks becomes less essential and more a tool to be used side-by-side with those networks. In essence, continuous data collection networks will allow for better model validation and will create an opportunity to increase our limited understanding of complex river systems. This can only be achieved if there is a shift away from "the data doesn't fit the model" mentality. Only when we have enough humility to agree that all models are wrong and that knowledge gaps exist can we move forward to a better understanding of systems thinking (Sterman, 2002). The only way to achieve improved systems thinking and to minimize uncertainty associated with contemporary modeling efforts, is to evaluate side-by-side dynamically collected, empirical data sets with model runs over the same time period.

As mentioned, model runs calibrated to SNSA's 2006 data showed low to no DO at Clyo when the empirical data showed mostly to near saturation. Model output also suggested that the DO standard could not be met in the harbor. DO within the harbor was below the 3.0 mg/L standard for ~8 hours from mid-July 2007 through December 2007. The standard was exceeded by 0.2 mg/L where the instrument error was 0.1 mg/L. Finally, model results suggested that the CSRA is responsible for nearly 50% of the oxygen demanding load to the harbor but organic matter concentrations, multiplied by estimated discharges in the harbor indicate that riverine carbon load may only equate to ~10% of the load. This proposed research will offer a unique opportunity to validate model runs and model input data. The continuous Lagrangian cruises will simulate a model run. Data will be collected along the entire river length from the CSRA to the harbor. Model runs can be conducted for the same time period and directly compared to the empirical data. In addition, in-situ rates can be compared to model input rates which may allow for improved model output resolution.

3.7 Impact of extended drought on DO TMDL issue

- The CSRA **receives** organic material from Thurmond Dam. This fact has never been taken into account since most of the synoptic samplings conducted by the regulatory agencies were initially conducted below Augusta (RM 185), from ~RM 61 to the harbor and have only recently been conducted within the CSRA. On average, the CSRA received 2.3 mg/L of dissolved organic material from the lake and average concentrations at RM *61 were 4.0 mg/L throughout the first two years of the Academy's study. In addition,* sustained drought conditions and increasing human population in the southeast are stressing water supplies. As a result of sustained drought, the Savannah Basin USACE is *nearing the Level 4 drought plan which results in "flow-*in flow-*out" discharges to the* middle and lower Savannah River. Furthermore, Level 4 also requires the Corps to switch from discharges originating from the mid depths of Thurmond Lake to sluices in the lower depths of the lake. It seems necessary, not only to continue monitoring conditions relating to reduced river discharges and the harbor DO TMDL issue but also to evaluate the potential increased load of oxygen demanding substances that the CSRA will receive as a result of water management decisions at the Level 4 drought condition. In addition, since Level 4 flows have never been necessary since establishment of the Thurmond Dam, a new low flow condition will be established for the Savannah River since the 1950s.

Extended drought conditions and increasing population in the southeast have stressed water resources to the point where lake level within Thurmond Lake is approaching the USACE's Level 4 drought condition; a condition for the lake that was once thought would never be reached. Level 4 denotes the elevation of the conservation pool and begins a flow-in flow-out condition and the end of power generation from the dam. The ceasing of power generation also stops lake withdrawals through the penstocks which pull water from the mid-lake depths. At level 4, water supply for the middle and lower Savannah will originate from sluices located lower within the water column. This causes several significant problems. Firstly, discharges of significant loads of reduced chemical species (i.e. Fe^{2+}, Mn^{2+}, HS^{-}), as a result of discharges through sluice gates, may cause increased costs to municipal users and/or unsuitable conditions for use within the CSRA. Secondly, loads of reduced iron, upon oxidation, can cause a significant pH decrease within the river and have an impact on the fragile shoals ecosystem. Finally, water feeding the river from sluice gates has never been the sole source for the Savannah, which means that the situation has no precedence. What will be mobilized from those historic sediments, will the shoals be able to handle the oxygen demand? It seems that sluice releases should be viewed as a last resort and other options should be favored (e.g. pumping and/or siphoning of water over the dam, etc). If oxygen demanding loads from the dam have never been considered by regulatory agencies, then loads from the dam will have to be established and taken into account in terms of total increased load (above current loads) of oxygen demanding substances to the harbor. This study will characterize and quantify those loads over the next year of study.

3.8 Tagged fish locations

The Cyber-infrastructure project, between Clemson University and SNSA for the Savannah River, will equip 5 of the permanent stations with hardware which will allow for real-time sonde data collection that will be accessible through the internet. One parameter that we will be working toward in the future is real-time tagged fish locations; however there was not enough money in the original budget for that work. Since the Savannah DO TMDL ultimately stems from the concern of low DO on survivability of 3 fish species, it seems necessary to address that issue within this proposal as well since there does not seem to be enough data to support such a claim. In light of all other parameters being addressed within this proposal, we propose to add tagged fish location to the continuous river cruises as a unique but important parameter to this study. The equipment will be added to the boat and as the boat passes an already tagged fish, it will record its location in reference to GPS coordinates and all other water quality parameters that are being proposed within this study, including continuous DO data. Not only is this a highly unique opportunity, it is expected to add considerably to the overall scope of work regarding the DO TMDL issue. We will be partnering with Jeff Isely at Clemson University since he has many tagged fish already in the Savannah River basin.

3.9 Study duration

Southeastern Natural Sciences Academy proposes to conduct this study for a total of 2 years. The first year of study will include all parameters as described above. During the second year, continuous data collection will continue as well as a minimum of two Lagrangian cruises. A final report (or collection of papers) will be available 24 months after the start of the project.

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Proposed budget

	monthly sampling					
Shealy	cost	instrument cost	# of sites	# of samples	**TOTAL**	
toc	21		8	14	$2,352.00	
doc	21		8	14	$2,352.00	
tic	21		8	14	$2,352.00	
alk	11		8	14	$1,232.00	
tkn	21		8	14	$2,352.00	
no3	16		8	14	$1,792.00	
nh3	21		8	14	$2,352.00	
phos	21		8	14	$2,352.00	
o-phos	21		8	14	$2,352.00	
icp metals	155		8	14	$17,360.00	
so4	16		8	14	$1,792.00	
cl	16		8	14	$1,792.00	
diss fe	26		8	14	$2,912.00	
					$43,344.00	
UGA-Culp						
lignophenol analyses	275		8	14	$30,800.00	
13C, N15, C:N seston	50		8	14	$5,600.00	
13C, N15, C:N periphyton	50		8	12	$4,800.00	
13C, N15, C:N macros	50		8	6	$2,400.00	
14C (dissolved inorganic and organic)	900		8	2	$14,400.00	
13C (CO2)	20		8	14	$2,240.00	
					$60,240.00	
Isotope Science Lab (Calgary)						
15N, 18O-NO3	150		8	14	**$16,800.00**	
32S, 18O-SO4	120		8	7	**$6,720.00**	
UGA-Maddox						
DOC/DIC-15N, 13C, C:N	150		8	14	**$16,800.00**	
SNSA						
BOD5		12,000			$12,000.00	
uBOD						
ash free dry mass						
SUVA		11,881			$11,881.00	
chlorophyll a						
TOC						
DOC		34,859			$34,859.00	
Total Nitrogen						
pCO2		Clemson				
total alkalinity		14,700			$14,700.00	
total inorganic carbon		40,500			$40,500.00	
organic acid pKa						
					$113,940.00	
Labor						
PI					$40,000.00	
Senior Sc					$80,000.00	
Re Sc 2					$36,225.00	
Re Sc 1					$32,000.00	
benefits					$48,938.50	26.00%
					$237,163.50	
other						
reagents, compressed air, filters, sample vials/bottles, fuel					**$30,000.00**	
computer					$1,000.00	
research vessel					**$20,000.00**	
fish location- Jeff Isely (Clemson)					**$23,000.00**	
discretionary for other isotope samples as needed					$10,000.00	
DIRECT COSTS					**$594,307.50**	
OVERHEAD RATE					**$154,519.95**	26%
					$748,827.45	
Year 2 funding (SNSA funded)						
Labor						
PI					$40,000.00	
Senior Sc						
Re Sc 2					$36,225.00	
Re Sc 1					$32,000.00	
benefits					$28,138.50	
					$136,363.50	

CSRA source characterization-3 industries				
cost per sample	**# ofindustries**	other sources	times/yr	**TOTAL**
765	3	7	2	**$15,300.00**
	IP	bottomland wetland		
	MESSERLY	brier creek		
	COLUMBIA CTY	SRS creek		
		Ebeneezer Creek		
		3 other		
		lake- accounted for in monthly sampling		
$143,904.00				

Engineering Services Committee Meeting
9/8/2008 1:00 PM
Property Condemnation Catherine T. James and Joann James Tapley

Department:	Attorney
Caption:	Motion to authorize condemnation to acquire title of a portion of property, designated as Butler Creek Upgrade East Project, 3491 Peach Orchard for permanent and temporary construction easements.
Background:	The City has been unable to reach an agreement to purchase the required easements on 3491 Peach Orchard Road, PIN 133-0-022-04-0. In order to proceed and avoid further delays, it is necessary to condemn a portion of subject property. The required property consists of a permanent easement of 22,999 square feet and a temporary construction easement of 9,274 square feet. The appraised value of the easements is $6,214.00.
Analysis:	Condemnation is necessary in order to acquire the easements.
Financial Impact:	The necessary costs will be covered by the project budget
Alternatives:	Deny condemnation.
Recommendation:	Approve condemnation.
Funds are Available in the Following Accounts:	Easement Purchase 60107 Butler Upgrade East 511043420-5411120 80360107-5411120

REVIEWED AND APPROVED BY:

Administrator.
Clerk of Commission

Engineering Services Committee Meeting
9/8/2008 1:00 PM
ROW Deborah P. Thomas and Brenda T. Tharpe

Department:	Attorney
Caption:	Approve an Option for Right-of-Way between Deborah P. Thomas and Brenda T. Tharpe, as owners, and Augusta, Georgia, for the property located at 1046 Alexander Drive for a purchase price of $42,100.00. 0.105 acre (4,571.61 sq. ft.) in fee and 0.038 acre (1,666.96 sq. ft.) of permanent construction & maintenance easement.
Background:	The property owners have agreed to convey the referenced right-of-way and easement to Augusta, Georgia for a total of $42,100.00, necessary for the Alexander Drive Project, GDOT Project No. – STP-0001-00(794), ARC Project No.: 323-04-296823215, Project Parcel 28 (Tax Map 013-1, Parcel 004).
Analysis:	The purchase of the referenced right-of-way and easement is necessary for the project.
Financial Impact:	The purchase of the referenced right-of-way and easement is within the project budget.
Alternatives:	Deny the request to approve the purchase of the referenced right-of-way and easement.
Recommendation:	Approve the purchase of the right-of-way and easement.
Funds are Available in the Following Accounts:	323041110-5411120 296823215-5411120

REVIEWED AND APPROVED BY:

Administrator.
Clerk of Commission

AUGUSTA, GEORGIA
OPTION FOR RIGHT-OF-WAY

GEORGIA, RICHMOND COUNTY
P.I.#: 0001794
~~S.S.N#:~~ FED ID# - 58-2055347

Received of Augusta, Georgia, the sum of one ($1.00) dollar, the receipt whereof is hereby acknowledged, and in consideration of the benefits derived by me from the proposed project mentioned herein, I bind myself, my heirs, executors and assigns as follows:

42 1m.-

If the said Augusta, Georgia, shall within 60 days after date hereof, pay me the sum of $ ~~27,100.00~~, then the undersigned agrees to execute and deliver to Augusta, Georgia, fee simple title and easements to the land owned by the undersigned, which is shown reflected in color on the right-of-way map attached hereto and made a part hereof by reference, to be used for highway purposes on the Alexander Drive Project, STP-0001-00(794), being Project Parcel 28, (Tax Map 013-1, Parcel(s) 004), consisting of 0.105 acre (4,571.61 sq. ft.) in fee and 0.038 acre (1,666.96 sq. ft.) of permanent construction & maintenance easement. Also granted is (are) one temporary driveway easement(s) on Alexander Drive Project, STP-0001-00(794)).

It is agreed and understood that TEMPORARY EASEMENTS are limited to the period required for the construction of said project and upon completion and acceptance of same by the Department of Transportation from the contractor, said TEMPORARY EASEMENT will terminate.

It is agreed and understood that I, or any tenant, now in possession or any other persons having a claim or interest in subject property, will have not less than two (2) months from date of execution of a deed and easements (or for residential properties three (3) months from the date replacement housing is available, whichever is greater) to vacate the premises and that on vacating of said premises, only items of personal property will be removed, all items attached to the property and being classed as realty to remain. The above agreement to apply unless otherwise provided in Special Provision. If Augusta, Georgia, agrees to allow the Grantor or tenant in possession to occupy the subject premises beyond the two month period stated above, that person will be required to pay a rental fee of N/A payable each month in advance. Subsequent to the date of transfer of title to Augusta, Georgia, and prior to vacation of subject premises, the person in possession will hold Augusta harmless as to any claim in connection with the occupancy of said premises. The above option price includes payment for the right-of-way above described, together with all improvements wholly or partially situated thereon and the right to enter upon the adjacent lands not included in said required right-of-way and easements, for the - purpose of removing or demolishing such improvements.

The undersigned further agrees that the Department will be designated an authorized agent for the removal of underground storage tank systems located wholly or partially in said right of way or easement.

************************SPECIAL PROVISION*********************

Grantor may retain title to N/A for sum of $ N/A, which shall be deducted from the option price at the time of closing, PROVIDED, he will obligate and firmly bind himself and his successors in title to strictly and faithfully comply with each of the following conditions:

1. Grantor will demolish or remove all above described improvements from the right-of-way, easements conveyed and set back area from the said right-of-way sufficient to comply with County Building Code requirements; however, in the absence of County Requirements, a minimum set back of 50 feet is required. All rubbish and debris must be removed to the satisfaction of authorized personnel of Augusta Engineering Department within 30 calendar days after notice to proceed.

2. Grantor will comply with all laws, ordinances, regulations, or building code applicable to demolition or removal of buildings in Richmond County, Georgia, and hold the Department of Transportation and Augusta, Georgia, harmless as to any claim in connection herein.

3. It is understood and agreed that no utility connections shall be made or allowed to relocated structures across or from a limited access right-of-way, and it is understood and agreed that grantor has agreed to bargain, sell, and convey to Augusta, Georgia, all existing utility rights, and Augusta will not be liable in any way for utility reconnections adjacent to acquired rights-of-way or any subsequent location improvements.

4. Grantor will leave on deposit with Augusta, Georgia, the additional sum of $ N/A, which will be deducted from the aforesaid option price at closing. This sum will be held as a cash performance bond conditioned on the strict and faithful performance of the aforesaid obligations.

PROJECT PARCEL 28
(Tax Map 013-1, Parcel No 004)

INITIALS BT

Item # 6

Time is expressly made of the essence of this Special Provision and in the event grantor fails to comply with aforesaid obligations, all sums held by Augusta, Georgia, shall be retained as liquidated damages, and title to and the right to remove said structures shall vest in the Augusta, Georgia.

************************OTHER PROVISIONS*****************************

Grantor may execute and deliver fee simple title to Augusta, Georgia, to the above referenced right of way and an additional _____ acres of land owned by the undersigned adjacent to an abutting on the above numbered highway for the total consideration of $ _______ which includes payment for the above referenced right of way requirements, other rights and conditions described herein and additional lands. This additional land being shown on the attached plat as Parcel No.

1. ESTIMATE FROM PLUMBER TO Hook up ~~to~~ Septic to County SEWER LINES - 1850.-
2. TAP ON FEE to Richmond County - 350.-

The undersigned herein agrees, for the same consideration, to provide, without cost to Augusta, Georgia, a quit claim deed or such other releases as may be required by the closing attorney from any tenant now in possession of subject property and any other parties having a claim or interest in subject property.

It is further agreed for said consideration to convey and relinquish to the City of Augusta all rights of access between the limited access highway and approaches thereto on the above numbered highway and all of the remaining real property of the undersigned except at such points as designated by the City of Augusta. This paragraph is not applicable unless access rights are indicated on the attached plat.

The said parcel of land as above indicated is shown upon plans on file in the office of Augusta Engineering, Augusta, Georgia, said plans being identified as Project Alexander Drive, STP-0001-00(794).

I (We) do (do not) elect to retain improvements as set out in Special Provision.

I (We) do (do not) elect to execute and deliver deeds set out in Other Provisions.

Item # 6

Witness my hand and seal this 8 day of MAY, 2008.

Signed, Sealed and Delivered
in the presence of:

____
Unofficial Witness

____
NOTARY PUBLIC

Notary Public, Richmond County, Georgia
My Commission Expires January 6, 2009

_______________________ (L.S.)
Deborah P. Thomas

_______________________ (L.S.)
Brenda T. Tharpe

_______________________ (L.S.)

AUGUSTA, GEORGIA

Administrator

____

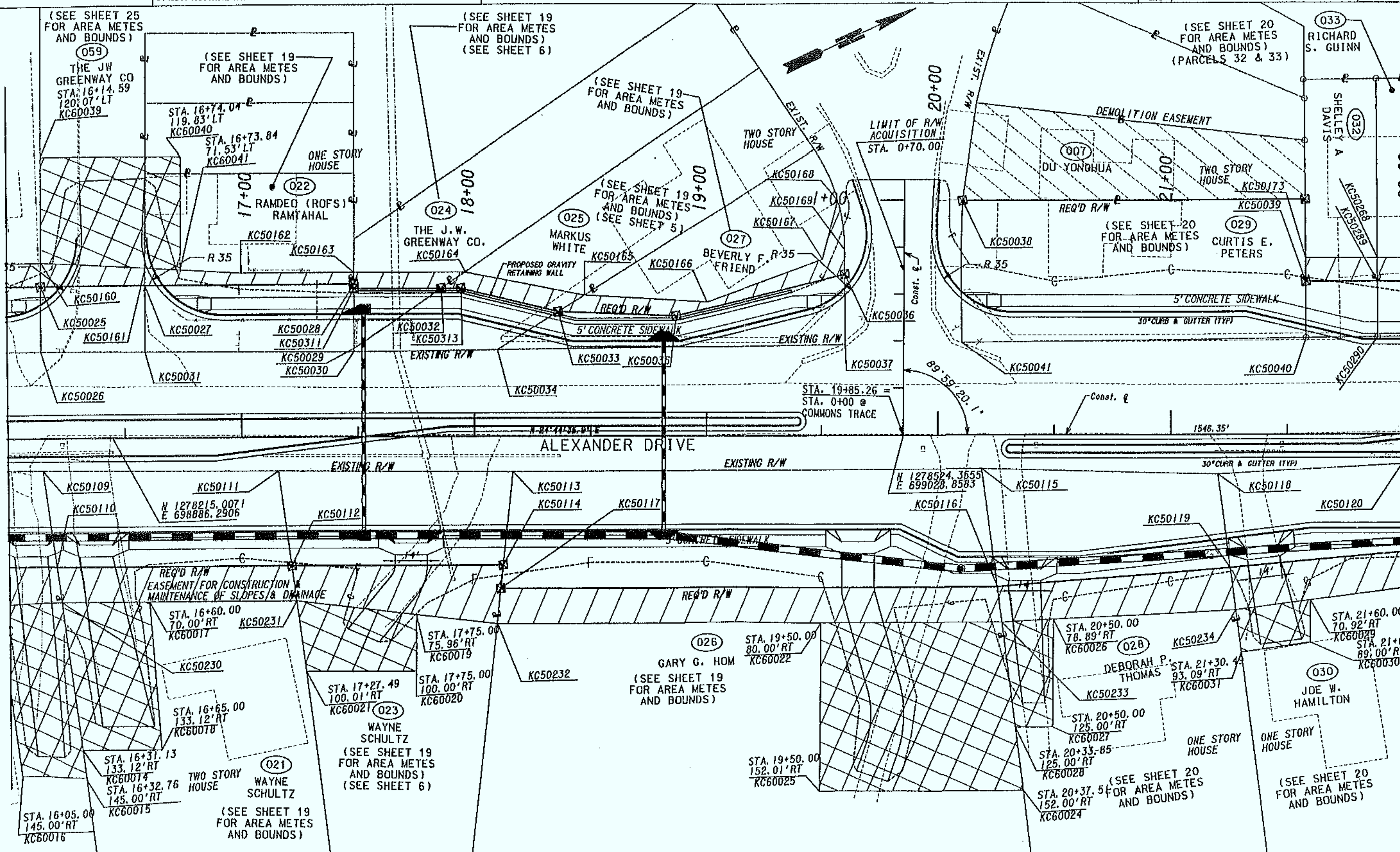
____

____

DATE_______________________

PROJECT PARCEL 28
(Tax Map 013-1, Parcel No 004)

2/2007	#PRF# C:\GDOT\GDOTROAD\TABLES\GPLOTBORDER.TBL	S:\001794\DGN\001794RW04.dgn(OH-45-49,57,60-62) GRWPLN	STATE	PROJECT NUMBER	SHEET NO.	TOTAL SHEETS
			GA	STP-0001-00(794)	06	25



PROPERTY AND EXISTING R/W LINE	
REQUIRED R/W LINE	
CONSTRUCTION LIMITS	
EASEMENT FOR CONSTR & MAINTENANCE OF SLOPES	
EASEMENT FOR CONSTR OF SLOPES	
EASEMENT FOR CONSTR OF DRIVES	

BEGIN LIMIT OF ACCESS............BLA
END LIMIT OF ACCESS..............ELA
LIMIT OF ACCESS
REQ'D R/W & LIMIT OF ACCESS

SCALE IN FEET
0 20 40 80

Cranston, Engineering Group, P.C.

DATE	REVISIONS	DATE	REVISIONS
01-31-07	REVISED EASEMENT & R/W FOR PARCELS 029, 007		

Item # 6

STATE OF GEORGIA
DEPARTMENT OF TRANSPORTATION
RIGHT OF WAY MAP
PROJECT NO: STP-0001-00(794)
COUNTY: RICHMOND
LAND LOT NO: N/A
LAND DISTRICT: N/A
GMD 90TH
DATE 5/4/06 SH 6 OF 25