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

COMMUNICATION

FROM

THE ASSISTANT SECRETARY OF THE ARMY, CIVIL WORKS, THE DEPARTMENT OF DEFENSE

TRANSMITTING

THE CORPS' FINAL GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

PART 3 OF 15

NOVEMBER 9, 2012.—Referred to the Committee on Transportation and Infrastructure and ordered to be printed

---

U.S. GOVERNMENT PRINTING OFFICE

81–592 WASHINGTON : 2013

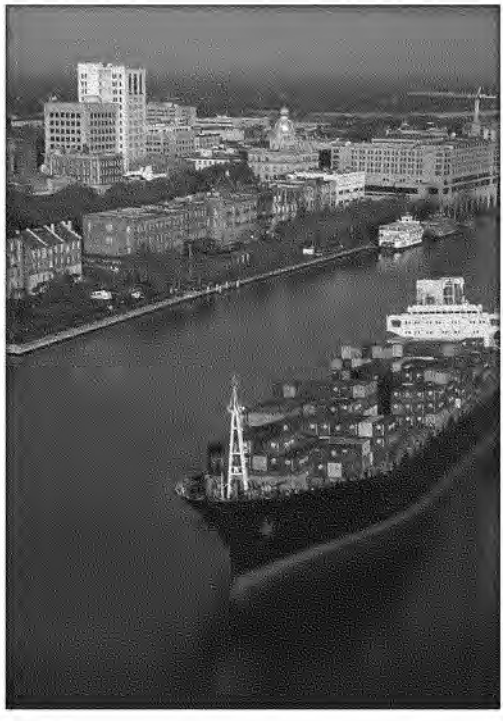
AUTHENTICATED
U.S. GOVERNMENT
INFORMATION
GPO

FINAL
GENERAL RE-EVALUATION REPORT
SAVANNAH HARBOR EXPANSION PROJECT
Chatham County, Georgia and Jasper County, South Carolina

January 2012
(Revised July 2012)

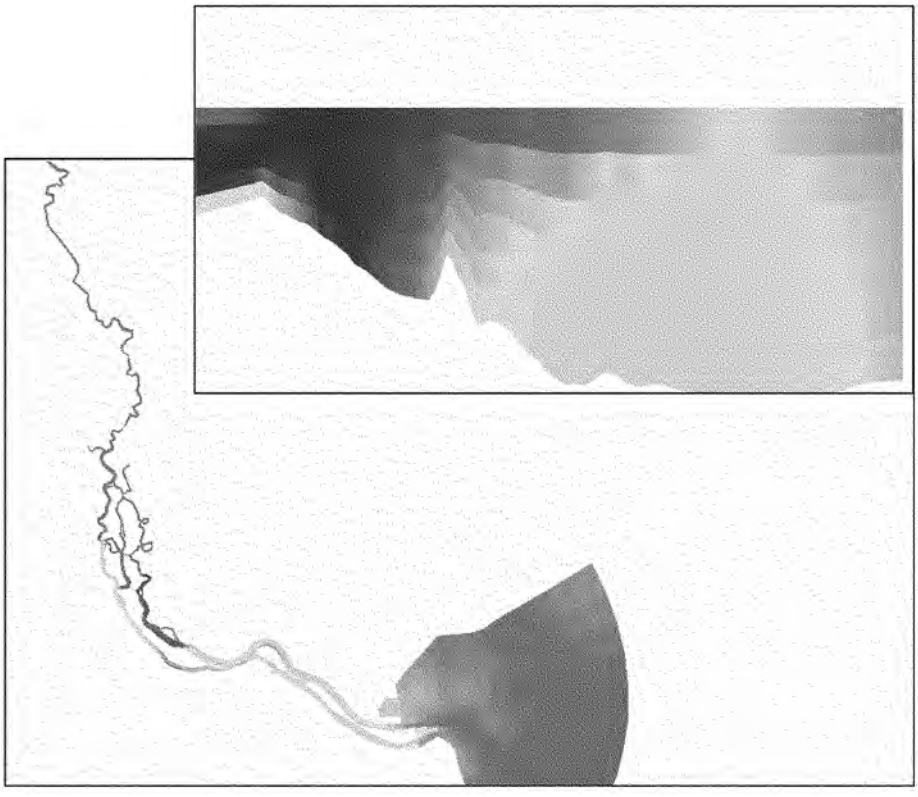
Appendix C
Attachment 3
Parts 6-15

Volume 3



US Army Corps of Engineers
Savannah District
South Atlantic Division

Habitat Impacts of the Savannah Harbor Expansion Project



PREPARED BY:

Tetra Tech, Inc.
2110 Powers Ferry Rd. SE, Suite 202
Atlanta, Georgia 30339
Phone: (770) 850-0949

PREPARED FOR:

USACE – Savannah District
100 West Oglethorpe Ave
Savannah, Georgia 31401
Contract No.: DACA65-99-D-0065-CV0101

October 12, 2006

Executive Summary

This report summarizes the results of the habitat impact runs for the Savannah Harbor Expansion (SHE) project.

The Savannah Harbor hydrodynamic and water quality models were developed and finalized in a Tetra Tech report dated January 30, 2006. The models were designed based on EFDC and WASP codes. A Savannah Harbor specified post-processor was developed by Tetra Tech to analyze the model results of various deepening scenarios. This is a stand-alone program that can read EFDC and WASP output files (BMD files) and generate required output in specific formats in accordance with requirements of the USACE Savannah District and the agencies involved in the Environmental Impact Statement (EIS) Tier II review

The hydrodynamic model runs were performed by the USACE Savannah District with the calibrated and confirmed EFDC model developed by Tetra Tech. The hydrodynamic model scenario assumes the constant Clyo flows during each simulated month: January and August 1999, and April and May 1997. The WASP outputs were generated by Tetra Tech and should be used to estimate the impact of 6 ft, 5 ft, 4 ft, 3 ft, and 2 ft harbor deepening on habitat.

For the current report the postprocessor was updated in accordance with the Memorandum for Records of the Meeting of Fisheries Interagency Coordination Team (June 1, 2006). MOVEM (standard postprocessor of WASP) was used to view the outputs of Tetra Tech's post-processor. These outputs are presented in the report's appendixes and include the following:

1. Tables of comparison of fish habitat areas for existing and deepening scenarios during the analyzed months
2. Figures with visualization of areas of suitable habitat for existing scenarios during the analyzed months
3. Figures with visualization of changes in areas of suitable habitat for deepening scenarios during the analyzed months
4. Tables of suitable habitat criteria pass / failure for existing and deepening scenarios within the analyzed months

The model results for the habitat review group are presented in following Appendixes:

- Appendix A – August 1999 50th %ile of Clyo flow
- Appendix B – January 1999 50th %ile of Clyo flow
- Appendix C – April 1997 20th %ile of Clyo flow
- Appendix D – April 1997 50th %ile of Clyo flow
- Appendix E – April 1997 80th %ile of Clyo flow
- Appendix F – May 1997 20th %ile of Clyo flow
- Appendix G – May 1997 50th %ile of Clyo flow
- Appendix H – May 1997 80th %ile of Clyo flow

Due to large volumes of pass / failure tables, they were placed into sub-appendixes: A-1, A-2, A-3, B-1, B-2, B-3, C-1, C-2, D-1, D-2, E-1, E-2, F-1, F-2, G-1, G-2, H-1, and H-2.

The report is accompanied by the original postprocessor outputs: TXT and BMD files. MOVEM postprocessor and GIS horizontal shape files for working with BMD files are included in the attached DVD. The reviewer has the opportunity of interacting with habitat scenarios outputs.

The suitable habitat criteria were collected and passed to Tetra Tech by the Savannah Division of the USACE. The criteria are presented in correspondent tables of suitable habitat criteria pass / failure (Sub- appendixes A-1 - I-2).

The suitable habitat criteria use the term "Exceedance" for definition of salinity and dissolved oxygen concentrations that limit the areas of suitable habitat. The criteria values of Percentage of Exceedance were converted to values of Percentile and used by the Savannah Harbor postprocessor for calculations of habitat areas locations.

A **percentile** is a value on a scale of one hundred that indicates the percent of a distribution that is equal to or below it. In some studies, a variation of the percentile known as the "percent exceedance" is used. It is simply obtained by subtracting the percentile scale value from 100 percent. For example, a discharge at the 75th percentile is the same as a discharge at the 25th percent exceedance (100-75=25).
http://water.usgs.gov/waterwatch/ptile.html

The water quality simulations' results allow making the following general conclusions:

- The suitable habitat areas of Southern Flounder, Shortnose Sturgeon Adults and Juveniles, and Striped Bass Spawning and Eggs are linearly decreased with increasing of the harbor deepening.
- The American Shad suitable habitat area is located in the top half of a water column. The D.O. concentrations in the top part of a water column in a stratified estuary do not depend on salinity as strongly as in a bottom part. The reaeration is the most important factor of the D.O. regime in surface layers of the water column. Temperature can also be a factor of D.O. regime formation during the warm summer months.
- American Shad experiences a very small impact of the harbor deepening. The impact can be identified only during a warm summer period (August 1999). The small nonlinearity of the deepening impact on 10th percentile of D.O. concentration in a top half of the harbor water column can be explained by the permanent trade between negative impact of the increased salinity intrusion and positive influence of the increased density stratification.
- Striped Bass Larvae suitable habitat requirement to salinity is: 50th %ile >=3 & <= 9 ppt. This requirement creates nonlinearity in the habitat area reaction on flow and deepening. Deepening pushes the salinity zone (50th %ile >=3 & <= 9) upstream, and an increase in flow pushes the zone downstream. . The size and location of the zone depend on the balance of these two opposite pushes. The size of the zone is a function of its location; the location of the zone is a function of salinity intrusion. D.O. acts as the secondary factor for the Striped Bass Larvae suitable habitat area formation. The Figures G.2.2 – G.2.6 display the changes in a size of the habitat suitable area under the influence of the harbor deepening.

Appendix A

AUGUST 1999

50th %ile of Clyo Flow

Habitat Analysis Output

Fisheries Review Group

1. Table A.1. Comparisons of Southern Flounder, American Shad and Sturgeon Adult habitat areas for existing and deepening (6 ft) scenarios within the analyzed period August 1 - August 31, 1999

	Baseline Scenario		Project Scenario		% Change
Southern Flounder	0.402031	km2	0.319004	km2	-20.7
American Shad	15.191188	km2	14.905516	km2	-1.9
Sturgeon Adults	0.292598	km2	0.170142	km2	-41.9

2. Table A.2. Comparisons of Southern Flounder, American Shad and Sturgeon Adult habitat areas for existing and deepening (4 ft) scenarios within the analyzed period August 1 - August 31, 1999

	Baseline Scenario		Project Scenario		% Change
Southern Flounder	0.402031	km2	0.328893	km2	-18.2
American Shad	15.191188	km2	15.123485	km2	-0.4
Sturgeon Adults	0.292598	km2	0.178336	km2	-39.1

3. Table A.3. Comparisons of Southern Flounder, American Shad and Sturgeon Adult habitat areas for existing and deepening (3 ft) scenarios within the analyzed period August 1 - August 31, 1999

	Baseline Scenario		Project Scenario		% Change
Southern Flounder	0.402031	km2	0.340264	km2	-15.4
American Shad	15.191188	km2	15.123485	km2	-0.4
Sturgeon Adults	0.292598	km2	0.193631	km2	-33.8

4. Table A.4. Comparisons of Southern Flounder, American Shad and Sturgeon Adult habitat areas for existing and deepening (2 ft) scenarios within the analyzed period August 1 - August 31, 1999

	Baseline Scenario		Project Scenario		% Change
Southern Flounder	0.402031	km2	0.348685	km2	-13.3
American Shad	15.191188	km2	14.973217	km2	-1.4
Sturgeon Adults	0.292598	km2	0.215859	km2	-26.2

5. Table A.6.1. Southern Flounder D.O. and Slope criteria passing for existing and deepening (6 ft) scenarios within the analyzed period August 1 - August 31, 1999
(See Appendix A-1)

6. Table A.6.2. Southern Flounder D.O. and Slope criteria passing for existing and deepening (4 ft) scenarios within the analyzed period August 1 - August 31, 1999
(See Appendix A-1)

7. Table A.6.3. Southern Flounder D.O. and Slope criteria passing for existing and deepening (3 ft) scenarios within the analyzed period August 1 - August 31, 1999
(See Appendix A-1)

8. Table A.6.4. Southern Flounder D.O. and Slope criteria passing for existing and deepening (2 ft) scenarios within the analyzed period August 1 - August 31, 1999
(See Appendix A-1)

9. Table A.7.1. American Shad D.O. criteria passing for existing and deepening (6 ft) scenarios within the analyzed period August 1 - August 31, 1999
(See Appendix A-2)

10. Table A.7.2. American Shad D.O. criteria passing for existing and deepening (4 ft) scenarios within the analyzed period August 1 - August 31, 1999
(See Appendix A-2)

11. Table A.7.3. American Shad D.O. criteria passing for existing and deepening (3 ft) scenarios within the analyzed period August 1 - August 31, 1999
(See Appendix A-2)

12. Table A.7.4. American Shad D.O. criteria passing for existing and deepening (2 ft) scenarios within the analyzed period August 1 - August 31, 1999
(See Appendix A-2)

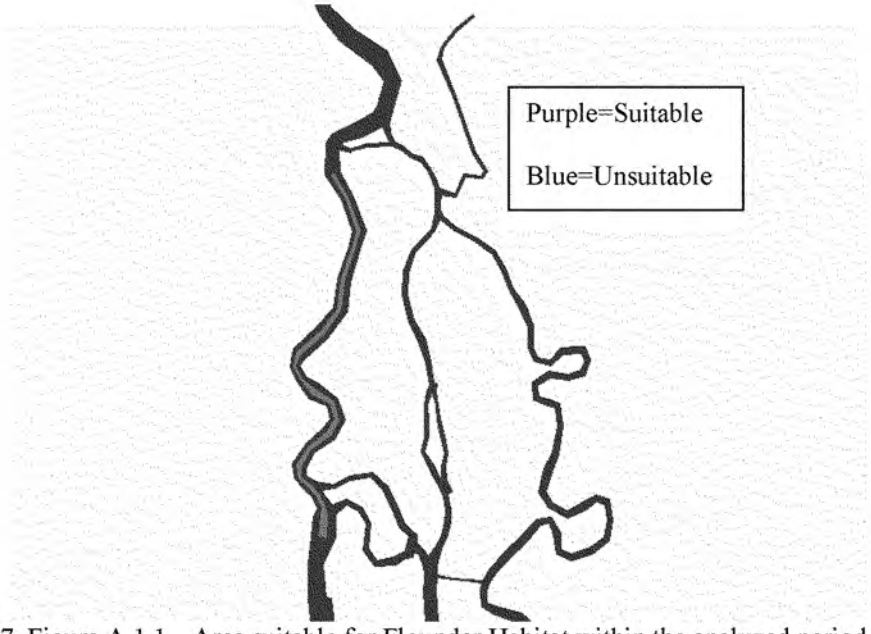
13. Table A.8.1. Sturgeon adults salinity and DO criteria passing criteria passing for existing and deepening (6 ft) scenarios within the analyzed period August 1 - August 31, 1999
(See Appendix A-3)

14. Table A.8.2. Sturgeon adults salinity and DO criteria passing criteria passing for existing and deepening (4 ft) scenarios within the analyzed period August 1 - August 31, 1999
(See Appendix A-3)

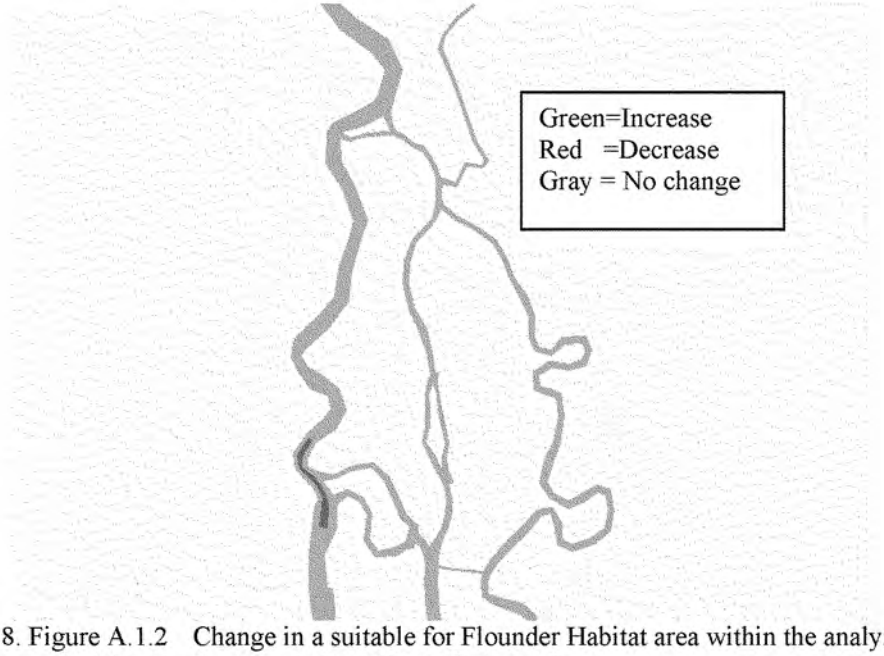
15. Table A.8.3. Sturgeon adults salinity and DO criteria passing criteria passing for existing and deepening (3 ft) scenarios within the analyzed period August 1 - August 31, 1999
(See Appendix A-3)

16. Table A.8.4. Sturgeon adults salinity and DO criteria passing criteria passing for existing and deepening (2 ft) scenarios within the analyzed period August 1 - August 31, 1999

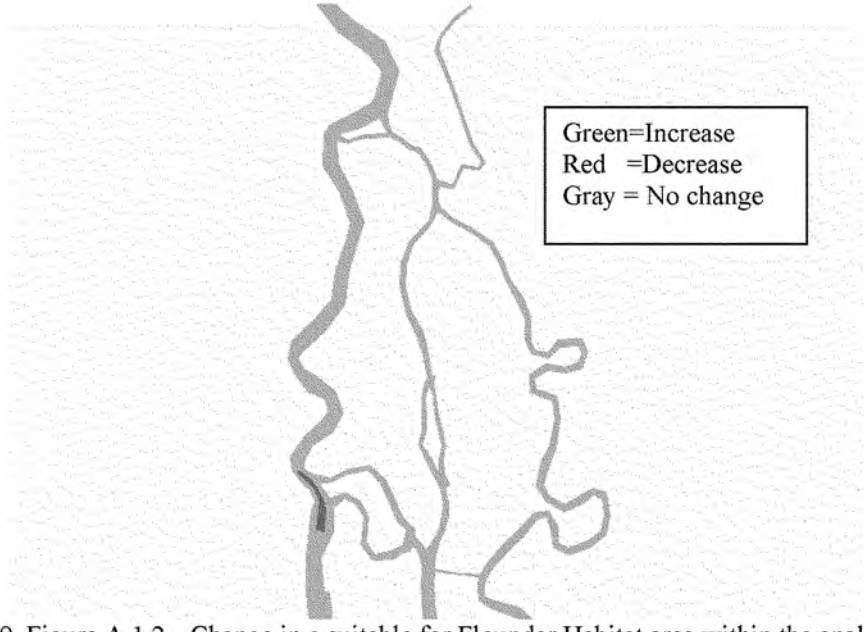
(See Appendix A-3)



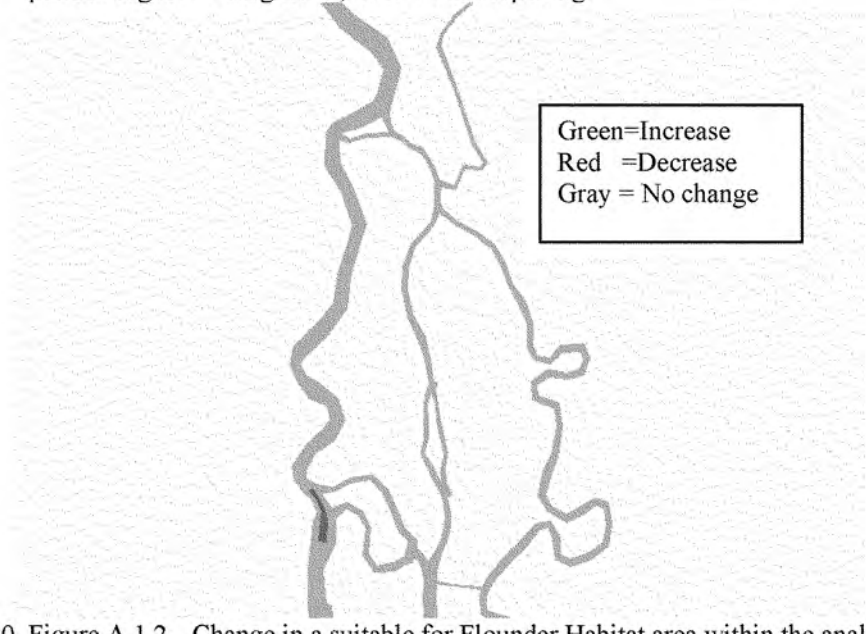
17. Figure A.1.1 Area suitable for Flounder Habitat within the analyzed period August 1 - August 31, 1999 : Existing bathymetry



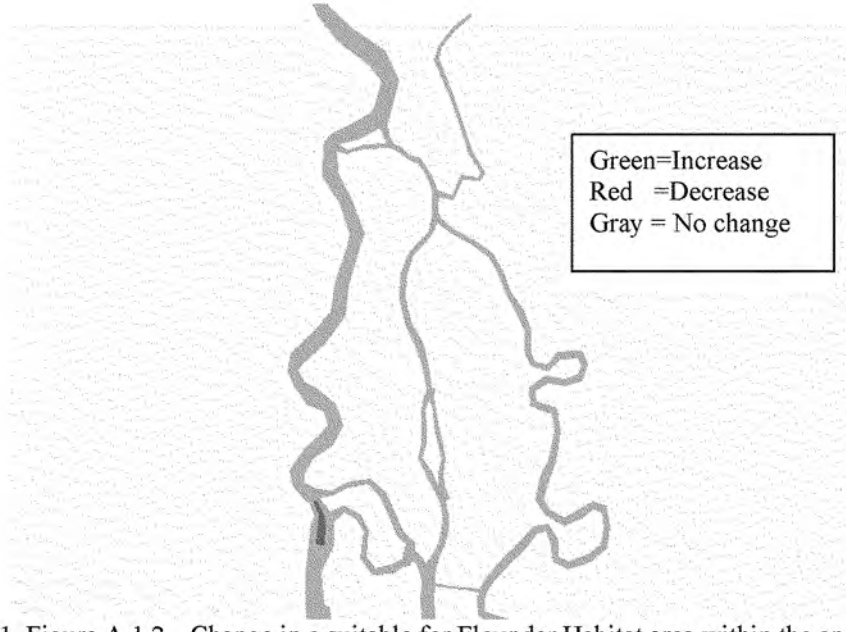
18. Figure A.1.2 Change in a suitable for Flounder Habitat area within the analyzed period August 1 - August 31, 1999 : 6 ft deepening



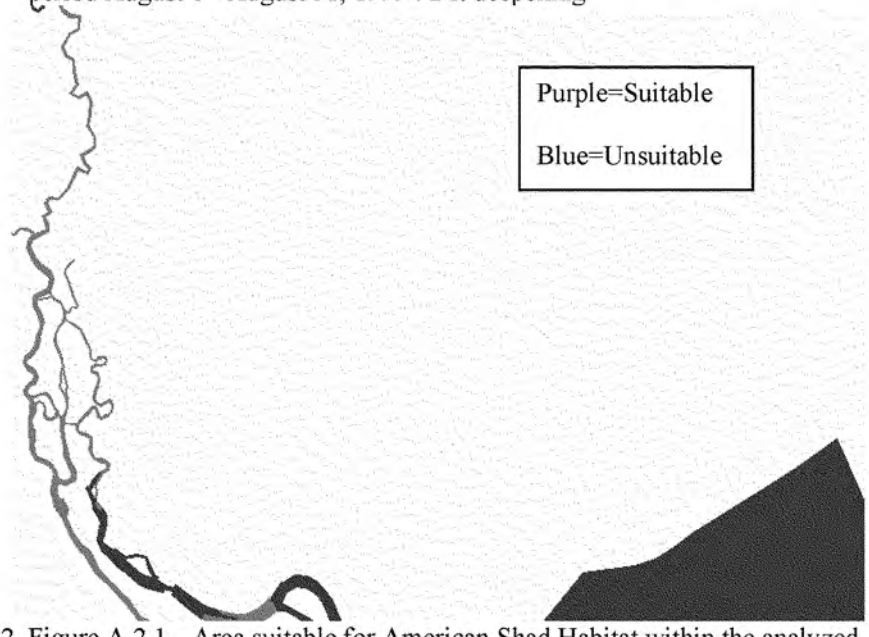
19. Figure A.1.2 Change in a suitable for Flounder Habitat area within the analyzed period August 1 - August 31, 1999 : 4 ft deepening



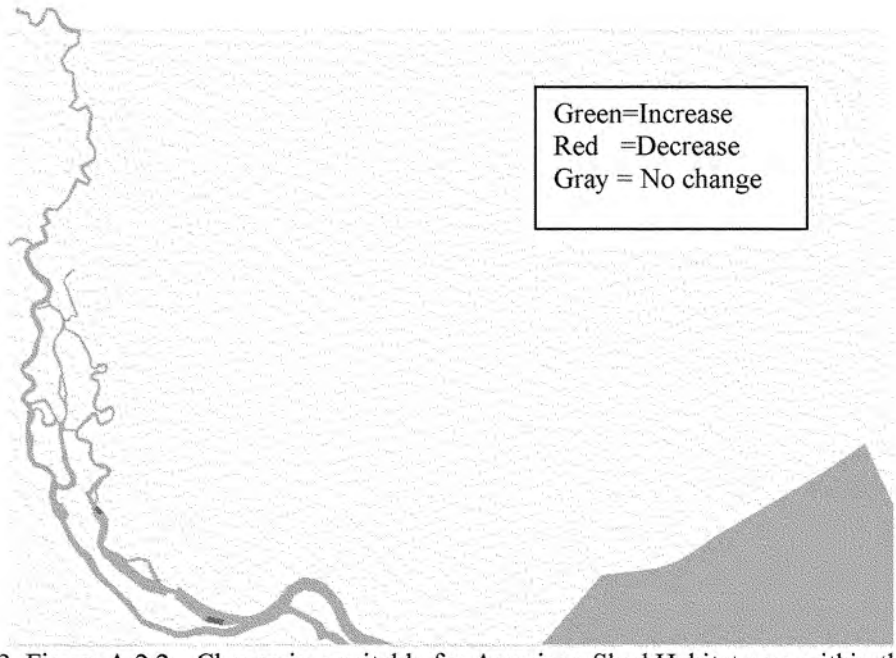
20. Figure A.1.2 Change in a suitable for Flounder Habitat area within the analyzed period August 1 - August 31, 1999 : 3 ft deepening



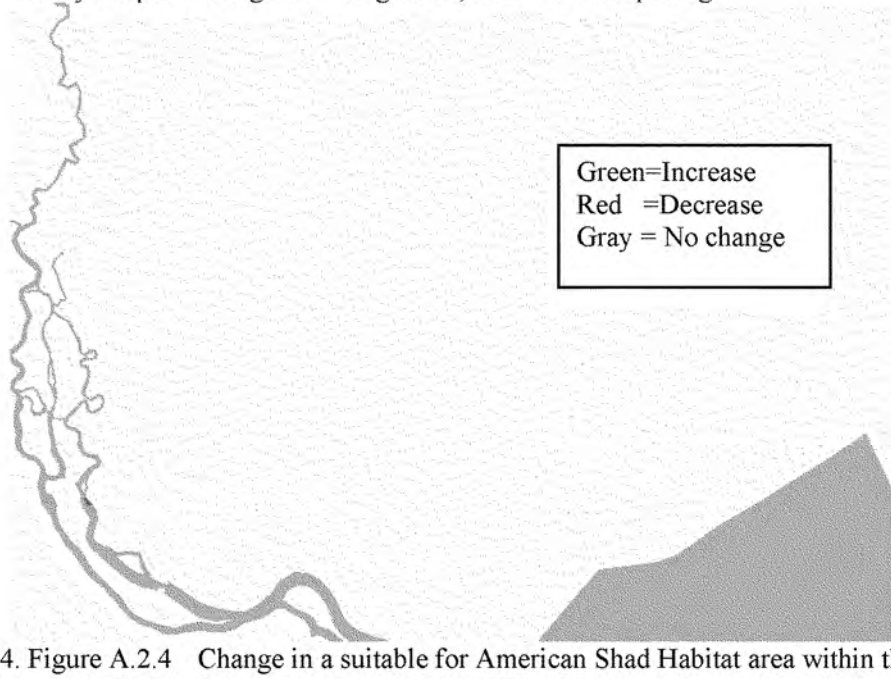
21. Figure A.1.2 Change in a suitable for Flounder Habitat area within the analyzed period August 1 - August 31, 1999 : 2 ft deepening



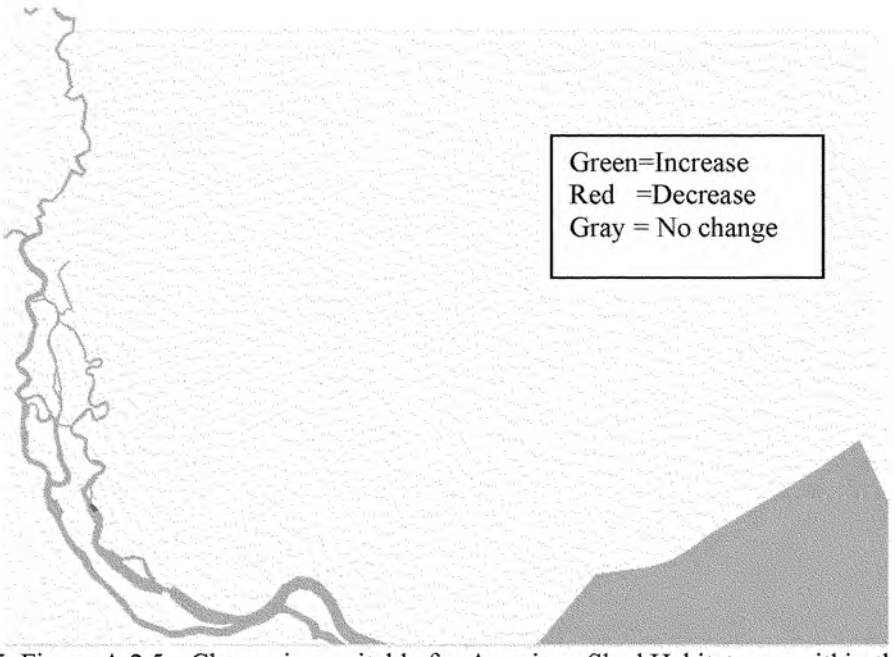
22. Figure A.2.1 Area suitable for American Shad Habitat within the analyzed period August 1 - August 31, 1999 : Existing bathymetry



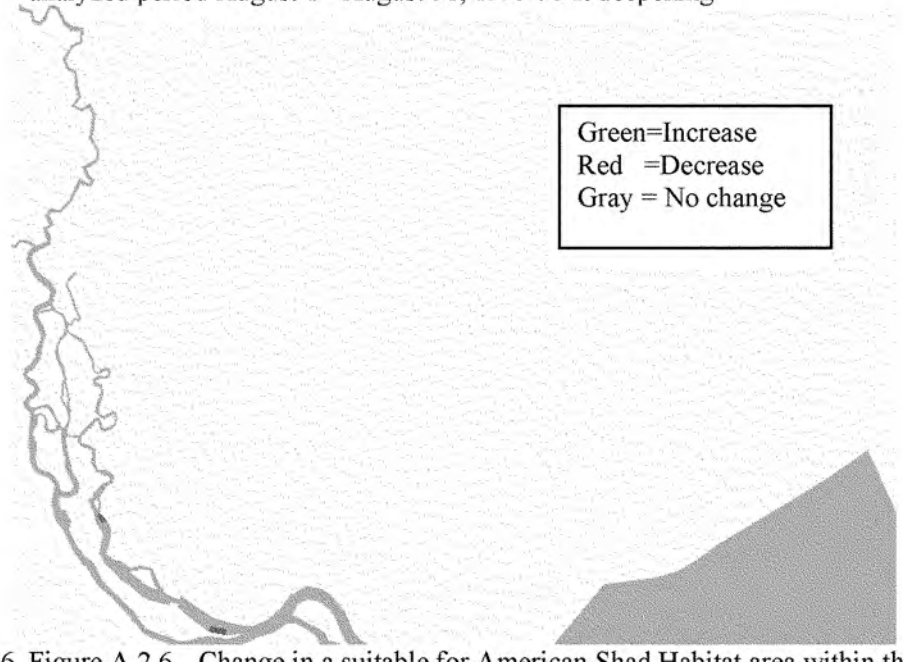
23. Figure A.2.2 Change in a suitable for American Shad Habitat area within the analyzed period August 1 - August 31, 1999 : 6 ft deepening



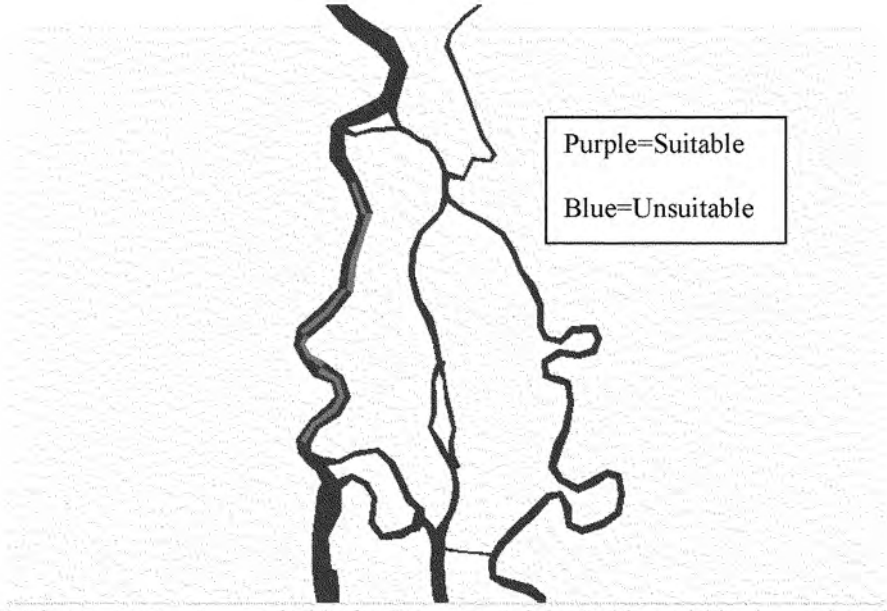
24. Figure A.2.4 Change in a suitable for American Shad Habitat area within the analyzed period August 1 - August 31, 1999 : 4 ft deepening



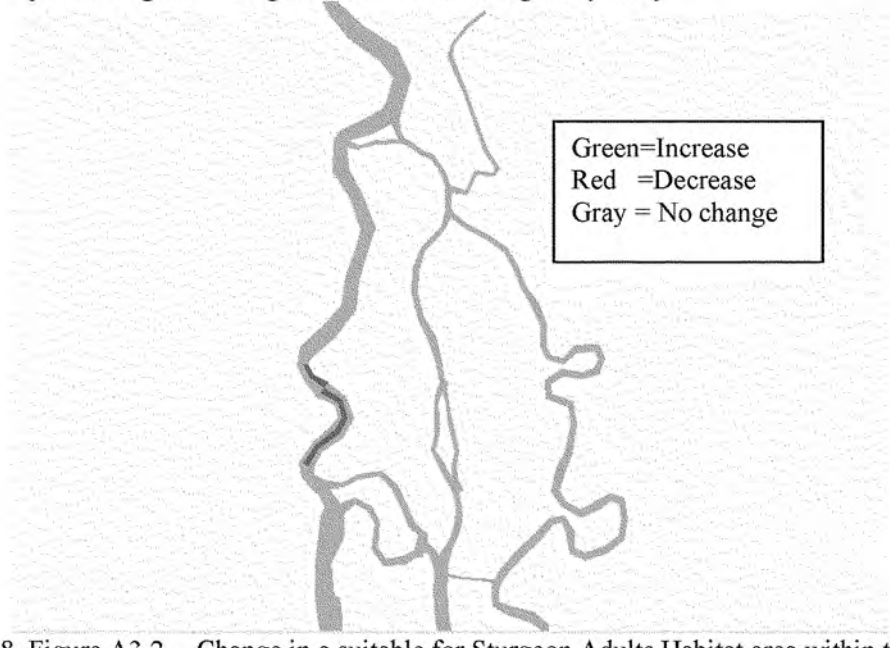
25. Figure A.2.5 Change in a suitable for American Shad Habitat area within the analyzed period August 1 - August 31, 1999 : 3 ft deepening



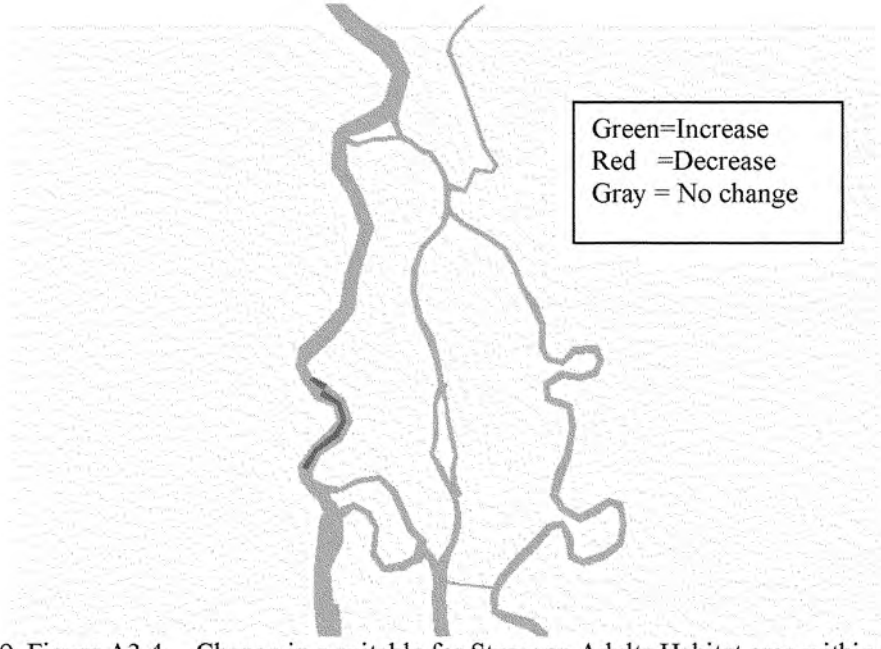
26. Figure A.2.6 Change in a suitable for American Shad Habitat area within the analyzed period August 1 - August 31, 1999 : 2 ft deepening



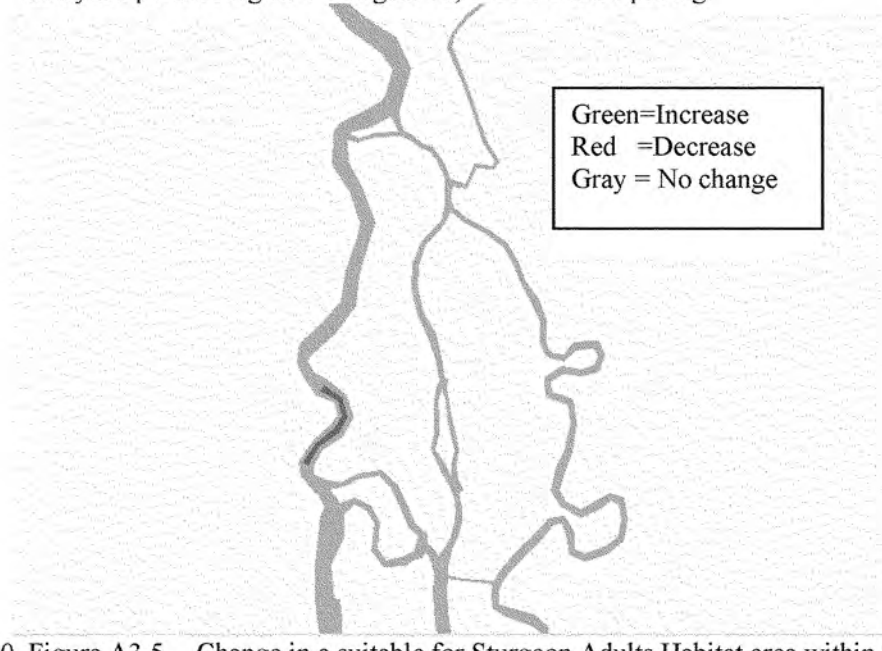
27. Figure A3.1 Area suitable for Sturgeon Adults Habitat within the analyzed period August 1 - August 31, 1999 : Existing bathymetry



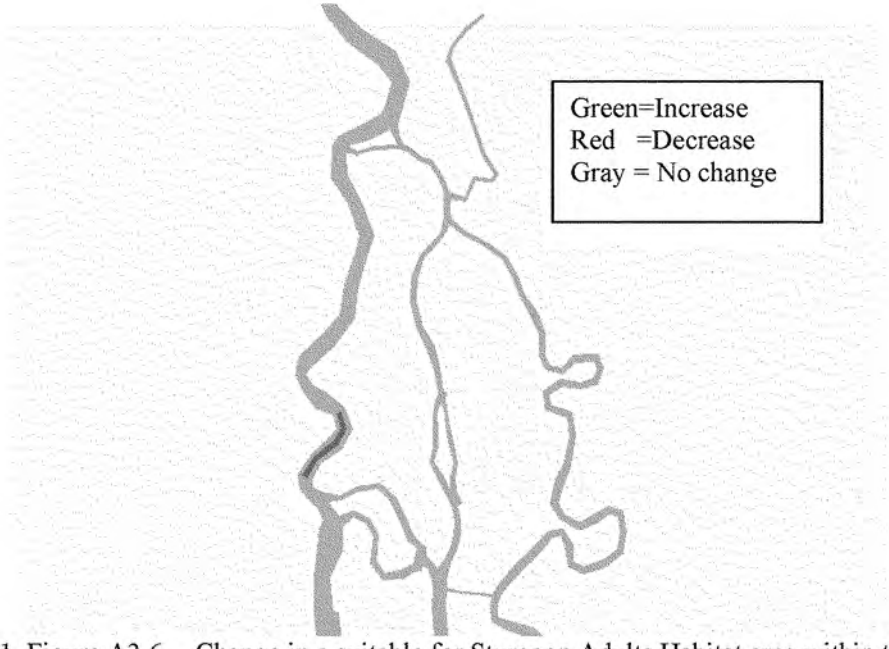
28. Figure A3.2 Change in a suitable for Sturgeon Adults Habitat area within the analyzed period August 1 - August 31, 1999 : 6 ft deepening



29. Figure A3.4 Change in a suitable for Sturgeon Adults Habitat area within the analyzed period August 1 - August 31, 1999 : 4 ft deepening



30. Figure A3.5 Change in a suitable for Sturgeon Adults Habitat area within the analyzed period August 1 - August 31, 1999 : 3 ft deepening



31. Figure A3.6 Change in a suitable for Sturgeon Adults Habitat area within the analyzed period August 1 - August 31, 1999 : 2 ft deepening

Appendix A-1

Tables of Criteria Passing for Southern Flounder Habitat Suitability

August 1999

50th %ile of Clyo Flow

Fisheries Review Group

1. Table A.6.1. Southern Flounder D.O. and Slope criteria passing for existing and deepening (6 ft) scenarios within the analyzed period August 1 - August 31, 1999

HABITAT REQUIREMENTS:
RM 10-31; Bottom Layer, Slope <=5%
D.O. August (MG/L):10th %ile >=4.0

Savannah Harbor Estuary

Segments		Baseline Scenario		Project Scenario	
J	I	D.O.	Slope	D.O.	Slope
47	13	Fail	Fail	Fail	Fail
47	14	Fail	Pass	Fail	Pass
47	15	Fail	Fail	Fail	Fail
47	16	Fail	Pass	Fail	Pass
47	17	Fail	Fail	Fail	Fail
48	13	Fail	Fail	Fail	Fail
48	14	Fail	Pass	Fail	Pass
48	15	Fail	Fail	Fail	Fail
48	16	Fail	Pass	Fail	Pass
48	17	Fail	Fail	Fail	Fail
49	13	Fail	Fail	Fail	Fail
49	14	Fail	Pass	Fail	Pass
49	15	Fail	Fail	Fail	Fail
49	16	Fail	Pass	Fail	Pass
49	17	Fail	Pass	Fail	Pass
50	13	Fail	Fail	Fail	Fail
50	14	Fail	Pass	Fail	Pass
50	15	Fail	Fail	Fail	Fail
50	16	Fail	Fail	Fail	Fail
50	17	Fail	Pass	Fail	Pass
50	18	Fail	Fail	Fail	Fail
51	13	Fail	Fail	Fail	Fail
51	14	Fail	Pass	Fail	Pass
51	15	Fail	Fail	Fail	Fail
52	13	Fail	Fail	Fail	Fail
52	14	Fail	Pass	Fail	Pass
52	15	Fail	Fail	Fail	Fail
53	13	Fail	Fail	Fail	Fail
53	14	Fail	Pass	Fail	Pass
53	15	Fail	Fail	Fail	Fail
54	13	Fail	Fail	Fail	Fail
54	14	Fail	Pass	Fail	Pass
54	15	Fail	Fail	Fail	Fail
55	13	Fail	Fail	Fail	Fail
55	14	Fail	Pass	Fail	Pass
55	15	Fail	Fail	Fail	Fail
56	13	Fail	Fail	Fail	Fail
56	14	Fail	Pass	Fail	Pass
56	15	Fail	Fail	Fail	Fail
57	13	Fail	Fail	Fail	Fail
57	14	Fail	Pass	Fail	Pass
57	15	Fail	Fail	Fail	Fail
58	13	Fail	Fail	Fail	Fail

58	14	Fail	Pass	Fail	Pass
58	15	Fail	Fail	Fail	Fail
59	13	Fail	Fail	Fail	Fail
59	14	Fail	Pass	Fail	Pass
59	15	Fail	Fail	Fail	Fail
59	30	Fail	Fail	Fail	Fail
59	31	Fail	Pass	Fail	Pass
59	32	Fail	Fail	Fail	Fail
60	13	Fail	Fail	Fail	Fail
60	14	Fail	Pass	Fail	Pass
60	15	Fail	Fail	Fail	Fail
60	30	Fail	Fail	Fail	Fail
60	31	Fail	Pass	Fail	Pass
60	32	Fail	Fail	Fail	Fail
61	13	Fail	Fail	Fail	Fail
61	14	Fail	Pass	Fail	Pass
61	15	Fail	Fail	Fail	Fail
61	30	Fail	Fail	Fail	Fail
61	31	Fail	Pass	Fail	Pass
61	32	Fail	Fail	Fail	Fail
62	13	Fail	Fail	Fail	Fail
62	14	Fail	Pass	Fail	Pass
62	15	Fail	Fail	Fail	Fail
62	30	Fail	Fail	Fail	Fail
62	31	Fail	Pass	Fail	Pass
62	32	Fail	Fail	Fail	Fail
63	13	Fail	Fail	Fail	Fail
63	14	Fail	Pass	Fail	Pass
63	15	Fail	Fail	Fail	Fail
63	31	Fail	Pass	Fail	Pass
64	13	Fail	Fail	Fail	Fail
64	14	Fail	Pass	Fail	Pass
64	15	Fail	Fail	Fail	Fail
64	30	Fail	Pass	Fail	Pass
64	31	Fail	Pass	Fail	Pass
64	32	Fail	Pass	Fail	Pass
65	13	Fail	Fail	Fail	Fail
65	14	Fail	Pass	Fail	Pass
65	15	Fail	Fail	Fail	Fail
65	30	Fail	Pass	Fail	Pass
65	31	Fail	Pass	Fail	Pass
65	32	Fail	Pass	Fail	Pass
65	33	Fail	Pass	Fail	Pass
66	13	Fail	Fail	Fail	Fail
66	14	Fail	Pass	Fail	Pass
66	15	Fail	Fail	Fail	Fail
66	30	Fail	Pass	Fail	Pass
66	31	Fail	Pass	Fail	Pass
66	32	Fail	Pass	Fail	Pass
66	36	Fail	Pass	Fail	Pass
67	13	Fail	Fail	Fail	Fail
67	14	Fail	Pass	Fail	Pass
67	15	Fail	Fail	Fail	Fail
67	30	Fail	Pass	Fail	Pass
67	31	Fail	Pass	Fail	Pass
67	32	Fail	Pass	Fail	Pass
67	36	Fail	Pass	Fail	Pass

68	13	Fail	Fail	Fail	Fail
68	14	Fail	Pass	Fail	Pass
68	15	Fail	Fail	Fail	Fail
68	30	Fail	Pass	Fail	Pass
68	31	Fail	Pass	Fail	Pass
68	32	Fail	Pass	Fail	Pass
68	36	Fail	Pass	Fail	Pass
69	13	Fail	Fail	Fail	Fail
69	14	Fail	Pass	Fail	Pass
69	15	Fail	Fail	Fail	Fail
69	30	Fail	Pass	Fail	Pass
69	31	Fail	Pass	Fail	Pass
69	32	Fail	Pass	Fail	Pass
69	36	Fail	Pass	Fail	Pass
70	13	Fail	Fail	Fail	Fail
70	14	Fail	Pass	Fail	Pass
70	15	Fail	Fail	Fail	Fail
70	30	Fail	Pass	Fail	Pass
70	31	Fail	Pass	Fail	Pass
70	32	Fail	Pass	Fail	Pass
70	33	Fail	Pass	Fail	Pass
71	13	Fail	Fail	Fail	Fail
71	14	Fail	Pass	Fail	Pass
71	15	Fail	Fail	Fail	Fail
71	30	Fail	Pass	Fail	Pass
71	31	Fail	Pass	Fail	Pass
71	32	Fail	Pass	Fail	Pass
72	13	Fail	Fail	Fail	Fail
72	14	Fail	Pass	Fail	Pass
72	15	Fail	Fail	Fail	Fail
72	30	Fail	Pass	Fail	Pass
72	31	Fail	Pass	Fail	Pass
72	32	Fail	Pass	Fail	Pass
73	13	Fail	Fail	Fail	Fail
73	14	Fail	Pass	Fail	Pass
73	15	Fail	Fail	Fail	Fail
73	30	Fail	Pass	Fail	Pass
73	31	Fail	Pass	Fail	Pass
74	13	Fail	Fail	Fail	Fail
74	14	Fail	Pass	Fail	Pass
74	15	Fail	Fail	Fail	Fail
74	30	Fail	Pass	Fail	Pass
74	31	Fail	Pass	Fail	Pass
75	13	Fail	Fail	Fail	Fail
75	14	Fail	Pass	Fail	Pass
75	15	Fail	Fail	Fail	Fail
75	30	Fail	Pass	Fail	Pass
75	31	Fail	Pass	Fail	Pass
76	13	Fail	Fail	Fail	Fail
76	14	Fail	Pass	Fail	Pass
76	15	Fail	Pass	Fail	Pass
76	16	Fail	Pass	Fail	Pass
76	17	Fail	Fail	Fail	Fail
76	30	Fail	Pass	Fail	Pass
76	31	Fail	Pass	Fail	Pass
77	13	Fail	Fail	Fail	Fail
77	14	Fail	Pass	Fail	Pass

77	15	Fail	Pass	Fail	Pass
77	16	Fail	Pass	Fail	Pass
77	17	Fail	Fail	Fail	Fail
77	30	Fail	Pass	Fail	Pass
77	31	Fail	Pass	Fail	Pass
78	13	Fail	Fail	Fail	Fail
78	14	Fail	Pass	Fail	Pass
78	15	Fail	Pass	Fail	Pass
78	16	Fail	Pass	Fail	Pass
78	17	Fail	Fail	Fail	Fail
78	30	Fail	Pass	Fail	Pass
78	31	Fail	Pass	Fail	Pass
79	13	Fail	Fail	Fail	Fail
79	14	Fail	Pass	Fail	Pass
79	15	Fail	Fail	Fail	Fail
79	30	Fail	Pass	Fail	Pass
79	31	Fail	Pass	Fail	Pass
80	13	Fail	Fail	Fail	Fail
80	14	Fail	Pass	Fail	Pass
80	15	Fail	Fail	Fail	Fail
80	30	Fail	Pass	Fail	Pass
80	31	Fail	Pass	Fail	Pass
81	13	Fail	Fail	Fail	Fail
81	14	Fail	Pass	Fail	Pass
81	15	Fail	Fail	Fail	Fail
81	30	Fail	Pass	Fail	Pass
81	31	Fail	Pass	Fail	Pass
82	13	Fail	Fail	Fail	Fail
82	14	Fail	Pass	Fail	Pass
82	15	Fail	Fail	Fail	Fail
82	16	Fail	Pass	Fail	Pass
82	17	Fail	Pass	Fail	Pass
82	18	Fail	Pass	Fail	Pass
82	19	Fail	Pass	Fail	Pass
82	20	Fail	Pass	Fail	Pass
82	21	Fail	Pass	Fail	Pass
82	29	Fail	Pass	Fail	Pass
82	30	Fail	Pass	Fail	Pass
82	31	Fail	Pass	Fail	Pass
83	13	Fail	Fail	Fail	Fail
83	14	Fail	Pass	Fail	Pass
83	15	Fail	Fail	Fail	Fail
83	21	Fail	Pass	Fail	Pass
83	30	Fail	Pass	Fail	Pass
83	31	Fail	Pass	Fail	Pass
84	13	Fail	Fail	Fail	Fail
84	14	Fail	Pass	Fail	Pass
84	15	Fail	Fail	Fail	Fail
84	21	Fail	Pass	Fail	Pass
84	30	Fail	Pass	Fail	Pass
84	31	Fail	Pass	Fail	Pass
85	13	Fail	Fail	Fail	Fail
85	14	Fail	Pass	Fail	Pass
85	15	Fail	Fail	Fail	Fail
85	21	Fail	Pass	Fail	Pass
85	30	Fail	Pass	Fail	Pass
86	13	Fail	Fail	Fail	Fail

86	14	Fail	Pass	Fail	Pass
86	15	Fail	Fail	Fail	Fail
86	21	Fail	Pass	Fail	Pass
86	30	Fail	Pass	Fail	Pass
87	13	Fail	Fail	Fail	Fail
87	14	Fail	Pass	Fail	Pass
87	15	Fail	Fail	Fail	Fail
87	30	Fail	Pass	Fail	Pass
88	13	Fail	Fail	Fail	Fail
88	14	Fail	Pass	Fail	Pass
88	15	Fail	Fail	Fail	Fail
88	30	Fail	Pass	Fail	Pass
89	13	Fail	Fail	Fail	Fail
89	14	Fail	Pass	Fail	Pass
89	15	Fail	Fail	Fail	Fail
89	30	Fail	Pass	Fail	Pass
90	13	Fail	Fail	Fail	Fail
90	14	Fail	Pass	Fail	Pass
90	15	Fail	Fail	Fail	Fail
90	30	Fail	Pass	Fail	Pass
91	13	Fail	Fail	Fail	Fail
91	14	Fail	Pass	Fail	Pass
91	15	Fail	Pass	Fail	Pass
91	16	Fail	Pass	Fail	Pass
91	30	Fail	Pass	Fail	Pass
92	13	Fail	Fail	Fail	Fail
92	14	Fail	Pass	Fail	Pass
92	15	Fail	Pass	Fail	Pass
92	16	Fail	Fail	Fail	Fail
92	30	Fail	Pass	Fail	Pass
93	13	Fail	Fail	Fail	Fail
93	14	Fail	Pass	Fail	Pass
93	15	Fail	Pass	Fail	Pass
93	16	Fail	Fail	Fail	Fail
93	30	Fail	Pass	Fail	Pass
94	13	Fail	Fail	Fail	Fail
94	14	Fail	Pass	Fail	Pass
94	15	Fail	Pass	Fail	Pass
94	16	Fail	Fail	Fail	Fail
94	26	Fail	Pass	Fail	Pass
94	30	Fail	Pass	Fail	Pass
95	13	Fail	Fail	Fail	Fail
95	14	Fail	Pass	Fail	Pass
95	15	Fail	Pass	Fail	Pass
95	16	Fail	Fail	Fail	Fail
95	26	Fail	Pass	Fail	Pass
95	30	Fail	Pass	Fail	Pass
96	13	Fail	Fail	Fail	Fail
96	14	Fail	Pass	Fail	Pass
96	15	Fail	Fail	Fail	Fail
96	26	Fail	Pass	Fail	Pass
96	30	Fail	Pass	Fail	Pass
97	13	Pass	Fail	Fail	Fail
97	14	Fail	Pass	Fail	Pass
97	15	Pass	Fail	Fail	Fail
97	26	Fail	Pass	Fail	Pass
97	30	Fail	Pass	Fail	Pass

98	13	Pass	Fail	Fail	Fail
98	14	Pass	Pass	Fail	Pass
98	15	Pass	Fail	Fail	Fail
98	26	Fail	Pass	Fail	Pass
98	27	Fail	Pass	Fail	Pass
98	28	Fail	Pass	Fail	Pass
98	29	Fail	Pass	Fail	Pass
98	30	Fail	Pass	Fail	Pass
99	13	Pass	Fail	Fail	Fail
99	14	Pass	Pass	Fail	Pass
99	15	Pass	Fail	Fail	Fail
99	16	Fail	Pass	Fail	Pass
99	17	Fail	Pass	Fail	Pass
99	18	Fail	Pass	Fail	Pass
99	19	Fail	Pass	Fail	Pass
99	20	Fail	Pass	Fail	Pass
99	21	Fail	Pass	Fail	Pass
99	22	Fail	Pass	Fail	Pass
99	23	Fail	Pass	Fail	Pass
99	26	Fail	Pass	Fail	Pass
99	30	Fail	Pass	Fail	Pass
100	13	Pass	Fail	Fail	Fail
100	14	Pass	Pass	Fail	Pass
100	15	Pass	Fail	Fail	Fail
100	23	Fail	Pass	Fail	Pass
100	24	Fail	Pass	Fail	Pass
100	25	Fail	Pass	Fail	Pass
100	26	Fail	Pass	Fail	Pass
100	30	Fail	Pass	Fail	Pass
101	13	Pass	Fail	Fail	Fail
101	14	Pass	Pass	Fail	Pass
101	15	Pass	Fail	Fail	Fail
101	16	Fail	Pass	Fail	Pass
101	17	Fail	Pass	Fail	Pass
101	18	Fail	Pass	Fail	Pass
101	19	Fail	Pass	Fail	Pass
101	20	Fail	Pass	Fail	Pass
101	21	Fail	Pass	Fail	Pass
101	22	Fail	Pass	Fail	Pass
101	23	Fail	Pass	Fail	Pass
101	26	Fail	Pass	Fail	Pass
101	30	Fail	Pass	Fail	Pass
102	13	Pass	Fail	Pass	Fail
102	14	Pass	Pass	Fail	Pass
102	15	Pass	Fail	Fail	Fail
102	26	Fail	Pass	Fail	Pass
102	30	Fail	Pass	Fail	Pass
103	13	Pass	Fail	Pass	Fail
103	14	Pass	Pass	Fail	Pass
103	15	Pass	Fail	Fail	Fail
103	26	Fail	Pass	Fail	Pass
103	30	Fail	Pass	Fail	Pass
104	13	Pass	Fail	Pass	Fail
104	14	Pass	Pass	Pass	Pass
104	15	Pass	Fail	Fail	Fail
104	26	Fail	Pass	Fail	Pass
104	30	Fail	Pass	Fail	Pass

105	13	Pass	Fail	Pass	Fail
105	14	Pass	Pass	Pass	Pass
105	15	Pass	Fail	Pass	Fail
105	26	Fail	Pass	Fail	Pass
105	30	Fail	Pass	Fail	Pass
106	13	Pass	Fail	Pass	Fail
106	14	Pass	Pass	Pass	Pass
106	15	Pass	Fail	Pass	Fail
106	26	Fail	Pass	Fail	Pass
106	27	Fail	Pass	Fail	Pass
106	30	Fail	Pass	Fail	Pass
106	39	Fail	Pass	Fail	Pass
107	13	Pass	Fail	Pass	Fail
107	14	Pass	Pass	Pass	Pass
107	15	Pass	Fail	Pass	Fail
107	22	Fail	Pass	Fail	Pass
107	26	Fail	Pass	Fail	Pass
107	30	Fail	Pass	Fail	Pass
107	39	Fail	Pass	Fail	Pass
108	13	Pass	Fail	Pass	Fail
108	14	Pass	Pass	Pass	Pass
108	15	Pass	Fail	Pass	Fail
108	22	Fail	Pass	Fail	Pass
108	26	Fail	Pass	Fail	Pass
108	30	Fail	Pass	Fail	Pass
108	39	Fail	Pass	Fail	Pass
109	13	Pass	Fail	Pass	Fail
109	14	Pass	Pass	Pass	Pass
109	15	Pass	Fail	Pass	Fail
109	22	Fail	Pass	Fail	Pass
109	26	Fail	Pass	Fail	Pass
109	30	Fail	Pass	Fail	Pass
109	39	Fail	Pass	Fail	Pass
110	13	Pass	Fail	Pass	Fail
110	14	Pass	Pass	Pass	Pass
110	15	Pass	Fail	Pass	Fail
110	22	Fail	Pass	Fail	Pass
110	26	Fail	Pass	Fail	Pass
110	39	Fail	Pass	Fail	Pass
111	13	Pass	Fail	Pass	Fail
111	14	Pass	Pass	Pass	Pass
111	15	Pass	Fail	Pass	Fail
111	22	Fail	Pass	Fail	Pass
111	26	Fail	Pass	Fail	Pass
111	39	Fail	Pass	Fail	Pass
112	13	Pass	Fail	Pass	Fail
112	14	Pass	Pass	Pass	Pass
112	15	Pass	Fail	Pass	Fail
112	22	Fail	Pass	Fail	Pass
112	26	Fail	Pass	Fail	Pass
112	39	Fail	Pass	Fail	Pass
113	13	Pass	Fail	Pass	Fail
113	14	Pass	Pass	Pass	Pass
113	15	Pass	Fail	Pass	Fail
113	26	Fail	Pass	Fail	Pass
113	27	Fail	Pass	Fail	Pass
113	39	Fail	Pass	Fail	Pass

114	13	Pass	Fail	Pass	Fail
114	14	Pass	Pass	Pass	Pass
114	15	Pass	Fail	Pass	Fail
114	26	Fail	Pass	Fail	Pass
114	39	Fail	Pass	Fail	Pass
115	13	Pass	Fail	Pass	Fail
115	14	Pass	Pass	Pass	Pass
115	15	Pass	Fail	Pass	Fail
115	26	Fail	Pass	Fail	Pass
115	39	Fail	Pass	Fail	Pass
116	13	Pass	Fail	Pass	Fail
116	14	Pass	Pass	Pass	Pass
116	15	Pass	Fail	Pass	Fail
116	26	Fail	Pass	Fail	Pass
116	39	Fail	Pass	Fail	Pass
117	13	Pass	Fail	Pass	Fail
117	14	Pass	Pass	Pass	Pass
117	15	Fail	Fail	Fail	Fail
117	26	Fail	Pass	Fail	Pass
117	39	Fail	Pass	Fail	Pass
118	13	Pass	Fail	Pass	Fail
118	14	Pass	Pass	Pass	Pass
118	15	Fail	Fail	Fail	Fail
118	20	Fail	Pass	Fail	Pass
118	26	Fail	Pass	Fail	Pass
118	39	Fail	Pass	Fail	Pass
119	13	Pass	Fail	Pass	Fail
119	14	Fail	Pass	Fail	Pass
119	15	Fail	Fail	Fail	Fail
119	20	Fail	Pass	Fail	Pass
119	26	Fail	Pass	Fail	Pass
119	39	Fail	Pass	Fail	Pass
120	13	Pass	Fail	Pass	Fail
120	14	Fail	Pass	Fail	Pass
120	15	Fail	Fail	Fail	Fail
120	16	Fail	Pass	Fail	Pass
120	26	Fail	Pass	Fail	Pass
120	39	Fail	Pass	Fail	Pass
121	13	Fail	Pass	Fail	Pass
121	14	Fail	Pass	Fail	Pass
121	26	Fail	Pass	Fail	Pass
121	39	Fail	Pass	Fail	Pass
122	13	Fail	Pass	Fail	Pass
122	14	Fail	Pass	Fail	Pass
122	26	Fail	Pass	Fail	Pass
122	39	Fail	Pass	Fail	Pass
123	13	Fail	Pass	Fail	Pass
123	14	Fail	Pass	Fail	Pass
123	15	Fail	Pass	Fail	Pass
123	16	Fail	Pass	Fail	Pass
123	17	Fail	Pass	Fail	Pass
123	18	Fail	Pass	Fail	Pass
123	19	Fail	Pass	Fail	Pass
123	20	Fail	Pass	Fail	Pass
123	21	Fail	Pass	Fail	Pass
123	22	Fail	Pass	Fail	Pass
123	23	Fail	Pass	Fail	Pass

123	24	Fail	Pass	Fail	Pass
123	25	Fail	Pass	Fail	Pass
123	26	Fail	Pass	Fail	Pass
123	27	Fail	Pass	Fail	Pass
123	28	Fail	Pass	Fail	Pass
123	29	Fail	Pass	Fail	Pass
123	30	Fail	Pass	Fail	Pass
123	31	Fail	Pass	Fail	Pass
123	32	Fail	Pass	Fail	Pass
123	33	Fail	Pass	Fail	Pass
123	34	Fail	Pass	Fail	Pass
123	35	Fail	Pass	Fail	Pass
123	36	Fail	Pass	Fail	Pass
123	37	Fail	Pass	Fail	Pass
123	38	Fail	Pass	Fail	Pass
123	39	Fail	Pass	Fail	Pass
124	13	Fail	Pass	Fail	Pass
124	14	Fail	Pass	Fail	Pass
124	23	Fail	Pass	Fail	Pass
125	13	Fail	Pass	Fail	Pass
125	14	Fail	Pass	Fail	Pass
125	23	Fail	Pass	Fail	Pass
126	13	Fail	Pass	Fail	Pass
126	14	Fail	Pass	Fail	Pass
126	23	Fail	Pass	Fail	Pass
127	13	Fail	Pass	Fail	Pass
127	14	Fail	Pass	Fail	Pass
127	23	Fail	Pass	Fail	Pass
128	13	Fail	Pass	Fail	Pass
128	14	Fail	Pass	Fail	Pass
128	23	Fail	Pass	Fail	Pass
129	13	Fail	Pass	Fail	Pass
129	14	Fail	Pass	Fail	Pass
129	23	Fail	Pass	Fail	Pass
130	8	Fail	Pass	Fail	Pass
130	9	Fail	Pass	Fail	Pass
130	10	Fail	Pass	Fail	Pass
130	11	Fail	Pass	Fail	Pass
130	12	Fail	Pass	Fail	Pass
130	13	Fail	Pass	Fail	Pass
130	14	Fail	Pass	Fail	Pass
130	23	Fail	Pass	Fail	Pass
131	14	Fail	Pass	Fail	Pass
131	23	Fail	Pass	Fail	Pass
132	14	Fail	Pass	Fail	Pass
132	23	Fail	Pass	Fail	Pass
133	14	Fail	Pass	Fail	Pass
133	23	Fail	Pass	Fail	Pass
134	14	Fail	Pass	Fail	Pass
134	23	Fail	Pass	Fail	Pass
135	14	Fail	Pass	Fail	Pass
136	14	Fail	Pass	Fail	Pass
137	14	Fail	Pass	Fail	Pass
138	14	Fail	Pass	Fail	Pass

2. Table A.6.2. Southern Flounder D.O. and Slope criteria passing for existing and deepening (4 ft) scenarios within the analyzed period August 1 - August 31, 1999

HABITAT REQUIREMENTS:
RM 10-31; Bottom Layer, Slope <=5%
D.O. August (MG/L):10th %ile >=4.0

Savannah Harbor Estuary

Segments		Baseline Scenario		Project Scenario	
J	I	D.O.	Slope	D.O.	Slope
47	13	Fail	Fail	Fail	Fail
47	14	Fail	Pass	Fail	Pass
47	15	Fail	Fail	Fail	Fail
47	16	Fail	Pass	Fail	Pass
47	17	Fail	Fail	Fail	Fail
48	13	Fail	Fail	Fail	Fail
48	14	Fail	Pass	Fail	Pass
48	15	Fail	Fail	Fail	Fail
48	16	Fail	Pass	Fail	Pass
48	17	Fail	Fail	Fail	Fail
49	13	Fail	Fail	Fail	Fail
49	14	Fail	Pass	Fail	Pass
49	15	Fail	Fail	Fail	Fail
49	16	Fail	Pass	Fail	Pass
49	17	Fail	Pass	Fail	Pass
50	13	Fail	Fail	Fail	Fail
50	14	Fail	Pass	Fail	Pass
50	15	Fail	Fail	Fail	Fail
50	16	Fail	Fail	Fail	Fail
50	17	Fail	Pass	Fail	Pass
50	18	Fail	Fail	Fail	Fail
51	13	Fail	Fail	Fail	Fail
51	14	Fail	Pass	Fail	Pass
51	15	Fail	Fail	Fail	Fail
52	13	Fail	Fail	Fail	Fail
52	14	Fail	Pass	Fail	Pass
52	15	Fail	Fail	Fail	Fail
53	13	Fail	Fail	Fail	Fail
53	14	Fail	Pass	Fail	Pass
53	15	Fail	Fail	Fail	Fail
54	13	Fail	Fail	Fail	Fail
54	14	Fail	Pass	Fail	Pass
54	15	Fail	Fail	Fail	Fail
55	13	Fail	Fail	Fail	Fail
55	14	Fail	Pass	Fail	Pass
55	15	Fail	Fail	Fail	Fail
56	13	Fail	Fail	Fail	Fail
56	14	Fail	Pass	Fail	Pass
56	15	Fail	Fail	Fail	Fail
57	13	Fail	Fail	Fail	Fail
57	14	Fail	Pass	Fail	Pass
57	15	Fail	Fail	Fail	Fail

58	13	Fail	Fail	Fail	Fail
58	14	Fail	Pass	Fail	Pass
58	15	Fail	Fail	Fail	Fail
59	13	Fail	Fail	Fail	Fail
59	14	Fail	Pass	Fail	Pass
59	15	Fail	Fail	Fail	Fail
59	30	Fail	Fail	Fail	Fail
59	31	Fail	Pass	Fail	Pass
59	32	Fail	Fail	Fail	Fail
60	13	Fail	Fail	Fail	Fail
60	14	Fail	Pass	Fail	Pass
60	15	Fail	Fail	Fail	Fail
60	30	Fail	Fail	Fail	Fail
60	31	Fail	Pass	Fail	Pass
60	32	Fail	Fail	Fail	Fail
61	13	Fail	Fail	Fail	Fail
61	14	Fail	Pass	Fail	Pass
61	15	Fail	Fail	Fail	Fail
61	30	Fail	Fail	Fail	Fail
61	31	Fail	Pass	Fail	Pass
61	32	Fail	Fail	Fail	Fail
62	13	Fail	Fail	Fail	Fail
62	14	Fail	Pass	Fail	Pass
62	15	Fail	Fail	Fail	Fail
62	30	Fail	Fail	Fail	Fail
62	31	Fail	Pass	Fail	Pass
62	32	Fail	Fail	Fail	Fail
63	13	Fail	Fail	Fail	Fail
63	14	Fail	Pass	Fail	Pass
63	15	Fail	Fail	Fail	Fail
63	31	Fail	Pass	Fail	Pass
64	13	Fail	Fail	Fail	Fail
64	14	Fail	Pass	Fail	Pass
64	15	Fail	Fail	Fail	Fail
64	30	Fail	Pass	Fail	Pass
64	31	Fail	Pass	Fail	Pass
64	32	Fail	Pass	Fail	Pass
65	13	Fail	Fail	Fail	Fail
65	14	Fail	Pass	Fail	Pass
65	15	Fail	Fail	Fail	Fail
65	30	Fail	Pass	Fail	Pass
65	31	Fail	Pass	Fail	Pass
65	32	Fail	Pass	Fail	Pass
65	33	Fail	Pass	Fail	Pass
66	13	Fail	Fail	Fail	Fail
66	14	Fail	Pass	Fail	Pass
66	15	Fail	Fail	Fail	Fail
66	30	Fail	Pass	Fail	Pass
66	31	Fail	Pass	Fail	Pass
66	32	Fail	Pass	Fail	Pass
66	36	Fail	Pass	Fail	Pass
67	13	Fail	Fail	Fail	Fail
67	14	Fail	Pass	Fail	Pass
67	15	Fail	Fail	Fail	Fail
67	30	Fail	Pass	Fail	Pass
67	31	Fail	Pass	Fail	Pass
67	32	Fail	Pass	Fail	Pass

67	36	Fail	Pass	Fail	Pass
68	13	Fail	Fail	Fail	Fail
68	14	Fail	Pass	Fail	Pass
68	15	Fail	Fail	Fail	Fail
68	30	Fail	Pass	Fail	Pass
68	31	Fail	Pass	Fail	Pass
68	32	Fail	Pass	Fail	Pass
68	36	Fail	Pass	Fail	Pass
69	13	Fail	Fail	Fail	Fail
69	14	Fail	Pass	Fail	Pass
69	15	Fail	Fail	Fail	Fail
69	30	Fail	Pass	Fail	Pass
69	31	Fail	Pass	Fail	Pass
69	32	Fail	Pass	Fail	Pass
69	36	Fail	Pass	Fail	Pass
70	13	Fail	Fail	Fail	Fail
70	14	Fail	Pass	Fail	Pass
70	15	Fail	Fail	Fail	Fail
70	30	Fail	Pass	Fail	Pass
70	31	Fail	Pass	Fail	Pass
70	32	Fail	Pass	Fail	Pass
70	33	Fail	Pass	Fail	Pass
71	13	Fail	Fail	Fail	Fail
71	14	Fail	Pass	Fail	Pass
71	15	Fail	Fail	Fail	Fail
71	30	Fail	Pass	Fail	Pass
71	31	Fail	Pass	Fail	Pass
71	32	Fail	Pass	Fail	Pass
72	13	Fail	Fail	Fail	Fail
72	14	Fail	Pass	Fail	Pass
72	15	Fail	Fail	Fail	Fail
72	30	Fail	Pass	Fail	Pass
72	31	Fail	Pass	Fail	Pass
72	32	Fail	Pass	Fail	Pass
73	13	Fail	Fail	Fail	Fail
73	14	Fail	Pass	Fail	Pass
73	15	Fail	Fail	Fail	Fail
73	30	Fail	Pass	Fail	Pass
73	31	Fail	Pass	Fail	Pass
74	13	Fail	Fail	Fail	Fail
74	14	Fail	Pass	Fail	Pass
74	15	Fail	Fail	Fail	Fail
74	30	Fail	Pass	Fail	Pass
74	31	Fail	Pass	Fail	Pass
75	13	Fail	Fail	Fail	Fail
75	14	Fail	Pass	Fail	Pass
75	15	Fail	Fail	Fail	Fail
75	30	Fail	Pass	Fail	Pass
75	31	Fail	Pass	Fail	Pass
76	13	Fail	Fail	Fail	Fail
76	14	Fail	Pass	Fail	Pass
76	15	Fail	Pass	Fail	Pass
76	16	Fail	Pass	Fail	Pass
76	17	Fail	Fail	Fail	Fail
76	30	Fail	Pass	Fail	Pass
76	31	Fail	Pass	Fail	Pass
77	13	Fail	Fail	Fail	Fail

77	14	Fail	Pass	Fail	Pass
77	15	Fail	Pass	Fail	Pass
77	16	Fail	Pass	Fail	Pass
77	17	Fail	Fail	Fail	Fail
77	30	Fail	Pass	Fail	Pass
77	31	Fail	Pass	Fail	Pass
78	13	Fail	Fail	Fail	Fail
78	14	Fail	Pass	Fail	Pass
78	15	Fail	Pass	Fail	Pass
78	16	Fail	Pass	Fail	Pass
78	17	Fail	Fail	Fail	Fail
78	30	Fail	Pass	Fail	Pass
78	31	Fail	Pass	Fail	Pass
79	13	Fail	Fail	Fail	Fail
79	14	Fail	Pass	Fail	Pass
79	15	Fail	Fail	Fail	Fail
79	30	Fail	Pass	Fail	Pass
79	31	Fail	Pass	Fail	Pass
80	13	Fail	Fail	Fail	Fail
80	14	Fail	Pass	Fail	Pass
80	15	Fail	Fail	Fail	Fail
80	30	Fail	Pass	Fail	Pass
80	31	Fail	Pass	Fail	Pass
81	13	Fail	Fail	Fail	Fail
81	14	Fail	Pass	Fail	Pass
81	15	Fail	Fail	Fail	Fail
81	30	Fail	Pass	Fail	Pass
81	31	Fail	Pass	Fail	Pass
82	13	Fail	Fail	Fail	Fail
82	14	Fail	Pass	Fail	Pass
82	15	Fail	Fail	Fail	Fail
82	16	Fail	Pass	Fail	Pass
82	17	Fail	Pass	Fail	Pass
82	18	Fail	Pass	Fail	Pass
82	19	Fail	Pass	Fail	Pass
82	20	Fail	Pass	Fail	Pass
82	21	Fail	Pass	Fail	Pass
82	29	Fail	Pass	Fail	Pass
82	30	Fail	Pass	Fail	Pass
82	31	Fail	Pass	Fail	Pass
83	13	Fail	Fail	Fail	Fail
83	14	Fail	Pass	Fail	Pass
83	15	Fail	Fail	Fail	Fail
83	21	Fail	Pass	Fail	Pass
83	30	Fail	Pass	Fail	Pass
83	31	Fail	Pass	Fail	Pass
84	13	Fail	Fail	Fail	Fail
84	14	Fail	Pass	Fail	Pass
84	15	Fail	Fail	Fail	Fail
84	21	Fail	Pass	Fail	Pass
84	30	Fail	Pass	Fail	Pass
84	31	Fail	Pass	Fail	Pass
85	13	Fail	Fail	Fail	Fail
85	14	Fail	Pass	Fail	Pass
85	15	Fail	Fail	Fail	Fail
85	21	Fail	Pass	Fail	Pass
85	30	Fail	Pass	Fail	Pass

86	13	Fail	Fail	Fail	Fail
86	14	Fail	Pass	Fail	Pass
86	15	Fail	Fail	Fail	Fail
86	21	Fail	Pass	Fail	Pass
86	30	Fail	Pass	Fail	Pass
87	13	Fail	Fail	Fail	Fail
87	14	Fail	Pass	Fail	Pass
87	15	Fail	Fail	Fail	Fail
87	30	Fail	Pass	Fail	Pass
88	13	Fail	Fail	Fail	Fail
88	14	Fail	Pass	Fail	Pass
88	15	Fail	Fail	Fail	Fail
88	30	Fail	Pass	Fail	Pass
89	13	Fail	Fail	Fail	Fail
89	14	Fail	Pass	Fail	Pass
89	15	Fail	Fail	Fail	Fail
89	30	Fail	Pass	Fail	Pass
90	13	Fail	Fail	Fail	Fail
90	14	Fail	Pass	Fail	Pass
90	15	Fail	Fail	Fail	Fail
90	30	Fail	Pass	Fail	Pass
91	13	Fail	Fail	Fail	Fail
91	14	Fail	Pass	Fail	Pass
91	15	Fail	Pass	Fail	Pass
91	16	Fail	Pass	Fail	Pass
91	30	Fail	Pass	Fail	Pass
92	13	Fail	Fail	Fail	Fail
92	14	Fail	Pass	Fail	Pass
92	15	Fail	Pass	Fail	Pass
92	16	Fail	Fail	Fail	Fail
92	30	Fail	Pass	Fail	Pass
93	13	Fail	Fail	Fail	Fail
93	14	Fail	Pass	Fail	Pass
93	15	Fail	Pass	Fail	Pass
93	16	Fail	Fail	Fail	Fail
93	30	Fail	Pass	Fail	Pass
94	13	Fail	Fail	Fail	Fail
94	14	Fail	Pass	Fail	Pass
94	15	Fail	Pass	Fail	Pass
94	16	Fail	Fail	Fail	Fail
94	26	Fail	Pass	Fail	Pass
94	30	Fail	Pass	Fail	Pass
95	13	Fail	Fail	Fail	Fail
95	14	Fail	Pass	Fail	Pass
95	15	Fail	Pass	Fail	Pass
95	16	Fail	Fail	Fail	Fail
95	26	Fail	Pass	Fail	Pass
95	30	Fail	Pass	Fail	Pass
96	13	Fail	Fail	Fail	Fail
96	14	Fail	Pass	Fail	Pass
96	15	Fail	Fail	Fail	Fail
96	26	Fail	Pass	Fail	Pass
96	30	Fail	Pass	Fail	Pass
97	13	Pass	Fail	Fail	Fail
97	14	Fail	Pass	Fail	Pass
97	15	Pass	Fail	Fail	Fail
97	26	Fail	Pass	Fail	Pass

97	30	Fail	Pass	Fail	Pass
98	13	Pass	Fail	Fail	Fail
98	14	Pass	Pass	Fail	Pass
98	15	Pass	Fail	Fail	Fail
98	26	Fail	Pass	Fail	Pass
98	27	Fail	Pass	Fail	Pass
98	28	Fail	Pass	Fail	Pass
98	29	Fail	Pass	Fail	Pass
98	30	Fail	Pass	Fail	Pass
99	13	Pass	Fail	Fail	Fail
99	14	Pass	Pass	Fail	Pass
99	15	Pass	Fail	Fail	Fail
99	16	Fail	Pass	Fail	Pass
99	17	Fail	Pass	Fail	Pass
99	18	Fail	Pass	Fail	Pass
99	19	Fail	Pass	Fail	Pass
99	20	Fail	Pass	Fail	Pass
99	21	Fail	Pass	Fail	Pass
99	22	Fail	Pass	Fail	Pass
99	23	Fail	Pass	Fail	Pass
99	26	Fail	Pass	Fail	Pass
99	30	Fail	Pass	Fail	Pass
100	13	Pass	Fail	Fail	Fail
100	14	Pass	Pass	Fail	Pass
100	15	Pass	Fail	Fail	Fail
100	23	Fail	Pass	Fail	Pass
100	24	Fail	Pass	Fail	Pass
100	25	Fail	Pass	Fail	Pass
100	26	Fail	Pass	Fail	Pass
100	30	Fail	Pass	Fail	Pass
101	13	Pass	Fail	Pass	Fail
101	14	Pass	Pass	Fail	Pass
101	15	Pass	Fail	Fail	Fail
101	16	Fail	Pass	Fail	Pass
101	17	Fail	Pass	Fail	Pass
101	18	Fail	Pass	Fail	Pass
101	19	Fail	Pass	Fail	Pass
101	20	Fail	Pass	Fail	Pass
101	21	Fail	Pass	Fail	Pass
101	22	Fail	Pass	Fail	Pass
101	23	Fail	Pass	Fail	Pass
101	26	Fail	Pass	Fail	Pass
101	30	Fail	Pass	Fail	Pass
102	13	Pass	Fail	Pass	Fail
102	14	Pass	Pass	Fail	Pass
102	15	Pass	Fail	Fail	Fail
102	26	Fail	Pass	Fail	Pass
102	30	Fail	Pass	Fail	Pass
103	13	Pass	Fail	Pass	Fail
103	14	Pass	Pass	Pass	Pass
103	15	Pass	Fail	Pass	Fail
103	26	Fail	Pass	Fail	Pass
103	30	Fail	Pass	Fail	Pass
104	13	Pass	Fail	Pass	Fail
104	14	Pass	Pass	Pass	Pass
104	15	Pass	Fail	Pass	Fail
104	26	Fail	Pass	Fail	Pass

104	30	Fail	Pass	Fail	Pass
105	13	Pass	Fail	Pass	Fail
105	14	Pass	Pass	Pass	Pass
105	15	Pass	Fail	Pass	Fail
105	26	Fail	Pass	Fail	Pass
105	30	Fail	Pass	Fail	Pass
106	13	Pass	Fail	Pass	Fail
106	14	Pass	Pass	Pass	Pass
106	15	Pass	Fail	Pass	Fail
106	26	Fail	Pass	Fail	Pass
106	27	Fail	Pass	Fail	Pass
106	30	Fail	Pass	Fail	Pass
106	39	Fail	Pass	Fail	Pass
107	13	Pass	Fail	Pass	Fail
107	14	Pass	Pass	Pass	Pass
107	15	Pass	Fail	Pass	Fail
107	22	Fail	Pass	Fail	Pass
107	26	Fail	Pass	Fail	Pass
107	30	Fail	Pass	Fail	Pass
107	39	Fail	Pass	Fail	Pass
108	13	Pass	Fail	Pass	Fail
108	14	Pass	Pass	Pass	Pass
108	15	Pass	Fail	Pass	Fail
108	22	Fail	Pass	Fail	Pass
108	26	Fail	Pass	Fail	Pass
108	30	Fail	Pass	Fail	Pass
108	39	Fail	Pass	Fail	Pass
109	13	Pass	Fail	Pass	Fail
109	14	Pass	Pass	Pass	Pass
109	15	Pass	Fail	Pass	Fail
109	22	Fail	Pass	Fail	Pass
109	26	Fail	Pass	Fail	Pass
109	30	Fail	Pass	Fail	Pass
109	39	Fail	Pass	Fail	Pass
110	13	Pass	Fail	Pass	Fail
110	14	Pass	Pass	Pass	Pass
110	15	Pass	Fail	Pass	Fail
110	22	Fail	Pass	Fail	Pass
110	26	Fail	Pass	Fail	Pass
110	39	Fail	Pass	Fail	Pass
111	13	Pass	Fail	Pass	Fail
111	14	Pass	Pass	Pass	Pass
111	15	Pass	Fail	Pass	Fail
111	22	Fail	Pass	Fail	Pass
111	26	Fail	Pass	Fail	Pass
111	39	Fail	Pass	Fail	Pass
112	13	Pass	Fail	Pass	Fail
112	14	Pass	Pass	Pass	Pass
112	15	Pass	Fail	Pass	Fail
112	22	Fail	Pass	Fail	Pass
112	26	Fail	Pass	Fail	Pass
112	39	Fail	Pass	Fail	Pass
113	13	Pass	Fail	Pass	Fail
113	14	Pass	Pass	Pass	Pass
113	15	Pass	Fail	Pass	Fail
113	26	Fail	Pass	Fail	Pass
113	27	Fail	Pass	Fail	Pass

113	39	Fail	Pass	Fail	Pass
114	13	Pass	Fail	Pass	Fail
114	14	Pass	Pass	Pass	Pass
114	15	Pass	Fail	Pass	Fail
114	26	Fail	Pass	Fail	Pass
114	39	Fail	Pass	Fail	Pass
115	13	Pass	Fail	Pass	Fail
115	14	Pass	Pass	Pass	Pass
115	15	Pass	Fail	Pass	Fail
115	26	Fail	Pass	Fail	Pass
115	39	Fail	Pass	Fail	Pass
116	13	Pass	Fail	Pass	Fail
116	14	Pass	Pass	Pass	Pass
116	15	Pass	Fail	Pass	Fail
116	26	Fail	Pass	Fail	Pass
116	39	Fail	Pass	Fail	Pass
117	13	Pass	Fail	Pass	Fail
117	14	Pass	Pass	Pass	Pass
117	15	Fail	Fail	Fail	Fail
117	26	Fail	Pass	Fail	Pass
117	39	Fail	Pass	Fail	Pass
118	13	Pass	Fail	Pass	Fail
118	14	Pass	Pass	Pass	Pass
118	15	Fail	Fail	Fail	Fail
118	20	Fail	Pass	Fail	Pass
118	26	Fail	Pass	Fail	Pass
118	39	Fail	Pass	Fail	Pass
119	13	Pass	Fail	Pass	Fail
119	14	Fail	Pass	Fail	Pass
119	15	Fail	Fail	Fail	Fail
119	20	Fail	Pass	Fail	Pass
119	26	Fail	Pass	Fail	Pass
119	39	Fail	Pass	Fail	Pass
120	13	Pass	Fail	Pass	Fail
120	14	Fail	Pass	Fail	Pass
120	15	Fail	Fail	Fail	Fail
120	16	Fail	Pass	Fail	Pass
120	26	Fail	Pass	Fail	Pass
120	39	Fail	Pass	Fail	Pass
121	13	Fail	Pass	Fail	Pass
121	14	Fail	Pass	Fail	Pass
121	26	Fail	Pass	Fail	Pass
121	39	Fail	Pass	Fail	Pass
122	13	Fail	Pass	Fail	Pass
122	14	Fail	Pass	Fail	Pass
122	26	Fail	Pass	Fail	Pass
122	39	Fail	Pass	Fail	Pass
123	13	Fail	Pass	Fail	Pass
123	14	Fail	Pass	Fail	Pass
123	15	Fail	Pass	Fail	Pass
123	16	Fail	Pass	Fail	Pass
123	17	Fail	Pass	Fail	Pass
123	18	Fail	Pass	Fail	Pass
123	19	Fail	Pass	Fail	Pass
123	20	Fail	Pass	Fail	Pass
123	21	Fail	Pass	Fail	Pass
123	22	Fail	Pass	Fail	Pass

123	23	Fail	Pass	Fail	Pass
123	24	Fail	Pass	Fail	Pass
123	25	Fail	Pass	Fail	Pass
123	26	Fail	Pass	Fail	Pass
123	27	Fail	Pass	Fail	Pass
123	28	Fail	Pass	Fail	Pass
123	29	Fail	Pass	Fail	Pass
123	30	Fail	Pass	Fail	Pass
123	31	Fail	Pass	Fail	Pass
123	32	Fail	Pass	Fail	Pass
123	33	Fail	Pass	Fail	Pass
123	34	Fail	Pass	Fail	Pass
123	35	Fail	Pass	Fail	Pass
123	36	Fail	Pass	Fail	Pass
123	37	Fail	Pass	Fail	Pass
123	38	Fail	Pass	Fail	Pass
123	39	Fail	Pass	Fail	Pass
124	13	Fail	Pass	Fail	Pass
124	14	Fail	Pass	Fail	Pass
124	23	Fail	Pass	Fail	Pass
125	13	Fail	Pass	Fail	Pass
125	14	Fail	Pass	Fail	Pass
125	23	Fail	Pass	Fail	Pass
126	13	Fail	Pass	Fail	Pass
126	14	Fail	Pass	Fail	Pass
126	23	Fail	Pass	Fail	Pass
127	13	Fail	Pass	Fail	Pass
127	14	Fail	Pass	Fail	Pass
127	23	Fail	Pass	Fail	Pass
128	13	Fail	Pass	Fail	Pass
128	14	Fail	Pass	Fail	Pass
128	23	Fail	Pass	Fail	Pass
129	13	Fail	Pass	Fail	Pass
129	14	Fail	Pass	Fail	Pass
129	23	Fail	Pass	Fail	Pass
130	8	Fail	Pass	Fail	Pass
130	9	Fail	Pass	Fail	Pass
130	10	Fail	Pass	Fail	Pass
130	11	Fail	Pass	Fail	Pass
130	12	Fail	Pass	Fail	Pass
130	13	Fail	Pass	Fail	Pass
130	14	Fail	Pass	Fail	Pass
130	23	Fail	Pass	Fail	Pass
131	14	Fail	Pass	Fail	Pass
131	23	Fail	Pass	Fail	Pass
132	14	Fail	Pass	Fail	Pass
132	23	Fail	Pass	Fail	Pass
133	14	Fail	Pass	Fail	Pass
133	23	Fail	Pass	Fail	Pass
134	14	Fail	Pass	Fail	Pass
134	23	Fail	Pass	Fail	Pass
135	14	Fail	Pass	Fail	Pass
136	14	Fail	Pass	Fail	Pass
137	14	Fail	Pass	Fail	Pass
138	14	Fail	Pass	Fail	Pass

3. Table A.6.3. Southern Flounder D.O. and Slope criteria passing for existing and deepening (3 ft) scenarios within the analyzed period August 1 - August 31, 1999

HABITAT REQUIREMENTS:
RM 10-31; Bottom Layer, Slope <=5%
D.O. August (MG/L):10th %ile >=4.0

Savannah Harbor Estuary

Segments		Baseline Scenario		Project Scenario	
J	I	D.O.	Slope	D.O.	Slope
47	13	Fail	Fail	Fail	Fail
47	14	Fail	Pass	Fail	Pass
47	15	Fail	Fail	Fail	Fail
47	16	Fail	Pass	Fail	Pass
47	17	Fail	Fail	Fail	Fail
48	13	Fail	Fail	Fail	Fail
48	14	Fail	Pass	Fail	Pass
48	15	Fail	Fail	Fail	Fail
48	16	Fail	Pass	Fail	Pass
48	17	Fail	Fail	Fail	Fail
49	13	Fail	Fail	Fail	Fail
49	14	Fail	Pass	Fail	Pass
49	15	Fail	Fail	Fail	Fail
49	16	Fail	Pass	Fail	Pass
49	17	Fail	Pass	Fail	Pass
50	13	Fail	Fail	Fail	Fail
50	14	Fail	Pass	Fail	Pass
50	15	Fail	Fail	Fail	Fail
50	16	Fail	Fail	Fail	Fail
50	17	Fail	Pass	Fail	Pass
50	18	Fail	Fail	Fail	Fail
51	13	Fail	Fail	Fail	Fail
51	14	Fail	Pass	Fail	Pass
51	15	Fail	Fail	Fail	Fail
52	13	Fail	Fail	Fail	Fail
52	14	Fail	Pass	Fail	Pass
52	15	Fail	Fail	Fail	Fail
53	13	Fail	Fail	Fail	Fail
53	14	Fail	Pass	Fail	Pass
53	15	Fail	Fail	Fail	Fail
54	13	Fail	Fail	Fail	Fail
54	14	Fail	Pass	Fail	Pass
54	15	Fail	Fail	Fail	Fail
55	13	Fail	Fail	Fail	Fail
55	14	Fail	Pass	Fail	Pass
55	15	Fail	Fail	Fail	Fail
56	13	Fail	Fail	Fail	Fail
56	14	Fail	Pass	Fail	Pass
56	15	Fail	Fail	Fail	Fail
57	13	Fail	Fail	Fail	Fail
57	14	Fail	Pass	Fail	Pass
57	15	Fail	Fail	Fail	Fail

58	13	Fail	Fail	Fail	Fail
58	14	Fail	Pass	Fail	Pass
58	15	Fail	Fail	Fail	Fail
59	13	Fail	Fail	Fail	Fail
59	14	Fail	Pass	Fail	Pass
59	15	Fail	Fail	Fail	Fail
59	30	Fail	Fail	Fail	Fail
59	31	Fail	Pass	Fail	Pass
59	32	Fail	Fail	Fail	Fail
60	13	Fail	Fail	Fail	Fail
60	14	Fail	Pass	Fail	Pass
60	15	Fail	Fail	Fail	Fail
60	30	Fail	Fail	Fail	Fail
60	31	Fail	Pass	Fail	Pass
60	32	Fail	Fail	Fail	Fail
61	13	Fail	Fail	Fail	Fail
61	14	Fail	Pass	Fail	Pass
61	15	Fail	Fail	Fail	Fail
61	30	Fail	Fail	Fail	Fail
61	31	Fail	Pass	Fail	Pass
61	32	Fail	Fail	Fail	Fail
62	13	Fail	Fail	Fail	Fail
62	14	Fail	Pass	Fail	Pass
62	15	Fail	Fail	Fail	Fail
62	30	Fail	Fail	Fail	Fail
62	31	Fail	Pass	Fail	Pass
62	32	Fail	Fail	Fail	Fail
63	13	Fail	Fail	Fail	Fail
63	14	Fail	Pass	Fail	Pass
63	15	Fail	Fail	Fail	Fail
63	31	Fail	Pass	Fail	Pass
64	13	Fail	Fail	Fail	Fail
64	14	Fail	Pass	Fail	Pass
64	15	Fail	Fail	Fail	Fail
64	30	Fail	Pass	Fail	Pass
64	31	Fail	Pass	Fail	Pass
64	32	Fail	Pass	Fail	Pass
65	13	Fail	Fail	Fail	Fail
65	14	Fail	Pass	Fail	Pass
65	15	Fail	Fail	Fail	Fail
65	30	Fail	Pass	Fail	Pass
65	31	Fail	Pass	Fail	Pass
65	32	Fail	Pass	Fail	Pass
65	33	Fail	Pass	Fail	Pass
66	13	Fail	Fail	Fail	Fail
66	14	Fail	Pass	Fail	Pass
66	15	Fail	Fail	Fail	Fail
66	30	Fail	Pass	Fail	Pass
66	31	Fail	Pass	Fail	Pass
66	32	Fail	Pass	Fail	Pass
66	36	Fail	Pass	Fail	Pass
67	13	Fail	Fail	Fail	Fail
67	14	Fail	Pass	Fail	Pass
67	15	Fail	Fail	Fail	Fail
67	30	Fail	Pass	Fail	Pass
67	31	Fail	Pass	Fail	Pass
67	32	Fail	Pass	Fail	Pass

67	36	Fail	Pass	Fail	Pass
68	13	Fail	Fail	Fail	Fail
68	14	Fail	Pass	Fail	Pass
68	15	Fail	Fail	Fail	Fail
68	30	Fail	Pass	Fail	Pass
68	31	Fail	Pass	Fail	Pass
68	32	Fail	Pass	Fail	Pass
68	36	Fail	Pass	Fail	Pass
69	13	Fail	Fail	Fail	Fail
69	14	Fail	Pass	Fail	Pass
69	15	Fail	Fail	Fail	Fail
69	30	Fail	Pass	Fail	Pass
69	31	Fail	Pass	Fail	Pass
69	32	Fail	Pass	Fail	Pass
69	36	Fail	Pass	Fail	Pass
70	13	Fail	Fail	Fail	Fail
70	14	Fail	Pass	Fail	Pass
70	15	Fail	Fail	Fail	Fail
70	30	Fail	Pass	Fail	Pass
70	31	Fail	Pass	Fail	Pass
70	32	Fail	Pass	Fail	Pass
70	33	Fail	Pass	Fail	Pass
71	13	Fail	Fail	Fail	Fail
71	14	Fail	Pass	Fail	Pass
71	15	Fail	Fail	Fail	Fail
71	30	Fail	Pass	Fail	Pass
71	31	Fail	Pass	Fail	Pass
71	32	Fail	Pass	Fail	Pass
72	13	Fail	Fail	Fail	Fail
72	14	Fail	Pass	Fail	Pass
72	15	Fail	Fail	Fail	Fail
72	30	Fail	Pass	Fail	Pass
72	31	Fail	Pass	Fail	Pass
72	32	Fail	Pass	Fail	Pass
73	13	Fail	Fail	Fail	Fail
73	14	Fail	Pass	Fail	Pass
73	15	Fail	Fail	Fail	Fail
73	30	Fail	Pass	Fail	Pass
73	31	Fail	Pass	Fail	Pass
74	13	Fail	Fail	Fail	Fail
74	14	Fail	Pass	Fail	Pass
74	15	Fail	Fail	Fail	Fail
74	30	Fail	Pass	Fail	Pass
74	31	Fail	Pass	Fail	Pass
75	13	Fail	Fail	Fail	Fail
75	14	Fail	Pass	Fail	Pass
75	15	Fail	Fail	Fail	Fail
75	30	Fail	Pass	Fail	Pass
75	31	Fail	Pass	Fail	Pass
76	13	Fail	Fail	Fail	Fail
76	14	Fail	Pass	Fail	Pass
76	15	Fail	Pass	Fail	Pass
76	16	Fail	Pass	Fail	Pass
76	17	Fail	Fail	Fail	Fail
76	30	Fail	Pass	Fail	Pass
76	31	Fail	Pass	Fail	Pass
77	13	Fail	Fail	Fail	Fail

77	14	Fail	Pass	Fail	Pass
77	15	Fail	Pass	Fail	Pass
77	16	Fail	Pass	Fail	Pass
77	17	Fail	Fail	Fail	Fail
77	30	Fail	Pass	Fail	Pass
77	31	Fail	Pass	Fail	Pass
78	13	Fail	Fail	Fail	Fail
78	14	Fail	Pass	Fail	Pass
78	15	Fail	Pass	Fail	Pass
78	16	Fail	Pass	Fail	Pass
78	17	Fail	Fail	Fail	Fail
78	30	Fail	Pass	Fail	Pass
78	31	Fail	Pass	Fail	Pass
79	13	Fail	Fail	Fail	Fail
79	14	Fail	Pass	Fail	Pass
79	15	Fail	Fail	Fail	Fail
79	30	Fail	Pass	Fail	Pass
79	31	Fail	Pass	Fail	Pass
80	13	Fail	Fail	Fail	Fail
80	14	Fail	Pass	Fail	Pass
80	15	Fail	Fail	Fail	Fail
80	30	Fail	Pass	Fail	Pass
80	31	Fail	Pass	Fail	Pass
81	13	Fail	Fail	Fail	Fail
81	14	Fail	Pass	Fail	Pass
81	15	Fail	Fail	Fail	Fail
81	30	Fail	Pass	Fail	Pass
81	31	Fail	Pass	Fail	Pass
82	13	Fail	Fail	Fail	Fail
82	14	Fail	Pass	Fail	Pass
82	15	Fail	Fail	Fail	Fail
82	16	Fail	Pass	Fail	Pass
82	17	Fail	Pass	Fail	Pass
82	18	Fail	Pass	Fail	Pass
82	19	Fail	Pass	Fail	Pass
82	20	Fail	Pass	Fail	Pass
82	21	Fail	Pass	Fail	Pass
82	29	Fail	Pass	Fail	Pass
82	30	Fail	Pass	Fail	Pass
82	31	Fail	Pass	Fail	Pass
83	13	Fail	Fail	Fail	Fail
83	14	Fail	Pass	Fail	Pass
83	15	Fail	Fail	Fail	Fail
83	21	Fail	Pass	Fail	Pass
83	30	Fail	Pass	Fail	Pass
83	31	Fail	Pass	Fail	Pass
84	13	Fail	Fail	Fail	Fail
84	14	Fail	Pass	Fail	Pass
84	15	Fail	Fail	Fail	Fail
84	21	Fail	Pass	Fail	Pass
84	30	Fail	Pass	Fail	Pass
84	31	Fail	Pass	Fail	Pass
85	13	Fail	Fail	Fail	Fail
85	14	Fail	Pass	Fail	Pass
85	15	Fail	Fail	Fail	Fail
85	21	Fail	Pass	Fail	Pass
85	30	Fail	Pass	Fail	Pass

86	13	Fail	Fail	Fail	Fail
86	14	Fail	Pass	Fail	Pass
86	15	Fail	Fail	Fail	Fail
86	21	Fail	Pass	Fail	Pass
86	30	Fail	Pass	Fail	Pass
87	13	Fail	Fail	Fail	Fail
87	14	Fail	Pass	Fail	Pass
87	15	Fail	Fail	Fail	Fail
87	30	Fail	Pass	Fail	Pass
88	13	Fail	Fail	Fail	Fail
88	14	Fail	Pass	Fail	Pass
88	15	Fail	Fail	Fail	Fail
88	30	Fail	Pass	Fail	Pass
89	13	Fail	Fail	Fail	Fail
89	14	Fail	Pass	Fail	Pass
89	15	Fail	Fail	Fail	Fail
89	30	Fail	Pass	Fail	Pass
90	13	Fail	Fail	Fail	Fail
90	14	Fail	Pass	Fail	Pass
90	15	Fail	Fail	Fail	Fail
90	30	Fail	Pass	Fail	Pass
91	13	Fail	Fail	Fail	Fail
91	14	Fail	Pass	Fail	Pass
91	15	Fail	Pass	Fail	Pass
91	16	Fail	Pass	Fail	Pass
91	30	Fail	Pass	Fail	Pass
92	13	Fail	Fail	Fail	Fail
92	14	Fail	Pass	Fail	Pass
92	15	Fail	Pass	Fail	Pass
92	16	Fail	Fail	Fail	Fail
92	30	Fail	Pass	Fail	Pass
93	13	Fail	Fail	Fail	Fail
93	14	Fail	Pass	Fail	Pass
93	15	Fail	Pass	Fail	Pass
93	16	Fail	Fail	Fail	Fail
93	30	Fail	Pass	Fail	Pass
94	13	Fail	Fail	Fail	Fail
94	14	Fail	Pass	Fail	Pass
94	15	Fail	Pass	Fail	Pass
94	16	Fail	Fail	Fail	Fail
94	26	Fail	Pass	Fail	Pass
94	30	Fail	Pass	Fail	Pass
95	13	Fail	Fail	Fail	Fail
95	14	Fail	Pass	Fail	Pass
95	15	Fail	Pass	Fail	Pass
95	16	Fail	Fail	Fail	Fail
95	26	Fail	Pass	Fail	Pass
95	30	Fail	Pass	Fail	Pass
96	13	Fail	Fail	Fail	Fail
96	14	Fail	Pass	Fail	Pass
96	15	Fail	Fail	Fail	Fail
96	26	Fail	Pass	Fail	Pass
96	30	Fail	Pass	Fail	Pass
97	13	Pass	Fail	Fail	Fail
97	14	Fail	Pass	Fail	Pass
97	15	Pass	Fail	Fail	Fail
97	26	Fail	Pass	Fail	Pass

97	30	Fail	Pass	Fail	Pass
98	13	Pass	Fail	Fail	Fail
98	14	Pass	Pass	Fail	Pass
98	15	Pass	Fail	Fail	Fail
98	26	Fail	Pass	Fail	Pass
98	27	Fail	Pass	Fail	Pass
98	28	Fail	Pass	Fail	Pass
98	29	Fail	Pass	Fail	Pass
98	30	Fail	Pass	Fail	Pass
99	13	Pass	Fail	Fail	Fail
99	14	Pass	Pass	Fail	Pass
99	15	Pass	Fail	Fail	Fail
99	16	Fail	Pass	Fail	Pass
99	17	Fail	Pass	Fail	Pass
99	18	Fail	Pass	Fail	Pass
99	19	Fail	Pass	Fail	Pass
99	20	Fail	Pass	Fail	Pass
99	21	Fail	Pass	Fail	Pass
99	22	Fail	Pass	Fail	Pass
99	23	Fail	Pass	Fail	Pass
99	26	Fail	Pass	Fail	Pass
99	30	Fail	Pass	Fail	Pass
100	13	Pass	Fail	Pass	Fail
100	14	Pass	Pass	Fail	Pass
100	15	Pass	Fail	Fail	Fail
100	23	Fail	Pass	Fail	Pass
100	24	Fail	Pass	Fail	Pass
100	25	Fail	Pass	Fail	Pass
100	26	Fail	Pass	Fail	Pass
100	30	Fail	Pass	Fail	Pass
101	13	Pass	Fail	Pass	Fail
101	14	Pass	Pass	Fail	Pass
101	15	Pass	Fail	Fail	Fail
101	16	Fail	Pass	Fail	Pass
101	17	Fail	Pass	Fail	Pass
101	18	Fail	Pass	Fail	Pass
101	19	Fail	Pass	Fail	Pass
101	20	Fail	Pass	Fail	Pass
101	21	Fail	Pass	Fail	Pass
101	22	Fail	Pass	Fail	Pass
101	23	Fail	Pass	Fail	Pass
101	26	Fail	Pass	Fail	Pass
101	30	Fail	Pass	Fail	Pass
102	13	Pass	Fail	Pass	Fail
102	14	Pass	Pass	Pass	Pass
102	15	Pass	Fail	Pass	Fail
102	26	Fail	Pass	Fail	Pass
102	30	Fail	Pass	Fail	Pass
103	13	Pass	Fail	Pass	Fail
103	14	Pass	Pass	Pass	Pass
103	15	Pass	Fail	Pass	Fail
103	26	Fail	Pass	Fail	Pass
103	30	Fail	Pass	Fail	Pass
104	13	Pass	Fail	Pass	Fail
104	14	Pass	Pass	Pass	Pass
104	15	Pass	Fail	Pass	Fail
104	26	Fail	Pass	Fail	Pass

104	30	Fail	Pass	Fail	Pass
105	13	Pass	Fail	Pass	Fail
105	14	Pass	Pass	Pass	Pass
105	15	Pass	Fail	Pass	Fail
105	26	Fail	Pass	Fail	Pass
105	30	Fail	Pass	Fail	Pass
106	13	Pass	Fail	Pass	Fail
106	14	Pass	Pass	Pass	Pass
106	15	Pass	Fail	Pass	Fail
106	26	Fail	Pass	Fail	Pass
106	27	Fail	Pass	Fail	Pass
106	30	Fail	Pass	Fail	Pass
106	39	Fail	Pass	Fail	Pass
107	13	Pass	Fail	Pass	Fail
107	14	Pass	Pass	Pass	Pass
107	15	Pass	Fail	Pass	Fail
107	22	Fail	Pass	Fail	Pass
107	26	Fail	Pass	Fail	Pass
107	30	Fail	Pass	Fail	Pass
107	39	Fail	Pass	Fail	Pass
108	13	Pass	Fail	Pass	Fail
108	14	Pass	Pass	Pass	Pass
108	15	Pass	Fail	Pass	Fail
108	22	Fail	Pass	Fail	Pass
108	26	Fail	Pass	Fail	Pass
108	30	Fail	Pass	Fail	Pass
108	39	Fail	Pass	Fail	Pass
109	13	Pass	Fail	Pass	Fail
109	14	Pass	Pass	Pass	Pass
109	15	Pass	Fail	Pass	Fail
109	22	Fail	Pass	Fail	Pass
109	26	Fail	Pass	Fail	Pass
109	30	Fail	Pass	Fail	Pass
109	39	Fail	Pass	Fail	Pass
110	13	Pass	Fail	Pass	Fail
110	14	Pass	Pass	Pass	Pass
110	15	Pass	Fail	Pass	Fail
110	22	Fail	Pass	Fail	Pass
110	26	Fail	Pass	Fail	Pass
110	39	Fail	Pass	Fail	Pass
111	13	Pass	Fail	Pass	Fail
111	14	Pass	Pass	Pass	Pass
111	15	Pass	Fail	Pass	Fail
111	22	Fail	Pass	Fail	Pass
111	26	Fail	Pass	Fail	Pass
111	39	Fail	Pass	Fail	Pass
112	13	Pass	Fail	Pass	Fail
112	14	Pass	Pass	Pass	Pass
112	15	Pass	Fail	Pass	Fail
112	22	Fail	Pass	Fail	Pass
112	26	Fail	Pass	Fail	Pass
112	39	Fail	Pass	Fail	Pass
113	13	Pass	Fail	Pass	Fail
113	14	Pass	Pass	Pass	Pass
113	15	Pass	Fail	Pass	Fail
113	26	Fail	Pass	Fail	Pass
113	27	Fail	Pass	Fail	Pass

113	39	Fail	Pass	Fail	Pass
114	13	Pass	Fail	Pass	Fail
114	14	Pass	Pass	Pass	Pass
114	15	Pass	Fail	Pass	Fail
114	26	Fail	Pass	Fail	Pass
114	39	Fail	Pass	Fail	Pass
115	13	Pass	Fail	Pass	Fail
115	14	Pass	Pass	Pass	Pass
115	15	Pass	Fail	Pass	Fail
115	26	Fail	Pass	Fail	Pass
115	39	Fail	Pass	Fail	Pass
116	13	Pass	Fail	Pass	Fail
116	14	Pass	Pass	Pass	Pass
116	15	Pass	Fail	Pass	Fail
116	26	Fail	Pass	Fail	Pass
116	39	Fail	Pass	Fail	Pass
117	13	Pass	Fail	Pass	Fail
117	14	Pass	Pass	Pass	Pass
117	15	Fail	Fail	Fail	Fail
117	26	Fail	Pass	Fail	Pass
117	39	Fail	Pass	Fail	Pass
118	13	Pass	Fail	Pass	Fail
118	14	Pass	Pass	Pass	Pass
118	15	Fail	Fail	Fail	Fail
118	20	Fail	Pass	Fail	Pass
118	26	Fail	Pass	Fail	Pass
118	39	Fail	Pass	Fail	Pass
119	13	Pass	Fail	Pass	Fail
119	14	Fail	Pass	Fail	Pass
119	15	Fail	Fail	Fail	Fail
119	20	Fail	Pass	Fail	Pass
119	26	Fail	Pass	Fail	Pass
119	39	Fail	Pass	Fail	Pass
120	13	Pass	Fail	Pass	Fail
120	14	Fail	Pass	Fail	Pass
120	15	Fail	Fail	Fail	Fail
120	16	Fail	Pass	Fail	Pass
120	26	Fail	Pass	Fail	Pass
120	39	Fail	Pass	Fail	Pass
121	13	Fail	Pass	Fail	Pass
121	14	Fail	Pass	Fail	Pass
121	26	Fail	Pass	Fail	Pass
121	39	Fail	Pass	Fail	Pass
122	13	Fail	Pass	Fail	Pass
122	14	Fail	Pass	Fail	Pass
122	26	Fail	Pass	Fail	Pass
122	39	Fail	Pass	Fail	Pass
123	13	Fail	Pass	Fail	Pass
123	14	Fail	Pass	Fail	Pass
123	15	Fail	Pass	Fail	Pass
123	16	Fail	Pass	Fail	Pass
123	17	Fail	Pass	Fail	Pass
123	18	Fail	Pass	Fail	Pass
123	19	Fail	Pass	Fail	Pass
123	20	Fail	Pass	Fail	Pass
123	21	Fail	Pass	Fail	Pass
123	22	Fail	Pass	Fail	Pass

123	23	Fail	Pass	Fail	Pass
123	24	Fail	Pass	Fail	Pass
123	25	Fail	Pass	Fail	Pass
123	26	Fail	Pass	Fail	Pass
123	27	Fail	Pass	Fail	Pass
123	28	Fail	Pass	Fail	Pass
123	29	Fail	Pass	Fail	Pass
123	30	Fail	Pass	Fail	Pass
123	31	Fail	Pass	Fail	Pass
123	32	Fail	Pass	Fail	Pass
123	33	Fail	Pass	Fail	Pass
123	34	Fail	Pass	Fail	Pass
123	35	Fail	Pass	Fail	Pass
123	36	Fail	Pass	Fail	Pass
123	37	Fail	Pass	Fail	Pass
123	38	Fail	Pass	Fail	Pass
123	39	Fail	Pass	Fail	Pass
124	13	Fail	Pass	Fail	Pass
124	14	Fail	Pass	Fail	Pass
124	23	Fail	Pass	Fail	Pass
125	13	Fail	Pass	Fail	Pass
125	14	Fail	Pass	Fail	Pass
125	23	Fail	Pass	Fail	Pass
126	13	Fail	Pass	Fail	Pass
126	14	Fail	Pass	Fail	Pass
126	23	Fail	Pass	Fail	Pass
127	13	Fail	Pass	Fail	Pass
127	14	Fail	Pass	Fail	Pass
127	23	Fail	Pass	Fail	Pass
128	13	Fail	Pass	Fail	Pass
128	14	Fail	Pass	Fail	Pass
128	23	Fail	Pass	Fail	Pass
129	13	Fail	Pass	Fail	Pass
129	14	Fail	Pass	Fail	Pass
129	23	Fail	Pass	Fail	Pass
130	8	Fail	Pass	Fail	Pass
130	9	Fail	Pass	Fail	Pass
130	10	Fail	Pass	Fail	Pass
130	11	Fail	Pass	Fail	Pass
130	12	Fail	Pass	Fail	Pass
130	13	Fail	Pass	Fail	Pass
130	14	Fail	Pass	Fail	Pass
130	23	Fail	Pass	Fail	Pass
131	14	Fail	Pass	Fail	Pass
131	23	Fail	Pass	Fail	Pass
132	14	Fail	Pass	Fail	Pass
132	23	Fail	Pass	Fail	Pass
133	14	Fail	Pass	Fail	Pass
133	23	Fail	Pass	Fail	Pass
134	14	Fail	Pass	Fail	Pass
134	23	Fail	Pass	Fail	Pass
135	14	Fail	Pass	Fail	Pass
136	14	Fail	Pass	Fail	Pass
137	14	Fail	Pass	Fail	Pass
138	14	Fail	Pass	Fail	Pass

4. Table A.6.4. Southern Flounder D.O. and Slope criteria passing for existing and deepening (2 ft) scenarios within the analyzed period August 1 - August 31, 1999

HABITAT REQUIREMENTS:
RM 10-31; Bottom Layer, Slope <=5%
D.O. August (MG/L):10th %ile >=4.0

Savannah Harbor Estuary

Segments		Baseline Scenario		Project Scenario	
J	I	D.O.	Slope	D.O.	Slope
47	13	Fail	Fail	Fail	Fail
47	14	Fail	Pass	Fail	Pass
47	15	Fail	Fail	Fail	Fail
47	16	Fail	Pass	Fail	Pass
47	17	Fail	Fail	Fail	Fail
48	13	Fail	Fail	Fail	Fail
48	14	Fail	Pass	Fail	Pass
48	15	Fail	Fail	Fail	Fail
48	16	Fail	Pass	Fail	Pass
48	17	Fail	Fail	Fail	Fail
49	13	Fail	Fail	Fail	Fail
49	14	Fail	Pass	Fail	Pass
49	15	Fail	Fail	Fail	Fail
49	16	Fail	Pass	Fail	Pass
49	17	Fail	Pass	Fail	Pass
50	13	Fail	Fail	Fail	Fail
50	14	Fail	Pass	Fail	Pass
50	15	Fail	Fail	Fail	Fail
50	16	Fail	Fail	Fail	Fail
50	17	Fail	Pass	Fail	Pass
50	18	Fail	Fail	Fail	Fail
51	13	Fail	Fail	Fail	Fail
51	14	Fail	Pass	Fail	Pass
51	15	Fail	Fail	Fail	Fail
52	13	Fail	Fail	Fail	Fail
52	14	Fail	Pass	Fail	Pass
52	15	Fail	Fail	Fail	Fail
53	13	Fail	Fail	Fail	Fail
53	14	Fail	Pass	Fail	Pass
53	15	Fail	Fail	Fail	Fail
54	13	Fail	Fail	Fail	Fail
54	14	Fail	Pass	Fail	Pass
54	15	Fail	Fail	Fail	Fail
55	13	Fail	Fail	Fail	Fail
55	14	Fail	Pass	Fail	Pass
55	15	Fail	Fail	Fail	Fail
56	13	Fail	Fail	Fail	Fail
56	14	Fail	Pass	Fail	Pass
56	15	Fail	Fail	Fail	Fail
57	13	Fail	Fail	Fail	Fail
57	14	Fail	Pass	Fail	Pass
57	15	Fail	Fail	Fail	Fail

58	13	Fail	Fail	Fail	Fail
58	14	Fail	Pass	Fail	Pass
58	15	Fail	Fail	Fail	Fail
59	13	Fail	Fail	Fail	Fail
59	14	Fail	Pass	Fail	Pass
59	15	Fail	Fail	Fail	Fail
59	30	Fail	Fail	Fail	Fail
59	31	Fail	Pass	Fail	Pass
59	32	Fail	Fail	Fail	Fail
60	13	Fail	Fail	Fail	Fail
60	14	Fail	Pass	Fail	Pass
60	15	Fail	Fail	Fail	Fail
60	30	Fail	Fail	Fail	Fail
60	31	Fail	Pass	Fail	Pass
60	32	Fail	Fail	Fail	Fail
61	13	Fail	Fail	Fail	Fail
61	14	Fail	Pass	Fail	Pass
61	15	Fail	Fail	Fail	Fail
61	30	Fail	Fail	Fail	Fail
61	31	Fail	Pass	Fail	Pass
61	32	Fail	Fail	Fail	Fail
62	13	Fail	Fail	Fail	Fail
62	14	Fail	Pass	Fail	Pass
62	15	Fail	Fail	Fail	Fail
62	30	Fail	Fail	Fail	Fail
62	31	Fail	Pass	Fail	Pass
62	32	Fail	Fail	Fail	Fail
63	13	Fail	Fail	Fail	Fail
63	14	Fail	Pass	Fail	Pass
63	15	Fail	Fail	Fail	Fail
63	31	Fail	Pass	Fail	Pass
64	13	Fail	Fail	Fail	Fail
64	14	Fail	Pass	Fail	Pass
64	15	Fail	Fail	Fail	Fail
64	30	Fail	Pass	Fail	Pass
64	31	Fail	Pass	Fail	Pass
64	32	Fail	Pass	Fail	Pass
65	13	Fail	Fail	Fail	Fail
65	14	Fail	Pass	Fail	Pass
65	15	Fail	Fail	Fail	Fail
65	30	Fail	Pass	Fail	Pass
65	31	Fail	Pass	Fail	Pass
65	32	Fail	Pass	Fail	Pass
65	33	Fail	Pass	Fail	Pass
66	13	Fail	Fail	Fail	Fail
66	14	Fail	Pass	Fail	Pass
66	15	Fail	Fail	Fail	Fail
66	30	Fail	Pass	Fail	Pass
66	31	Fail	Pass	Fail	Pass
66	32	Fail	Pass	Fail	Pass
66	36	Fail	Pass	Fail	Pass
67	13	Fail	Fail	Fail	Fail
67	14	Fail	Pass	Fail	Pass
67	15	Fail	Fail	Fail	Fail
67	30	Fail	Pass	Fail	Pass
67	31	Fail	Pass	Fail	Pass
67	32	Fail	Pass	Fail	Pass

67	36	Fail	Pass	Fail	Pass
68	13	Fail	Fail	Fail	Fail
68	14	Fail	Pass	Fail	Pass
68	15	Fail	Fail	Fail	Fail
68	30	Fail	Pass	Fail	Pass
68	31	Fail	Pass	Fail	Pass
68	32	Fail	Pass	Fail	Pass
68	36	Fail	Pass	Fail	Pass
69	13	Fail	Fail	Fail	Fail
69	14	Fail	Pass	Fail	Pass
69	15	Fail	Fail	Fail	Fail
69	30	Fail	Pass	Fail	Pass
69	31	Fail	Pass	Fail	Pass
69	32	Fail	Pass	Fail	Pass
69	36	Fail	Pass	Fail	Pass
70	13	Fail	Fail	Fail	Fail
70	14	Fail	Pass	Fail	Pass
70	15	Fail	Fail	Fail	Fail
70	30	Fail	Pass	Fail	Pass
70	31	Fail	Pass	Fail	Pass
70	32	Fail	Pass	Fail	Pass
70	33	Fail	Pass	Fail	Pass
71	13	Fail	Fail	Fail	Fail
71	14	Fail	Pass	Fail	Pass
71	15	Fail	Fail	Fail	Fail
71	30	Fail	Pass	Fail	Pass
71	31	Fail	Pass	Fail	Pass
71	32	Fail	Pass	Fail	Pass
72	13	Fail	Fail	Fail	Fail
72	14	Fail	Pass	Fail	Pass
72	15	Fail	Fail	Fail	Fail
72	30	Fail	Pass	Fail	Pass
72	31	Fail	Pass	Fail	Pass
72	32	Fail	Pass	Fail	Pass
73	13	Fail	Fail	Fail	Fail
73	14	Fail	Pass	Fail	Pass
73	15	Fail	Fail	Fail	Fail
73	30	Fail	Pass	Fail	Pass
73	31	Fail	Pass	Fail	Pass
74	13	Fail	Fail	Fail	Fail
74	14	Fail	Pass	Fail	Pass
74	15	Fail	Fail	Fail	Fail
74	30	Fail	Pass	Fail	Pass
74	31	Fail	Pass	Fail	Pass
75	13	Fail	Fail	Fail	Fail
75	14	Fail	Pass	Fail	Pass
75	15	Fail	Fail	Fail	Fail
75	30	Fail	Pass	Fail	Pass
75	31	Fail	Pass	Fail	Pass
76	13	Fail	Fail	Fail	Fail
76	14	Fail	Pass	Fail	Pass
76	15	Fail	Pass	Fail	Pass
76	16	Fail	Pass	Fail	Pass
76	17	Fail	Fail	Fail	Fail
76	30	Fail	Pass	Fail	Pass
76	31	Fail	Pass	Fail	Pass
77	13	Fail	Fail	Fail	Fail

77	14	Fail	Pass	Fail	Pass
77	15	Fail	Pass	Fail	Pass
77	16	Fail	Pass	Fail	Pass
77	17	Fail	Fail	Fail	Fail
77	30	Fail	Pass	Fail	Pass
77	31	Fail	Pass	Fail	Pass
78	13	Fail	Fail	Fail	Fail
78	14	Fail	Pass	Fail	Pass
78	15	Fail	Pass	Fail	Pass
78	16	Fail	Pass	Fail	Pass
78	17	Fail	Fail	Fail	Fail
78	30	Fail	Pass	Fail	Pass
78	31	Fail	Pass	Fail	Pass
79	13	Fail	Fail	Fail	Fail
79	14	Fail	Pass	Fail	Pass
79	15	Fail	Fail	Fail	Fail
79	30	Fail	Pass	Fail	Pass
79	31	Fail	Pass	Fail	Pass
80	13	Fail	Fail	Fail	Fail
80	14	Fail	Pass	Fail	Pass
80	15	Fail	Fail	Fail	Fail
80	30	Fail	Pass	Fail	Pass
80	31	Fail	Pass	Fail	Pass
81	13	Fail	Fail	Fail	Fail
81	14	Fail	Pass	Fail	Pass
81	15	Fail	Fail	Fail	Fail
81	30	Fail	Pass	Fail	Pass
81	31	Fail	Pass	Fail	Pass
82	13	Fail	Fail	Fail	Fail
82	14	Fail	Pass	Fail	Pass
82	15	Fail	Fail	Fail	Fail
82	16	Fail	Pass	Fail	Pass
82	17	Fail	Pass	Fail	Pass
82	18	Fail	Pass	Fail	Pass
82	19	Fail	Pass	Fail	Pass
82	20	Fail	Pass	Fail	Pass
82	21	Fail	Pass	Fail	Pass
82	29	Fail	Pass	Fail	Pass
82	30	Fail	Pass	Fail	Pass
82	31	Fail	Pass	Fail	Pass
83	13	Fail	Fail	Fail	Fail
83	14	Fail	Pass	Fail	Pass
83	15	Fail	Fail	Fail	Fail
83	21	Fail	Pass	Fail	Pass
83	30	Fail	Pass	Fail	Pass
83	31	Fail	Pass	Fail	Pass
84	13	Fail	Fail	Fail	Fail
84	14	Fail	Pass	Fail	Pass
84	15	Fail	Fail	Fail	Fail
84	21	Fail	Pass	Fail	Pass
84	30	Fail	Pass	Fail	Pass
84	31	Fail	Pass	Fail	Pass
85	13	Fail	Fail	Fail	Fail
85	14	Fail	Pass	Fail	Pass
85	15	Fail	Fail	Fail	Fail
85	21	Fail	Pass	Fail	Pass
85	30	Fail	Pass	Fail	Pass

86	13	Fail	Fail	Fail	Fail
86	14	Fail	Pass	Fail	Pass
86	15	Fail	Fail	Fail	Fail
86	21	Fail	Pass	Fail	Pass
86	30	Fail	Pass	Fail	Pass
87	13	Fail	Fail	Fail	Fail
87	14	Fail	Pass	Fail	Pass
87	15	Fail	Fail	Fail	Fail
87	30	Fail	Pass	Fail	Pass
88	13	Fail	Fail	Fail	Fail
88	14	Fail	Pass	Fail	Pass
88	15	Fail	Fail	Fail	Fail
88	30	Fail	Pass	Fail	Pass
89	13	Fail	Fail	Fail	Fail
89	14	Fail	Pass	Fail	Pass
89	15	Fail	Fail	Fail	Fail
89	30	Fail	Pass	Fail	Pass
90	13	Fail	Fail	Fail	Fail
90	14	Fail	Pass	Fail	Pass
90	15	Fail	Fail	Fail	Fail
90	30	Fail	Pass	Fail	Pass
91	13	Fail	Fail	Fail	Fail
91	14	Fail	Pass	Fail	Pass
91	15	Fail	Pass	Fail	Pass
91	16	Fail	Pass	Fail	Pass
91	30	Fail	Pass	Fail	Pass
92	13	Fail	Fail	Fail	Fail
92	14	Fail	Pass	Fail	Pass
92	15	Fail	Pass	Fail	Pass
92	16	Fail	Fail	Fail	Fail
92	30	Fail	Pass	Fail	Pass
93	13	Fail	Fail	Fail	Fail
93	14	Fail	Pass	Fail	Pass
93	15	Fail	Pass	Fail	Pass
93	16	Fail	Fail	Fail	Fail
93	30	Fail	Pass	Fail	Pass
94	13	Fail	Fail	Fail	Fail
94	14	Fail	Pass	Fail	Pass
94	15	Fail	Pass	Fail	Pass
94	16	Fail	Fail	Fail	Fail
94	26	Fail	Pass	Fail	Pass
94	30	Fail	Pass	Fail	Pass
95	13	Fail	Fail	Fail	Fail
95	14	Fail	Pass	Fail	Pass
95	15	Fail	Pass	Fail	Pass
95	16	Fail	Fail	Fail	Fail
95	26	Fail	Pass	Fail	Pass
95	30	Fail	Pass	Fail	Pass
96	13	Fail	Fail	Fail	Fail
96	14	Fail	Pass	Fail	Pass
96	15	Fail	Fail	Fail	Fail
96	26	Fail	Pass	Fail	Pass
96	30	Fail	Pass	Fail	Pass
97	13	Pass	Fail	Fail	Fail
97	14	Fail	Pass	Fail	Pass
97	15	Pass	Fail	Fail	Fail
97	26	Fail	Pass	Fail	Pass

97	30	Fail	Pass	Fail	Pass
98	13	Pass	Fail	Fail	Fail
98	14	Pass	Pass	Fail	Pass
98	15	Pass	Fail	Fail	Fail
98	26	Fail	Pass	Fail	Pass
98	27	Fail	Pass	Fail	Pass
98	28	Fail	Pass	Fail	Pass
98	29	Fail	Pass	Fail	Pass
98	30	Fail	Pass	Fail	Pass
99	13	Pass	Fail	Fail	Fail
99	14	Pass	Pass	Fail	Pass
99	15	Pass	Fail	Fail	Fail
99	16	Fail	Pass	Fail	Pass
99	17	Fail	Pass	Fail	Pass
99	18	Fail	Pass	Fail	Pass
99	19	Fail	Pass	Fail	Pass
99	20	Fail	Pass	Fail	Pass
99	21	Fail	Pass	Fail	Pass
99	22	Fail	Pass	Fail	Pass
99	23	Fail	Pass	Fail	Pass
99	26	Fail	Pass	Fail	Pass
99	30	Fail	Pass	Fail	Pass
100	13	Pass	Fail	Pass	Fail
100	14	Pass	Pass	Fail	Pass
100	15	Pass	Fail	Fail	Fail
100	23	Fail	Pass	Fail	Pass
100	24	Fail	Pass	Fail	Pass
100	25	Fail	Pass	Fail	Pass
100	26	Fail	Pass	Fail	Pass
100	30	Fail	Pass	Fail	Pass
101	13	Pass	Fail	Pass	Fail
101	14	Pass	Pass	Pass	Pass
101	15	Pass	Fail	Pass	Fail
101	16	Fail	Pass	Fail	Pass
101	17	Fail	Pass	Fail	Pass
101	18	Fail	Pass	Fail	Pass
101	19	Fail	Pass	Fail	Pass
101	20	Fail	Pass	Fail	Pass
101	21	Fail	Pass	Fail	Pass
101	22	Fail	Pass	Fail	Pass
101	23	Fail	Pass	Fail	Pass
101	26	Fail	Pass	Fail	Pass
101	30	Fail	Pass	Fail	Pass
102	13	Pass	Fail	Pass	Fail
102	14	Pass	Pass	Pass	Pass
102	15	Pass	Fail	Pass	Fail
102	26	Fail	Pass	Fail	Pass
102	30	Fail	Pass	Fail	Pass
103	13	Pass	Fail	Pass	Fail
103	14	Pass	Pass	Pass	Pass
103	15	Pass	Fail	Pass	Fail
103	26	Fail	Pass	Fail	Pass
103	30	Fail	Pass	Fail	Pass
104	13	Pass	Fail	Pass	Fail
104	14	Pass	Pass	Pass	Pass
104	15	Pass	Fail	Pass	Fail
104	26	Fail	Pass	Fail	Pass

104	30	Fail	Pass	Fail	Pass
105	13	Pass	Fail	Pass	Fail
105	14	Pass	Pass	Pass	Pass
105	15	Pass	Fail	Pass	Fail
105	26	Fail	Pass	Fail	Pass
105	30	Fail	Pass	Fail	Pass
106	13	Pass	Fail	Pass	Fail
106	14	Pass	Pass	Pass	Pass
106	15	Pass	Fail	Pass	Fail
106	26	Fail	Pass	Fail	Pass
106	27	Fail	Pass	Fail	Pass
106	30	Fail	Pass	Fail	Pass
106	39	Fail	Pass	Fail	Pass
107	13	Pass	Fail	Pass	Fail
107	14	Pass	Pass	Pass	Pass
107	15	Pass	Fail	Pass	Fail
107	22	Fail	Pass	Fail	Pass
107	26	Fail	Pass	Fail	Pass
107	30	Fail	Pass	Fail	Pass
107	39	Fail	Pass	Fail	Pass
108	13	Pass	Fail	Pass	Fail
108	14	Pass	Pass	Pass	Pass
108	15	Pass	Fail	Pass	Fail
108	22	Fail	Pass	Fail	Pass
108	26	Fail	Pass	Fail	Pass
108	30	Fail	Pass	Fail	Pass
108	39	Fail	Pass	Fail	Pass
109	13	Pass	Fail	Pass	Fail
109	14	Pass	Pass	Pass	Pass
109	15	Pass	Fail	Pass	Fail
109	22	Fail	Pass	Fail	Pass
109	26	Fail	Pass	Fail	Pass
109	30	Fail	Pass	Fail	Pass
109	39	Fail	Pass	Fail	Pass
110	13	Pass	Fail	Pass	Fail
110	14	Pass	Pass	Pass	Pass
110	15	Pass	Fail	Pass	Fail
110	22	Fail	Pass	Fail	Pass
110	26	Fail	Pass	Fail	Pass
110	39	Fail	Pass	Fail	Pass
111	13	Pass	Fail	Pass	Fail
111	14	Pass	Pass	Pass	Pass
111	15	Pass	Fail	Pass	Fail
111	22	Fail	Pass	Fail	Pass
111	26	Fail	Pass	Fail	Pass
111	39	Fail	Pass	Fail	Pass
112	13	Pass	Fail	Pass	Fail
112	14	Pass	Pass	Pass	Pass
112	15	Pass	Fail	Pass	Fail
112	22	Fail	Pass	Fail	Pass
112	26	Fail	Pass	Fail	Pass
112	39	Fail	Pass	Fail	Pass
113	13	Pass	Fail	Pass	Fail
113	14	Pass	Pass	Pass	Pass
113	15	Pass	Fail	Pass	Fail
113	26	Fail	Pass	Fail	Pass
113	27	Fail	Pass	Fail	Pass

113	39	Fail	Pass	Fail	Pass
114	13	Pass	Fail	Pass	Fail
114	14	Pass	Pass	Pass	Pass
114	15	Pass	Fail	Pass	Fail
114	26	Fail	Pass	Fail	Pass
114	39	Fail	Pass	Fail	Pass
115	13	Pass	Fail	Pass	Fail
115	14	Pass	Pass	Pass	Pass
115	15	Pass	Fail	Pass	Fail
115	26	Fail	Pass	Fail	Pass
115	39	Fail	Pass	Fail	Pass
116	13	Pass	Fail	Pass	Fail
116	14	Pass	Pass	Pass	Pass
116	15	Pass	Fail	Pass	Fail
116	26	Fail	Pass	Fail	Pass
116	39	Fail	Pass	Fail	Pass
117	13	Pass	Fail	Pass	Fail
117	14	Pass	Pass	Pass	Pass
117	15	Fail	Fail	Fail	Fail
117	26	Fail	Pass	Fail	Pass
117	39	Fail	Pass	Fail	Pass
118	13	Pass	Fail	Pass	Fail
118	14	Pass	Pass	Pass	Pass
118	15	Fail	Fail	Fail	Fail
118	20	Fail	Pass	Fail	Pass
118	26	Fail	Pass	Fail	Pass
118	39	Fail	Pass	Fail	Pass
119	13	Pass	Fail	Pass	Fail
119	14	Fail	Pass	Fail	Pass
119	15	Fail	Fail	Fail	Fail
119	20	Fail	Pass	Fail	Pass
119	26	Fail	Pass	Fail	Pass
119	39	Fail	Pass	Fail	Pass
120	13	Pass	Fail	Pass	Fail
120	14	Fail	Pass	Fail	Pass
120	15	Fail	Fail	Fail	Fail
120	16	Fail	Pass	Fail	Pass
120	26	Fail	Pass	Fail	Pass
120	39	Fail	Pass	Fail	Pass
121	13	Fail	Pass	Fail	Pass
121	14	Fail	Pass	Fail	Pass
121	26	Fail	Pass	Fail	Pass
121	39	Fail	Pass	Fail	Pass
122	13	Fail	Pass	Fail	Pass
122	14	Fail	Pass	Fail	Pass
122	26	Fail	Pass	Fail	Pass
122	39	Fail	Pass	Fail	Pass
123	13	Fail	Pass	Fail	Pass
123	14	Fail	Pass	Fail	Pass
123	15	Fail	Pass	Fail	Pass
123	16	Fail	Pass	Fail	Pass
123	17	Fail	Pass	Fail	Pass
123	18	Fail	Pass	Fail	Pass
123	19	Fail	Pass	Fail	Pass
123	20	Fail	Pass	Fail	Pass
123	21	Fail	Pass	Fail	Pass
123	22	Fail	Pass	Fail	Pass

123	23	Fail	Pass	Fail	Pass
123	24	Fail	Pass	Fail	Pass
123	25	Fail	Pass	Fail	Pass
123	26	Fail	Pass	Fail	Pass
123	27	Fail	Pass	Fail	Pass
123	28	Fail	Pass	Fail	Pass
123	29	Fail	Pass	Fail	Pass
123	30	Fail	Pass	Fail	Pass
123	31	Fail	Pass	Fail	Pass
123	32	Fail	Pass	Fail	Pass
123	33	Fail	Pass	Fail	Pass
123	34	Fail	Pass	Fail	Pass
123	35	Fail	Pass	Fail	Pass
123	36	Fail	Pass	Fail	Pass
123	37	Fail	Pass	Fail	Pass
123	38	Fail	Pass	Fail	Pass
123	39	Fail	Pass	Fail	Pass
124	13	Fail	Pass	Fail	Pass
124	14	Fail	Pass	Fail	Pass
124	23	Fail	Pass	Fail	Pass
125	13	Fail	Pass	Fail	Pass
125	14	Fail	Pass	Fail	Pass
125	23	Fail	Pass	Fail	Pass
126	13	Fail	Pass	Fail	Pass
126	14	Fail	Pass	Fail	Pass
126	23	Fail	Pass	Fail	Pass
127	13	Fail	Pass	Fail	Pass
127	14	Fail	Pass	Fail	Pass
127	23	Fail	Pass	Fail	Pass
128	13	Fail	Pass	Fail	Pass
128	14	Fail	Pass	Fail	Pass
128	23	Fail	Pass	Fail	Pass
129	13	Fail	Pass	Fail	Pass
129	14	Fail	Pass	Fail	Pass
129	23	Fail	Pass	Fail	Pass
130	8	Fail	Pass	Fail	Pass
130	9	Fail	Pass	Fail	Pass
130	10	Fail	Pass	Fail	Pass
130	11	Fail	Pass	Fail	Pass
130	12	Fail	Pass	Fail	Pass
130	13	Fail	Pass	Fail	Pass
130	14	Fail	Pass	Fail	Pass
130	23	Fail	Pass	Fail	Pass
131	14	Fail	Pass	Fail	Pass
131	23	Fail	Pass	Fail	Pass
132	14	Fail	Pass	Fail	Pass
132	23	Fail	Pass	Fail	Pass
133	14	Fail	Pass	Fail	Pass
133	23	Fail	Pass	Fail	Pass
134	14	Fail	Pass	Fail	Pass
134	23	Fail	Pass	Fail	Pass
135	14	Fail	Pass	Fail	Pass
136	14	Fail	Pass	Fail	Pass
137	14	Fail	Pass	Fail	Pass
138	14	Fail	Pass	Fail	Pass

Appendix A-2

Tables of Criteria Passing for American Shad Habitat Suitability

August 1999

50th %ile of Clyo Flow

Fisheries Review Group

1. Table A.7.1. American Shad D.O. criteria passing for existing and deepening (6 ft) scenarios within the analyzed period August 1 - August 31, 1999

HABITAT REQUIREMENTS:
RM 10-40; Top half of water column
D.O. January, May, and August (MG/L):10th %ile >=4.0

Savannah Harbor Estuary

Segments J	Segments I	Baseline Scenario D.O.	Project Scenario D.O.
47	13	Pass	Pass
47	14	Pass	Pass
47	15	Pass	Pass
47	16	Pass	Pass
47	17	Pass	Pass
48	13	Pass	Pass
48	14	Pass	Pass
48	15	Pass	Pass
48	16	Pass	Pass
48	17	Pass	Pass
49	13	Pass	Pass
49	14	Pass	Pass
49	15	Pass	Pass
49	16	Pass	Pass
49	17	Pass	Pass
50	13	Pass	Pass
50	14	Pass	Pass
50	15	Pass	Pass
50	16	Pass	Pass
50	17	Pass	Pass
50	18	Pass	Pass
51	13	Pass	Pass
51	14	Pass	Pass
51	15	Pass	Pass
52	13	Pass	Pass
52	14	Pass	Pass
52	15	Pass	Pass
53	13	Pass	Pass
53	14	Pass	Pass
53	15	Pass	Pass
54	13	Pass	Pass
54	14	Pass	Pass
54	15	Pass	Pass
55	13	Pass	Pass
55	14	Pass	Pass
55	15	Pass	Pass
56	13	Pass	Pass
56	14	Pass	Pass
56	15	Pass	Pass
57	13	Pass	Pass
57	14	Pass	Pass
57	15	Pass	Pass
58	13	Pass	Pass

58	14	Pass	Pass
58	15	Pass	Pass
59	13	Pass	Pass
59	14	Pass	Pass
59	15	Pass	Pass
59	30	Pass	Pass
59	31	Fail	Fail
59	32	Pass	Pass
60	13	Pass	Pass
60	14	Pass	Pass
60	15	Pass	Pass
60	30	Pass	Fail
60	31	Fail	Fail
60	32	Fail	Fail
61	13	Pass	Pass
61	14	Pass	Pass
61	15	Pass	Pass
61	30	Fail	Fail
61	31	Fail	Fail
61	32	Fail	Fail
62	13	Pass	Pass
62	14	Pass	Pass
62	15	Pass	Pass
62	30	Fail	Fail
62	31	Fail	Fail
62	32	Fail	Fail
63	13	Pass	Pass
63	14	Pass	Pass
63	15	Pass	Pass
63	31	Fail	Fail
64	13	Pass	Pass
64	14	Pass	Pass
64	15	Pass	Pass
64	30	Fail	Fail
64	31	Fail	Fail
64	32	Fail	Fail
65	13	Pass	Pass
65	14	Pass	Pass
65	15	Pass	Pass
65	30	Fail	Fail
65	31	Fail	Fail
65	32	Fail	Fail
65	33	Fail	Fail
66	13	Pass	Pass
66	14	Pass	Pass
66	15	Pass	Pass
66	30	Fail	Fail
66	31	Fail	Fail
66	32	Fail	Fail
66	36	Fail	Fail
67	13	Pass	Pass
67	14	Pass	Pass
67	15	Pass	Pass
67	30	Fail	Fail
67	31	Fail	Fail
67	32	Fail	Fail
67	36	Fail	Fail

68	13	Pass	Pass
68	14	Pass	Pass
68	15	Pass	Pass
68	30	Fail	Fail
68	31	Fail	Fail
68	32	Fail	Fail
68	36	Fail	Fail
69	13	Pass	Pass
69	14	Pass	Pass
69	15	Pass	Pass
69	30	Fail	Fail
69	31	Fail	Fail
69	32	Fail	Fail
69	36	Fail	Fail
70	13	Pass	Pass
70	14	Pass	Pass
70	15	Pass	Pass
70	30	Fail	Fail
70	31	Fail	Fail
70	32	Fail	Fail
70	33	Fail	Fail
71	13	Pass	Pass
71	14	Pass	Pass
71	15	Pass	Pass
71	30	Fail	Fail
71	31	Fail	Fail
71	32	Fail	Fail
72	13	Pass	Pass
72	14	Pass	Pass
72	15	Pass	Pass
72	30	Fail	Fail
72	31	Fail	Fail
72	32	Fail	Fail
73	13	Pass	Pass
73	14	Pass	Pass
73	15	Pass	Pass
73	30	Fail	Fail
73	31	Fail	Fail
74	13	Pass	Pass
74	14	Pass	Pass
74	15	Pass	Pass
74	30	Fail	Fail
74	31	Fail	Fail
75	13	Pass	Pass
75	14	Pass	Pass
75	15	Pass	Pass
75	30	Fail	Fail
75	31	Fail	Fail
76	13	Pass	Pass
76	14	Pass	Pass
76	15	Pass	Pass
76	16	Pass	Pass
76	17	Pass	Pass
76	30	Fail	Fail
76	31	Fail	Fail
77	13	Pass	Pass
77	14	Pass	Pass

77	15	Pass	Pass
77	16	Pass	Pass
77	17	Pass	Pass
77	30	Fail	Fail
77	31	Fail	Fail
78	13	Pass	Pass
78	14	Pass	Pass
78	15	Pass	Pass
78	16	Pass	Pass
78	17	Pass	Pass
78	30	Fail	Fail
78	31	Pass	Fail
79	13	Pass	Pass
79	14	Pass	Pass
79	15	Pass	Pass
79	30	Fail	Fail
79	31	Fail	Fail
80	13	Pass	Pass
80	14	Pass	Pass
80	15	Pass	Pass
80	30	Fail	Fail
80	31	Pass	Pass
81	13	Pass	Pass
81	14	Pass	Pass
81	15	Pass	Pass
81	30	Fail	Fail
81	31	Pass	Pass
82	13	Pass	Pass
82	14	Pass	Pass
82	15	Pass	Pass
82	16	Pass	Pass
82	17	Pass	Pass
82	18	Pass	Pass
82	19	Pass	Pass
82	20	Pass	Pass
82	21	Pass	Pass
82	29	Fail	Fail
82	30	Fail	Fail
82	31	Pass	Pass
83	13	Pass	Pass
83	14	Pass	Pass
83	15	Pass	Pass
83	21	Pass	Pass
83	30	Fail	Fail
83	31	Pass	Pass
84	13	Pass	Pass
84	14	Pass	Pass
84	15	Pass	Pass
84	21	Pass	Pass
84	30	Fail	Fail
84	31	Pass	Pass
85	13	Pass	Pass
85	14	Pass	Pass
85	15	Pass	Pass
85	21	Pass	Pass
85	30	Pass	Pass
86	13	Pass	Pass

86	14	Pass	Pass
86	15	Pass	Pass
86	21	Pass	Pass
86	30	Pass	Pass
87	13	Pass	Pass
87	14	Pass	Pass
87	15	Pass	Pass
87	30	Pass	Pass
88	13	Pass	Pass
88	14	Pass	Pass
88	15	Pass	Pass
88	30	Pass	Pass
89	13	Pass	Pass
89	14	Pass	Pass
89	15	Pass	Pass
89	30	Pass	Pass
90	13	Pass	Pass
90	14	Pass	Pass
90	15	Pass	Pass
90	30	Pass	Pass
91	13	Pass	Pass
91	14	Pass	Pass
91	15	Pass	Pass
91	16	Pass	Pass
91	30	Pass	Pass
92	13	Pass	Pass
92	14	Pass	Pass
92	15	Pass	Pass
92	16	Pass	Pass
92	30	Pass	Pass
93	13	Pass	Pass
93	14	Pass	Pass
93	15	Pass	Pass
93	16	Pass	Pass
93	30	Pass	Pass
94	13	Pass	Pass
94	14	Pass	Pass
94	15	Pass	Pass
94	16	Pass	Pass
94	26	Pass	Pass
94	30	Pass	Pass
95	13	Pass	Pass
95	14	Pass	Pass
95	15	Pass	Pass
95	16	Pass	Pass
95	26	Pass	Pass
95	30	Pass	Pass
96	13	Pass	Pass
96	14	Pass	Pass
96	15	Pass	Pass
96	26	Pass	Pass
96	30	Pass	Pass
97	13	Pass	Pass
97	14	Pass	Pass
97	15	Pass	Pass
97	26	Pass	Pass
97	30	Pass	Pass

98	13	Pass	Pass
98	14	Pass	Pass
98	15	Pass	Pass
98	26	Pass	Pass
98	27	Pass	Pass
98	28	Pass	Pass
98	29	Pass	Pass
98	30	Pass	Pass
99	13	Pass	Pass
99	14	Pass	Pass
99	15	Pass	Pass
99	16	Pass	Pass
99	17	Pass	Pass
99	18	Pass	Pass
99	19	Pass	Pass
99	20	Pass	Pass
99	21	Pass	Pass
99	22	Pass	Pass
99	23	Pass	Pass
99	26	Pass	Pass
99	30	Pass	Pass
100	13	Pass	Pass
100	14	Pass	Pass
100	15	Pass	Pass
100	23	Pass	Pass
100	24	Pass	Pass
100	25	Pass	Pass
100	26	Pass	Pass
100	30	Pass	Pass
101	13	Pass	Pass
101	14	Pass	Pass
101	15	Pass	Pass
101	16	Pass	Pass
101	17	Pass	Pass
101	18	Pass	Pass
101	19	Pass	Pass
101	20	Pass	Pass
101	21	Pass	Pass
101	22	Pass	Pass
101	23	Pass	Pass
101	26	Pass	Pass
101	30	Pass	Pass
102	13	Pass	Pass
102	14	Pass	Pass
102	15	Pass	Pass
102	26	Pass	Pass
102	30	Pass	Pass
103	13	Pass	Pass
103	14	Pass	Pass
103	15	Pass	Pass
103	26	Pass	Pass
103	30	Pass	Pass
104	13	Pass	Pass
104	14	Pass	Pass
104	15	Pass	Pass
104	26	Pass	Pass
104	30	Pass	Pass

105	13	Pass	Pass
105	14	Pass	Pass
105	15	Pass	Pass
105	26	Pass	Pass
105	30	Pass	Pass
106	13	Pass	Pass
106	14	Pass	Pass
106	15	Pass	Pass
106	26	Pass	Pass
106	27	Pass	Pass
106	30	Pass	Pass
106	39	Pass	Pass
107	13	Pass	Pass
107	14	Pass	Pass
107	15	Pass	Pass
107	22	Pass	Pass
107	26	Pass	Pass
107	30	Pass	Pass
107	39	Pass	Pass
108	13	Pass	Pass
108	14	Pass	Pass
108	15	Pass	Pass
108	22	Pass	Pass
108	26	Pass	Pass
108	30	Pass	Pass
108	39	Pass	Pass
109	13	Pass	Pass
109	14	Pass	Pass
109	15	Pass	Pass
109	22	Pass	Pass
109	26	Pass	Pass
109	30	Pass	Pass
109	39	Pass	Pass
110	13	Pass	Pass
110	14	Pass	Pass
110	15	Pass	Pass
110	22	Pass	Pass
110	26	Pass	Pass
110	39	Pass	Pass
111	13	Pass	Pass
111	14	Pass	Pass
111	15	Pass	Pass
111	22	Pass	Pass
111	26	Pass	Pass
111	39	Pass	Pass
112	13	Pass	Pass
112	14	Pass	Pass
112	15	Pass	Pass
112	22	Pass	Pass
112	26	Pass	Pass
112	39	Pass	Pass
113	13	Pass	Pass
113	14	Pass	Pass
113	15	Pass	Pass
113	26	Pass	Pass
113	27	Pass	Pass
113	39	Pass	Pass

114	13	Pass	Pass
114	14	Pass	Pass
114	15	Pass	Pass
114	26	Pass	Pass
114	39	Pass	Pass
115	13	Pass	Pass
115	14	Pass	Pass
115	15	Pass	Pass
115	26	Pass	Pass
115	39	Pass	Pass
116	13	Pass	Pass
116	14	Pass	Pass
116	15	Pass	Pass
116	26	Pass	Pass
116	39	Pass	Pass
117	13	Pass	Pass
117	14	Pass	Pass
117	15	Pass	Pass
117	26	Pass	Pass
117	39	Pass	Pass
118	13	Pass	Pass
118	14	Pass	Pass
118	15	Pass	Pass
118	20	Pass	Pass
118	26	Pass	Pass
118	39	Pass	Pass
119	13	Pass	Pass
119	14	Pass	Pass
119	15	Pass	Pass
119	20	Pass	Pass
119	26	Pass	Pass
119	39	Pass	Pass
120	13	Pass	Pass
120	14	Pass	Pass
120	15	Pass	Pass
120	16	Pass	Pass
120	26	Pass	Pass
120	39	Pass	Pass
121	13	Pass	Pass
121	14	Pass	Pass
121	26	Pass	Pass
121	39	Pass	Pass
122	13	Pass	Pass
122	14	Pass	Pass
122	26	Pass	Pass
122	39	Pass	Pass
123	13	Pass	Pass
123	14	Pass	Pass
123	15	Pass	Pass
123	16	Pass	Pass
123	17	Pass	Pass
123	18	Pass	Pass
123	19	Pass	Pass
123	20	Pass	Pass
123	21	Pass	Pass
123	22	Pass	Pass
123	23	Pass	Pass

123	24	Pass	Pass
123	25	Pass	Pass
123	26	Pass	Pass
123	27	Pass	Pass
123	28	Pass	Pass
123	29	Pass	Pass
123	30	Pass	Pass
123	31	Pass	Pass
123	32	Pass	Pass
123	33	Pass	Pass
123	34	Pass	Pass
123	35	Pass	Pass
123	36	Pass	Pass
123	37	Pass	Pass
123	38	Pass	Pass
123	39	Pass	Pass
124	13	Pass	Pass
124	14	Pass	Pass
124	23	Pass	Pass
125	13	Pass	Pass
125	14	Pass	Pass
125	23	Pass	Pass
126	13	Pass	Pass
126	14	Pass	Pass
126	23	Pass	Pass
127	13	Pass	Pass
127	14	Pass	Pass
127	23	Pass	Pass
128	13	Pass	Pass
128	14	Pass	Pass
128	23	Pass	Pass
129	13	Pass	Pass
129	14	Pass	Pass
129	23	Pass	Pass
130	8	Fail	Fail
130	9	Pass	Pass
130	10	Pass	Pass
130	11	Pass	Pass
130	12	Pass	Pass
130	13	Pass	Pass
130	14	Pass	Pass
130	23	Pass	Pass
131	14	Pass	Pass
131	23	Pass	Pass
132	14	Pass	Pass
132	23	Pass	Pass
133	14	Pass	Pass
133	23	Pass	Pass
134	14	Pass	Pass
134	23	Pass	Pass
135	14	Pass	Pass
136	14	Pass	Pass
137	14	Pass	Pass
138	14	Pass	Pass
139	14	Pass	Pass
140	14	Pass	Pass
141	14	Pass	Pass

142	14	Pass	Pass
143	14	Pass	Pass
144	14	Pass	Pass
145	14	Pass	Pass
146	14	Pass	Pass
147	14	Pass	Pass
148	14	Pass	Pass
149	14	Pass	Pass
150	14	Pass	Pass
151	14	Pass	Pass
152	14	Pass	Pass
153	14	Pass	Pass
154	14	Pass	Pass
155	14	Pass	Pass
156	14	Pass	Pass
157	14	Pass	Pass
158	14	Pass	Pass
159	14	Pass	Pass
160	14	Pass	Pass
161	14	Pass	Pass
162	14	Pass	Pass
163	14	Pass	Pass
164	14	Pass	Pass
165	14	Pass	Pass
166	14	Pass	Pass

2. Table A.7.2. American Shad D.O. criteria passing for existing and deepening (4 ft) scenarios within the analyzed period August 1 - August 31, 1999

HABITAT REQUIREMENTS:
RM 10-40; Top half of water column
D.O. January, May, and August (MG/L):10th %ile >=4.0

Savannah Harbor Estuary

Segments J	Segments I	Baseline Scenario D.O.	Project Scenario D.O.
47	13	Pass	Pass
47	14	Pass	Pass
47	15	Pass	Pass
47	16	Pass	Pass
47	17	Pass	Pass
48	13	Pass	Pass
48	14	Pass	Pass
48	15	Pass	Pass
48	16	Pass	Pass
48	17	Pass	Pass
49	13	Pass	Pass
49	14	Pass	Pass
49	15	Pass	Pass
49	16	Pass	Pass
49	17	Pass	Pass
50	13	Pass	Pass
50	14	Pass	Pass
50	15	Pass	Pass
50	16	Pass	Pass
50	17	Pass	Pass
50	18	Pass	Pass
51	13	Pass	Pass
51	14	Pass	Pass
51	15	Pass	Pass
52	13	Pass	Pass
52	14	Pass	Pass
52	15	Pass	Pass
53	13	Pass	Pass
53	14	Pass	Pass
53	15	Pass	Pass
54	13	Pass	Pass
54	14	Pass	Pass
54	15	Pass	Pass
55	13	Pass	Pass
55	14	Pass	Pass
55	15	Pass	Pass
56	13	Pass	Pass
56	14	Pass	Pass
56	15	Pass	Pass
57	13	Pass	Pass
57	14	Pass	Pass

57	15	Pass	Pass
58	13	Pass	Pass
58	14	Pass	Pass
58	15	Pass	Pass
59	13	Pass	Pass
59	14	Pass	Pass
59	15	Pass	Pass
59	30	Pass	Pass
59	31	Fail	Fail
59	32	Pass	Pass
60	13	Pass	Pass
60	14	Pass	Pass
60	15	Pass	Pass
60	30	Pass	Pass
60	31	Fail	Fail
60	32	Fail	Fail
61	13	Pass	Pass
61	14	Pass	Pass
61	15	Pass	Pass
61	30	Fail	Fail
61	31	Fail	Fail
61	32	Fail	Fail
62	13	Pass	Pass
62	14	Pass	Pass
62	15	Pass	Pass
62	30	Fail	Fail
62	31	Fail	Fail
62	32	Fail	Fail
63	13	Pass	Pass
63	14	Pass	Pass
63	15	Pass	Pass
63	31	Fail	Fail
64	13	Pass	Pass
64	14	Pass	Pass
64	15	Pass	Pass
64	30	Fail	Fail
64	31	Fail	Fail
64	32	Fail	Fail
65	13	Pass	Pass
65	14	Pass	Pass
65	15	Pass	Pass
65	30	Fail	Fail
65	31	Fail	Fail
65	32	Fail	Fail
65	33	Fail	Fail
66	13	Pass	Pass
66	14	Pass	Pass
66	15	Pass	Pass
66	30	Fail	Fail
66	31	Fail	Fail
66	32	Fail	Fail
66	36	Fail	Fail
67	13	Pass	Pass
67	14	Pass	Pass
67	15	Pass	Pass
67	30	Fail	Fail
67	31	Fail	Fail

67	32	Fail	Fail
67	36	Fail	Fail
68	13	Pass	Pass
68	14	Pass	Pass
68	15	Pass	Pass
68	30	Fail	Fail
68	31	Fail	Fail
68	32	Fail	Fail
68	36	Fail	Fail
69	13	Pass	Pass
69	14	Pass	Pass
69	15	Pass	Pass
69	30	Fail	Fail
69	31	Fail	Fail
69	32	Fail	Fail
69	36	Fail	Fail
70	13	Pass	Pass
70	14	Pass	Pass
70	15	Pass	Pass
70	30	Fail	Fail
70	31	Fail	Fail
70	32	Fail	Fail
70	33	Fail	Fail
71	13	Pass	Pass
71	14	Pass	Pass
71	15	Pass	Pass
71	30	Fail	Fail
71	31	Fail	Fail
71	32	Fail	Fail
72	13	Pass	Pass
72	14	Pass	Pass
72	15	Pass	Pass
72	30	Fail	Fail
72	31	Fail	Fail
72	32	Fail	Fail
73	13	Pass	Pass
73	14	Pass	Pass
73	15	Pass	Pass
73	30	Fail	Fail
73	31	Fail	Fail
74	13	Pass	Pass
74	14	Pass	Pass
74	15	Pass	Pass
74	30	Fail	Fail
74	31	Fail	Fail
75	13	Pass	Pass
75	14	Pass	Pass
75	15	Pass	Pass
75	30	Fail	Fail
75	31	Fail	Fail
76	13	Pass	Pass
76	14	Pass	Pass
76	15	Pass	Pass
76	16	Pass	Pass
76	17	Pass	Pass
76	30	Fail	Fail
76	31	Fail	Fail

77	13	Pass	Pass
77	14	Pass	Pass
77	15	Pass	Pass
77	16	Pass	Pass
77	17	Pass	Pass
77	30	Fail	Fail
77	31	Fail	Fail
78	13	Pass	Pass
78	14	Pass	Pass
78	15	Pass	Pass
78	16	Pass	Pass
78	17	Pass	Pass
78	30	Fail	Fail
78	31	Pass	Fail
79	13	Pass	Pass
79	14	Pass	Pass
79	15	Pass	Pass
79	30	Fail	Fail
79	31	Fail	Fail
80	13	Pass	Pass
80	14	Pass	Pass
80	15	Pass	Pass
80	30	Fail	Fail
80	31	Pass	Pass
81	13	Pass	Pass
81	14	Pass	Pass
81	15	Pass	Pass
81	30	Fail	Fail
81	31	Pass	Pass
82	13	Pass	Pass
82	14	Pass	Pass
82	15	Pass	Pass
82	16	Pass	Pass
82	17	Pass	Pass
82	18	Pass	Pass
82	19	Pass	Pass
82	20	Pass	Pass
82	21	Pass	Pass
82	29	Fail	Fail
82	30	Fail	Fail
82	31	Pass	Pass
83	13	Pass	Pass
83	14	Pass	Pass
83	15	Pass	Pass
83	21	Pass	Pass
83	30	Fail	Fail
83	31	Pass	Pass
84	13	Pass	Pass
84	14	Pass	Pass
84	15	Pass	Pass
84	21	Pass	Pass
84	30	Fail	Fail
84	31	Pass	Pass
85	13	Pass	Pass
85	14	Pass	Pass
85	15	Pass	Pass
85	21	Pass	Pass

85	30	Pass	Pass
86	13	Pass	Pass
86	14	Pass	Pass
86	15	Pass	Pass
86	21	Pass	Pass
86	30	Pass	Pass
87	13	Pass	Pass
87	14	Pass	Pass
87	15	Pass	Pass
87	30	Pass	Pass
88	13	Pass	Pass
88	14	Pass	Pass
88	15	Pass	Pass
88	30	Pass	Pass
89	13	Pass	Pass
89	14	Pass	Pass
89	15	Pass	Pass
89	30	Pass	Pass
90	13	Pass	Pass
90	14	Pass	Pass
90	15	Pass	Pass
90	30	Pass	Pass
91	13	Pass	Pass
91	14	Pass	Pass
91	15	Pass	Pass
91	16	Pass	Pass
91	30	Pass	Pass
92	13	Pass	Pass
92	14	Pass	Pass
92	15	Pass	Pass
92	16	Pass	Pass
92	30	Pass	Pass
93	13	Pass	Pass
93	14	Pass	Pass
93	15	Pass	Pass
93	16	Pass	Pass
93	30	Pass	Pass
94	13	Pass	Pass
94	14	Pass	Pass
94	15	Pass	Pass
94	16	Pass	Pass
94	26	Pass	Pass
94	30	Pass	Pass
95	13	Pass	Pass
95	14	Pass	Pass
95	15	Pass	Pass
95	16	Pass	Pass
95	26	Pass	Pass
95	30	Pass	Pass
96	13	Pass	Pass
96	14	Pass	Pass
96	15	Pass	Pass
96	26	Pass	Pass
96	30	Pass	Pass
97	13	Pass	Pass
97	14	Pass	Pass
97	15	Pass	Pass

97	26	Pass	Pass
97	30	Pass	Pass
98	13	Pass	Pass
98	14	Pass	Pass
98	15	Pass	Pass
98	26	Pass	Pass
98	27	Pass	Pass
98	28	Pass	Pass
98	29	Pass	Pass
98	30	Pass	Pass
99	13	Pass	Pass
99	14	Pass	Pass
99	15	Pass	Pass
99	16	Pass	Pass
99	17	Pass	Pass
99	18	Pass	Pass
99	19	Pass	Pass
99	20	Pass	Pass
99	21	Pass	Pass
99	22	Pass	Pass
99	23	Pass	Pass
99	26	Pass	Pass
99	30	Pass	Pass
100	13	Pass	Pass
100	14	Pass	Pass
100	15	Pass	Pass
100	23	Pass	Pass
100	24	Pass	Pass
100	25	Pass	Pass
100	26	Pass	Pass
100	30	Pass	Pass
101	13	Pass	Pass
101	14	Pass	Pass
101	15	Pass	Pass
101	16	Pass	Pass
101	17	Pass	Pass
101	18	Pass	Pass
101	19	Pass	Pass
101	20	Pass	Pass
101	21	Pass	Pass
101	22	Pass	Pass
101	23	Pass	Pass
101	26	Pass	Pass
101	30	Pass	Pass
102	13	Pass	Pass
102	14	Pass	Pass
102	15	Pass	Pass
102	26	Pass	Pass
102	30	Pass	Pass
103	13	Pass	Pass
103	14	Pass	Pass
103	15	Pass	Pass
103	26	Pass	Pass
103	30	Pass	Pass
104	13	Pass	Pass
104	14	Pass	Pass
104	15	Pass	Pass

104	26	Pass	Pass
104	30	Pass	Pass
105	13	Pass	Pass
105	14	Pass	Pass
105	15	Pass	Pass
105	26	Pass	Pass
105	30	Pass	Pass
106	13	Pass	Pass
106	14	Pass	Pass
106	15	Pass	Pass
106	26	Pass	Pass
106	27	Pass	Pass
106	30	Pass	Pass
106	39	Pass	Pass
107	13	Pass	Pass
107	14	Pass	Pass
107	15	Pass	Pass
107	22	Pass	Pass
107	26	Pass	Pass
107	30	Pass	Pass
107	39	Pass	Pass
108	13	Pass	Pass
108	14	Pass	Pass
108	15	Pass	Pass
108	22	Pass	Pass
108	26	Pass	Pass
108	30	Pass	Pass
108	39	Pass	Pass
109	13	Pass	Pass
109	14	Pass	Pass
109	15	Pass	Pass
109	22	Pass	Pass
109	26	Pass	Pass
109	30	Pass	Pass
109	39	Pass	Pass
110	13	Pass	Pass
110	14	Pass	Pass
110	15	Pass	Pass
110	22	Pass	Pass
110	26	Pass	Pass
110	39	Pass	Pass
111	13	Pass	Pass
111	14	Pass	Pass
111	15	Pass	Pass
111	22	Pass	Pass
111	26	Pass	Pass
111	39	Pass	Pass
112	13	Pass	Pass
112	14	Pass	Pass
112	15	Pass	Pass
112	22	Pass	Pass
112	26	Pass	Pass
112	39	Pass	Pass
113	13	Pass	Pass
113	14	Pass	Pass
113	15	Pass	Pass
113	26	Pass	Pass

113	27	Pass	Pass
113	39	Pass	Pass
114	13	Pass	Pass
114	14	Pass	Pass
114	15	Pass	Pass
114	26	Pass	Pass
114	39	Pass	Pass
115	13	Pass	Pass
115	14	Pass	Pass
115	15	Pass	Pass
115	26	Pass	Pass
115	39	Pass	Pass
116	13	Pass	Pass
116	14	Pass	Pass
116	15	Pass	Pass
116	26	Pass	Pass
116	39	Pass	Pass
117	13	Pass	Pass
117	14	Pass	Pass
117	15	Pass	Pass
117	26	Pass	Pass
117	39	Pass	Pass
118	13	Pass	Pass
118	14	Pass	Pass
118	15	Pass	Pass
118	20	Pass	Pass
118	26	Pass	Pass
118	39	Pass	Pass
119	13	Pass	Pass
119	14	Pass	Pass
119	15	Pass	Pass
119	20	Pass	Pass
119	26	Pass	Pass
119	39	Pass	Pass
120	13	Pass	Pass
120	14	Pass	Pass
120	15	Pass	Pass
120	16	Pass	Pass
120	26	Pass	Pass
120	39	Pass	Pass
121	13	Pass	Pass
121	14	Pass	Pass
121	26	Pass	Pass
121	39	Pass	Pass
122	13	Pass	Pass
122	14	Pass	Pass
122	26	Pass	Pass
122	39	Pass	Pass
123	13	Pass	Pass
123	14	Pass	Pass
123	15	Pass	Pass
123	16	Pass	Pass
123	17	Pass	Pass
123	18	Pass	Pass
123	19	Pass	Pass
123	20	Pass	Pass
123	21	Pass	Pass

123	22	Pass	Pass
123	23	Pass	Pass
123	24	Pass	Pass
123	25	Pass	Pass
123	26	Pass	Pass
123	27	Pass	Pass
123	28	Pass	Pass
123	29	Pass	Pass
123	30	Pass	Pass
123	31	Pass	Pass
123	32	Pass	Pass
123	33	Pass	Pass
123	34	Pass	Pass
123	35	Pass	Pass
123	36	Pass	Pass
123	37	Pass	Pass
123	38	Pass	Pass
123	39	Pass	Pass
124	13	Pass	Pass
124	14	Pass	Pass
124	23	Pass	Pass
125	13	Pass	Pass
125	14	Pass	Pass
125	23	Pass	Pass
126	13	Pass	Pass
126	14	Pass	Pass
126	23	Pass	Pass
127	13	Pass	Pass
127	14	Pass	Pass
127	23	Pass	Pass
128	13	Pass	Pass
128	14	Pass	Pass
128	23	Pass	Pass
129	13	Pass	Pass
129	14	Pass	Pass
129	23	Pass	Pass
130	8	Fail	Fail
130	9	Pass	Pass
130	10	Pass	Pass
130	11	Pass	Pass
130	12	Pass	Pass
130	13	Pass	Pass
130	14	Pass	Pass
130	23	Pass	Pass
131	14	Pass	Pass
131	23	Pass	Pass
132	14	Pass	Pass
132	23	Pass	Pass
133	14	Pass	Pass
133	23	Pass	Pass
134	14	Pass	Pass
134	23	Pass	Pass
135	14	Pass	Pass
136	14	Pass	Pass
137	14	Pass	Pass
138	14	Pass	Pass
139	14	Pass	Pass

140	14	Pass	Pass
141	14	Pass	Pass
142	14	Pass	Pass
143	14	Pass	Pass
144	14	Pass	Pass
145	14	Pass	Pass
146	14	Pass	Pass
147	14	Pass	Pass
148	14	Pass	Pass
149	14	Pass	Pass
150	14	Pass	Pass
151	14	Pass	Pass
152	14	Pass	Pass
153	14	Pass	Pass
154	14	Pass	Pass
155	14	Pass	Pass
156	14	Pass	Pass
157	14	Pass	Pass
158	14	Pass	Pass
159	14	Pass	Pass
160	14	Pass	Pass
161	14	Pass	Pass
162	14	Pass	Pass
163	14	Pass	Pass
164	14	Pass	Pass
165	14	Pass	Pass
166	14	Pass	Pass

3. Table A.7.3. American Shad D.O. criteria passing for existing and deepening (3 ft) scenarios within the analyzed period August 1 - August 31, 1999

HABITAT REQUIREMENTS:
RM 10-40; Top half of water column
D.O. January, May, and August (MG/L):10th %ile >=4.0

Savannah Harbor Estuary

Segments J	Segments I	Baseline Scenario D.O.	Project Scenario D.O.
47	13	Pass	Pass
47	14	Pass	Pass
47	15	Pass	Pass
47	16	Pass	Pass
47	17	Pass	Pass
48	13	Pass	Pass
48	14	Pass	Pass
48	15	Pass	Pass
48	16	Pass	Pass
48	17	Pass	Pass
49	13	Pass	Pass
49	14	Pass	Pass
49	15	Pass	Pass
49	16	Pass	Pass
49	17	Pass	Pass
50	13	Pass	Pass
50	14	Pass	Pass
50	15	Pass	Pass
50	16	Pass	Pass
50	17	Pass	Pass
50	18	Pass	Pass
51	13	Pass	Pass
51	14	Pass	Pass
51	15	Pass	Pass
52	13	Pass	Pass
52	14	Pass	Pass
52	15	Pass	Pass
53	13	Pass	Pass
53	14	Pass	Pass
53	15	Pass	Pass
54	13	Pass	Pass
54	14	Pass	Pass
54	15	Pass	Pass
55	13	Pass	Pass
55	14	Pass	Pass
55	15	Pass	Pass
56	13	Pass	Pass
56	14	Pass	Pass
56	15	Pass	Pass
57	13	Pass	Pass
57	14	Pass	Pass
57	15	Pass	Pass

58	13	Pass	Pass
58	14	Pass	Pass
58	15	Pass	Pass
59	13	Pass	Pass
59	14	Pass	Pass
59	15	Pass	Pass
59	30	Pass	Pass
59	31	Fail	Fail
59	32	Pass	Pass
60	13	Pass	Pass
60	14	Pass	Pass
60	15	Pass	Pass
60	30	Pass	Pass
60	31	Fail	Fail
60	32	Fail	Fail
61	13	Pass	Pass
61	14	Pass	Pass
61	15	Pass	Pass
61	30	Fail	Fail
61	31	Fail	Fail
61	32	Fail	Fail
62	13	Pass	Pass
62	14	Pass	Pass
62	15	Pass	Pass
62	30	Fail	Fail
62	31	Fail	Fail
62	32	Fail	Fail
63	13	Pass	Pass
63	14	Pass	Pass
63	15	Pass	Pass
63	31	Fail	Fail
64	13	Pass	Pass
64	14	Pass	Pass
64	15	Pass	Pass
64	30	Fail	Fail
64	31	Fail	Fail
64	32	Fail	Fail
65	13	Pass	Pass
65	14	Pass	Pass
65	15	Pass	Pass
65	30	Fail	Fail
65	31	Fail	Fail
65	32	Fail	Fail
65	33	Fail	Fail
66	13	Pass	Pass
66	14	Pass	Pass
66	15	Pass	Pass
66	30	Fail	Fail
66	31	Fail	Fail
66	32	Fail	Fail
66	36	Fail	Fail
67	13	Pass	Pass
67	14	Pass	Pass
67	15	Pass	Pass
67	30	Fail	Fail
67	31	Fail	Fail
67	32	Fail	Fail

67	36	Fail	Fail
68	13	Pass	Pass
68	14	Pass	Pass
68	15	Pass	Pass
68	30	Fail	Fail
68	31	Fail	Fail
68	32	Fail	Fail
68	36	Fail	Fail
69	13	Pass	Pass
69	14	Pass	Pass
69	15	Pass	Pass
69	30	Fail	Fail
69	31	Fail	Fail
69	32	Fail	Fail
69	36	Fail	Fail
70	13	Pass	Pass
70	14	Pass	Pass
70	15	Pass	Pass
70	30	Fail	Fail
70	31	Fail	Fail
70	32	Fail	Fail
70	33	Fail	Fail
71	13	Pass	Pass
71	14	Pass	Pass
71	15	Pass	Pass
71	30	Fail	Fail
71	31	Fail	Fail
71	32	Fail	Fail
72	13	Pass	Pass
72	14	Pass	Pass
72	15	Pass	Pass
72	30	Fail	Fail
72	31	Fail	Fail
72	32	Fail	Fail
73	13	Pass	Pass
73	14	Pass	Pass
73	15	Pass	Pass
73	30	Fail	Fail
73	31	Fail	Fail
74	13	Pass	Pass
74	14	Pass	Pass
74	15	Pass	Pass
74	30	Fail	Fail
74	31	Fail	Fail
75	13	Pass	Pass
75	14	Pass	Pass
75	15	Pass	Pass
75	30	Fail	Fail
75	31	Fail	Fail
76	13	Pass	Pass
76	14	Pass	Pass
76	15	Pass	Pass
76	16	Pass	Pass
76	17	Pass	Pass
76	30	Fail	Fail
76	31	Fail	Fail
77	13	Pass	Pass

77	14	Pass	Pass
77	15	Pass	Pass
77	16	Pass	Pass
77	17	Pass	Pass
77	30	Fail	Fail
77	31	Fail	Fail
78	13	Pass	Pass
78	14	Pass	Pass
78	15	Pass	Pass
78	16	Pass	Pass
78	17	Pass	Pass
78	30	Fail	Fail
78	31	Pass	Fail
79	13	Pass	Pass
79	14	Pass	Pass
79	15	Pass	Pass
79	30	Fail	Fail
79	31	Fail	Fail
80	13	Pass	Pass
80	14	Pass	Pass
80	15	Pass	Pass
80	30	Fail	Fail
80	31	Pass	Pass
81	13	Pass	Pass
81	14	Pass	Pass
81	15	Pass	Pass
81	30	Fail	Fail
81	31	Pass	Pass
82	13	Pass	Pass
82	14	Pass	Pass
82	15	Pass	Pass
82	16	Pass	Pass
82	17	Pass	Pass
82	18	Pass	Pass
82	19	Pass	Pass
82	20	Pass	Pass
82	21	Pass	Pass
82	29	Fail	Fail
82	30	Fail	Fail
82	31	Pass	Pass
83	13	Pass	Pass
83	14	Pass	Pass
83	15	Pass	Pass
83	21	Pass	Pass
83	30	Fail	Fail
83	31	Pass	Pass
84	13	Pass	Pass
84	14	Pass	Pass
84	15	Pass	Pass
84	21	Pass	Pass
84	30	Fail	Fail
84	31	Pass	Pass
85	13	Pass	Pass
85	14	Pass	Pass
85	15	Pass	Pass
85	21	Pass	Pass
85	30	Pass	Pass

86	13	Pass	Pass
86	14	Pass	Pass
86	15	Pass	Pass
86	21	Pass	Pass
86	30	Pass	Pass
87	13	Pass	Pass
87	14	Pass	Pass
87	15	Pass	Pass
87	30	Pass	Pass
88	13	Pass	Pass
88	14	Pass	Pass
88	15	Pass	Pass
88	30	Pass	Pass
89	13	Pass	Pass
89	14	Pass	Pass
89	15	Pass	Pass
89	30	Pass	Pass
90	13	Pass	Pass
90	14	Pass	Pass
90	15	Pass	Pass
90	30	Pass	Pass
91	13	Pass	Pass
91	14	Pass	Pass
91	15	Pass	Pass
91	16	Pass	Pass
91	30	Pass	Pass
92	13	Pass	Pass
92	14	Pass	Pass
92	15	Pass	Pass
92	16	Pass	Pass
92	30	Pass	Pass
93	13	Pass	Pass
93	14	Pass	Pass
93	15	Pass	Pass
93	16	Pass	Pass
93	30	Pass	Pass
94	13	Pass	Pass
94	14	Pass	Pass
94	15	Pass	Pass
94	16	Pass	Pass
94	26	Pass	Pass
94	30	Pass	Pass
95	13	Pass	Pass
95	14	Pass	Pass
95	15	Pass	Pass
95	16	Pass	Pass
95	26	Pass	Pass
95	30	Pass	Pass
96	13	Pass	Pass
96	14	Pass	Pass
96	15	Pass	Pass
96	26	Pass	Pass
96	30	Pass	Pass
97	13	Pass	Pass
97	14	Pass	Pass
97	15	Pass	Pass
97	26	Pass	Pass

97	30	Pass	Pass
98	13	Pass	Pass
98	14	Pass	Pass
98	15	Pass	Pass
98	26	Pass	Pass
98	27	Pass	Pass
98	28	Pass	Pass
98	29	Pass	Pass
98	30	Pass	Pass
99	13	Pass	Pass
99	14	Pass	Pass
99	15	Pass	Pass
99	16	Pass	Pass
99	17	Pass	Pass
99	18	Pass	Pass
99	19	Pass	Pass
99	20	Pass	Pass
99	21	Pass	Pass
99	22	Pass	Pass
99	23	Pass	Pass
99	26	Pass	Pass
99	30	Pass	Pass
100	13	Pass	Pass
100	14	Pass	Pass
100	15	Pass	Pass
100	23	Pass	Pass
100	24	Pass	Pass
100	25	Pass	Pass
100	26	Pass	Pass
100	30	Pass	Pass
101	13	Pass	Pass
101	14	Pass	Pass
101	15	Pass	Pass
101	16	Pass	Pass
101	17	Pass	Pass
101	18	Pass	Pass
101	19	Pass	Pass
101	20	Pass	Pass
101	21	Pass	Pass
101	22	Pass	Pass
101	23	Pass	Pass
101	26	Pass	Pass
101	30	Pass	Pass
102	13	Pass	Pass
102	14	Pass	Pass
102	15	Pass	Pass
102	26	Pass	Pass
102	30	Pass	Pass
103	13	Pass	Pass
103	14	Pass	Pass
103	15	Pass	Pass
103	26	Pass	Pass
103	30	Pass	Pass
104	13	Pass	Pass
104	14	Pass	Pass
104	15	Pass	Pass
104	26	Pass	Pass

104	30	Pass	Pass
105	13	Pass	Pass
105	14	Pass	Pass
105	15	Pass	Pass
105	26	Pass	Pass
105	30	Pass	Pass
106	13	Pass	Pass
106	14	Pass	Pass
106	15	Pass	Pass
106	26	Pass	Pass
106	27	Pass	Pass
106	30	Pass	Pass
106	39	Pass	Pass
107	13	Pass	Pass
107	14	Pass	Pass
107	15	Pass	Pass
107	22	Pass	Pass
107	26	Pass	Pass
107	30	Pass	Pass
107	39	Pass	Pass
108	13	Pass	Pass
108	14	Pass	Pass
108	15	Pass	Pass
108	22	Pass	Pass
108	26	Pass	Pass
108	30	Pass	Pass
108	39	Pass	Pass
109	13	Pass	Pass
109	14	Pass	Pass
109	15	Pass	Pass
109	22	Pass	Pass
109	26	Pass	Pass
109	30	Pass	Pass
109	39	Pass	Pass
110	13	Pass	Pass
110	14	Pass	Pass
110	15	Pass	Pass
110	22	Pass	Pass
110	26	Pass	Pass
110	39	Pass	Pass
111	13	Pass	Pass
111	14	Pass	Pass
111	15	Pass	Pass
111	22	Pass	Pass
111	26	Pass	Pass
111	39	Pass	Pass
112	13	Pass	Pass
112	14	Pass	Pass
112	15	Pass	Pass
112	22	Pass	Pass
112	26	Pass	Pass
112	39	Pass	Pass
113	13	Pass	Pass
113	14	Pass	Pass
113	15	Pass	Pass
113	26	Pass	Pass
113	27	Pass	Pass

113	39	Pass	Pass
114	13	Pass	Pass
114	14	Pass	Pass
114	15	Pass	Pass
114	26	Pass	Pass
114	39	Pass	Pass
115	13	Pass	Pass
115	14	Pass	Pass
115	15	Pass	Pass
115	26	Pass	Pass
115	39	Pass	Pass
116	13	Pass	Pass
116	14	Pass	Pass
116	15	Pass	Pass
116	26	Pass	Pass
116	39	Pass	Pass
117	13	Pass	Pass
117	14	Pass	Pass
117	15	Pass	Pass
117	26	Pass	Pass
117	39	Pass	Pass
118	13	Pass	Pass
118	14	Pass	Pass
118	15	Pass	Pass
118	20	Pass	Pass
118	26	Pass	Pass
118	39	Pass	Pass
119	13	Pass	Pass
119	14	Pass	Pass
119	15	Pass	Pass
119	20	Pass	Pass
119	26	Pass	Pass
119	39	Pass	Pass
120	13	Pass	Pass
120	14	Pass	Pass
120	15	Pass	Pass
120	16	Pass	Pass
120	26	Pass	Pass
120	39	Pass	Pass
121	13	Pass	Pass
121	14	Pass	Pass
121	26	Pass	Pass
121	39	Pass	Pass
122	13	Pass	Pass
122	14	Pass	Pass
122	26	Pass	Pass
122	39	Pass	Pass
123	13	Pass	Pass
123	14	Pass	Pass
123	15	Pass	Pass
123	16	Pass	Pass
123	17	Pass	Pass
123	18	Pass	Pass
123	19	Pass	Pass
123	20	Pass	Pass
123	21	Pass	Pass
123	22	Pass	Pass

123	23	Pass	Pass
123	24	Pass	Pass
123	25	Pass	Pass
123	26	Pass	Pass
123	27	Pass	Pass
123	28	Pass	Pass
123	29	Pass	Pass
123	30	Pass	Pass
123	31	Pass	Pass
123	32	Pass	Pass
123	33	Pass	Pass
123	34	Pass	Pass
123	35	Pass	Pass
123	36	Pass	Pass
123	37	Pass	Pass
123	38	Pass	Pass
123	39	Pass	Pass
124	13	Pass	Pass
124	14	Pass	Pass
124	23	Pass	Pass
125	13	Pass	Pass
125	14	Pass	Pass
125	23	Pass	Pass
126	13	Pass	Pass
126	14	Pass	Pass
126	23	Pass	Pass
127	13	Pass	Pass
127	14	Pass	Pass
127	23	Pass	Pass
128	13	Pass	Pass
128	14	Pass	Pass
128	23	Pass	Pass
129	13	Pass	Pass
129	14	Pass	Pass
129	23	Pass	Pass
130	8	Fail	Fail
130	9	Pass	Pass
130	10	Pass	Pass
130	11	Pass	Pass
130	12	Pass	Pass
130	13	Pass	Pass
130	14	Pass	Pass
130	23	Pass	Pass
131	14	Pass	Pass
131	23	Pass	Pass
132	14	Pass	Pass
132	23	Pass	Pass
133	14	Pass	Pass
133	23	Pass	Pass
134	14	Pass	Pass
134	23	Pass	Pass
135	14	Pass	Pass
136	14	Pass	Pass
137	14	Pass	Pass
138	14	Pass	Pass
139	14	Pass	Pass
140	14	Pass	Pass

141	14	Pass	Pass
142	14	Pass	Pass
143	14	Pass	Pass
144	14	Pass	Pass
145	14	Pass	Pass
146	14	Pass	Pass
147	14	Pass	Pass
148	14	Pass	Pass
149	14	Pass	Pass
150	14	Pass	Pass
151	14	Pass	Pass
152	14	Pass	Pass
153	14	Pass	Pass
154	14	Pass	Pass
155	14	Pass	Pass
156	14	Pass	Pass
157	14	Pass	Pass
158	14	Pass	Pass
159	14	Pass	Pass
160	14	Pass	Pass
161	14	Pass	Pass
162	14	Pass	Pass
163	14	Pass	Pass
164	14	Pass	Pass
165	14	Pass	Pass
166	14	Pass	Pass

4. Table A.7.4. American Shad D.O. criteria passing for existing and deepening (2 ft) scenarios within the analyzed period August 1 - August 31, 1999

HABITAT REQUIREMENTS:
RM 10-40; Top half of water column
D.O. January, May, and August (MG/L):10th %ile >=4.0

Savannah Harbor Estuary

Segments J	Segments I	Baseline Scenario D.O.	Project Scenario D.O.
47	13	Pass	Pass
47	14	Pass	Pass
47	15	Pass	Pass
47	16	Pass	Pass
47	17	Pass	Pass
48	13	Pass	Pass
48	14	Pass	Pass
48	15	Pass	Pass
48	16	Pass	Pass
48	17	Pass	Pass
49	13	Pass	Pass
49	14	Pass	Pass
49	15	Pass	Pass
49	16	Pass	Pass
49	17	Pass	Pass
50	13	Pass	Pass
50	14	Pass	Pass
50	15	Pass	Pass
50	16	Pass	Pass
50	17	Pass	Pass
50	18	Pass	Pass
51	13	Pass	Pass
51	14	Pass	Pass
51	15	Pass	Pass
52	13	Pass	Pass
52	14	Pass	Pass
52	15	Pass	Pass
53	13	Pass	Pass
53	14	Pass	Pass
53	15	Pass	Pass
54	13	Pass	Pass
54	14	Pass	Pass
54	15	Pass	Pass
55	13	Pass	Pass
55	14	Pass	Pass
55	15	Pass	Pass
56	13	Pass	Pass
56	14	Pass	Pass
56	15	Pass	Pass
57	13	Pass	Pass
57	14	Pass	Pass
57	15	Pass	Pass

58	13	Pass	Pass
58	14	Pass	Pass
58	15	Pass	Pass
59	13	Pass	Pass
59	14	Pass	Pass
59	15	Pass	Pass
59	30	Pass	Pass
59	31	Fail	Fail
59	32	Pass	Pass
60	13	Pass	Pass
60	14	Pass	Pass
60	15	Pass	Pass
60	30	Pass	Fail
60	31	Fail	Fail
60	32	Fail	Fail
61	13	Pass	Pass
61	14	Pass	Pass
61	15	Pass	Pass
61	30	Fail	Fail
61	31	Fail	Fail
61	32	Fail	Fail
62	13	Pass	Pass
62	14	Pass	Pass
62	15	Pass	Pass
62	30	Fail	Fail
62	31	Fail	Fail
62	32	Fail	Fail
63	13	Pass	Pass
63	14	Pass	Pass
63	15	Pass	Pass
63	31	Fail	Fail
64	13	Pass	Pass
64	14	Pass	Pass
64	15	Pass	Pass
64	30	Fail	Fail
64	31	Fail	Fail
64	32	Fail	Fail
65	13	Pass	Pass
65	14	Pass	Pass
65	15	Pass	Pass
65	30	Fail	Fail
65	31	Fail	Fail
65	32	Fail	Fail
65	33	Fail	Fail
66	13	Pass	Pass
66	14	Pass	Pass
66	15	Pass	Pass
66	30	Fail	Fail
66	31	Fail	Fail
66	32	Fail	Fail
66	36	Fail	Fail
67	13	Pass	Pass
67	14	Pass	Pass
67	15	Pass	Pass
67	30	Fail	Fail
67	31	Fail	Fail
67	32	Fail	Fail

67	36	Fail	Fail
68	13	Pass	Pass
68	14	Pass	Pass
68	15	Pass	Pass
68	30	Fail	Fail
68	31	Fail	Fail
68	32	Fail	Fail
68	36	Fail	Fail
69	13	Pass	Pass
69	14	Pass	Pass
69	15	Pass	Pass
69	30	Fail	Fail
69	31	Fail	Fail
69	32	Fail	Fail
69	36	Fail	Fail
70	13	Pass	Pass
70	14	Pass	Pass
70	15	Pass	Pass
70	30	Fail	Fail
70	31	Fail	Fail
70	32	Fail	Fail
70	33	Fail	Fail
71	13	Pass	Pass
71	14	Pass	Pass
71	15	Pass	Pass
71	30	Fail	Fail
71	31	Fail	Fail
71	32	Fail	Fail
72	13	Pass	Pass
72	14	Pass	Pass
72	15	Pass	Pass
72	30	Fail	Fail
72	31	Fail	Fail
72	32	Fail	Fail
73	13	Pass	Pass
73	14	Pass	Pass
73	15	Pass	Pass
73	30	Fail	Fail
73	31	Fail	Fail
74	13	Pass	Pass
74	14	Pass	Pass
74	15	Pass	Pass
74	30	Fail	Fail
74	31	Fail	Fail
75	13	Pass	Pass
75	14	Pass	Pass
75	15	Pass	Pass
75	30	Fail	Fail
75	31	Fail	Fail
76	13	Pass	Pass
76	14	Pass	Pass
76	15	Pass	Pass
76	16	Pass	Pass
76	17	Pass	Pass
76	30	Fail	Fail
76	31	Fail	Fail
77	13	Pass	Pass

77	14	Pass	Pass
77	15	Pass	Pass
77	16	Pass	Pass
77	17	Pass	Pass
77	30	Fail	Fail
77	31	Fail	Fail
78	13	Pass	Pass
78	14	Pass	Pass
78	15	Pass	Pass
78	16	Pass	Pass
78	17	Pass	Pass
78	30	Fail	Fail
78	31	Pass	Pass
79	13	Pass	Pass
79	14	Pass	Pass
79	15	Pass	Pass
79	30	Fail	Fail
79	31	Fail	Fail
80	13	Pass	Pass
80	14	Pass	Pass
80	15	Pass	Pass
80	30	Fail	Fail
80	31	Pass	Pass
81	13	Pass	Pass
81	14	Pass	Pass
81	15	Pass	Pass
81	30	Fail	Fail
81	31	Pass	Pass
82	13	Pass	Pass
82	14	Pass	Pass
82	15	Pass	Pass
82	16	Pass	Pass
82	17	Pass	Pass
82	18	Pass	Pass
82	19	Pass	Pass
82	20	Pass	Pass
82	21	Pass	Pass
82	29	Fail	Fail
82	30	Fail	Fail
82	31	Pass	Pass
83	13	Pass	Pass
83	14	Pass	Pass
83	15	Pass	Pass
83	21	Pass	Pass
83	30	Fail	Fail
83	31	Pass	Pass
84	13	Pass	Pass
84	14	Pass	Pass
84	15	Pass	Pass
84	21	Pass	Pass
84	30	Fail	Fail
84	31	Pass	Pass
85	13	Pass	Pass
85	14	Pass	Pass
85	15	Pass	Pass
85	21	Pass	Pass
85	30	Pass	Pass

86	13	Pass	Pass
86	14	Pass	Pass
86	15	Pass	Pass
86	21	Pass	Pass
86	30	Pass	Pass
87	13	Pass	Pass
87	14	Pass	Pass
87	15	Pass	Pass
87	30	Pass	Pass
88	13	Pass	Pass
88	14	Pass	Pass
88	15	Pass	Pass
88	30	Pass	Pass
89	13	Pass	Pass
89	14	Pass	Pass
89	15	Pass	Pass
89	30	Pass	Pass
90	13	Pass	Pass
90	14	Pass	Pass
90	15	Pass	Pass
90	30	Pass	Pass
91	13	Pass	Pass
91	14	Pass	Pass
91	15	Pass	Pass
91	16	Pass	Pass
91	30	Pass	Pass
92	13	Pass	Pass
92	14	Pass	Pass
92	15	Pass	Pass
92	16	Pass	Pass
92	30	Pass	Pass
93	13	Pass	Pass
93	14	Pass	Pass
93	15	Pass	Pass
93	16	Pass	Pass
93	30	Pass	Pass
94	13	Pass	Pass
94	14	Pass	Pass
94	15	Pass	Pass
94	16	Pass	Pass
94	26	Pass	Pass
94	30	Pass	Pass
95	13	Pass	Pass
95	14	Pass	Pass
95	15	Pass	Pass
95	16	Pass	Pass
95	26	Pass	Pass
95	30	Pass	Pass
96	13	Pass	Pass
96	14	Pass	Pass
96	15	Pass	Pass
96	26	Pass	Pass
96	30	Pass	Pass
97	13	Pass	Pass
97	14	Pass	Pass
97	15	Pass	Pass
97	26	Pass	Pass

97	30	Pass	Pass
98	13	Pass	Pass
98	14	Pass	Pass
98	15	Pass	Pass
98	26	Pass	Pass
98	27	Pass	Pass
98	28	Pass	Pass
98	29	Pass	Pass
98	30	Pass	Pass
99	13	Pass	Pass
99	14	Pass	Pass
99	15	Pass	Pass
99	16	Pass	Pass
99	17	Pass	Pass
99	18	Pass	Pass
99	19	Pass	Pass
99	20	Pass	Pass
99	21	Pass	Pass
99	22	Pass	Pass
99	23	Pass	Pass
99	26	Pass	Pass
99	30	Pass	Pass
100	13	Pass	Pass
100	14	Pass	Pass
100	15	Pass	Pass
100	23	Pass	Pass
100	24	Pass	Pass
100	25	Pass	Pass
100	26	Pass	Pass
100	30	Pass	Pass
101	13	Pass	Pass
101	14	Pass	Pass
101	15	Pass	Pass
101	16	Pass	Pass
101	17	Pass	Pass
101	18	Pass	Pass
101	19	Pass	Pass
101	20	Pass	Pass
101	21	Pass	Pass
101	22	Pass	Pass
101	23	Pass	Pass
101	26	Pass	Pass
101	30	Pass	Pass
102	13	Pass	Pass
102	14	Pass	Pass
102	15	Pass	Pass
102	26	Pass	Pass
102	30	Pass	Pass
103	13	Pass	Pass
103	14	Pass	Pass
103	15	Pass	Pass
103	26	Pass	Pass
103	30	Pass	Pass
104	13	Pass	Pass
104	14	Pass	Pass
104	15	Pass	Pass
104	26	Pass	Pass

104	30	Pass	Pass
105	13	Pass	Pass
105	14	Pass	Pass
105	15	Pass	Pass
105	26	Pass	Pass
105	30	Pass	Pass
106	13	Pass	Pass
106	14	Pass	Pass
106	15	Pass	Pass
106	26	Pass	Pass
106	27	Pass	Pass
106	30	Pass	Pass
106	39	Pass	Pass
107	13	Pass	Pass
107	14	Pass	Pass
107	15	Pass	Pass
107	22	Pass	Pass
107	26	Pass	Pass
107	30	Pass	Pass
107	39	Pass	Pass
108	13	Pass	Pass
108	14	Pass	Pass
108	15	Pass	Pass
108	22	Pass	Pass
108	26	Pass	Pass
108	30	Pass	Pass
108	39	Pass	Pass
109	13	Pass	Pass
109	14	Pass	Pass
109	15	Pass	Pass
109	22	Pass	Pass
109	26	Pass	Pass
109	30	Pass	Pass
109	39	Pass	Pass
110	13	Pass	Pass
110	14	Pass	Pass
110	15	Pass	Pass
110	22	Pass	Pass
110	26	Pass	Pass
110	39	Pass	Pass
111	13	Pass	Pass
111	14	Pass	Pass
111	15	Pass	Pass
111	22	Pass	Pass
111	26	Pass	Pass
111	39	Pass	Pass
112	13	Pass	Pass
112	14	Pass	Pass
112	15	Pass	Pass
112	22	Pass	Pass
112	26	Pass	Pass
112	39	Pass	Pass
113	13	Pass	Pass
113	14	Pass	Pass
113	15	Pass	Pass
113	26	Pass	Pass
113	27	Pass	Pass

113	39	Pass	Pass
114	13	Pass	Pass
114	14	Pass	Pass
114	15	Pass	Pass
114	26	Pass	Pass
114	39	Pass	Pass
115	13	Pass	Pass
115	14	Pass	Pass
115	15	Pass	Pass
115	26	Pass	Pass
115	39	Pass	Pass
116	13	Pass	Pass
116	14	Pass	Pass
116	15	Pass	Pass
116	26	Pass	Pass
116	39	Pass	Pass
117	13	Pass	Pass
117	14	Pass	Pass
117	15	Pass	Pass
117	26	Pass	Pass
117	39	Pass	Pass
118	13	Pass	Pass
118	14	Pass	Pass
118	15	Pass	Pass
118	20	Pass	Pass
118	26	Pass	Pass
118	39	Pass	Pass
119	13	Pass	Pass
119	14	Pass	Pass
119	15	Pass	Pass
119	20	Pass	Pass
119	26	Pass	Pass
119	39	Pass	Pass
120	13	Pass	Pass
120	14	Pass	Pass
120	15	Pass	Pass
120	16	Pass	Pass
120	26	Pass	Pass
120	39	Pass	Pass
121	13	Pass	Pass
121	14	Pass	Pass
121	26	Pass	Pass
121	39	Pass	Pass
122	13	Pass	Pass
122	14	Pass	Pass
122	26	Pass	Pass
122	39	Pass	Pass
123	13	Pass	Pass
123	14	Pass	Pass
123	15	Pass	Pass
123	16	Pass	Pass
123	17	Pass	Pass
123	18	Pass	Pass
123	19	Pass	Pass
123	20	Pass	Pass
123	21	Pass	Pass
123	22	Pass	Pass

123	23	Pass	Pass
123	24	Pass	Pass
123	25	Pass	Pass
123	26	Pass	Pass
123	27	Pass	Pass
123	28	Pass	Pass
123	29	Pass	Pass
123	30	Pass	Pass
123	31	Pass	Pass
123	32	Pass	Pass
123	33	Pass	Pass
123	34	Pass	Pass
123	35	Pass	Pass
123	36	Pass	Pass
123	37	Pass	Pass
123	38	Pass	Pass
123	39	Pass	Pass
124	13	Pass	Pass
124	14	Pass	Pass
124	23	Pass	Pass
125	13	Pass	Pass
125	14	Pass	Pass
125	23	Pass	Pass
126	13	Pass	Pass
126	14	Pass	Pass
126	23	Pass	Pass
127	13	Pass	Pass
127	14	Pass	Pass
127	23	Pass	Pass
128	13	Pass	Pass
128	14	Pass	Pass
128	23	Pass	Pass
129	13	Pass	Pass
129	14	Pass	Pass
129	23	Pass	Pass
130	8	Fail	Fail
130	9	Pass	Pass
130	10	Pass	Pass
130	11	Pass	Pass
130	12	Pass	Pass
130	13	Pass	Pass
130	14	Pass	Pass
130	23	Pass	Pass
131	14	Pass	Pass
131	23	Pass	Pass
132	14	Pass	Pass
132	23	Pass	Pass
133	14	Pass	Pass
133	23	Pass	Pass
134	14	Pass	Pass
134	23	Pass	Pass
135	14	Pass	Pass
136	14	Pass	Pass
137	14	Pass	Pass
138	14	Pass	Pass
139	14	Pass	Pass
140	14	Pass	Pass

141	14	Pass	Pass
142	14	Pass	Pass
143	14	Pass	Pass
144	14	Pass	Pass
145	14	Pass	Pass
146	14	Pass	Pass
147	14	Pass	Pass
148	14	Pass	Pass
149	14	Pass	Pass
150	14	Pass	Pass
151	14	Pass	Pass
152	14	Pass	Pass
153	14	Pass	Pass
154	14	Pass	Pass
155	14	Pass	Pass
156	14	Pass	Pass
157	14	Pass	Pass
158	14	Pass	Pass
159	14	Pass	Pass
160	14	Pass	Pass
161	14	Pass	Pass
162	14	Pass	Pass
163	14	Pass	Pass
164	14	Pass	Pass
165	14	Pass	Pass
166	14	Pass	Pass

Appendix A-3

Tables of Criteria Passing for Shortnose Sturgeon Adults Habitat Suitability

August 1999

50th %ile of Clyo Flow

Fisheries Review Group

1. Table A.8.1. Sturgeon adults salinity and DO criteria passing criteria passing for existing and deepening (6 ft) scenarios within the analyzed period August 1 - August 31, 1999

```
HABITAT REQUIREMENTS:
RM 10-40; Bottom Layer
D.O. August (MG/L):10th %ile>=4.0;5th %ile>=3.0;1th %ile>=2.0
Max Salinity <= 10 ppt
D.O. January (MG/L):10th %ile>=3.5;5th %ile>=3.0;1th %ile>=2.0
```

Savannah Harbor Estuary

Segments J	Segments I	Baseline Scenario Salinity	Baseline Scenario D.O.	Project Scenario Salinity	Project Scenario D.O.
47	14	Fail	Fail	Fail	Fail
47	17	Fail	Fail	Fail	Fail
48	14	Fail	Fail	Fail	Fail
48	16	Fail	Fail	Fail	Fail
49	14	Fail	Fail	Fail	Fail
49	16	Fail	Fail	Fail	Fail
50	14	Fail	Fail	Fail	Fail
50	15	Fail	Fail	Fail	Fail
51	14	Fail	Fail	Fail	Fail
52	14	Fail	Fail	Fail	Fail
53	14	Fail	Fail	Fail	Fail
54	14	Fail	Fail	Fail	Fail
55	14	Fail	Fail	Fail	Fail
56	14	Fail	Fail	Fail	Fail
57	14	Fail	Fail	Fail	Fail
58	14	Fail	Fail	Fail	Fail
59	14	Fail	Fail	Fail	Fail
60	14	Fail	Fail	Fail	Fail
61	14	Fail	Fail	Fail	Fail
62	14	Fail	Fail	Fail	Fail
63	14	Fail	Fail	Fail	Fail
64	14	Fail	Fail	Fail	Fail
65	14	Fail	Fail	Fail	Fail
66	14	Fail	Fail	Fail	Fail
67	14	Fail	Fail	Fail	Fail
68	14	Fail	Fail	Fail	Fail
69	14	Fail	Fail	Fail	Fail
70	14	Fail	Fail	Fail	Fail
71	14	Fail	Fail	Fail	Fail
72	14	Fail	Fail	Fail	Fail
73	14	Fail	Fail	Fail	Fail
74	14	Fail	Fail	Fail	Fail
75	14	Fail	Fail	Fail	Fail
76	14	Fail	Fail	Fail	Fail
76	15	Fail	Fail	Fail	Fail
77	14	Fail	Fail	Fail	Fail
77	15	Fail	Fail	Fail	Fail
78	15	Fail	Fail	Fail	Fail
78	16	Fail	Fail	Fail	Fail

79	14	Fail	Fail	Fail	Fail
80	14	Fail	Fail	Fail	Fail
81	14	Fail	Fail	Fail	Fail
82	14	Fail	Fail	Fail	Fail
82	16	Fail	Fail	Fail	Fail
83	14	Fail	Fail	Fail	Fail
84	14	Fail	Fail	Fail	Fail
85	14	Fail	Fail	Fail	Fail
86	14	Fail	Fail	Fail	Fail
87	14	Fail	Fail	Fail	Fail
88	14	Fail	Fail	Fail	Fail
89	14	Fail	Fail	Fail	Fail
90	14	Fail	Fail	Fail	Fail
91	13	Fail	Fail	Fail	Fail
91	14	Fail	Fail	Fail	Fail
92	14	Fail	Fail	Fail	Fail
92	16	Fail	Fail	Fail	Fail
93	13	Fail	Fail	Fail	Fail
93	14	Fail	Fail	Fail	Fail
94	13	Fail	Fail	Fail	Fail
94	14	Fail	Fail	Fail	Fail
95	14	Fail	Fail	Fail	Fail
95	30	Pass	Fail	Pass	Fail
96	14	Fail	Fail	Fail	Fail
97	14	Fail	Fail	Fail	Fail
98	14	Fail	Pass	Fail	Fail
99	14	Fail	Pass	Fail	Fail
99	15	Fail	Pass	Fail	Fail
100	14	Fail	Pass	Fail	Fail
101	14	Fail	Pass	Fail	Fail
101	15	Fail	Pass	Fail	Fail
102	14	Fail	Pass	Fail	Fail
103	14	Fail	Pass	Fail	Fail
104	14	Pass	Pass	Fail	Fail
105	14	Pass	Pass	Fail	Pass
106	14	Pass	Pass	Fail	Pass
107	14	Pass	Pass	Fail	Pass
108	14	Pass	Pass	Fail	Pass
109	15	Pass	Pass	Fail	Pass
110	15	Pass	Pass	Fail	Pass
111	15	Pass	Pass	Pass	Pass
112	14	Pass	Pass	Pass	Pass
113	14	Pass	Pass	Pass	Pass
114	15	Pass	Pass	Pass	Pass
115	15	Pass	Pass	Pass	Pass
116	15	Pass	Pass	Pass	Pass
117	14	Pass	Pass	Pass	Pass
118	15	Pass	Fail	Pass	Fail
119	14	Pass	Fail	Pass	Fail
120	14	Pass	Fail	Pass	Fail
120	15	Pass	Fail	Pass	Fail
121	14	Pass	Fail	Pass	Fail
122	14	Pass	Fail	Pass	Fail
123	13	Pass	Fail	Pass	Fail
123	14	Pass	Fail	Pass	Fail
124	14	Pass	Fail	Pass	Fail
125	14	Pass	Fail	Pass	Fail

126	14	Pass	Fail	Pass	Fail
127	14	Pass	Fail	Pass	Fail
128	14	Pass	Fail	Pass	Fail
129	14	Pass	Fail	Pass	Fail
130	13	Pass	Fail	Pass	Fail
130	14	Pass	Fail	Pass	Fail
131	14	Pass	Fail	Pass	Fail
132	14	Pass	Fail	Pass	Fail
133	14	Pass	Fail	Pass	Fail
134	14	Pass	Fail	Pass	Fail
135	14	Pass	Fail	Pass	Fail
136	14	Pass	Fail	Pass	Fail
137	14	Pass	Fail	Pass	Fail
138	14	Pass	Fail	Pass	Fail
139	14	Pass	Fail	Pass	Fail
140	14	Pass	Fail	Pass	Fail
141	14	Pass	Fail	Pass	Fail
142	14	Pass	Fail	Pass	Fail
143	14	Pass	Fail	Pass	Fail
144	14	Pass	Fail	Pass	Fail
145	14	Pass	Fail	Pass	Fail
146	14	Pass	Fail	Pass	Fail
147	14	Pass	Fail	Pass	Fail
148	14	Pass	Fail	Pass	Fail
149	14	Pass	Fail	Pass	Fail
150	14	Pass	Fail	Pass	Fail
151	14	Pass	Fail	Pass	Fail
152	14	Pass	Fail	Pass	Fail
153	14	Pass	Fail	Pass	Fail
154	14	Pass	Fail	Pass	Fail
155	14	Pass	Fail	Pass	Fail
156	14	Pass	Fail	Pass	Fail
157	14	Pass	Fail	Pass	Fail
158	14	Pass	Fail	Pass	Fail
159	14	Pass	Fail	Pass	Fail
160	14	Pass	Fail	Pass	Fail
161	14	Pass	Fail	Pass	Fail
162	14	Pass	Fail	Pass	Fail
163	14	Pass	Fail	Pass	Fail
164	14	Pass	Fail	Pass	Fail
165	14	Pass	Fail	Pass	Fail
166	14	Pass	Fail	Pass	Fail

2. Table A.8.2. Sturgeon adults salinity and DO criteria passing criteria passing for existing and deepening (4 ft) scenarios within the analyzed period August 1 - August 31, 1999

```
HABITAT REQUIREMENTS:
RM 10-40; Bottom Layer
D.O. August (MG/L):10th %ile>=4.0;5th %ile>=3.0;1th %ile>=2.0
Max Salinity <= 10 ppt
D.O. January (MG/L):10th %ile>=3.5;5th %ile>=3.0;1th %ile>=2.0
Max Salinity <= 25 ppt
```

Savannah Harbor Estuary

Segments J	Segments I	Baseline Scenario Salinity	Baseline Scenario D.O.	Project Scenario Salinity	Project Scenario D.O.
47	14	Fail	Fail	Fail	Fail
47	17	Fail	Fail	Fail	Fail
48	14	Fail	Fail	Fail	Fail
48	16	Fail	Fail	Fail	Fail
49	14	Fail	Fail	Fail	Fail
49	16	Fail	Fail	Fail	Fail
50	14	Fail	Fail	Fail	Fail
50	15	Fail	Fail	Fail	Fail
51	14	Fail	Fail	Fail	Fail
52	14	Fail	Fail	Fail	Fail
53	14	Fail	Fail	Fail	Fail
54	14	Fail	Fail	Fail	Fail
55	14	Fail	Fail	Fail	Fail
56	14	Fail	Fail	Fail	Fail
57	14	Fail	Fail	Fail	Fail
58	14	Fail	Fail	Fail	Fail
59	14	Fail	Fail	Fail	Fail
60	14	Fail	Fail	Fail	Fail
61	14	Fail	Fail	Fail	Fail
62	14	Fail	Fail	Fail	Fail
63	14	Fail	Fail	Fail	Fail
64	14	Fail	Fail	Fail	Fail
65	14	Fail	Fail	Fail	Fail
66	14	Fail	Fail	Fail	Fail
67	14	Fail	Fail	Fail	Fail
68	14	Fail	Fail	Fail	Fail
69	14	Fail	Fail	Fail	Fail
70	14	Fail	Fail	Fail	Fail
71	14	Fail	Fail	Fail	Fail
72	14	Fail	Fail	Fail	Fail
73	14	Fail	Fail	Fail	Fail
74	14	Fail	Fail	Fail	Fail
75	14	Fail	Fail	Fail	Fail
76	14	Fail	Fail	Fail	Fail
76	15	Fail	Fail	Fail	Fail
77	14	Fail	Fail	Fail	Fail
77	15	Fail	Fail	Fail	Fail
78	15	Fail	Fail	Fail	Fail

78	16	Fail	Fail	Fail	Fail
79	14	Fail	Fail	Fail	Fail
80	14	Fail	Fail	Fail	Fail
81	14	Fail	Fail	Fail	Fail
82	14	Fail	Fail	Fail	Fail
82	16	Fail	Fail	Fail	Fail
83	14	Fail	Fail	Fail	Fail
84	14	Fail	Fail	Fail	Fail
85	14	Fail	Fail	Fail	Fail
86	14	Fail	Fail	Fail	Fail
87	14	Fail	Fail	Fail	Fail
88	14	Fail	Fail	Fail	Fail
89	14	Fail	Fail	Fail	Fail
90	14	Fail	Fail	Fail	Fail
91	13	Fail	Fail	Fail	Fail
91	14	Fail	Fail	Fail	Fail
92	14	Fail	Fail	Fail	Fail
92	16	Fail	Fail	Fail	Fail
93	13	Fail	Fail	Fail	Fail
93	14	Fail	Fail	Fail	Fail
94	13	Fail	Fail	Fail	Fail
94	14	Fail	Fail	Fail	Fail
95	14	Fail	Fail	Fail	Fail
95	30	Pass	Fail	Pass	Fail
96	14	Fail	Fail	Fail	Fail
97	14	Fail	Fail	Fail	Fail
98	14	Fail	Pass	Fail	Fail
99	14	Fail	Pass	Fail	Fail
99	15	Fail	Pass	Fail	Fail
100	14	Fail	Pass	Fail	Fail
101	14	Fail	Pass	Fail	Fail
101	15	Fail	Pass	Fail	Fail
102	14	Fail	Pass	Fail	Fail
103	14	Fail	Pass	Fail	Pass
104	14	Pass	Pass	Fail	Pass
105	14	Pass	Pass	Fail	Pass
106	14	Pass	Pass	Fail	Pass
107	14	Pass	Pass	Fail	Pass
108	14	Pass	Pass	Fail	Pass
109	15	Pass	Pass	Fail	Pass
110	15	Pass	Pass	Pass	Pass
111	15	Pass	Pass	Pass	Pass
112	14	Pass	Pass	Pass	Pass
113	14	Pass	Pass	Pass	Pass
114	15	Pass	Pass	Pass	Pass
115	15	Pass	Pass	Pass	Pass
116	15	Pass	Pass	Pass	Pass
117	14	Pass	Pass	Pass	Pass
118	15	Pass	Fail	Pass	Fail
119	14	Pass	Fail	Pass	Fail
120	14	Pass	Fail	Pass	Fail
120	15	Pass	Fail	Pass	Fail
121	14	Pass	Fail	Pass	Fail
122	14	Pass	Fail	Pass	Fail
123	13	Pass	Fail	Pass	Fail
123	14	Pass	Fail	Pass	Fail
124	14	Pass	Fail	Pass	Fail

125	14	Pass	Fail	Pass	Fail
126	14	Pass	Fail	Pass	Fail
127	14	Pass	Fail	Pass	Fail
128	14	Pass	Fail	Pass	Fail
129	14	Pass	Fail	Pass	Fail
130	13	Pass	Fail	Pass	Fail
130	14	Pass	Fail	Pass	Fail
131	14	Pass	Fail	Pass	Fail
132	14	Pass	Fail	Pass	Fail
133	14	Pass	Fail	Pass	Fail
134	14	Pass	Fail	Pass	Fail
135	14	Pass	Fail	Pass	Fail
136	14	Pass	Fail	Pass	Fail
137	14	Pass	Fail	Pass	Fail
138	14	Pass	Fail	Pass	Fail
139	14	Pass	Fail	Pass	Fail
140	14	Pass	Fail	Pass	Fail
141	14	Pass	Fail	Pass	Fail
142	14	Pass	Fail	Pass	Fail
143	14	Pass	Fail	Pass	Fail
144	14	Pass	Fail	Pass	Fail
145	14	Pass	Fail	Pass	Fail
146	14	Pass	Fail	Pass	Fail
147	14	Pass	Fail	Pass	Fail
148	14	Pass	Fail	Pass	Fail
149	14	Pass	Fail	Pass	Fail
150	14	Pass	Fail	Pass	Fail
151	14	Pass	Fail	Pass	Fail
152	14	Pass	Fail	Pass	Fail
153	14	Pass	Fail	Pass	Fail
154	14	Pass	Fail	Pass	Fail
155	14	Pass	Fail	Pass	Fail
156	14	Pass	Fail	Pass	Fail
157	14	Pass	Fail	Pass	Fail
158	14	Pass	Fail	Pass	Fail
159	14	Pass	Fail	Pass	Fail
160	14	Pass	Fail	Pass	Fail
161	14	Pass	Fail	Pass	Fail
162	14	Pass	Fail	Pass	Fail
163	14	Pass	Fail	Pass	Fail
164	14	Pass	Fail	Pass	Fail
165	14	Pass	Fail	Pass	Fail
166	14	Pass	Fail	Pass	Fail

3. Table A.8.3. Sturgeon adults salinity and DO criteria passing criteria passing for existing and deepening (3 ft) scenarios within the analyzed period August 1 - August 31, 1999

```
HABITAT REQUIREMENTS:
RM 10-40; Bottom Layer
D.O. August (MG/L):10th %ile>=4.0;5th %ile>=3.0;1th %ile>=2.0
Max Salinity <= 10 ppt
D.O. January (MG/L):10th %ile>=3.5;5th %ile>=3.0;1th %ile>=2.0
```

Savannah Harbor Estuary

Segments		Baseline Scenario		Project Scenario	
J	I	Salinity	D.O.	Salinity	D.O.
47	14	Fail	Fail	Fail	Fail
47	17	Fail	Fail	Fail	Fail
48	14	Fail	Fail	Fail	Fail
48	16	Fail	Fail	Fail	Fail
49	14	Fail	Fail	Fail	Fail
49	16	Fail	Fail	Fail	Fail
50	14	Fail	Fail	Fail	Fail
50	15	Fail	Fail	Fail	Fail
51	14	Fail	Fail	Fail	Fail
52	14	Fail	Fail	Fail	Fail
53	14	Fail	Fail	Fail	Fail
54	14	Fail	Fail	Fail	Fail
55	14	Fail	Fail	Fail	Fail
56	14	Fail	Fail	Fail	Fail
57	14	Fail	Fail	Fail	Fail
58	14	Fail	Fail	Fail	Fail
59	14	Fail	Fail	Fail	Fail
60	14	Fail	Fail	Fail	Fail
61	14	Fail	Fail	Fail	Fail
62	14	Fail	Fail	Fail	Fail
63	14	Fail	Fail	Fail	Fail
64	14	Fail	Fail	Fail	Fail
65	14	Fail	Fail	Fail	Fail
66	14	Fail	Fail	Fail	Fail
67	14	Fail	Fail	Fail	Fail
68	14	Fail	Fail	Fail	Fail
69	14	Fail	Fail	Fail	Fail
70	14	Fail	Fail	Fail	Fail
71	14	Fail	Fail	Fail	Fail
72	14	Fail	Fail	Fail	Fail
73	14	Fail	Fail	Fail	Fail
74	14	Fail	Fail	Fail	Fail
75	14	Fail	Fail	Fail	Fail
76	14	Fail	Fail	Fail	Fail
76	15	Fail	Fail	Fail	Fail
77	14	Fail	Fail	Fail	Fail
77	15	Fail	Fail	Fail	Fail
78	15	Fail	Fail	Fail	Fail

78	16	Fail	Fail	Fail	Fail
79	14	Fail	Fail	Fail	Fail
80	14	Fail	Fail	Fail	Fail
81	14	Fail	Fail	Fail	Fail
82	14	Fail	Fail	Fail	Fail
82	16	Fail	Fail	Fail	Fail
83	14	Fail	Fail	Fail	Fail
84	14	Fail	Fail	Fail	Fail
85	14	Fail	Fail	Fail	Fail
86	14	Fail	Fail	Fail	Fail
87	14	Fail	Fail	Fail	Fail
88	14	Fail	Fail	Fail	Fail
89	14	Fail	Fail	Fail	Fail
90	14	Fail	Fail	Fail	Fail
91	13	Fail	Fail	Fail	Fail
91	14	Fail	Fail	Fail	Fail
92	14	Fail	Fail	Fail	Fail
92	16	Fail	Fail	Fail	Fail
93	13	Fail	Fail	Fail	Fail
93	14	Fail	Fail	Fail	Fail
94	13	Fail	Fail	Fail	Fail
94	14	Fail	Fail	Fail	Fail
95	14	Fail	Fail	Fail	Fail
95	30	Pass	Fail	Pass	Fail
96	14	Fail	Fail	Fail	Fail
97	14	Fail	Fail	Fail	Fail
98	14	Fail	Pass	Fail	Fail
99	14	Fail	Pass	Fail	Fail
99	15	Fail	Pass	Fail	Fail
100	14	Fail	Pass	Fail	Fail
101	14	Fail	Pass	Fail	Fail
101	15	Fail	Pass	Fail	Fail
102	14	Fail	Pass	Fail	Pass
103	14	Fail	Pass	Fail	Pass
104	14	Pass	Pass	Fail	Pass
105	14	Pass	Pass	Fail	Pass
106	14	Pass	Pass	Fail	Pass
107	14	Pass	Pass	Fail	Pass
108	14	Pass	Pass	Fail	Pass
109	15	Pass	Pass	Pass	Pass
110	15	Pass	Pass	Pass	Pass
111	15	Pass	Pass	Pass	Pass
112	14	Pass	Pass	Pass	Pass
113	14	Pass	Pass	Pass	Pass
114	15	Pass	Pass	Pass	Pass
115	15	Pass	Pass	Pass	Pass
116	15	Pass	Pass	Pass	Pass
117	14	Pass	Pass	Pass	Pass
118	15	Pass	Fail	Pass	Fail
119	14	Pass	Fail	Pass	Fail
120	14	Pass	Fail	Pass	Fail
120	15	Pass	Fail	Pass	Fail
121	14	Pass	Fail	Pass	Fail
122	14	Pass	Fail	Pass	Fail
123	13	Pass	Fail	Pass	Fail
123	14	Pass	Fail	Pass	Fail
124	14	Pass	Fail	Pass	Fail

125	14	Pass	Fail	Pass	Fail
126	14	Pass	Fail	Pass	Fail
127	14	Pass	Fail	Pass	Fail
128	14	Pass	Fail	Pass	Fail
129	14	Pass	Fail	Pass	Fail
130	13	Pass	Fail	Pass	Fail
130	14	Pass	Fail	Pass	Fail
131	14	Pass	Fail	Pass	Fail
132	14	Pass	Fail	Pass	Fail
133	14	Pass	Fail	Pass	Fail
134	14	Pass	Fail	Pass	Fail
135	14	Pass	Fail	Pass	Fail
136	14	Pass	Fail	Pass	Fail
137	14	Pass	Fail	Pass	Fail
138	14	Pass	Fail	Pass	Fail
139	14	Pass	Fail	Pass	Fail
140	14	Pass	Fail	Pass	Fail
141	14	Pass	Fail	Pass	Fail
142	14	Pass	Fail	Pass	Fail
143	14	Pass	Fail	Pass	Fail
144	14	Pass	Fail	Pass	Fail
145	14	Pass	Fail	Pass	Fail
146	14	Pass	Fail	Pass	Fail
147	14	Pass	Fail	Pass	Fail
148	14	Pass	Fail	Pass	Fail
149	14	Pass	Fail	Pass	Fail
150	14	Pass	Fail	Pass	Fail
151	14	Pass	Fail	Pass	Fail
152	14	Pass	Fail	Pass	Fail
153	14	Pass	Fail	Pass	Fail
154	14	Pass	Fail	Pass	Fail
155	14	Pass	Fail	Pass	Fail
156	14	Pass	Fail	Pass	Fail
157	14	Pass	Fail	Pass	Fail
158	14	Pass	Fail	Pass	Fail
159	14	Pass	Fail	Pass	Fail
160	14	Pass	Fail	Pass	Fail
161	14	Pass	Fail	Pass	Fail
162	14	Pass	Fail	Pass	Fail
163	14	Pass	Fail	Pass	Fail
164	14	Pass	Fail	Pass	Fail
165	14	Pass	Fail	Pass	Fail
166	14	Pass	Fail	Pass	Fail

4. Table A.8.4. Sturgeon adults salinity and DO criteria passing criteria passing for existing and deepening (2 ft) scenarios within the analyzed period August 1 - August 31, 1999

```
HABITAT REQUIREMENTS:
RM 10-40; Bottom Layer
D.O. August (MG/L):10th %ile>=4.0;5th %ile>=3.0;1th %ile>=2.0
Max Salinity <= 10 ppt
D.O. January (MG/L):10th %ile>=3.5;5th %ile>=3.0;1th %ile>=2.0
Max Salinity <= 25 ppt
```

Savannah Harbor Estuary

Segments		Baseline Scenario		Project Scenario	
J	I	Salinity	D.O.	Salinity	D.O.
47	14	Fail	Fail	Fail	Fail
47	17	Fail	Fail	Fail	Fail
48	14	Fail	Fail	Fail	Fail
48	16	Fail	Fail	Fail	Fail
49	14	Fail	Fail	Fail	Fail
49	16	Fail	Fail	Fail	Fail
50	14	Fail	Fail	Fail	Fail
50	15	Fail	Fail	Fail	Fail
51	14	Fail	Fail	Fail	Fail
52	14	Fail	Fail	Fail	Fail
53	14	Fail	Fail	Fail	Fail
54	14	Fail	Fail	Fail	Fail
55	14	Fail	Fail	Fail	Fail
56	14	Fail	Fail	Fail	Fail
57	14	Fail	Fail	Fail	Fail
58	14	Fail	Fail	Fail	Fail
59	14	Fail	Fail	Fail	Fail
60	14	Fail	Fail	Fail	Fail
61	14	Fail	Fail	Fail	Fail
62	14	Fail	Fail	Fail	Fail
63	14	Fail	Fail	Fail	Fail
64	14	Fail	Fail	Fail	Fail
65	14	Fail	Fail	Fail	Fail
66	14	Fail	Fail	Fail	Fail
67	14	Fail	Fail	Fail	Fail
68	14	Fail	Fail	Fail	Fail
69	14	Fail	Fail	Fail	Fail
70	14	Fail	Fail	Fail	Fail
71	14	Fail	Fail	Fail	Fail
72	14	Fail	Fail	Fail	Fail
73	14	Fail	Fail	Fail	Fail
74	14	Fail	Fail	Fail	Fail
75	14	Fail	Fail	Fail	Fail
76	14	Fail	Fail	Fail	Fail
76	15	Fail	Fail	Fail	Fail
77	14	Fail	Fail	Fail	Fail
77	15	Fail	Fail	Fail	Fail
78	15	Fail	Fail	Fail	Fail

78	16	Fail	Fail	Fail	Fail
79	14	Fail	Fail	Fail	Fail
80	14	Fail	Fail	Fail	Fail
81	14	Fail	Fail	Fail	Fail
82	14	Fail	Fail	Fail	Fail
82	16	Fail	Fail	Fail	Fail
83	14	Fail	Fail	Fail	Fail
84	14	Fail	Fail	Fail	Fail
85	14	Fail	Fail	Fail	Fail
86	14	Fail	Fail	Fail	Fail
87	14	Fail	Fail	Fail	Fail
88	14	Fail	Fail	Fail	Fail
89	14	Fail	Fail	Fail	Fail
90	14	Fail	Fail	Fail	Fail
91	13	Fail	Fail	Fail	Fail
91	14	Fail	Fail	Fail	Fail
92	14	Fail	Fail	Fail	Fail
92	16	Fail	Fail	Fail	Fail
93	13	Fail	Fail	Fail	Fail
93	14	Fail	Fail	Fail	Fail
94	13	Fail	Fail	Fail	Fail
94	14	Fail	Fail	Fail	Fail
95	14	Fail	Fail	Fail	Fail
95	30	Pass	Fail	Pass	Fail
96	14	Fail	Fail	Fail	Fail
97	14	Fail	Fail	Fail	Fail
98	14	Fail	Pass	Fail	Fail
99	14	Fail	Pass	Fail	Fail
99	15	Fail	Pass	Fail	Fail
100	14	Fail	Pass	Fail	Fail
101	14	Fail	Pass	Fail	Pass
101	15	Fail	Pass	Fail	Pass
102	14	Fail	Pass	Fail	Pass
103	14	Fail	Pass	Fail	Pass
104	14	Pass	Pass	Fail	Pass
105	14	Pass	Pass	Fail	Pass
106	14	Pass	Pass	Fail	Pass
107	14	Pass	Pass	Fail	Pass
108	14	Pass	Pass	Pass	Pass
109	15	Pass	Pass	Pass	Pass
110	15	Pass	Pass	Pass	Pass
111	15	Pass	Pass	Pass	Pass
112	14	Pass	Pass	Pass	Pass
113	14	Pass	Pass	Pass	Pass
114	15	Pass	Pass	Pass	Pass
115	15	Pass	Pass	Pass	Pass
116	15	Pass	Pass	Pass	Pass
117	14	Pass	Pass	Pass	Pass
118	15	Pass	Fail	Pass	Fail
119	14	Pass	Fail	Pass	Fail
120	14	Pass	Fail	Pass	Fail
120	15	Pass	Fail	Pass	Fail
121	14	Pass	Fail	Pass	Fail
122	14	Pass	Fail	Pass	Fail
123	13	Pass	Fail	Pass	Fail
123	14	Pass	Fail	Pass	Fail
124	14	Pass	Fail	Pass	Fail

125	14	Pass	Fail	Pass	Fail
126	14	Pass	Fail	Pass	Fail
127	14	Pass	Fail	Pass	Fail
128	14	Pass	Fail	Pass	Fail
129	14	Pass	Fail	Pass	Fail
130	13	Pass	Fail	Pass	Fail
130	14	Pass	Fail	Pass	Fail
131	14	Pass	Fail	Pass	Fail
132	14	Pass	Fail	Pass	Fail
133	14	Pass	Fail	Pass	Fail
134	14	Pass	Fail	Pass	Fail
135	14	Pass	Fail	Pass	Fail
136	14	Pass	Fail	Pass	Fail
137	14	Pass	Fail	Pass	Fail
138	14	Pass	Fail	Pass	Fail
139	14	Pass	Fail	Pass	Fail
140	14	Pass	Fail	Pass	Fail
141	14	Pass	Fail	Pass	Fail
142	14	Pass	Fail	Pass	Fail
143	14	Pass	Fail	Pass	Fail
144	14	Pass	Fail	Pass	Fail
145	14	Pass	Fail	Pass	Fail
146	14	Pass	Fail	Pass	Fail
147	14	Pass	Fail	Pass	Fail
148	14	Pass	Fail	Pass	Fail
149	14	Pass	Fail	Pass	Fail
150	14	Pass	Fail	Pass	Fail
151	14	Pass	Fail	Pass	Fail
152	14	Pass	Fail	Pass	Fail
153	14	Pass	Fail	Pass	Fail
154	14	Pass	Fail	Pass	Fail
155	14	Pass	Fail	Pass	Fail
156	14	Pass	Fail	Pass	Fail
157	14	Pass	Fail	Pass	Fail
158	14	Pass	Fail	Pass	Fail
159	14	Pass	Fail	Pass	Fail
160	14	Pass	Fail	Pass	Fail
161	14	Pass	Fail	Pass	Fail
162	14	Pass	Fail	Pass	Fail
163	14	Pass	Fail	Pass	Fail
164	14	Pass	Fail	Pass	Fail
165	14	Pass	Fail	Pass	Fail
166	14	Pass	Fail	Pass	Fail

Appendix B

JANUARY 1999

50th %ile of Clyo Flow

Habitat Analysis Output

Fisheries Review Group

1. Table B.1. Comparisons of American Shad, Sturgeon Adults, and Sturgeon Juveniles habitat areas for existing and deepening (6 ft) scenarios within the analyzed period January 1 - January 31, 1999

	Baseline Scenario		Project Scenario		% Change
American Shad	19.962807	km2	19.962807	km2	0.0
Sturgeon Adults	5.012443	km2	3.929443	km2	-21.6
Sturgeon Juveniles	2.815892	km2	2.784542	km2	-1.1

2. Table B.2. Comparisons of American Shad, Sturgeon Adults, and Sturgeon Juveniles habitat areas for existing and deepening (4 ft) scenarios within the analyzed period January 1 - January 31, 1999

	Baseline Scenario		Project Scenario		% Change
American Shad	19.962807	km2	19.962807	km2	0.0
Sturgeon Adults	5.012443	km2	4.215274	km2	-15.9
Sturgeon Juveniles	2.815892	km2	2.792404	km2	-0.8

3. Table B.3. Comparisons of American Shad, Sturgeon Adults, and Sturgeon Juveniles habitat areas for existing and deepening (3 ft) scenarios within the analyzed period January 1 - January 31, 1999

	Baseline Scenario		Project Scenario		% Change
American Shad	19.962807	km2	19.962807	km2	0.0
Sturgeon Adults	5.012443	km2	4.490778	km2	-10.4
Sturgeon Juveniles	2.815892	km2	2.800597	km2	-0.5

4. Table B.4. Comparisons of American Shad, Sturgeon Adults, and Sturgeon Juveniles habitat areas for existing and deepening (2 ft) scenarios within the analyzed period January 1 - January 31, 1999

	Baseline Scenario		Project Scenario		% Change
American Shad	19.962807	km2	19.962807	km2	0.0
Sturgeon Adults	5.012443	km2	4.763175	km2	-5.0
Sturgeon Juveniles	2.815892	km2	2.800597	km2	-0.5

5. Table B.6.1. American Shad D.O criteria passing for existing and deepening (6 ft, 4 ft, 3 ft, and 2 ft) scenarios within the analyzed period January 1 - January 31, 1999

(See Appendix B-1)

6. Table B.7.1. Sturgeon adults salinity and D.O. criteria passing for existing and deepening (6 ft) scenarios within the analyzed period January 1 - January 31, 1999

(See Appendix B-2)

7. Table B.7.2. Sturgeon adults salinity and D.O. criteria passing for existing and deepening (4 ft) scenarios within the analyzed period January 1 - January 31, 1999

(See Appendix B-2)

8. Table B.7.3. Sturgeon adults salinity and D.O. criteria passing for existing and deepening (3 ft) scenarios within the analyzed period January 1 - January 31, 1999

(See Appendix B-2)

9. Table B.7.4. Sturgeon adults salinity and D.O. criteria passing for existing and deepening (2 ft) scenarios within the analyzed period January 1 - January 31, 1999

(See Appendix B-2)

10. Table B.8.1. Sturgeon juveniles salinity and DO criteria passing criteria passing for existing and deepening (6 ft) scenarios within the analyzed period January 1 - January 31, 1999

(See Appendix B-3)

11. Table B.8.2. Sturgeon juveniles salinity and DO criteria passing criteria passing for existing and deepening (4 ft) scenarios within the analyzed period January 1 - January 31, 1999

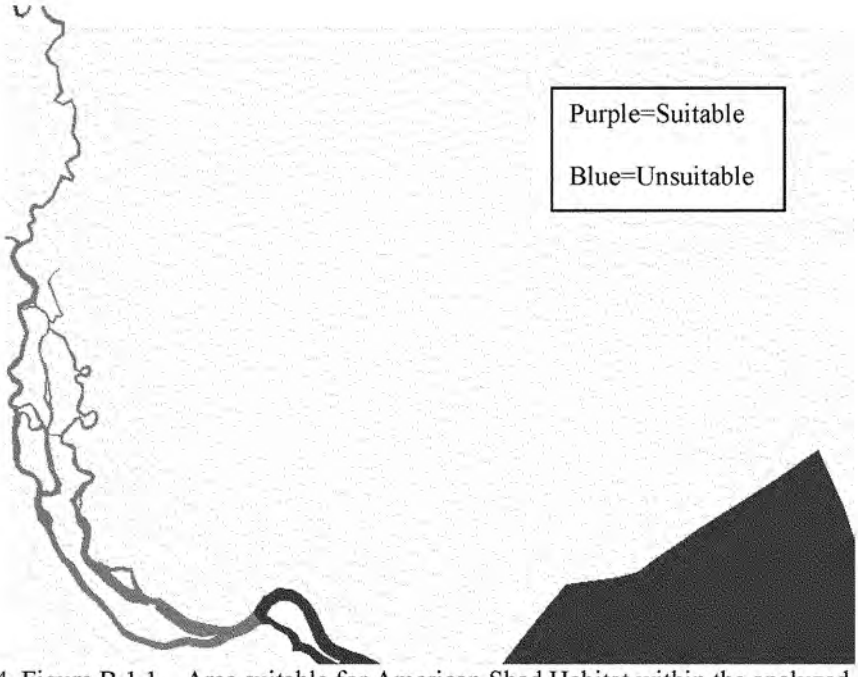
(See Appendix B-3)

12. Table B.8.3. Sturgeon juveniles salinity and DO criteria passing criteria passing for existing and deepening (3 ft) scenarios within the analyzed period January 1 - January 31, 1999

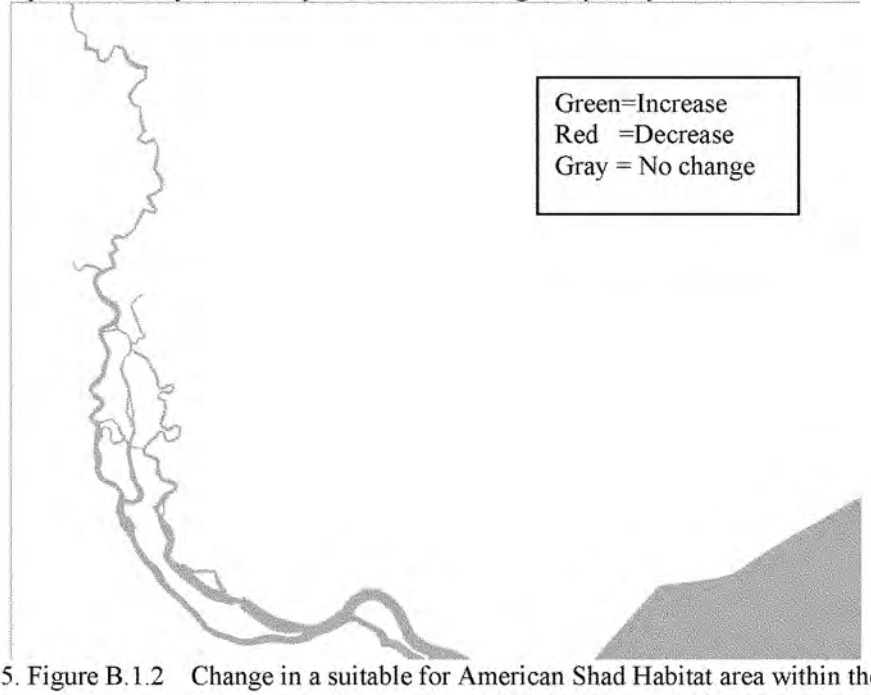
(See Appendix B-3)

13. Table B.8.4. Sturgeon juveniles salinity and DO criteria passing criteria passing for existing and deepening (2 ft) scenarios within the analyzed period January 1 - January 31, 1999

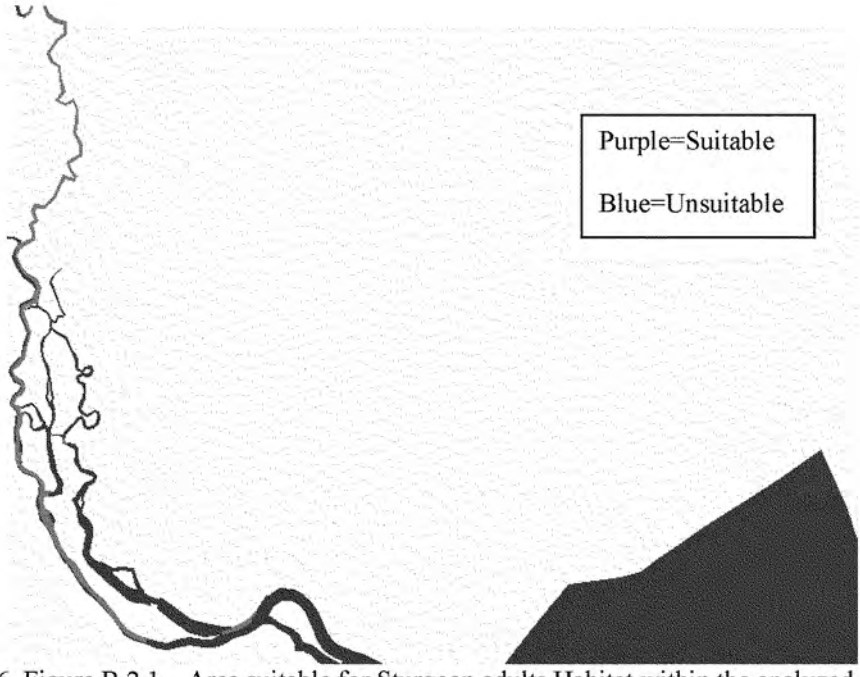
(See Appendix B-3)



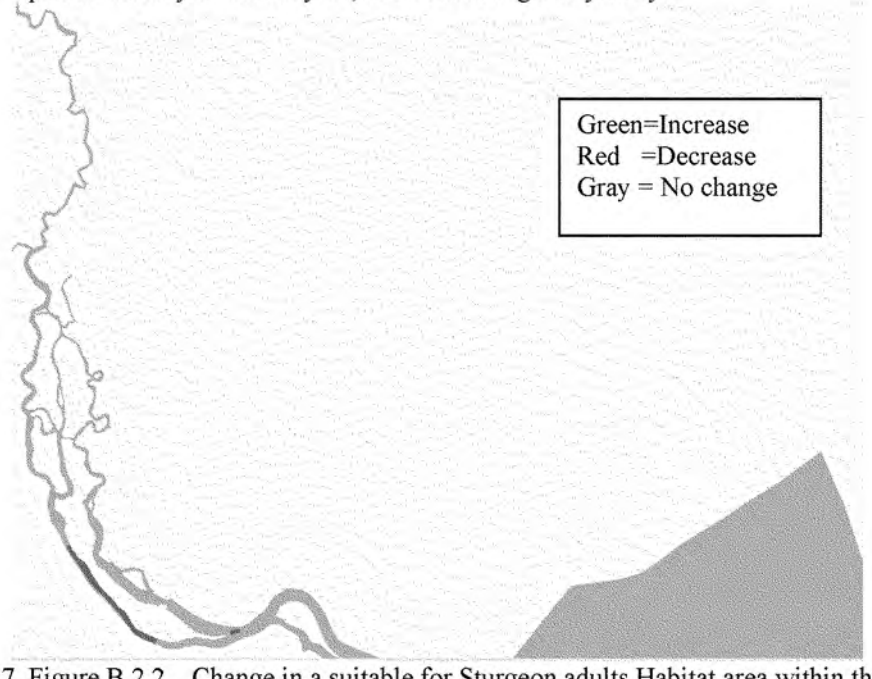
14. Figure B.1.1 Area suitable for American Shad Habitat within the analyzed period January 1 - January 31, 1999 : Existing bathymetry



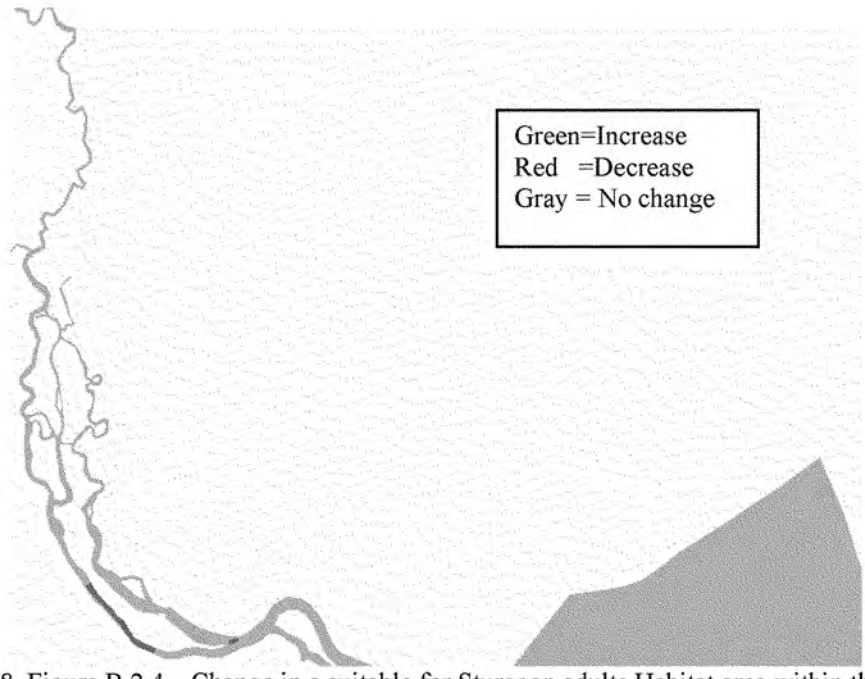
15. Figure B.1.2 Change in a suitable for American Shad Habitat area within the analyzed period January 1 - January 31, 1999 : 6, 4, 3, and 2 ft deepening



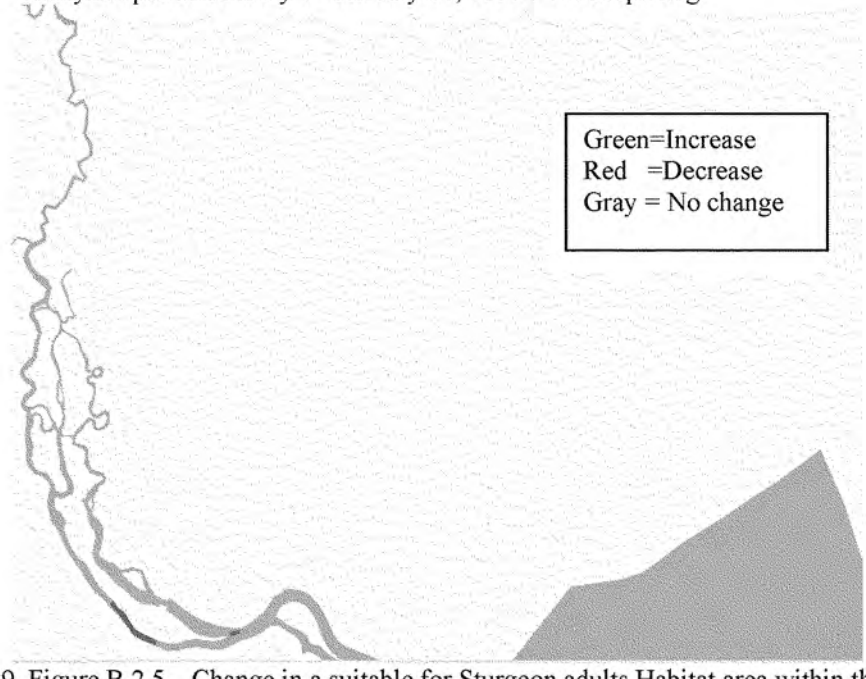
16. Figure B.2.1 Area suitable for Sturgeon adults Habitat within the analyzed period January 1 - January 31, 1999 : Existing bathymetry



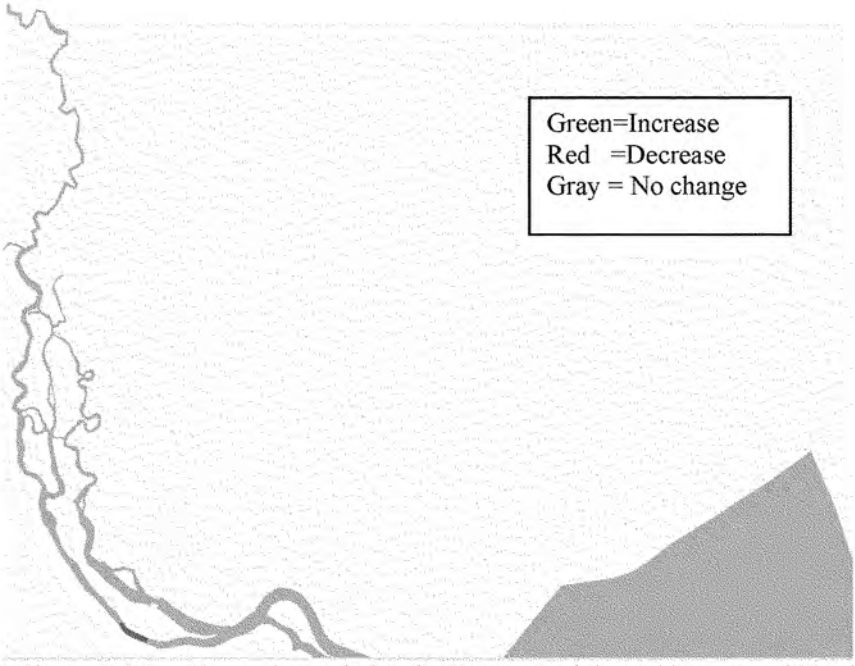
17. Figure B.2.2 Change in a suitable for Sturgeon adults Habitat area within the analyzed period January 1 - January 31, 1999 : 6 ft deepening



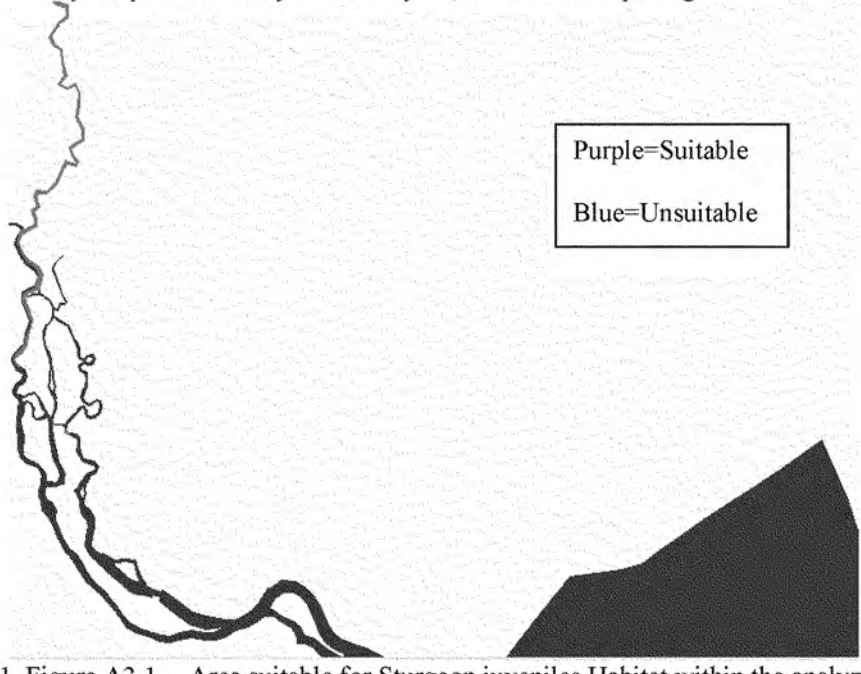
18. Figure B.2.4 Change in a suitable for Sturgeon adults Habitat area within the analyzed period January 1 - January 31, 1999 : 4 ft deepening



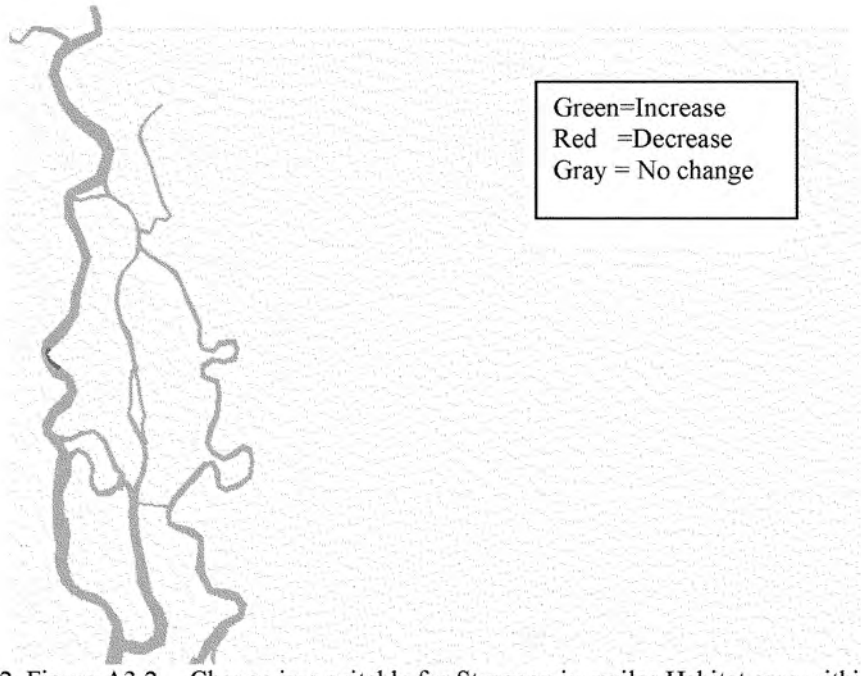
19. Figure B.2.5 Change in a suitable for Sturgeon adults Habitat area within the analyzed period January 1 - January 31, 1999 : 3 ft deepening



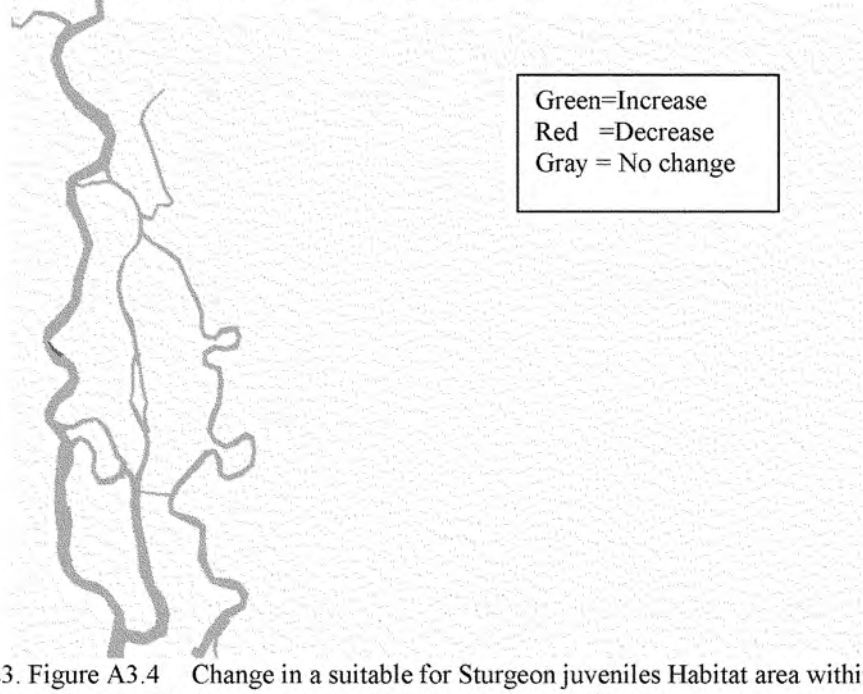
20. Figure B.2.6 Change in a suitable for Sturgeon adults Habitat area within the analyzed period January 1 - January 31, 1999 : 2 ft deepening



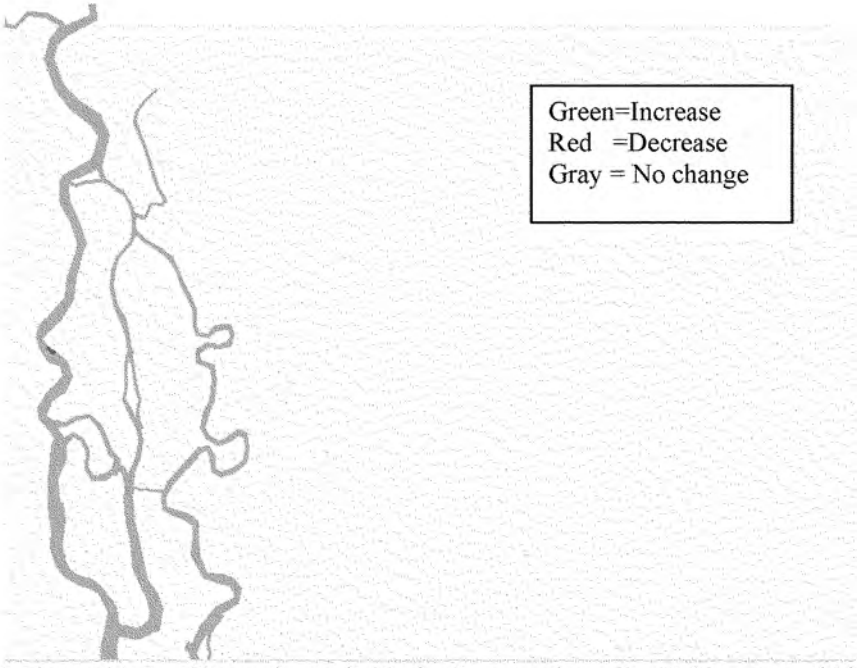
21. Figure A3.1 Area suitable for Sturgeon juveniles Habitat within the analyzed period January 1 - January 31, 1999 : Existing bathymetry



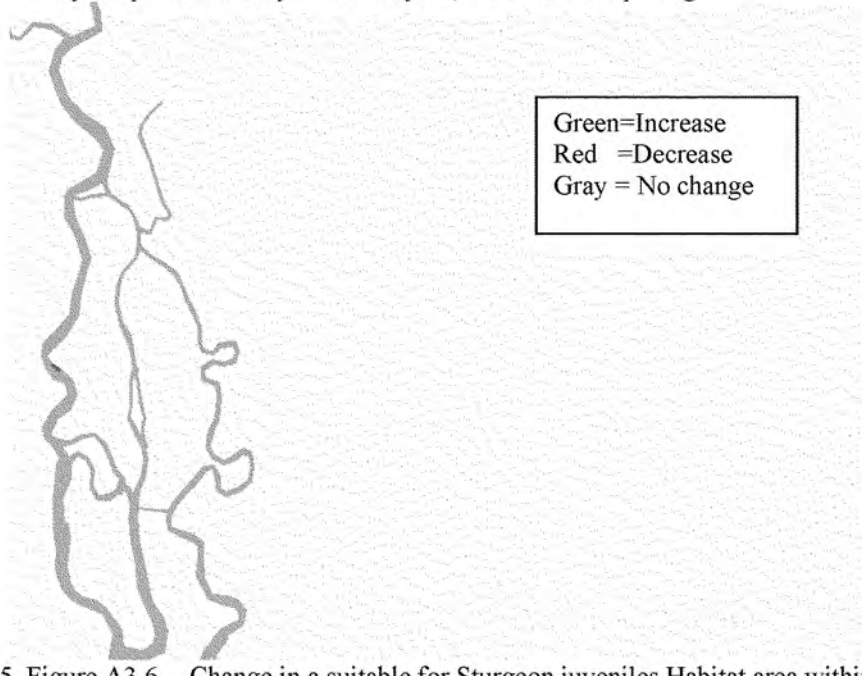
22. Figure A3.2 Change in a suitable for Sturgeon juveniles Habitat area within the analyzed period January 1 - January 31, 1999 : 6 ft deepening



23. Figure A3.4 Change in a suitable for Sturgeon juveniles Habitat area within the analyzed period January 1 - January 31, 1999 : 4 ft deepening



24. Figure A3.5 Change in a suitable for Sturgeon juveniles Habitat area within the analyzed period January 1 - January 31, 1999 : 3 ft deepening



25. Figure A3.6 Change in a suitable for Sturgeon juveniles Habitat area within the analyzed period January 1 - January 31, 1999 : 2 ft deepening

Appendix B-1

Tables of Criteria Passing for American Shad Habitat Suitability

January 1999

50th %ile of Clyo Flow

Fisheries Review Group

1. Table B.6.1. American Shad D.O criteria passing for existing and deepening (6 ft, 4 ft, 3 ft, and 2 ft) scenarios within the analyzed period January 1 - January 31, 1999

HABITAT REQUIREMENTS:
RM 10-40; Top half of water column
D.O. January, May, and August (MG/L):10th %ile >=4.0

Savannah Harbor Estuary

Segments J	Segments I	Baseline Scenario D.O.	Project Scenario D.O.
47	13	Pass	Pass
47	14	Pass	Pass
47	15	Pass	Pass
47	16	Pass	Pass
47	17	Pass	Pass
48	13	Pass	Pass
48	14	Pass	Pass
48	15	Pass	Pass
48	16	Pass	Pass
48	17	Pass	Pass
49	13	Pass	Pass
49	14	Pass	Pass
49	15	Pass	Pass
49	16	Pass	Pass
49	17	Pass	Pass
50	13	Pass	Pass
50	14	Pass	Pass
50	15	Pass	Pass
50	16	Pass	Pass
50	17	Pass	Pass
50	18	Pass	Pass
51	13	Pass	Pass
51	14	Pass	Pass
51	15	Pass	Pass
52	13	Pass	Pass
52	14	Pass	Pass
52	15	Pass	Pass
53	13	Pass	Pass
53	14	Pass	Pass
53	15	Pass	Pass
54	13	Pass	Pass
54	14	Pass	Pass
54	15	Pass	Pass
55	13	Pass	Pass
55	14	Pass	Pass
55	15	Pass	Pass
56	13	Pass	Pass
56	14	Pass	Pass
56	15	Pass	Pass
57	13	Pass	Pass
57	14	Pass	Pass
57	15	Pass	Pass

58	13	Pass	Pass
58	14	Pass	Pass
58	15	Pass	Pass
59	13	Pass	Pass
59	14	Pass	Pass
59	15	Pass	Pass
59	30	Pass	Pass
59	31	Pass	Pass
59	32	Pass	Pass
60	13	Pass	Pass
60	14	Pass	Pass
60	15	Pass	Pass
60	30	Pass	Pass
60	31	Pass	Pass
60	32	Pass	Pass
61	13	Pass	Pass
61	14	Pass	Pass
61	15	Pass	Pass
61	30	Pass	Pass
61	31	Pass	Pass
61	32	Pass	Pass
62	13	Pass	Pass
62	14	Pass	Pass
62	15	Pass	Pass
62	30	Pass	Pass
62	31	Pass	Pass
62	32	Pass	Pass
63	13	Pass	Pass
63	14	Pass	Pass
63	15	Pass	Pass
63	31	Pass	Pass
64	13	Pass	Pass
64	14	Pass	Pass
64	15	Pass	Pass
64	30	Pass	Pass
64	31	Pass	Pass
64	32	Pass	Pass
65	13	Pass	Pass
65	14	Pass	Pass
65	15	Pass	Pass
65	30	Pass	Pass
65	31	Pass	Pass
65	32	Pass	Pass
65	33	Pass	Pass
66	13	Pass	Pass
66	14	Pass	Pass
66	15	Pass	Pass
66	30	Pass	Pass
66	31	Pass	Pass
66	32	Pass	Pass
66	36	Pass	Pass
67	13	Pass	Pass
67	14	Pass	Pass
67	15	Pass	Pass
67	30	Pass	Pass
67	31	Pass	Pass
67	32	Pass	Pass

67	36	Pass	Pass
68	13	Pass	Pass
68	14	Pass	Pass
68	15	Pass	Pass
68	30	Pass	Pass
68	31	Pass	Pass
68	32	Pass	Pass
68	36	Pass	Pass
69	13	Pass	Pass
69	14	Pass	Pass
69	15	Pass	Pass
69	30	Pass	Pass
69	31	Pass	Pass
69	32	Pass	Pass
69	36	Pass	Pass
70	13	Pass	Pass
70	14	Pass	Pass
70	15	Pass	Pass
70	30	Pass	Pass
70	31	Pass	Pass
70	32	Pass	Pass
70	33	Pass	Pass
71	13	Pass	Pass
71	14	Pass	Pass
71	15	Pass	Pass
71	30	Pass	Pass
71	31	Pass	Pass
71	32	Pass	Pass
72	13	Pass	Pass
72	14	Pass	Pass
72	15	Pass	Pass
72	30	Pass	Pass
72	31	Pass	Pass
72	32	Pass	Pass
73	13	Pass	Pass
73	14	Pass	Pass
73	15	Pass	Pass
73	30	Pass	Pass
73	31	Pass	Pass
74	13	Pass	Pass
74	14	Pass	Pass
74	15	Pass	Pass
74	30	Pass	Pass
74	31	Pass	Pass
75	13	Pass	Pass
75	14	Pass	Pass
75	15	Pass	Pass
75	30	Pass	Pass
75	31	Pass	Pass
76	13	Pass	Pass
76	14	Pass	Pass
76	15	Pass	Pass
76	16	Pass	Pass
76	17	Pass	Pass
76	30	Pass	Pass
76	31	Pass	Pass
77	13	Pass	Pass

77	14	Pass	Pass
77	15	Pass	Pass
77	16	Pass	Pass
77	17	Pass	Pass
77	30	Pass	Pass
77	31	Pass	Pass
78	13	Pass	Pass
78	14	Pass	Pass
78	15	Pass	Pass
78	16	Pass	Pass
78	17	Pass	Pass
78	30	Pass	Pass
78	31	Pass	Pass
79	13	Pass	Pass
79	14	Pass	Pass
79	15	Pass	Pass
79	30	Pass	Pass
79	31	Pass	Pass
80	13	Pass	Pass
80	14	Pass	Pass
80	15	Pass	Pass
80	30	Pass	Pass
80	31	Pass	Pass
81	13	Pass	Pass
81	14	Pass	Pass
81	15	Pass	Pass
81	30	Pass	Pass
81	31	Pass	Pass
82	13	Pass	Pass
82	14	Pass	Pass
82	15	Pass	Pass
82	16	Pass	Pass
82	17	Pass	Pass
82	18	Pass	Pass
82	19	Pass	Pass
82	20	Pass	Pass
82	21	Pass	Pass
82	29	Pass	Pass
82	30	Pass	Pass
82	31	Pass	Pass
83	13	Pass	Pass
83	14	Pass	Pass
83	15	Pass	Pass
83	21	Pass	Pass
83	30	Pass	Pass
83	31	Pass	Pass
84	13	Pass	Pass
84	14	Pass	Pass
84	15	Pass	Pass
84	21	Pass	Pass
84	30	Pass	Pass
84	31	Pass	Pass
85	13	Pass	Pass
85	14	Pass	Pass
85	15	Pass	Pass
85	21	Pass	Pass
85	30	Pass	Pass

86	13	Pass	Pass
86	14	Pass	Pass
86	15	Pass	Pass
86	21	Pass	Pass
86	30	Pass	Pass
87	13	Pass	Pass
87	14	Pass	Pass
87	15	Pass	Pass
87	30	Pass	Pass
88	13	Pass	Pass
88	14	Pass	Pass
88	15	Pass	Pass
88	30	Pass	Pass
89	13	Pass	Pass
89	14	Pass	Pass
89	15	Pass	Pass
89	30	Pass	Pass
90	13	Pass	Pass
90	14	Pass	Pass
90	15	Pass	Pass
90	30	Pass	Pass
91	13	Pass	Pass
91	14	Pass	Pass
91	15	Pass	Pass
91	16	Pass	Pass
91	30	Pass	Pass
92	13	Pass	Pass
92	14	Pass	Pass
92	15	Pass	Pass
92	16	Pass	Pass
92	30	Pass	Pass
93	13	Pass	Pass
93	14	Pass	Pass
93	15	Pass	Pass
93	16	Pass	Pass
93	30	Pass	Pass
94	13	Pass	Pass
94	14	Pass	Pass
94	15	Pass	Pass
94	16	Pass	Pass
94	26	Pass	Pass
94	30	Pass	Pass
95	13	Pass	Pass
95	14	Pass	Pass
95	15	Pass	Pass
95	16	Pass	Pass
95	26	Pass	Pass
95	30	Pass	Pass
96	13	Pass	Pass
96	14	Pass	Pass
96	15	Pass	Pass
96	26	Pass	Pass
96	30	Pass	Pass
97	13	Pass	Pass
97	14	Pass	Pass
97	15	Pass	Pass
97	26	Pass	Pass

97	30	Pass	Pass
98	13	Pass	Pass
98	14	Pass	Pass
98	15	Pass	Pass
98	26	Pass	Pass
98	27	Pass	Pass
98	28	Pass	Pass
98	29	Pass	Pass
98	30	Pass	Pass
99	13	Pass	Pass
99	14	Pass	Pass
99	15	Pass	Pass
99	16	Pass	Pass
99	17	Pass	Pass
99	18	Pass	Pass
99	19	Pass	Pass
99	20	Pass	Pass
99	21	Pass	Pass
99	22	Pass	Pass
99	23	Pass	Pass
99	26	Pass	Pass
99	30	Pass	Pass
100	13	Pass	Pass
100	14	Pass	Pass
100	15	Pass	Pass
100	23	Pass	Pass
100	24	Pass	Pass
100	25	Pass	Pass
100	26	Pass	Pass
100	30	Pass	Pass
101	13	Pass	Pass
101	14	Pass	Pass
101	15	Pass	Pass
101	16	Pass	Pass
101	17	Pass	Pass
101	18	Pass	Pass
101	19	Pass	Pass
101	20	Pass	Pass
101	21	Pass	Pass
101	22	Pass	Pass
101	23	Pass	Pass
101	26	Pass	Pass
101	30	Pass	Pass
102	13	Pass	Pass
102	14	Pass	Pass
102	15	Pass	Pass
102	26	Pass	Pass
102	30	Pass	Pass
103	13	Pass	Pass
103	14	Pass	Pass
103	15	Pass	Pass
103	26	Pass	Pass
103	30	Pass	Pass
104	13	Pass	Pass
104	14	Pass	Pass
104	15	Pass	Pass
104	26	Pass	Pass

104	30	Pass	Pass
105	13	Pass	Pass
105	14	Pass	Pass
105	15	Pass	Pass
105	26	Pass	Pass
105	30	Pass	Pass
106	13	Pass	Pass
106	14	Pass	Pass
106	15	Pass	Pass
106	26	Pass	Pass
106	27	Pass	Pass
106	30	Pass	Pass
106	39	Pass	Pass
107	13	Pass	Pass
107	14	Pass	Pass
107	15	Pass	Pass
107	22	Pass	Pass
107	26	Pass	Pass
107	30	Pass	Pass
107	39	Pass	Pass
108	13	Pass	Pass
108	14	Pass	Pass
108	15	Pass	Pass
108	22	Pass	Pass
108	26	Pass	Pass
108	30	Pass	Pass
108	39	Pass	Pass
109	13	Pass	Pass
109	14	Pass	Pass
109	15	Pass	Pass
109	22	Pass	Pass
109	26	Pass	Pass
109	30	Pass	Pass
109	39	Pass	Pass
110	13	Pass	Pass
110	14	Pass	Pass
110	15	Pass	Pass
110	22	Pass	Pass
110	26	Pass	Pass
110	39	Pass	Pass
111	13	Pass	Pass
111	14	Pass	Pass
111	15	Pass	Pass
111	22	Pass	Pass
111	26	Pass	Pass
111	39	Pass	Pass
112	13	Pass	Pass
112	14	Pass	Pass
112	15	Pass	Pass
112	22	Pass	Pass
112	26	Pass	Pass
112	39	Pass	Pass
113	13	Pass	Pass
113	14	Pass	Pass
113	15	Pass	Pass
113	26	Pass	Pass
113	27	Pass	Pass

113	39	Pass	Pass
114	13	Pass	Pass
114	14	Pass	Pass
114	15	Pass	Pass
114	26	Pass	Pass
114	39	Pass	Pass
115	13	Pass	Pass
115	14	Pass	Pass
115	15	Pass	Pass
115	26	Pass	Pass
115	39	Pass	Pass
116	13	Pass	Pass
116	14	Pass	Pass
116	15	Pass	Pass
116	26	Pass	Pass
116	39	Pass	Pass
117	13	Pass	Pass
117	14	Pass	Pass
117	15	Pass	Pass
117	26	Pass	Pass
117	39	Pass	Pass
118	13	Pass	Pass
118	14	Pass	Pass
118	15	Pass	Pass
118	20	Pass	Pass
118	26	Pass	Pass
118	39	Pass	Pass
119	13	Pass	Pass
119	14	Pass	Pass
119	15	Pass	Pass
119	20	Pass	Pass
119	26	Pass	Pass
119	39	Pass	Pass
120	13	Pass	Pass
120	14	Pass	Pass
120	15	Pass	Pass
120	16	Pass	Pass
120	26	Pass	Pass
120	39	Pass	Pass
121	13	Pass	Pass
121	14	Pass	Pass
121	26	Pass	Pass
121	39	Pass	Pass
122	13	Pass	Pass
122	14	Pass	Pass
122	26	Pass	Pass
122	39	Pass	Pass
123	13	Pass	Pass
123	14	Pass	Pass
123	15	Pass	Pass
123	16	Pass	Pass
123	17	Pass	Pass
123	18	Pass	Pass
123	19	Pass	Pass
123	20	Pass	Pass
123	21	Pass	Pass
123	22	Pass	Pass

123	23	Pass	Pass
123	24	Pass	Pass
123	25	Pass	Pass
123	26	Pass	Pass
123	27	Pass	Pass
123	28	Pass	Pass
123	29	Pass	Pass
123	30	Pass	Pass
123	31	Pass	Pass
123	32	Pass	Pass
123	33	Pass	Pass
123	34	Pass	Pass
123	35	Pass	Pass
123	36	Pass	Pass
123	37	Pass	Pass
123	38	Pass	Pass
123	39	Pass	Pass
124	13	Pass	Pass
124	14	Pass	Pass
124	23	Pass	Pass
125	13	Pass	Pass
125	14	Pass	Pass
125	23	Pass	Pass
126	13	Pass	Pass
126	14	Pass	Pass
126	23	Pass	Pass
127	13	Pass	Pass
127	14	Pass	Pass
127	23	Pass	Pass
128	13	Pass	Pass
128	14	Pass	Pass
128	23	Pass	Pass
129	13	Pass	Pass
129	14	Pass	Pass
129	23	Pass	Pass
130	8	Pass	Pass
130	9	Pass	Pass
130	10	Pass	Pass
130	11	Pass	Pass
130	12	Pass	Pass
130	13	Pass	Pass
130	14	Pass	Pass
130	23	Pass	Pass
131	14	Pass	Pass
131	23	Pass	Pass
132	14	Pass	Pass
132	23	Pass	Pass
133	14	Pass	Pass
133	23	Pass	Pass
134	14	Pass	Pass
134	23	Pass	Pass
135	14	Pass	Pass
136	14	Pass	Pass
137	14	Pass	Pass
138	14	Pass	Pass
139	14	Pass	Pass
140	14	Pass	Pass

141	14	Pass	Pass
142	14	Pass	Pass
143	14	Pass	Pass
144	14	Pass	Pass
145	14	Pass	Pass
146	14	Pass	Pass
147	14	Pass	Pass
148	14	Pass	Pass
149	14	Pass	Pass
150	14	Pass	Pass
151	14	Pass	Pass
152	14	Pass	Pass
153	14	Pass	Pass
154	14	Pass	Pass
155	14	Pass	Pass
156	14	Pass	Pass
157	14	Pass	Pass
158	14	Pass	Pass
159	14	Pass	Pass
160	14	Pass	Pass
161	14	Pass	Pass
162	14	Pass	Pass
163	14	Pass	Pass
164	14	Pass	Pass
165	14	Pass	Pass
166	14	Pass	Pass

Appendix B-2

Tables of Criteria Passing for Shortnose Sturgeon Adults Habitat Suitability

January 1999

50th %ile of Clyo Flow

Fisheries Review Group

1. Table B.7.1. Sturgeon adults salinity and D.O. criteria passing for existing and deepening (6 ft) scenarios within the analyzed period January 1 - January 31, 1999

```
HABITAT REQUIREMENTS:
RM 10-40; Bottom Layer
D.O. August (MG/L):10th %ile>=4.0;5th %ile>=3.0;1th %ile>=2.0
Max Salinity <= 10 ppt
D.O. January (MG/L):10th %ile>=3.5;5th %ile>=3.0;1th %ile>=2.0
Max Salinity <= 25 ppt
```

Savannah Harbor Estuary

Segments		Baseline Scenario		Project Scenario	
J	I	Salinity	D.O.	Salinity	D.O.
47	14	Fail	Pass	Fail	Pass
47	17	Pass	Pass	Pass	Pass
48	14	Fail	Pass	Fail	Pass
48	16	Pass	Pass	Pass	Pass
49	14	Fail	Pass	Fail	Pass
49	16	Pass	Pass	Fail	Pass
50	14	Fail	Pass	Fail	Pass
50	15	Fail	Pass	Fail	Pass
51	14	Fail	Pass	Fail	Pass
52	14	Fail	Pass	Fail	Pass
53	14	Fail	Pass	Fail	Pass
54	14	Fail	Pass	Fail	Pass
55	14	Fail	Pass	Fail	Pass
56	14	Fail	Pass	Fail	Pass
57	14	Fail	Pass	Fail	Pass
58	14	Pass	Pass	Fail	Pass
59	14	Pass	Pass	Fail	Pass
60	14	Pass	Pass	Fail	Pass
61	14	Pass	Pass	Fail	Pass
62	14	Pass	Pass	Fail	Pass
63	14	Pass	Pass	Fail	Pass
64	14	Pass	Pass	Fail	Pass
65	14	Pass	Pass	Fail	Pass
66	14	Pass	Pass	Fail	Pass
67	14	Pass	Pass	Fail	Pass
68	14	Pass	Pass	Fail	Pass
69	14	Pass	Pass	Fail	Pass
70	14	Pass	Pass	Fail	Pass
71	14	Pass	Pass	Fail	Pass
72	14	Pass	Pass	Fail	Pass
73	14	Pass	Pass	Fail	Pass
74	14	Pass	Pass	Pass	Pass
75	14	Pass	Pass	Pass	Pass
76	14	Pass	Pass	Pass	Pass
76	15	Pass	Pass	Pass	Pass
77	14	Pass	Pass	Pass	Pass
77	15	Pass	Pass	Pass	Pass
78	15	Pass	Pass	Pass	Pass
78	16	Pass	Pass	Pass	Pass

79	14	Pass	Pass	Pass	Pass
80	14	Pass	Pass	Pass	Pass
81	14	Pass	Pass	Pass	Pass
82	14	Pass	Pass	Pass	Pass
82	16	Pass	Pass	Pass	Pass
83	14	Pass	Pass	Pass	Pass
84	14	Pass	Pass	Pass	Pass
85	14	Pass	Pass	Pass	Pass
86	14	Pass	Pass	Pass	Pass
87	14	Pass	Pass	Pass	Pass
88	14	Pass	Pass	Pass	Pass
89	14	Pass	Pass	Pass	Pass
90	14	Pass	Pass	Pass	Pass
91	13	Pass	Pass	Pass	Pass
91	14	Pass	Pass	Pass	Pass
92	14	Pass	Pass	Pass	Pass
92	16	Pass	Pass	Pass	Pass
93	13	Pass	Pass	Pass	Pass
93	14	Pass	Pass	Pass	Pass
94	13	Pass	Pass	Pass	Pass
94	14	Pass	Pass	Pass	Pass
95	14	Pass	Pass	Pass	Pass
95	30	Pass	Pass	Pass	Pass
96	14	Pass	Pass	Pass	Pass
97	14	Pass	Pass	Pass	Pass
98	14	Pass	Pass	Pass	Pass
99	14	Pass	Pass	Pass	Pass
99	15	Pass	Pass	Pass	Pass
100	14	Pass	Pass	Pass	Pass
101	14	Pass	Pass	Pass	Pass
101	15	Pass	Pass	Pass	Pass
102	14	Pass	Pass	Pass	Pass
103	14	Pass	Pass	Pass	Pass
104	14	Pass	Pass	Pass	Pass
105	14	Pass	Pass	Pass	Pass
106	14	Pass	Pass	Pass	Pass
107	14	Pass	Pass	Pass	Pass
108	14	Pass	Pass	Pass	Pass
109	15	Pass	Pass	Pass	Pass
110	15	Pass	Pass	Pass	Pass
111	15	Pass	Pass	Pass	Pass
112	14	Pass	Pass	Pass	Pass
113	14	Pass	Pass	Pass	Pass
114	15	Pass	Pass	Pass	Pass
115	15	Pass	Pass	Pass	Pass
116	15	Pass	Pass	Pass	Pass
117	14	Pass	Pass	Pass	Pass
118	15	Pass	Pass	Pass	Pass
119	14	Pass	Pass	Pass	Pass
120	14	Pass	Pass	Pass	Pass
120	15	Pass	Pass	Pass	Pass
121	14	Pass	Pass	Pass	Pass
122	14	Pass	Pass	Pass	Pass
123	13	Pass	Pass	Pass	Pass
123	14	Pass	Pass	Pass	Pass
124	14	Pass	Pass	Pass	Pass
125	14	Pass	Pass	Pass	Pass

126	14	Pass	Pass	Pass	Pass
127	14	Pass	Pass	Pass	Pass
128	14	Pass	Pass	Pass	Pass
129	14	Pass	Pass	Pass	Pass
130	13	Pass	Pass	Pass	Pass
130	14	Pass	Pass	Pass	Pass
131	14	Pass	Pass	Pass	Pass
132	14	Pass	Pass	Pass	Pass
133	14	Pass	Pass	Pass	Pass
134	14	Pass	Pass	Pass	Pass
135	14	Pass	Pass	Pass	Pass
136	14	Pass	Pass	Pass	Pass
137	14	Pass	Pass	Pass	Pass
138	14	Pass	Pass	Pass	Pass
139	14	Pass	Pass	Pass	Pass
140	14	Pass	Pass	Pass	Pass
141	14	Pass	Pass	Pass	Pass
142	14	Pass	Pass	Pass	Pass
143	14	Pass	Pass	Pass	Pass
144	14	Pass	Pass	Pass	Pass
145	14	Pass	Pass	Pass	Pass
146	14	Pass	Pass	Pass	Pass
147	14	Pass	Pass	Pass	Pass
148	14	Pass	Pass	Pass	Pass
149	14	Pass	Pass	Pass	Pass
150	14	Pass	Pass	Pass	Pass
151	14	Pass	Pass	Pass	Pass
152	14	Pass	Pass	Pass	Pass
153	14	Pass	Pass	Pass	Pass
154	14	Pass	Pass	Pass	Pass
155	14	Pass	Pass	Pass	Pass
156	14	Pass	Pass	Pass	Pass
157	14	Pass	Pass	Pass	Pass
158	14	Pass	Pass	Pass	Pass
159	14	Pass	Pass	Pass	Pass
160	14	Pass	Pass	Pass	Pass
161	14	Pass	Pass	Pass	Pass
162	14	Pass	Pass	Pass	Pass
163	14	Pass	Pass	Pass	Pass
164	14	Pass	Pass	Pass	Pass
165	14	Pass	Pass	Pass	Pass
166	14	Pass	Pass	Pass	Pass

2. Table B.7.2. Sturgeon adults salinity and D.O. criteria passing for existing and deepening (4 ft) scenarios within the analyzed period January 1 - January 31, 1999

```
HABITAT REQUIREMENTS:
RM 10-40; Bottom Layer
D.O. August (MG/L):10th %ile>=4.0;5th %ile>=3.0;1th %ile>=2.0
Max Salinity <= 10 ppt
D.O. January (MG/L):10th %ile>=3.5;5th %ile>=3.0;1th %ile>=2.0
```

Savannah Harbor Estuary

Segments		Baseline Scenario		Project Scenario	
J	I	Salinity	D.O.	Salinity	D.O.
47	14	Fail	Pass	Fail	Pass
47	17	Pass	Pass	Pass	Pass
48	14	Fail	Pass	Fail	Pass
48	16	Pass	Pass	Pass	Pass
49	14	Fail	Pass	Fail	Pass
49	16	Pass	Pass	Fail	Pass
50	14	Fail	Pass	Fail	Pass
50	15	Fail	Pass	Fail	Pass
51	14	Fail	Pass	Fail	Pass
52	14	Fail	Pass	Fail	Pass
53	14	Fail	Pass	Fail	Pass
54	14	Fail	Pass	Fail	Pass
55	14	Fail	Pass	Fail	Pass
56	14	Fail	Pass	Fail	Pass
57	14	Fail	Pass	Fail	Pass
58	14	Pass	Pass	Fail	Pass
59	14	Pass	Pass	Fail	Pass
60	14	Pass	Pass	Fail	Pass
61	14	Pass	Pass	Fail	Pass
62	14	Pass	Pass	Fail	Pass
63	14	Pass	Pass	Fail	Pass
64	14	Pass	Pass	Fail	Pass
65	14	Pass	Pass	Fail	Pass
66	14	Pass	Pass	Fail	Pass
67	14	Pass	Pass	Fail	Pass
68	14	Pass	Pass	Pass	Pass
69	14	Pass	Pass	Pass	Pass
70	14	Pass	Pass	Pass	Pass
71	14	Pass	Pass	Pass	Pass
72	14	Pass	Pass	Pass	Pass
73	14	Pass	Pass	Pass	Pass
74	14	Pass	Pass	Pass	Pass
75	14	Pass	Pass	Pass	Pass
76	14	Pass	Pass	Pass	Pass
76	15	Pass	Pass	Pass	Pass
77	14	Pass	Pass	Pass	Pass
77	15	Pass	Pass	Pass	Pass

78	15	Pass	Pass	Pass	Pass
78	16	Pass	Pass	Pass	Pass
79	14	Pass	Pass	Pass	Pass
80	14	Pass	Pass	Pass	Pass
81	14	Pass	Pass	Pass	Pass
82	14	Pass	Pass	Pass	Pass
82	16	Pass	Pass	Pass	Pass
83	14	Pass	Pass	Pass	Pass
84	14	Pass	Pass	Pass	Pass
85	14	Pass	Pass	Pass	Pass
86	14	Pass	Pass	Pass	Pass
87	14	Pass	Pass	Pass	Pass
88	14	Pass	Pass	Pass	Pass
89	14	Pass	Pass	Pass	Pass
90	14	Pass	Pass	Pass	Pass
91	13	Pass	Pass	Pass	Pass
91	14	Pass	Pass	Pass	Pass
92	14	Pass	Pass	Pass	Pass
92	16	Pass	Pass	Pass	Pass
93	13	Pass	Pass	Pass	Pass
93	14	Pass	Pass	Pass	Pass
94	13	Pass	Pass	Pass	Pass
94	14	Pass	Pass	Pass	Pass
95	14	Pass	Pass	Pass	Pass
95	30	Pass	Pass	Pass	Pass
96	14	Pass	Pass	Pass	Pass
97	14	Pass	Pass	Pass	Pass
98	14	Pass	Pass	Pass	Pass
99	14	Pass	Pass	Pass	Pass
99	15	Pass	Pass	Pass	Pass
100	14	Pass	Pass	Pass	Pass
101	14	Pass	Pass	Pass	Pass
101	15	Pass	Pass	Pass	Pass
102	14	Pass	Pass	Pass	Pass
103	14	Pass	Pass	Pass	Pass
104	14	Pass	Pass	Pass	Pass
105	14	Pass	Pass	Pass	Pass
106	14	Pass	Pass	Pass	Pass
107	14	Pass	Pass	Pass	Pass
108	14	Pass	Pass	Pass	Pass
109	15	Pass	Pass	Pass	Pass
110	15	Pass	Pass	Pass	Pass
111	15	Pass	Pass	Pass	Pass
112	14	Pass	Pass	Pass	Pass
113	14	Pass	Pass	Pass	Pass
114	15	Pass	Pass	Pass	Pass
115	15	Pass	Pass	Pass	Pass
116	15	Pass	Pass	Pass	Pass
117	14	Pass	Pass	Pass	Pass
118	15	Pass	Pass	Pass	Pass
119	14	Pass	Pass	Pass	Pass
120	14	Pass	Pass	Pass	Pass
120	15	Pass	Pass	Pass	Pass
121	14	Pass	Pass	Pass	Pass
122	14	Pass	Pass	Pass	Pass
123	13	Pass	Pass	Pass	Pass
123	14	Pass	Pass	Pass	Pass

124	14	Pass	Pass	Pass	Pass
125	14	Pass	Pass	Pass	Pass
126	14	Pass	Pass	Pass	Pass
127	14	Pass	Pass	Pass	Pass
128	14	Pass	Pass	Pass	Pass
129	14	Pass	Pass	Pass	Pass
130	13	Pass	Pass	Pass	Pass
130	14	Pass	Pass	Pass	Pass
131	14	Pass	Pass	Pass	Pass
132	14	Pass	Pass	Pass	Pass
133	14	Pass	Pass	Pass	Pass
134	14	Pass	Pass	Pass	Pass
135	14	Pass	Pass	Pass	Pass
136	14	Pass	Pass	Pass	Pass
137	14	Pass	Pass	Pass	Pass
138	14	Pass	Pass	Pass	Pass
139	14	Pass	Pass	Pass	Pass
140	14	Pass	Pass	Pass	Pass
141	14	Pass	Pass	Pass	Pass
142	14	Pass	Pass	Pass	Pass
143	14	Pass	Pass	Pass	Pass
144	14	Pass	Pass	Pass	Pass
145	14	Pass	Pass	Pass	Pass
146	14	Pass	Pass	Pass	Pass
147	14	Pass	Pass	Pass	Pass
148	14	Pass	Pass	Pass	Pass
149	14	Pass	Pass	Pass	Pass
150	14	Pass	Pass	Pass	Pass
151	14	Pass	Pass	Pass	Pass
152	14	Pass	Pass	Pass	Pass
153	14	Pass	Pass	Pass	Pass
154	14	Pass	Pass	Pass	Pass
155	14	Pass	Pass	Pass	Pass
156	14	Pass	Pass	Pass	Pass
157	14	Pass	Pass	Pass	Pass
158	14	Pass	Pass	Pass	Pass
159	14	Pass	Pass	Pass	Pass
160	14	Pass	Pass	Pass	Pass
161	14	Pass	Pass	Pass	Pass
162	14	Pass	Pass	Pass	Pass
163	14	Pass	Pass	Pass	Pass
164	14	Pass	Pass	Pass	Pass
165	14	Pass	Pass	Pass	Pass
166	14	Pass	Pass	Pass	Pass

3. Table B.7.3. Sturgeon adults salinity and D.O. criteria passing for existing and deepening (3 ft) scenarios within the analyzed period January 1 - January 31, 1999

```
HABITAT REQUIREMENTS:
RM 10-40; Bottom Layer
D.O. August (MG/L):10th %ile>=4.0;5th %ile>=3.0;1th %ile>=2.0
Max Salinity <= 10 ppt
D.O. January (MG/L):10th %ile>=3.5;5th %ile>=3.0;1th %ile>=2.0
Max Salinity <= 25 ppt
```

Savannah Harbor Estuary

Segments J	Segments I	Baseline Scenario Salinity	Baseline Scenario D.O.	Project Scenario Salinity	Project Scenario D.O.
47	14	Fail	Pass	Fail	Pass
47	17	Pass	Pass	Pass	Pass
48	14	Fail	Pass	Fail	Pass
48	16	Pass	Pass	Pass	Pass
49	14	Fail	Pass	Fail	Pass
49	16	Pass	Pass	Fail	Pass
50	14	Fail	Pass	Fail	Pass
50	15	Fail	Pass	Fail	Pass
51	14	Fail	Pass	Fail	Pass
52	14	Fail	Pass	Fail	Pass
53	14	Fail	Pass	Fail	Pass
54	14	Fail	Pass	Fail	Pass
55	14	Fail	Pass	Fail	Pass
56	14	Fail	Pass	Fail	Pass
57	14	Fail	Pass	Fail	Pass
58	14	Pass	Pass	Fail	Pass
59	14	Pass	Pass	Fail	Pass
60	14	Pass	Pass	Fail	Pass
61	14	Pass	Pass	Fail	Pass
62	14	Pass	Pass	Fail	Pass
63	14	Pass	Pass	Fail	Pass
64	14	Pass	Pass	Pass	Pass
65	14	Pass	Pass	Pass	Pass
66	14	Pass	Pass	Pass	Pass
67	14	Pass	Pass	Pass	Pass
68	14	Pass	Pass	Pass	Pass
69	14	Pass	Pass	Pass	Pass
70	14	Pass	Pass	Pass	Pass
71	14	Pass	Pass	Pass	Pass
72	14	Pass	Pass	Pass	Pass
73	14	Pass	Pass	Pass	Pass
74	14	Pass	Pass	Pass	Pass
75	14	Pass	Pass	Pass	Pass
76	14	Pass	Pass	Pass	Pass
76	15	Pass	Pass	Pass	Pass
77	14	Pass	Pass	Pass	Pass
77	15	Pass	Pass	Pass	Pass
78	15	Pass	Pass	Pass	Pass

78	16	Pass	Pass	Pass	Pass
79	14	Pass	Pass	Pass	Pass
80	14	Pass	Pass	Pass	Pass
81	14	Pass	Pass	Pass	Pass
82	14	Pass	Pass	Pass	Pass
82	16	Pass	Pass	Pass	Pass
83	14	Pass	Pass	Pass	Pass
84	14	Pass	Pass	Pass	Pass
85	14	Pass	Pass	Pass	Pass
86	14	Pass	Pass	Pass	Pass
87	14	Pass	Pass	Pass	Pass
88	14	Pass	Pass	Pass	Pass
89	14	Pass	Pass	Pass	Pass
90	14	Pass	Pass	Pass	Pass
91	13	Pass	Pass	Pass	Pass
91	14	Pass	Pass	Pass	Pass
92	14	Pass	Pass	Pass	Pass
92	16	Pass	Pass	Pass	Pass
93	13	Pass	Pass	Pass	Pass
93	14	Pass	Pass	Pass	Pass
94	13	Pass	Pass	Pass	Pass
94	14	Pass	Pass	Pass	Pass
95	14	Pass	Pass	Pass	Pass
95	30	Pass	Pass	Pass	Pass
96	14	Pass	Pass	Pass	Pass
97	14	Pass	Pass	Pass	Pass
98	14	Pass	Pass	Pass	Pass
99	14	Pass	Pass	Pass	Pass
99	15	Pass	Pass	Pass	Pass
100	14	Pass	Pass	Pass	Pass
101	14	Pass	Pass	Pass	Pass
101	15	Pass	Pass	Pass	Pass
102	14	Pass	Pass	Pass	Pass
103	14	Pass	Pass	Pass	Pass
104	14	Pass	Pass	Pass	Pass
105	14	Pass	Pass	Pass	Pass
106	14	Pass	Pass	Pass	Pass
107	14	Pass	Pass	Pass	Pass
108	14	Pass	Pass	Pass	Pass
109	15	Pass	Pass	Pass	Pass
110	15	Pass	Pass	Pass	Pass
111	15	Pass	Pass	Pass	Pass
112	14	Pass	Pass	Pass	Pass
113	14	Pass	Pass	Pass	Pass
114	15	Pass	Pass	Pass	Pass
115	15	Pass	Pass	Pass	Pass
116	15	Pass	Pass	Pass	Pass
117	14	Pass	Pass	Pass	Pass
118	15	Pass	Pass	Pass	Pass
119	14	Pass	Pass	Pass	Pass
120	14	Pass	Pass	Pass	Pass
120	15	Pass	Pass	Pass	Pass
121	14	Pass	Pass	Pass	Pass
122	14	Pass	Pass	Pass	Pass
123	13	Pass	Pass	Pass	Pass
123	14	Pass	Pass	Pass	Pass
124	14	Pass	Pass	Pass	Pass

125	14	Pass	Pass	Pass	Pass
126	14	Pass	Pass	Pass	Pass
127	14	Pass	Pass	Pass	Pass
128	14	Pass	Pass	Pass	Pass
129	14	Pass	Pass	Pass	Pass
130	13	Pass	Pass	Pass	Pass
130	14	Pass	Pass	Pass	Pass
131	14	Pass	Pass	Pass	Pass
132	14	Pass	Pass	Pass	Pass
133	14	Pass	Pass	Pass	Pass
134	14	Pass	Pass	Pass	Pass
135	14	Pass	Pass	Pass	Pass
136	14	Pass	Pass	Pass	Pass
137	14	Pass	Pass	Pass	Pass
138	14	Pass	Pass	Pass	Pass
139	14	Pass	Pass	Pass	Pass
140	14	Pass	Pass	Pass	Pass
141	14	Pass	Pass	Pass	Pass
142	14	Pass	Pass	Pass	Pass
143	14	Pass	Pass	Pass	Pass
144	14	Pass	Pass	Pass	Pass
145	14	Pass	Pass	Pass	Pass
146	14	Pass	Pass	Pass	Pass
147	14	Pass	Pass	Pass	Pass
148	14	Pass	Pass	Pass	Pass
149	14	Pass	Pass	Pass	Pass
150	14	Pass	Pass	Pass	Pass
151	14	Pass	Pass	Pass	Pass
152	14	Pass	Pass	Pass	Pass
153	14	Pass	Pass	Pass	Pass
154	14	Pass	Pass	Pass	Pass
155	14	Pass	Pass	Pass	Pass
156	14	Pass	Pass	Pass	Pass
157	14	Pass	Pass	Pass	Pass
158	14	Pass	Pass	Pass	Pass
159	14	Pass	Pass	Pass	Pass
160	14	Pass	Pass	Pass	Pass
161	14	Pass	Pass	Pass	Pass
162	14	Pass	Pass	Pass	Pass
163	14	Pass	Pass	Pass	Pass
164	14	Pass	Pass	Pass	Pass
165	14	Pass	Pass	Pass	Pass
166	14	Pass	Pass	Pass	Pass

4. Table B.7.4. Sturgeon adults salinity and D.O. criteria passing for existing and deepening (2 ft) scenarios within the analyzed period January 1 - January 31, 1999

```
HABITAT REQUIREMENTS:
RM 10-40; Bottom Layer
D.O. August (MG/L):10th %ile>=4.0;5th %ile>=3.0;1th %ile>=2.0
Max Salinity <= 10 ppt
D.O. January (MG/L):10th %ile>=3.5;5th %ile>=3.0;1th %ile>=2.0
```

Savannah Harbor Estuary

Segments J	Segments I	Baseline Scenario Salinity	Baseline Scenario D.O.	Project Scenario Salinity	Project Scenario D.O.
47	14	Fail	Pass	Fail	Pass
47	17	Pass	Pass	Pass	Pass
48	14	Fail	Pass	Fail	Pass
48	16	Pass	Pass	Pass	Pass
49	14	Fail	Pass	Fail	Pass
49	16	Pass	Pass	Pass	Pass
50	14	Fail	Pass	Fail	Pass
50	15	Fail	Pass	Fail	Pass
51	14	Fail	Pass	Fail	Pass
52	14	Fail	Pass	Fail	Pass
53	14	Fail	Pass	Fail	Pass
54	14	Fail	Pass	Fail	Pass
55	14	Fail	Pass	Fail	Pass
56	14	Fail	Pass	Fail	Pass
57	14	Fail	Pass	Fail	Pass
58	14	Pass	Pass	Fail	Pass
59	14	Pass	Pass	Fail	Pass
60	14	Pass	Pass	Fail	Pass
61	14	Pass	Pass	Pass	Pass
62	14	Pass	Pass	Pass	Pass
63	14	Pass	Pass	Pass	Pass
64	14	Pass	Pass	Pass	Pass
65	14	Pass	Pass	Pass	Pass
66	14	Pass	Pass	Pass	Pass
67	14	Pass	Pass	Pass	Pass
68	14	Pass	Pass	Pass	Pass
69	14	Pass	Pass	Pass	Pass
70	14	Pass	Pass	Pass	Pass
71	14	Pass	Pass	Pass	Pass
72	14	Pass	Pass	Pass	Pass
73	14	Pass	Pass	Pass	Pass
74	14	Pass	Pass	Pass	Pass
75	14	Pass	Pass	Pass	Pass
76	14	Pass	Pass	Pass	Pass
76	15	Pass	Pass	Pass	Pass
77	14	Pass	Pass	Pass	Pass
77	15	Pass	Pass	Pass	Pass
78	15	Pass	Pass	Pass	Pass

78	16	Pass	Pass	Pass	Pass
79	14	Pass	Pass	Pass	Pass
80	14	Pass	Pass	Pass	Pass
81	14	Pass	Pass	Pass	Pass
82	14	Pass	Pass	Pass	Pass
82	16	Pass	Pass	Pass	Pass
83	14	Pass	Pass	Pass	Pass
84	14	Pass	Pass	Pass	Pass
85	14	Pass	Pass	Pass	Pass
86	14	Pass	Pass	Pass	Pass
87	14	Pass	Pass	Pass	Pass
88	14	Pass	Pass	Pass	Pass
89	14	Pass	Pass	Pass	Pass
90	14	Pass	Pass	Pass	Pass
91	13	Pass	Pass	Pass	Pass
91	14	Pass	Pass	Pass	Pass
92	14	Pass	Pass	Pass	Pass
92	16	Pass	Pass	Pass	Pass
93	13	Pass	Pass	Pass	Pass
93	14	Pass	Pass	Pass	Pass
94	13	Pass	Pass	Pass	Pass
94	14	Pass	Pass	Pass	Pass
95	14	Pass	Pass	Pass	Pass
95	30	Pass	Pass	Pass	Pass
96	14	Pass	Pass	Pass	Pass
97	14	Pass	Pass	Pass	Pass
98	14	Pass	Pass	Pass	Pass
99	14	Pass	Pass	Pass	Pass
99	15	Pass	Pass	Pass	Pass
100	14	Pass	Pass	Pass	Pass
101	14	Pass	Pass	Pass	Pass
101	15	Pass	Pass	Pass	Pass
102	14	Pass	Pass	Pass	Pass
103	14	Pass	Pass	Pass	Pass
104	14	Pass	Pass	Pass	Pass
105	14	Pass	Pass	Pass	Pass
106	14	Pass	Pass	Pass	Pass
107	14	Pass	Pass	Pass	Pass
108	14	Pass	Pass	Pass	Pass
109	15	Pass	Pass	Pass	Pass
110	15	Pass	Pass	Pass	Pass
111	15	Pass	Pass	Pass	Pass
112	14	Pass	Pass	Pass	Pass
113	14	Pass	Pass	Pass	Pass
114	15	Pass	Pass	Pass	Pass
115	15	Pass	Pass	Pass	Pass
116	15	Pass	Pass	Pass	Pass
117	14	Pass	Pass	Pass	Pass
118	15	Pass	Pass	Pass	Pass
119	14	Pass	Pass	Pass	Pass
120	14	Pass	Pass	Pass	Pass
120	15	Pass	Pass	Pass	Pass
121	14	Pass	Pass	Pass	Pass
122	14	Pass	Pass	Pass	Pass
123	13	Pass	Pass	Pass	Pass
123	14	Pass	Pass	Pass	Pass
124	14	Pass	Pass	Pass	Pass

125	14	Pass	Pass	Pass	Pass
126	14	Pass	Pass	Pass	Pass
127	14	Pass	Pass	Pass	Pass
128	14	Pass	Pass	Pass	Pass
129	14	Pass	Pass	Pass	Pass
130	13	Pass	Pass	Pass	Pass
130	14	Pass	Pass	Pass	Pass
131	14	Pass	Pass	Pass	Pass
132	14	Pass	Pass	Pass	Pass
133	14	Pass	Pass	Pass	Pass
134	14	Pass	Pass	Pass	Pass
135	14	Pass	Pass	Pass	Pass
136	14	Pass	Pass	Pass	Pass
137	14	Pass	Pass	Pass	Pass
138	14	Pass	Pass	Pass	Pass
139	14	Pass	Pass	Pass	Pass
140	14	Pass	Pass	Pass	Pass
141	14	Pass	Pass	Pass	Pass
142	14	Pass	Pass	Pass	Pass
143	14	Pass	Pass	Pass	Pass
144	14	Pass	Pass	Pass	Pass
145	14	Pass	Pass	Pass	Pass
146	14	Pass	Pass	Pass	Pass
147	14	Pass	Pass	Pass	Pass
148	14	Pass	Pass	Pass	Pass
149	14	Pass	Pass	Pass	Pass
150	14	Pass	Pass	Pass	Pass
151	14	Pass	Pass	Pass	Pass
152	14	Pass	Pass	Pass	Pass
153	14	Pass	Pass	Pass	Pass
154	14	Pass	Pass	Pass	Pass
155	14	Pass	Pass	Pass	Pass
156	14	Pass	Pass	Pass	Pass
157	14	Pass	Pass	Pass	Pass
158	14	Pass	Pass	Pass	Pass
159	14	Pass	Pass	Pass	Pass
160	14	Pass	Pass	Pass	Pass
161	14	Pass	Pass	Pass	Pass
162	14	Pass	Pass	Pass	Pass
163	14	Pass	Pass	Pass	Pass
164	14	Pass	Pass	Pass	Pass
165	14	Pass	Pass	Pass	Pass
166	14	Pass	Pass	Pass	Pass

Appendix B-3

Tables of Criteria Passing for Shortnose Sturgeon Juveniles Habitat Suitability

January 1999

50th %ile of Clyo Flow

Fisheries Review Group

1. Table B.8.1. Sturgeon juveniles salinity and DO criteria passing criteria passing for existing and deepening (6 ft) scenarios within the analyzed period January 1 - January 31, 1999

HABITAT REQUIREMENTS:
RM 10-40; Bottom Layer
D.O. August (MG/L):10th %ile>=3.5;5th %ile>=3.0;1th %ile>=2.0
Max Salinity <= 4 ppt

Savannah Harbor Estuary

Segments		Baseline Scenario		Project Scenario	
J	I	Salinity	D.O.	Salinity	D.O.
47	14	Fail	Pass	Fail	Pass
47	17	Fail	Pass	Fail	Pass
48	14	Fail	Pass	Fail	Pass
48	16	Fail	Pass	Fail	Pass
49	14	Fail	Pass	Fail	Pass
49	16	Fail	Pass	Fail	Pass
50	14	Fail	Pass	Fail	Pass
50	15	Fail	Pass	Fail	Pass
51	14	Fail	Pass	Fail	Pass
52	14	Fail	Pass	Fail	Pass
53	14	Fail	Pass	Fail	Pass
54	14	Fail	Pass	Fail	Pass
55	14	Fail	Pass	Fail	Pass
56	14	Fail	Pass	Fail	Pass
57	14	Fail	Pass	Fail	Pass
58	14	Fail	Pass	Fail	Pass
59	14	Fail	Pass	Fail	Pass
60	14	Fail	Pass	Fail	Pass
61	14	Fail	Pass	Fail	Pass
62	14	Fail	Pass	Fail	Pass
63	14	Fail	Pass	Fail	Pass
64	14	Fail	Pass	Fail	Pass
65	14	Fail	Pass	Fail	Pass
66	14	Fail	Pass	Fail	Pass
67	14	Fail	Pass	Fail	Pass
68	14	Fail	Pass	Fail	Pass
69	14	Fail	Pass	Fail	Pass
70	14	Fail	Pass	Fail	Pass
71	14	Fail	Pass	Fail	Pass
72	14	Fail	Pass	Fail	Pass
73	14	Fail	Pass	Fail	Pass
74	14	Fail	Pass	Fail	Pass
75	14	Fail	Pass	Fail	Pass
76	14	Fail	Pass	Fail	Pass
76	15	Fail	Pass	Fail	Pass
77	14	Fail	Pass	Fail	Pass
77	15	Fail	Pass	Fail	Pass
78	15	Fail	Pass	Fail	Pass
78	16	Fail	Pass	Fail	Pass
79	14	Fail	Pass	Fail	Pass
80	14	Fail	Pass	Fail	Pass

81	14	Fail	Pass	Fail	Pass
82	14	Fail	Pass	Fail	Pass
82	16	Fail	Pass	Fail	Pass
83	14	Fail	Pass	Fail	Pass
84	14	Fail	Pass	Fail	Pass
85	14	Fail	Pass	Fail	Pass
86	14	Fail	Pass	Fail	Pass
87	14	Fail	Pass	Fail	Pass
88	14	Fail	Pass	Fail	Pass
89	14	Fail	Pass	Fail	Pass
90	14	Fail	Pass	Fail	Pass
91	13	Fail	Pass	Fail	Pass
91	14	Fail	Pass	Fail	Pass
92	14	Fail	Pass	Fail	Pass
92	16	Fail	Pass	Fail	Pass
93	13	Fail	Pass	Fail	Pass
93	14	Fail	Pass	Fail	Pass
94	13	Fail	Pass	Fail	Pass
94	14	Fail	Pass	Fail	Pass
95	14	Fail	Pass	Fail	Pass
95	30	Pass	Pass	Pass	Pass
96	14	Fail	Pass	Fail	Pass
97	14	Fail	Pass	Fail	Pass
98	14	Fail	Pass	Fail	Pass
99	14	Fail	Pass	Fail	Pass
99	15	Fail	Pass	Fail	Pass
100	14	Fail	Pass	Fail	Pass
101	14	Fail	Pass	Fail	Pass
101	15	Fail	Pass	Fail	Pass
102	14	Fail	Pass	Fail	Pass
103	14	Fail	Pass	Fail	Pass
104	14	Fail	Pass	Fail	Pass
105	14	Fail	Pass	Fail	Pass
106	14	Fail	Pass	Fail	Pass
107	14	Fail	Pass	Fail	Pass
108	14	Fail	Pass	Fail	Pass
109	15	Pass	Pass	Fail	Pass
110	15	Pass	Pass	Pass	Pass
111	15	Pass	Pass	Pass	Pass
112	14	Pass	Pass	Pass	Pass
113	14	Pass	Pass	Pass	Pass
114	15	Pass	Pass	Pass	Pass
115	15	Pass	Pass	Pass	Pass
116	15	Pass	Pass	Pass	Pass
117	14	Pass	Pass	Pass	Pass
118	15	Pass	Pass	Pass	Pass
119	14	Pass	Pass	Pass	Pass
120	14	Pass	Pass	Pass	Pass
120	15	Pass	Pass	Pass	Pass
121	14	Pass	Pass	Pass	Pass
122	14	Pass	Pass	Pass	Pass
123	13	Pass	Pass	Pass	Pass
123	14	Pass	Pass	Pass	Pass
124	14	Pass	Pass	Pass	Pass
125	14	Pass	Pass	Pass	Pass
126	14	Pass	Pass	Pass	Pass
127	14	Pass	Pass	Pass	Pass

128	14	Pass	Pass	Pass	Pass
129	14	Pass	Pass	Pass	Pass
130	13	Pass	Pass	Pass	Pass
130	14	Pass	Pass	Pass	Pass
131	14	Pass	Pass	Pass	Pass
132	14	Pass	Pass	Pass	Pass
133	14	Pass	Pass	Pass	Pass
134	14	Pass	Pass	Pass	Pass
135	14	Pass	Pass	Pass	Pass
136	14	Pass	Pass	Pass	Pass
137	14	Pass	Pass	Pass	Pass
138	14	Pass	Pass	Pass	Pass
139	14	Pass	Pass	Pass	Pass
140	14	Pass	Pass	Pass	Pass
141	14	Pass	Pass	Pass	Pass
142	14	Pass	Pass	Pass	Pass
143	14	Pass	Pass	Pass	Pass
144	14	Pass	Pass	Pass	Pass
145	14	Pass	Pass	Pass	Pass
146	14	Pass	Pass	Pass	Pass
147	14	Pass	Pass	Pass	Pass
148	14	Pass	Pass	Pass	Pass
149	14	Pass	Pass	Pass	Pass
150	14	Pass	Pass	Pass	Pass
151	14	Pass	Pass	Pass	Pass
152	14	Pass	Pass	Pass	Pass
153	14	Pass	Pass	Pass	Pass
154	14	Pass	Pass	Pass	Pass
155	14	Pass	Pass	Pass	Pass
156	14	Pass	Pass	Pass	Pass
157	14	Pass	Pass	Pass	Pass
158	14	Pass	Pass	Pass	Pass
159	14	Pass	Pass	Pass	Pass
160	14	Pass	Pass	Pass	Pass
161	14	Pass	Pass	Pass	Pass
162	14	Pass	Pass	Pass	Pass
163	14	Pass	Pass	Pass	Pass
164	14	Pass	Pass	Pass	Pass
165	14	Pass	Pass	Pass	Pass
166	14	Pass	Pass	Pass	Pass

2. Table B.8.2. Sturgeon juveniles salinity and DO criteria passing criteria passing for existing and deepening (4 ft) scenarios within the analyzed period January 1 - January 31, 1999

HABITAT REQUIREMENTS:
RM 10-40; Bottom Layer
D.O. August (MG/L):10th %ile>=3.5;5th %ile>=3.0;1th %ile>=2.0
Max Salinity <= 4 ppt

Savannah Harbor Estuary

Segments		Baseline Scenario		Project Scenario	
J	I	Salinity	D.O.	Salinity	D.O.
47	14	Fail	Pass	Fail	Pass
47	17	Fail	Pass	Fail	Pass
48	14	Fail	Pass	Fail	Pass
48	16	Fail	Pass	Fail	Pass
49	14	Fail	Pass	Fail	Pass
49	16	Fail	Pass	Fail	Pass
50	14	Fail	Pass	Fail	Pass
50	15	Fail	Pass	Fail	Pass
51	14	Fail	Pass	Fail	Pass
52	14	Fail	Pass	Fail	Pass
53	14	Fail	Pass	Fail	Pass
54	14	Fail	Pass	Fail	Pass
55	14	Fail	Pass	Fail	Pass
56	14	Fail	Pass	Fail	Pass
57	14	Fail	Pass	Fail	Pass
58	14	Fail	Pass	Fail	Pass
59	14	Fail	Pass	Fail	Pass
60	14	Fail	Pass	Fail	Pass
61	14	Fail	Pass	Fail	Pass
62	14	Fail	Pass	Fail	Pass
63	14	Fail	Pass	Fail	Pass
64	14	Fail	Pass	Fail	Pass
65	14	Fail	Pass	Fail	Pass
66	14	Fail	Pass	Fail	Pass
67	14	Fail	Pass	Fail	Pass
68	14	Fail	Pass	Fail	Pass
69	14	Fail	Pass	Fail	Pass
70	14	Fail	Pass	Fail	Pass
71	14	Fail	Pass	Fail	Pass
72	14	Fail	Pass	Fail	Pass
73	14	Fail	Pass	Fail	Pass
74	14	Fail	Pass	Fail	Pass
75	14	Fail	Pass	Fail	Pass
76	14	Fail	Pass	Fail	Pass
76	15	Fail	Pass	Fail	Pass
77	14	Fail	Pass	Fail	Pass
77	15	Fail	Pass	Fail	Pass
78	15	Fail	Pass	Fail	Pass
78	16	Fail	Pass	Fail	Pass
79	14	Fail	Pass	Fail	Pass

80	14	Fail	Pass	Fail	Pass
81	14	Fail	Pass	Fail	Pass
82	14	Fail	Pass	Fail	Pass
82	16	Fail	Pass	Fail	Pass
83	14	Fail	Pass	Fail	Pass
84	14	Fail	Pass	Fail	Pass
85	14	Fail	Pass	Fail	Pass
86	14	Fail	Pass	Fail	Pass
87	14	Fail	Pass	Fail	Pass
88	14	Fail	Pass	Fail	Pass
89	14	Fail	Pass	Fail	Pass
90	14	Fail	Pass	Fail	Pass
91	13	Fail	Pass	Fail	Pass
91	14	Fail	Pass	Fail	Pass
92	14	Fail	Pass	Fail	Pass
92	16	Fail	Pass	Fail	Pass
93	13	Fail	Pass	Fail	Pass
93	14	Fail	Pass	Fail	Pass
94	13	Fail	Pass	Fail	Pass
94	14	Fail	Pass	Fail	Pass
95	14	Fail	Pass	Fail	Pass
95	30	Pass	Pass	Pass	Pass
96	14	Fail	Pass	Fail	Pass
97	14	Fail	Pass	Fail	Pass
98	14	Fail	Pass	Fail	Pass
99	14	Fail	Pass	Fail	Pass
99	15	Fail	Pass	Fail	Pass
100	14	Fail	Pass	Fail	Pass
101	14	Fail	Pass	Fail	Pass
101	15	Fail	Pass	Fail	Pass
102	14	Fail	Pass	Fail	Pass
103	14	Fail	Pass	Fail	Pass
104	14	Fail	Pass	Fail	Pass
105	14	Fail	Pass	Fail	Pass
106	14	Fail	Pass	Fail	Pass
107	14	Fail	Pass	Fail	Pass
108	14	Fail	Pass	Fail	Pass
109	15	Pass	Pass	Fail	Pass
110	15	Pass	Pass	Fail	Pass
111	15	Pass	Pass	Pass	Pass
112	14	Pass	Pass	Pass	Pass
113	14	Pass	Pass	Pass	Pass
114	15	Pass	Pass	Pass	Pass
115	15	Pass	Pass	Pass	Pass
116	15	Pass	Pass	Pass	Pass
117	14	Pass	Pass	Pass	Pass
118	15	Pass	Pass	Pass	Pass
119	14	Pass	Pass	Pass	Pass
120	14	Pass	Pass	Pass	Pass
120	15	Pass	Pass	Pass	Pass
121	14	Pass	Pass	Pass	Pass
122	14	Pass	Pass	Pass	Pass
123	13	Pass	Pass	Pass	Pass
123	14	Pass	Pass	Pass	Pass
124	14	Pass	Pass	Pass	Pass
125	14	Pass	Pass	Pass	Pass
126	14	Pass	Pass	Pass	Pass

127	14	Pass	Pass	Pass	Pass
128	14	Pass	Pass	Pass	Pass
129	14	Pass	Pass	Pass	Pass
130	13	Pass	Pass	Pass	Pass
130	14	Pass	Pass	Pass	Pass
131	14	Pass	Pass	Pass	Pass
132	14	Pass	Pass	Pass	Pass
133	14	Pass	Pass	Pass	Pass
134	14	Pass	Pass	Pass	Pass
135	14	Pass	Pass	Pass	Pass
136	14	Pass	Pass	Pass	Pass
137	14	Pass	Pass	Pass	Pass
138	14	Pass	Pass	Pass	Pass
139	14	Pass	Pass	Pass	Pass
140	14	Pass	Pass	Pass	Pass
141	14	Pass	Pass	Pass	Pass
142	14	Pass	Pass	Pass	Pass
143	14	Pass	Pass	Pass	Pass
144	14	Pass	Pass	Pass	Pass
145	14	Pass	Pass	Pass	Pass
146	14	Pass	Pass	Pass	Pass
147	14	Pass	Pass	Pass	Pass
148	14	Pass	Pass	Pass	Pass
149	14	Pass	Pass	Pass	Pass
150	14	Pass	Pass	Pass	Pass
151	14	Pass	Pass	Pass	Pass
152	14	Pass	Pass	Pass	Pass
153	14	Pass	Pass	Pass	Pass
154	14	Pass	Pass	Pass	Pass
155	14	Pass	Pass	Pass	Pass
156	14	Pass	Pass	Pass	Pass
157	14	Pass	Pass	Pass	Pass
158	14	Pass	Pass	Pass	Pass
159	14	Pass	Pass	Pass	Pass
160	14	Pass	Pass	Pass	Pass
161	14	Pass	Pass	Pass	Pass
162	14	Pass	Pass	Pass	Pass
163	14	Pass	Pass	Pass	Pass
164	14	Pass	Pass	Pass	Pass
165	14	Pass	Pass	Pass	Pass
166	14	Pass	Pass	Pass	Pass

3. Table B.8.3. Sturgeon juveniles salinity and DO criteria passing criteria passing for existing and deepening (3 ft) scenarios within the analyzed period January 1 - January 31, 1999

HABITAT REQUIREMENTS:
RM 10-40; Bottom Layer
D.O. August (MG/L):10th %ile>=3.5;5th %ile>=3.0;1th %ile>=2.0
Max Salinity <= 4 ppt

Savannah Harbor Estuary

Segments		Baseline Scenario		Project Scenario	
J	I	Salinity	D.O.	Salinity	D.O.
47	14	Fail	Pass	Fail	Pass
47	17	Fail	Pass	Fail	Pass
48	14	Fail	Pass	Fail	Pass
48	16	Fail	Pass	Fail	Pass
49	14	Fail	Pass	Fail	Pass
49	16	Fail	Pass	Fail	Pass
50	14	Fail	Pass	Fail	Pass
50	15	Fail	Pass	Fail	Pass
51	14	Fail	Pass	Fail	Pass
52	14	Fail	Pass	Fail	Pass
53	14	Fail	Pass	Fail	Pass
54	14	Fail	Pass	Fail	Pass
55	14	Fail	Pass	Fail	Pass
56	14	Fail	Pass	Fail	Pass
57	14	Fail	Pass	Fail	Pass
58	14	Fail	Pass	Fail	Pass
59	14	Fail	Pass	Fail	Pass
60	14	Fail	Pass	Fail	Pass
61	14	Fail	Pass	Fail	Pass
62	14	Fail	Pass	Fail	Pass
63	14	Fail	Pass	Fail	Pass
64	14	Fail	Pass	Fail	Pass
65	14	Fail	Pass	Fail	Pass
66	14	Fail	Pass	Fail	Pass
67	14	Fail	Pass	Fail	Pass
68	14	Fail	Pass	Fail	Pass
69	14	Fail	Pass	Fail	Pass
70	14	Fail	Pass	Fail	Pass
71	14	Fail	Pass	Fail	Pass
72	14	Fail	Pass	Fail	Pass
73	14	Fail	Pass	Fail	Pass
74	14	Fail	Pass	Fail	Pass
75	14	Fail	Pass	Fail	Pass
76	14	Fail	Pass	Fail	Pass
76	15	Fail	Pass	Fail	Pass
77	14	Fail	Pass	Fail	Pass
77	15	Fail	Pass	Fail	Pass
78	15	Fail	Pass	Fail	Pass
78	16	Fail	Pass	Fail	Pass
79	14	Fail	Pass	Fail	Pass

80	14	Fail	Pass	Fail	Pass
81	14	Fail	Pass	Fail	Pass
82	14	Fail	Pass	Fail	Pass
82	16	Fail	Pass	Fail	Pass
83	14	Fail	Pass	Fail	Pass
84	14	Fail	Pass	Fail	Pass
85	14	Fail	Pass	Fail	Pass
86	14	Fail	Pass	Fail	Pass
87	14	Fail	Pass	Fail	Pass
88	14	Fail	Pass	Fail	Pass
89	14	Fail	Pass	Fail	Pass
90	14	Fail	Pass	Fail	Pass
91	13	Fail	Pass	Fail	Pass
91	14	Fail	Pass	Fail	Pass
92	14	Fail	Pass	Fail	Pass
92	16	Fail	Pass	Fail	Pass
93	13	Fail	Pass	Fail	Pass
93	14	Fail	Pass	Fail	Pass
94	13	Fail	Pass	Fail	Pass
94	14	Fail	Pass	Fail	Pass
95	14	Fail	Pass	Fail	Pass
95	30	Pass	Pass	Pass	Pass
96	14	Fail	Pass	Fail	Pass
97	14	Fail	Pass	Fail	Pass
98	14	Fail	Pass	Fail	Pass
99	14	Fail	Pass	Fail	Pass
99	15	Fail	Pass	Fail	Pass
100	14	Fail	Pass	Fail	Pass
101	14	Fail	Pass	Fail	Pass
101	15	Fail	Pass	Fail	Pass
102	14	Fail	Pass	Fail	Pass
103	14	Fail	Pass	Fail	Pass
104	14	Fail	Pass	Fail	Pass
105	14	Fail	Pass	Fail	Pass
106	14	Fail	Pass	Fail	Pass
107	14	Fail	Pass	Fail	Pass
108	14	Fail	Pass	Fail	Pass
109	15	Pass	Pass	Fail	Pass
110	15	Pass	Pass	Pass	Pass
111	15	Pass	Pass	Pass	Pass
112	14	Pass	Pass	Pass	Pass
113	14	Pass	Pass	Pass	Pass
114	15	Pass	Pass	Pass	Pass
115	15	Pass	Pass	Pass	Pass
116	15	Pass	Pass	Pass	Pass
117	14	Pass	Pass	Pass	Pass
118	15	Pass	Pass	Pass	Pass
119	14	Pass	Pass	Pass	Pass
120	14	Pass	Pass	Pass	Pass
120	15	Pass	Pass	Pass	Pass
121	14	Pass	Pass	Pass	Pass
122	14	Pass	Pass	Pass	Pass
123	13	Pass	Pass	Pass	Pass
123	14	Pass	Pass	Pass	Pass
124	14	Pass	Pass	Pass	Pass
125	14	Pass	Pass	Pass	Pass
126	14	Pass	Pass	Pass	Pass

127	14	Pass	Pass	Pass	Pass
128	14	Pass	Pass	Pass	Pass
129	14	Pass	Pass	Pass	Pass
130	13	Pass	Pass	Pass	Pass
130	14	Pass	Pass	Pass	Pass
131	14	Pass	Pass	Pass	Pass
132	14	Pass	Pass	Pass	Pass
133	14	Pass	Pass	Pass	Pass
134	14	Pass	Pass	Pass	Pass
135	14	Pass	Pass	Pass	Pass
136	14	Pass	Pass	Pass	Pass
137	14	Pass	Pass	Pass	Pass
138	14	Pass	Pass	Pass	Pass
139	14	Pass	Pass	Pass	Pass
140	14	Pass	Pass	Pass	Pass
141	14	Pass	Pass	Pass	Pass
142	14	Pass	Pass	Pass	Pass
143	14	Pass	Pass	Pass	Pass
144	14	Pass	Pass	Pass	Pass
145	14	Pass	Pass	Pass	Pass
146	14	Pass	Pass	Pass	Pass
147	14	Pass	Pass	Pass	Pass
148	14	Pass	Pass	Pass	Pass
149	14	Pass	Pass	Pass	Pass
150	14	Pass	Pass	Pass	Pass
151	14	Pass	Pass	Pass	Pass
152	14	Pass	Pass	Pass	Pass
153	14	Pass	Pass	Pass	Pass
154	14	Pass	Pass	Pass	Pass
155	14	Pass	Pass	Pass	Pass
156	14	Pass	Pass	Pass	Pass
157	14	Pass	Pass	Pass	Pass
158	14	Pass	Pass	Pass	Pass
159	14	Pass	Pass	Pass	Pass
160	14	Pass	Pass	Pass	Pass
161	14	Pass	Pass	Pass	Pass
162	14	Pass	Pass	Pass	Pass
163	14	Pass	Pass	Pass	Pass
164	14	Pass	Pass	Pass	Pass
165	14	Pass	Pass	Pass	Pass
166	14	Pass	Pass	Pass	Pass

4. Table B.8.4. Sturgeon juveniles salinity and DO criteria passing criteria passing for existing and deepening (2 ft) scenarios within the analyzed period January 1 - January 31, 1999

HABITAT REQUIREMENTS:
RM 10-40; Bottom Layer
D.O. August (MG/L):10th %ile>=3.5;5th %ile>=3.0;1th %ile>=2.0
Max Salinity <= 4 ppt

Savannah Harbor Estuary

Segments J	Segments I	Baseline Scenario Salinity	Baseline Scenario D.O.	Project Scenario Salinity	Project Scenario D.O.
47	14	Fail	Pass	Fail	Pass
47	17	Fail	Pass	Fail	Pass
48	14	Fail	Pass	Fail	Pass
48	16	Fail	Pass	Fail	Pass
49	14	Fail	Pass	Fail	Pass
49	16	Fail	Pass	Fail	Pass
50	14	Fail	Pass	Fail	Pass
50	15	Fail	Pass	Fail	Pass
51	14	Fail	Pass	Fail	Pass
52	14	Fail	Pass	Fail	Pass
53	14	Fail	Pass	Fail	Pass
54	14	Fail	Pass	Fail	Pass
55	14	Fail	Pass	Fail	Pass
56	14	Fail	Pass	Fail	Pass
57	14	Fail	Pass	Fail	Pass
58	14	Fail	Pass	Fail	Pass
59	14	Fail	Pass	Fail	Pass
60	14	Fail	Pass	Fail	Pass
61	14	Fail	Pass	Fail	Pass
62	14	Fail	Pass	Fail	Pass
63	14	Fail	Pass	Fail	Pass
64	14	Fail	Pass	Fail	Pass
65	14	Fail	Pass	Fail	Pass
66	14	Fail	Pass	Fail	Pass
67	14	Fail	Pass	Fail	Pass
68	14	Fail	Pass	Fail	Pass
69	14	Fail	Pass	Fail	Pass
70	14	Fail	Pass	Fail	Pass
71	14	Fail	Pass	Fail	Pass
72	14	Fail	Pass	Fail	Pass
73	14	Fail	Pass	Fail	Pass
74	14	Fail	Pass	Fail	Pass
75	14	Fail	Pass	Fail	Pass
76	14	Fail	Pass	Fail	Pass
76	15	Fail	Pass	Fail	Pass
77	14	Fail	Pass	Fail	Pass
77	15	Fail	Pass	Fail	Pass
78	15	Fail	Pass	Fail	Pass
78	16	Fail	Pass	Fail	Pass
79	14	Fail	Pass	Fail	Pass

80	14	Fail	Pass	Fail	Pass
81	14	Fail	Pass	Fail	Pass
82	14	Fail	Pass	Fail	Pass
82	16	Fail	Pass	Fail	Pass
83	14	Fail	Pass	Fail	Pass
84	14	Fail	Pass	Fail	Pass
85	14	Fail	Pass	Fail	Pass
86	14	Fail	Pass	Fail	Pass
87	14	Fail	Pass	Fail	Pass
88	14	Fail	Pass	Fail	Pass
89	14	Fail	Pass	Fail	Pass
90	14	Fail	Pass	Fail	Pass
91	13	Fail	Pass	Fail	Pass
91	14	Fail	Pass	Fail	Pass
92	14	Fail	Pass	Fail	Pass
92	16	Fail	Pass	Fail	Pass
93	13	Fail	Pass	Fail	Pass
93	14	Fail	Pass	Fail	Pass
94	13	Fail	Pass	Fail	Pass
94	14	Fail	Pass	Fail	Pass
95	14	Fail	Pass	Fail	Pass
95	30	Pass	Pass	Pass	Pass
96	14	Fail	Pass	Fail	Pass
97	14	Fail	Pass	Fail	Pass
98	14	Fail	Pass	Fail	Pass
99	14	Fail	Pass	Fail	Pass
99	15	Fail	Pass	Fail	Pass
100	14	Fail	Pass	Fail	Pass
101	14	Fail	Pass	Fail	Pass
101	15	Fail	Pass	Fail	Pass
102	14	Fail	Pass	Fail	Pass
103	14	Fail	Pass	Fail	Pass
104	14	Fail	Pass	Fail	Pass
105	14	Fail	Pass	Fail	Pass
106	14	Fail	Pass	Fail	Pass
107	14	Fail	Pass	Fail	Pass
108	14	Fail	Pass	Fail	Pass
109	15	Pass	Pass	Fail	Pass
110	15	Pass	Pass	Pass	Pass
111	15	Pass	Pass	Pass	Pass
112	14	Pass	Pass	Pass	Pass
113	14	Pass	Pass	Pass	Pass
114	15	Pass	Pass	Pass	Pass
115	15	Pass	Pass	Pass	Pass
116	15	Pass	Pass	Pass	Pass
117	14	Pass	Pass	Pass	Pass
118	15	Pass	Pass	Pass	Pass
119	14	Pass	Pass	Pass	Pass
120	14	Pass	Pass	Pass	Pass
120	15	Pass	Pass	Pass	Pass
121	14	Pass	Pass	Pass	Pass
122	14	Pass	Pass	Pass	Pass
123	13	Pass	Pass	Pass	Pass
123	14	Pass	Pass	Pass	Pass
124	14	Pass	Pass	Pass	Pass
125	14	Pass	Pass	Pass	Pass
126	14	Pass	Pass	Pass	Pass

127	14	Pass	Pass	Pass	Pass
128	14	Pass	Pass	Pass	Pass
129	14	Pass	Pass	Pass	Pass
130	13	Pass	Pass	Pass	Pass
130	14	Pass	Pass	Pass	Pass
131	14	Pass	Pass	Pass	Pass
132	14	Pass	Pass	Pass	Pass
133	14	Pass	Pass	Pass	Pass
134	14	Pass	Pass	Pass	Pass
135	14	Pass	Pass	Pass	Pass
136	14	Pass	Pass	Pass	Pass
137	14	Pass	Pass	Pass	Pass
138	14	Pass	Pass	Pass	Pass
139	14	Pass	Pass	Pass	Pass
140	14	Pass	Pass	Pass	Pass
141	14	Pass	Pass	Pass	Pass
142	14	Pass	Pass	Pass	Pass
143	14	Pass	Pass	Pass	Pass
144	14	Pass	Pass	Pass	Pass
145	14	Pass	Pass	Pass	Pass
146	14	Pass	Pass	Pass	Pass
147	14	Pass	Pass	Pass	Pass
148	14	Pass	Pass	Pass	Pass
149	14	Pass	Pass	Pass	Pass
150	14	Pass	Pass	Pass	Pass
151	14	Pass	Pass	Pass	Pass
152	14	Pass	Pass	Pass	Pass
153	14	Pass	Pass	Pass	Pass
154	14	Pass	Pass	Pass	Pass
155	14	Pass	Pass	Pass	Pass
156	14	Pass	Pass	Pass	Pass
157	14	Pass	Pass	Pass	Pass
158	14	Pass	Pass	Pass	Pass
159	14	Pass	Pass	Pass	Pass
160	14	Pass	Pass	Pass	Pass
161	14	Pass	Pass	Pass	Pass
162	14	Pass	Pass	Pass	Pass
163	14	Pass	Pass	Pass	Pass
164	14	Pass	Pass	Pass	Pass
165	14	Pass	Pass	Pass	Pass
166	14	Pass	Pass	Pass	Pass

Appendix C

APRIL 1997

20th %ile of Clyo Flow

Habitat Analysis Output

Fisheries Review Group

1. Table C.1. Comparisons of Bass Spawning and Bass Eggs habitat areas for existing and deepening (6 ft) scenarios and 20 %ile Clyo Flow within the analyzed period April 1 – April 30, 1997

	Baseline Scenario		Project Scenario		% Change
Bass Spawning	2.958258	km2	2.457762	km2	-16.9
Bass Eggs	4.903563	km2	3.949856	km2	-19.4

2. Table C.2. Comparisons of Bass Spawning and Bass Eggs habitat areas for existing and deepening (4 ft) scenarios and 20 %ile Clyo Flow within the analyzed period April 1 – April 30, 1997

	Baseline Scenario		Project Scenario		% Change
Bass Spawning	2.958258	km2	2.583305	km2	-12.7
Bass Eggs	4.903563	km2	4.215578	km2	-14.0

3. Table C.3. Comparisons of Bass Spawning and Bass Eggs habitat areas for existing and deepening (3 ft) scenarios and 20 %ile Clyo Flow within the analyzed period April 1 – April 30, 1997

	Baseline Scenario		Project Scenario		% Change
Bass Spawning	2.958258	km2	2.635751	km2	-10.9
Bass Eggs	4.903563	km2	4.298213	km2	-12.3

4. Table C.4. Comparisons of Bass Spawning and Bass Eggs habitat areas for existing and deepening (2 ft) scenarios and 20 %ile Clyo flow within the analyzed period April 1 – April 30, 1997

	Baseline Scenario		Project Scenario		% Change
Bass Spawning	2.958258	km2	2.731976	km2	-7.6
Bass Eggs	4.903563	km2	4.391474	km2	-10.4

5. Table C.6.1 Striped Bass spawning D.O. , Salinity, and Velocity criteria passing for existing and deepening (6 ft) scenarios within the analyzed period April 1 - April 30, 1997

(See Appendix C-1)

6. Table C.6.2 Striped Bass spawning D.O. , Salinity, and Velocity criteria passing for existing and deepening (4 ft) scenarios within the analyzed period April 1 - April 30, 1997

(See Appendix C-1)

7.

8. Table C.6.3 Striped Bass spawning D.O. , Salinity, and Velocity criteria passing for existing and deepening (3 ft) scenarios within the analyzed period April 1 - April 30, 1997

(See Appendix C-1)

9. Table C.6.4 Striped Bass spawning D.O. , Salinity, and Velocity criteria passing for existing and deepening (2 ft) scenarios within the analyzed period April 1 - April 30, 1997

(See Appendix C-1)

10. Table C.7.1 Striped Bass eggs D.O. , Salinity, and Velocity criteria passing for existing and deepening (6 ft) scenarios within the analyzed period April 1 - April 30, 1997

(See Appendix C-2)

11. Table C.7.2 Striped Bass eggs D.O. , Salinity, and Velocity criteria passing for existing and deepening (4 ft) scenarios within the analyzed period April 1 - April 30, 1997

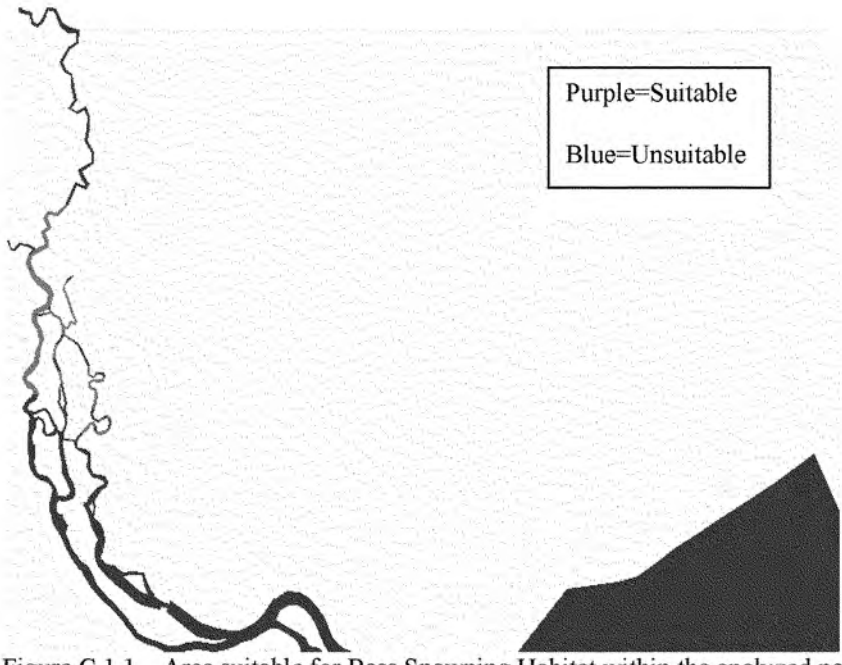
(See Appendix C-2)

12. Table C.7.3 Striped Bass eggs D.O. , Salinity, and Velocity criteria passing for existing and deepening (3 ft) scenarios within the analyzed period April 1 - April 30, 1997

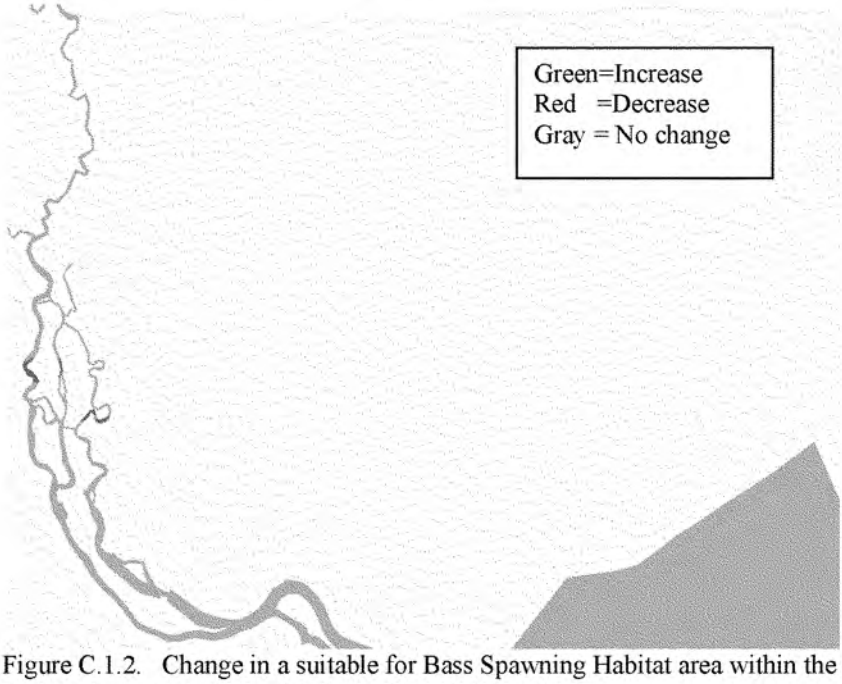
(See Appendix C-2)

13. Table C.7.4 Striped Bass eggs D.O. , Salinity, and Velocity criteria passing for existing and deepening (2 ft) scenarios within the analyzed period April 1 - April 30, 1997

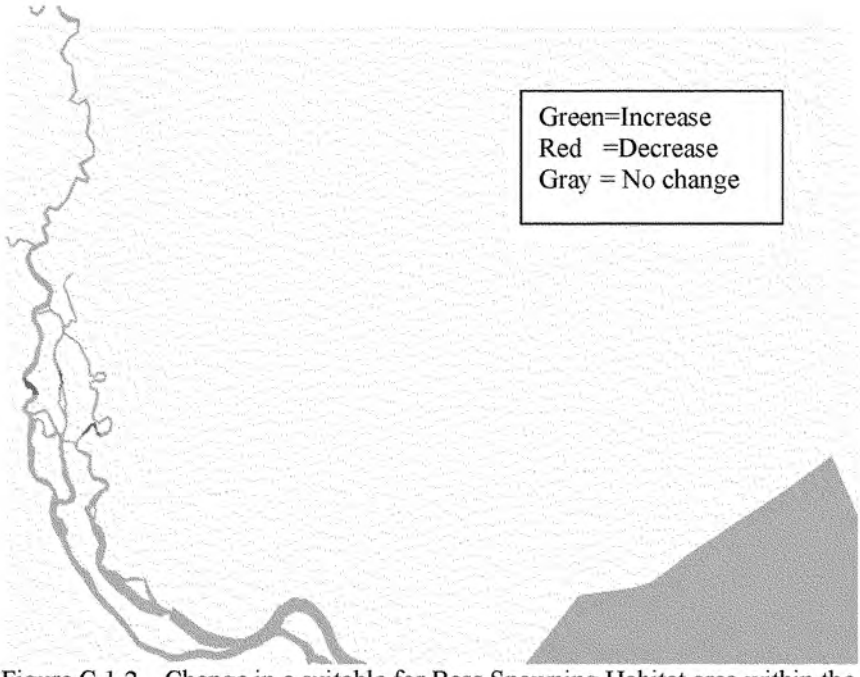
(See Appendix C-2)



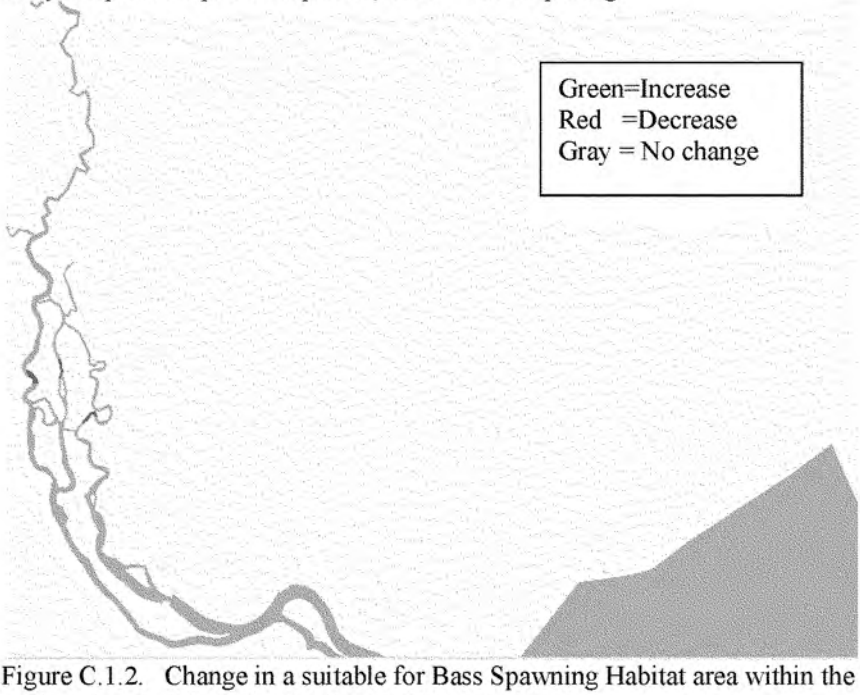
14. Figure C.1.1. Area suitable for Bass Spawning Habitat within the analyzed period April 1 – April 30, 1997: Existing bathymetry



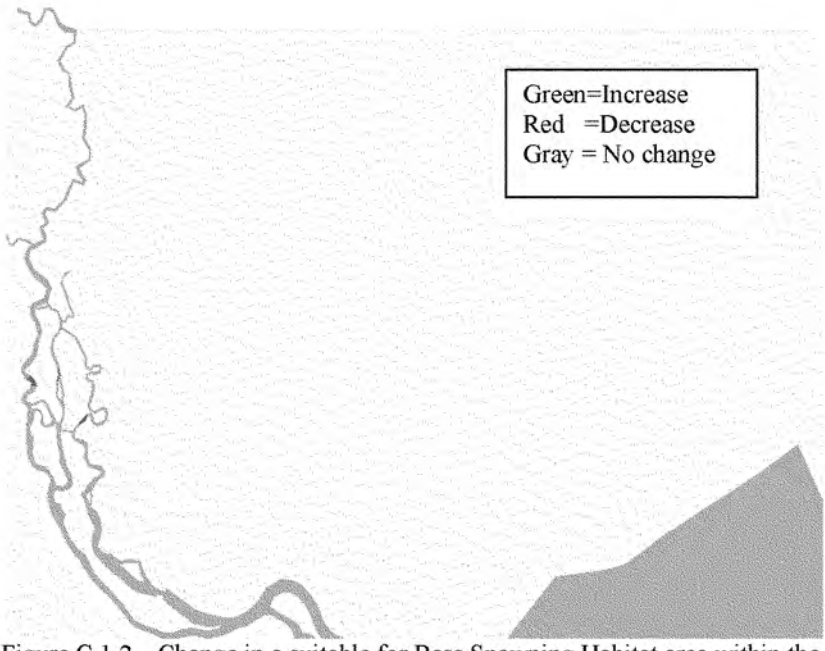
15. Figure C.1.2. Change in a suitable for Bass Spawning Habitat area within the analyzed period April 1 - April 30, 1999 : 6 ft deepening



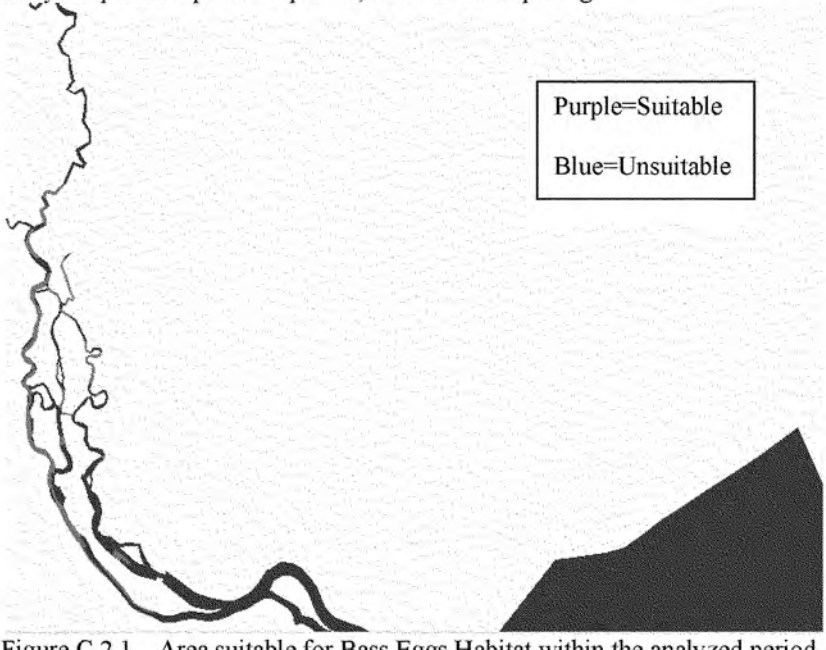
16. Figure C.1.2. Change in a suitable for Bass Spawning Habitat area within the analyzed period April 1 - April 30, 1999 : 4 ft deepening



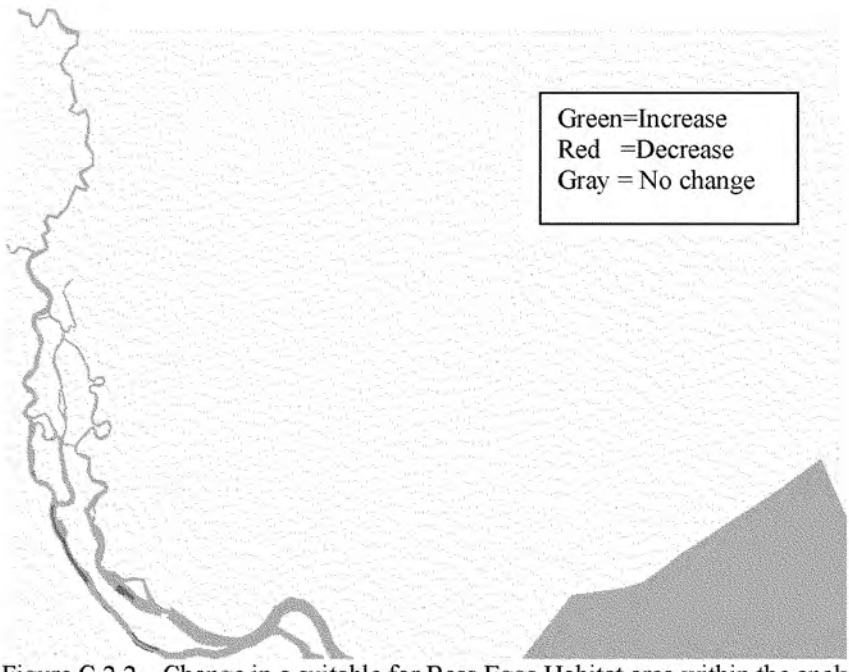
17. Figure C.1.2. Change in a suitable for Bass Spawning Habitat area within the analyzed period April 1 - April 30, 1999 : 3 ft deepening



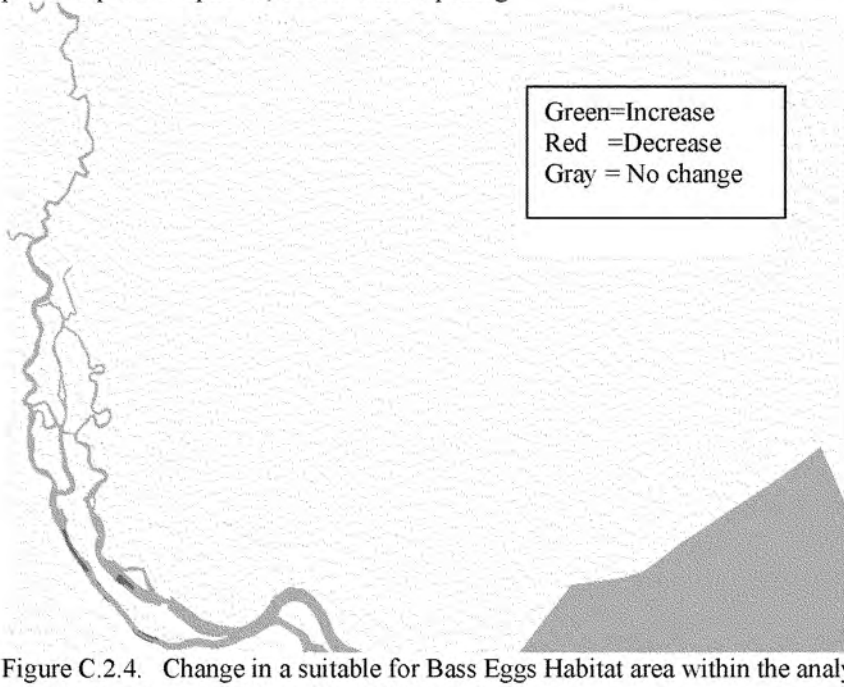
18. Figure C.1.2. Change in a suitable for Bass Spawning Habitat area within the analyzed period April 1 - April 30, 1999 : 2 ft deepening



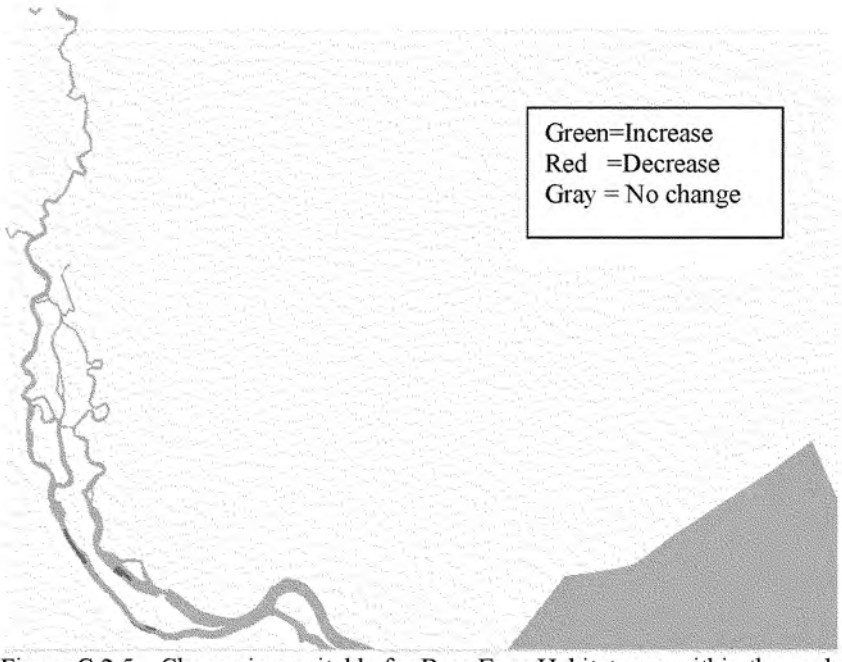
19. Figure C.2.1. Area suitable for Bass Eggs Habitat within the analyzed period April 1 – April 30, 1997: Existing bathymetry



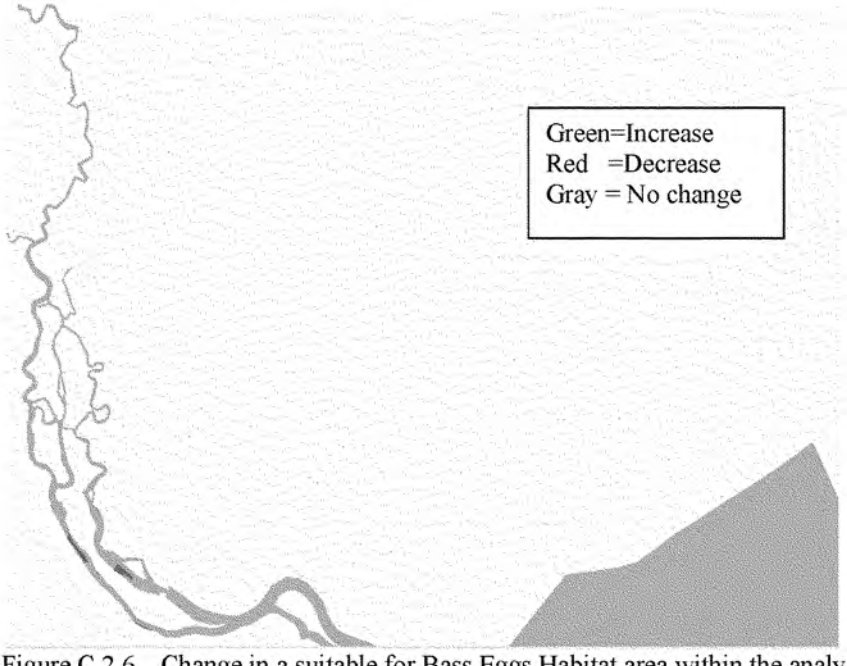
20. Figure C.2.2. Change in a suitable for Bass Eggs Habitat area within the analyzed period April 1 - April 30, 1999 : 6 ft deepening



21. Figure C.2.4. Change in a suitable for Bass Eggs Habitat area within the analyzed period April 1 - April 30, 1999 : 4 ft deepening



22. Figure C.2.5. Change in a suitable for Bass Eggs Habitat area within the analyzed period April 1 - April 30, 1999 : 3 ft deepening



23. Figure C.2.6. Change in a suitable for Bass Eggs Habitat area within the analyzed period April 1 - April 30, 1999 : 2 ft deepening

Appendix C-1

Tables of Criteria Passing for Striped Bass Spawning Habitat Suitability

April 1997

20th %ile of Clyo Flow

Fisheries Review Group

1. Table C.6.1 Striped Bass spawning D.O. , Salinity, and Velocity criteria passing for existing and deepening (6 ft) scenarios within the analyzed period April 1 - April 30, 1997

HABITAT REQUIREMENTS:
RM 10-31; Surface Layer
D.O. April (MG/L):n/a
Salinity 90th %ile <= 1 ppt
Mean Velocity >= 30 cm/s

Savannah Harbor Estuary

Segments J	Segments I	Baseline Scenario Salinity	Baseline Scenario Velocity	Project Scenario Salinity	Project Scenario Velocity
47	13	Fail	Pass	Fail	Pass
47	14	Fail	Pass	Fail	Pass
47	15	Fail	Pass	Fail	Pass
47	16	Fail	Pass	Fail	Pass
47	17	Fail	Fail	Fail	Fail
48	13	Fail	Pass	Fail	Pass
48	14	Fail	Pass	Fail	Pass
48	15	Fail	Pass	Fail	Pass
48	16	Fail	Pass	Fail	Pass
48	17	Fail	Pass	Fail	Pass
49	13	Fail	Pass	Fail	Pass
49	14	Fail	Pass	Fail	Pass
49	15	Fail	Pass	Fail	Pass
49	16	Fail	Pass	Fail	Pass
49	17	Fail	Pass	Fail	Pass
50	13	Fail	Pass	Fail	Pass
50	14	Fail	Pass	Fail	Pass
50	15	Fail	Pass	Fail	Pass
50	16	Fail	Pass	Fail	Pass
50	17	Fail	Pass	Fail	Pass
50	18	Fail	Fail	Fail	Fail
51	13	Fail	Pass	Fail	Pass
51	14	Fail	Pass	Fail	Pass
51	15	Fail	Pass	Fail	Pass
52	13	Fail	Pass	Fail	Pass
52	14	Fail	Pass	Fail	Pass
52	15	Fail	Pass	Fail	Pass
53	13	Fail	Pass	Fail	Pass
53	14	Fail	Pass	Fail	Pass
53	15	Fail	Pass	Fail	Pass
54	13	Fail	Pass	Fail	Pass
54	14	Fail	Pass	Fail	Pass
54	15	Fail	Pass	Fail	Pass
55	13	Fail	Pass	Fail	Pass
55	14	Fail	Pass	Fail	Pass
55	15	Fail	Pass	Fail	Pass
56	13	Fail	Pass	Fail	Pass
56	14	Fail	Pass	Fail	Pass
56	15	Fail	Pass	Fail	Pass
57	13	Fail	Pass	Fail	Pass

57	14	Fail	Pass	Fail	Pass
57	15	Fail	Pass	Fail	Pass
58	13	Fail	Pass	Fail	Pass
58	14	Fail	Pass	Fail	Pass
58	15	Fail	Pass	Fail	Pass
59	13	Fail	Pass	Fail	Pass
59	14	Fail	Pass	Fail	Pass
59	15	Fail	Pass	Fail	Pass
59	30	Fail	Pass	Fail	Pass
59	31	Fail	Pass	Fail	Pass
59	32	Fail	Fail	Fail	Fail
60	13	Fail	Pass	Fail	Pass
60	14	Fail	Pass	Fail	Pass
60	15	Fail	Pass	Fail	Pass
60	30	Fail	Fail	Fail	Fail
60	31	Fail	Pass	Fail	Fail
60	32	Fail	Fail	Fail	Fail
61	13	Fail	Pass	Fail	Pass
61	14	Fail	Pass	Fail	Pass
61	15	Fail	Pass	Fail	Pass
61	30	Fail	Fail	Fail	Fail
61	31	Fail	Pass	Fail	Fail
61	32	Fail	Fail	Fail	Fail
62	13	Fail	Pass	Fail	Pass
62	14	Fail	Pass	Fail	Pass
62	15	Fail	Pass	Fail	Pass
62	30	Fail	Fail	Fail	Fail
62	31	Fail	Pass	Fail	Pass
62	32	Fail	Fail	Fail	Fail
63	13	Fail	Pass	Fail	Pass
63	14	Fail	Pass	Fail	Pass
63	15	Fail	Pass	Fail	Pass
63	31	Fail	Pass	Fail	Pass
64	13	Fail	Pass	Fail	Pass
64	14	Fail	Pass	Fail	Pass
64	15	Fail	Pass	Fail	Pass
64	30	Fail	Fail	Fail	Fail
64	31	Fail	Pass	Fail	Pass
64	32	Fail	Fail	Fail	Fail
65	13	Fail	Pass	Fail	Pass
65	14	Fail	Pass	Fail	Pass
65	15	Fail	Pass	Fail	Pass
65	30	Fail	Pass	Fail	Pass
65	31	Fail	Pass	Fail	Pass
65	32	Fail	Pass	Fail	Pass
65	33	Fail	Fail	Fail	Fail
66	13	Fail	Pass	Fail	Pass
66	14	Fail	Pass	Fail	Pass
66	15	Fail	Pass	Fail	Pass
66	30	Fail	Pass	Fail	Pass
66	31	Fail	Pass	Fail	Pass
66	32	Fail	Pass	Fail	Pass
66	36	Fail	Pass	Fail	Pass
66	38	Fail	Fail	Fail	Fail
67	13	Fail	Pass	Fail	Pass
67	14	Fail	Pass	Fail	Pass
67	15	Fail	Pass	Fail	Pass

67	30	Fail	Pass	Fail	Pass
67	31	Fail	Pass	Fail	Pass
67	32	Fail	Pass	Fail	Pass
67	36	Fail	Fail	Fail	Fail
68	13	Fail	Pass	Fail	Pass
68	14	Fail	Pass	Fail	Pass
68	15	Fail	Pass	Fail	Pass
68	30	Fail	Pass	Fail	Pass
68	31	Fail	Pass	Fail	Pass
68	32	Fail	Pass	Fail	Pass
68	36	Fail	Fail	Fail	Fail
68	38	Fail	Fail	Fail	Fail
69	13	Fail	Pass	Fail	Pass
69	14	Fail	Pass	Fail	Pass
69	15	Fail	Pass	Fail	Pass
69	30	Fail	Pass	Fail	Pass
69	31	Fail	Pass	Fail	Pass
69	32	Fail	Fail	Fail	Fail
69	36	Fail	Fail	Fail	Fail
70	13	Fail	Pass	Fail	Pass
70	14	Fail	Pass	Fail	Pass
70	15	Fail	Pass	Fail	Pass
70	30	Fail	Pass	Fail	Pass
70	31	Fail	Pass	Fail	Pass
70	32	Fail	Fail	Fail	Fail
70	33	Fail	Fail	Fail	Fail
71	13	Fail	Pass	Fail	Pass
71	14	Fail	Pass	Fail	Pass
71	15	Fail	Pass	Fail	Pass
71	30	Fail	Pass	Fail	Pass
71	31	Fail	Pass	Fail	Pass
71	32	Fail	Fail	Fail	Fail
72	13	Fail	Pass	Fail	Pass
72	14	Fail	Pass	Fail	Pass
72	15	Fail	Pass	Fail	Pass
72	30	Fail	Pass	Fail	Pass
72	31	Fail	Pass	Fail	Pass
72	32	Fail	Fail	Fail	Fail
73	13	Fail	Pass	Fail	Pass
73	14	Fail	Pass	Fail	Pass
73	15	Fail	Pass	Fail	Pass
73	30	Fail	Fail	Fail	Pass
73	31	Fail	Pass	Fail	Pass
74	13	Fail	Pass	Fail	Pass
74	14	Fail	Pass	Fail	Pass
74	15	Fail	Pass	Fail	Pass
74	30	Fail	Fail	Fail	Fail
74	31	Fail	Pass	Fail	Pass
75	13	Fail	Pass	Fail	Pass
75	14	Fail	Pass	Fail	Pass
75	15	Fail	Pass	Fail	Pass
75	30	Fail	Pass	Fail	Pass
75	31	Fail	Pass	Fail	Pass
76	13	Fail	Pass	Fail	Pass
76	14	Fail	Pass	Fail	Pass
76	15	Fail	Fail	Fail	Fail
76	16	Fail	Fail	Fail	Fail

76	17	Fail	Fail	Fail	Fail
76	30	Fail	Pass	Fail	Pass
76	31	Fail	Pass	Fail	Pass
76	33	Fail	Fail	Fail	Fail
77	13	Fail	Pass	Fail	Pass
77	14	Fail	Pass	Fail	Pass
77	15	Fail	Fail	Fail	Fail
77	16	Fail	Fail	Fail	Fail
77	17	Fail	Fail	Fail	Fail
77	30	Fail	Fail	Fail	Fail
77	31	Fail	Fail	Fail	Fail
78	13	Fail	Pass	Fail	Pass
78	14	Fail	Pass	Fail	Pass
78	15	Fail	Fail	Fail	Fail
78	16	Fail	Fail	Fail	Fail
78	17	Fail	Fail	Fail	Fail
78	30	Fail	Fail	Fail	Pass
78	31	Fail	Fail	Fail	Fail
79	13	Fail	Pass	Fail	Pass
79	14	Fail	Pass	Fail	Pass
79	15	Fail	Pass	Fail	Pass
79	30	Fail	Pass	Fail	Pass
79	31	Fail	Fail	Fail	Fail
80	13	Fail	Pass	Fail	Pass
80	14	Fail	Pass	Fail	Pass
80	15	Fail	Pass	Fail	Pass
80	30	Fail	Pass	Fail	Pass
80	31	Fail	Fail	Fail	Fail
81	13	Fail	Pass	Fail	Pass
81	14	Fail	Pass	Fail	Pass
81	15	Fail	Pass	Fail	Pass
81	30	Fail	Pass	Fail	Pass
81	31	Fail	Fail	Fail	Fail
82	13	Fail	Pass	Fail	Pass
82	14	Fail	Pass	Fail	Pass
82	15	Fail	Pass	Fail	Pass
82	16	Fail	Fail	Fail	Fail
82	17	Fail	Fail	Fail	Fail
82	18	Fail	Pass	Fail	Pass
82	19	Fail	Fail	Fail	Fail
82	20	Fail	Fail	Fail	Fail
82	21	Fail	Fail	Fail	Fail
82	29	Fail	Fail	Fail	Fail
82	30	Fail	Pass	Fail	Pass
82	31	Fail	Fail	Fail	Fail
83	13	Fail	Pass	Fail	Pass
83	14	Fail	Pass	Fail	Pass
83	15	Fail	Pass	Fail	Pass
83	21	Fail	Pass	Fail	Pass
83	30	Fail	Fail	Fail	Pass
83	31	Fail	Fail	Fail	Fail
84	13	Fail	Pass	Fail	Pass
84	14	Fail	Pass	Fail	Pass
84	15	Fail	Pass	Fail	Pass
84	21	Fail	Pass	Fail	Pass
84	30	Fail	Fail	Fail	Pass
84	31	Fail	Fail	Fail	Fail

85	13	Fail	Pass	Fail	Pass
85	14	Fail	Pass	Fail	Pass
85	15	Fail	Pass	Fail	Pass
85	21	Fail	Pass	Fail	Pass
85	30	Fail	Fail	Fail	Fail
86	13	Fail	Pass	Fail	Pass
86	14	Fail	Pass	Fail	Pass
86	15	Fail	Pass	Fail	Pass
86	17	Fail	Fail	Fail	Fail
86	21	Fail	Pass	Fail	Pass
86	30	Fail	Pass	Fail	Pass
87	13	Fail	Pass	Fail	Pass
87	14	Fail	Pass	Fail	Pass
87	15	Fail	Pass	Fail	Pass
87	30	Fail	Pass	Fail	Pass
87	32	Fail	Fail	Fail	Fail
88	13	Fail	Pass	Fail	Pass
88	14	Fail	Pass	Fail	Pass
88	15	Fail	Pass	Fail	Pass
88	30	Fail	Fail	Fail	Fail
89	13	Fail	Pass	Fail	Pass
89	14	Fail	Pass	Fail	Pass
89	15	Fail	Pass	Fail	Pass
89	30	Fail	Fail	Fail	Pass
90	13	Fail	Pass	Fail	Pass
90	14	Fail	Pass	Fail	Pass
90	15	Fail	Pass	Fail	Pass
90	30	Fail	Fail	Fail	Fail
91	13	Fail	Pass	Fail	Pass
91	14	Fail	Pass	Fail	Pass
91	15	Fail	Pass	Fail	Pass
91	16	Fail	Fail	Fail	Fail
91	30	Fail	Fail	Fail	Fail
92	13	Fail	Pass	Fail	Pass
92	14	Fail	Pass	Fail	Pass
92	15	Fail	Pass	Fail	Pass
92	16	Fail	Pass	Fail	Fail
92	30	Fail	Fail	Fail	Fail
92	32	Fail	Fail	Fail	Fail
93	13	Fail	Pass	Fail	Pass
93	14	Fail	Pass	Fail	Pass
93	15	Fail	Pass	Fail	Pass
93	16	Fail	Pass	Fail	Pass
93	30	Fail	Fail	Fail	Fail
94	13	Fail	Pass	Fail	Pass
94	14	Fail	Pass	Fail	Pass
94	15	Fail	Pass	Fail	Pass
94	16	Fail	Pass	Fail	Pass
94	26	Fail	Pass	Fail	Pass
94	30	Fail	Fail	Fail	Fail
95	13	Fail	Pass	Fail	Pass
95	14	Fail	Pass	Fail	Pass
95	15	Fail	Pass	Fail	Pass
95	16	Fail	Fail	Fail	Fail
95	26	Fail	Pass	Fail	Pass
95	28	Fail	Fail	Fail	Fail
95	30	Fail	Fail	Fail	Fail

96	11	Fail	Fail	Fail	Fail
96	13	Fail	Pass	Fail	Pass
96	14	Fail	Pass	Fail	Pass
96	15	Fail	Pass	Fail	Pass
96	26	Fail	Pass	Fail	Pass
96	30	Fail	Fail	Fail	Fail
97	13	Fail	Pass	Fail	Pass
97	14	Fail	Pass	Fail	Pass
97	15	Fail	Pass	Fail	Pass
97	26	Fail	Pass	Fail	Pass
97	30	Pass	Fail	Fail	Fail
98	13	Fail	Pass	Fail	Pass
98	14	Fail	Pass	Fail	Pass
98	15	Fail	Pass	Fail	Pass
98	26	Fail	Pass	Fail	Pass
98	27	Fail	Pass	Fail	Pass
98	28	Fail	Pass	Fail	Pass
98	29	Fail	Pass	Fail	Pass
98	30	Fail	Fail	Fail	Fail
99	13	Fail	Pass	Fail	Pass
99	14	Fail	Pass	Fail	Pass
99	15	Fail	Pass	Fail	Pass
99	16	Fail	Fail	Fail	Fail
99	17	Fail	Fail	Fail	Fail
99	18	Fail	Fail	Fail	Fail
99	19	Fail	Fail	Fail	Fail
99	20	Fail	Fail	Fail	Fail
99	21	Fail	Fail	Fail	Fail
99	22	Fail	Fail	Fail	Fail
99	23	Fail	Fail	Fail	Fail
99	26	Fail	Fail	Fail	Fail
99	30	Fail	Fail	Fail	Fail
100	13	Fail	Pass	Fail	Pass
100	14	Fail	Pass	Fail	Pass
100	15	Fail	Pass	Fail	Pass
100	23	Fail	Fail	Fail	Fail
100	24	Fail	Fail	Fail	Fail
100	25	Fail	Fail	Fail	Fail
100	26	Fail	Pass	Fail	Pass
100	30	Fail	Fail	Fail	Fail
101	13	Fail	Pass	Fail	Pass
101	14	Fail	Pass	Fail	Pass
101	15	Fail	Pass	Fail	Pass
101	16	Fail	Fail	Fail	Fail
101	17	Fail	Fail	Fail	Fail
101	18	Fail	Fail	Fail	Fail
101	19	Fail	Fail	Fail	Fail
101	20	Fail	Fail	Fail	Fail
101	21	Fail	Fail	Fail	Fail
101	22	Fail	Fail	Fail	Fail
101	23	Fail	Fail	Fail	Fail
101	26	Fail	Pass	Fail	Pass
101	30	Pass	Pass	Fail	Pass
102	13	Fail	Pass	Fail	Pass
102	14	Fail	Pass	Fail	Pass
102	15	Fail	Pass	Fail	Pass
102	26	Fail	Pass	Fail	Pass

102	30	Pass	Pass	Fail	Pass
103	13	Fail	Pass	Fail	Pass
103	14	Fail	Pass	Fail	Pass
103	15	Fail	Pass	Fail	Pass
103	26	Fail	Pass	Fail	Pass
103	30	Pass	Pass	Fail	Pass
104	11	Fail	Fail	Fail	Fail
104	13	Fail	Pass	Fail	Pass
104	14	Fail	Pass	Fail	Pass
104	15	Fail	Pass	Fail	Pass
104	26	Fail	Pass	Fail	Pass
104	30	Pass	Pass	Fail	Pass
105	13	Fail	Pass	Fail	Pass
105	14	Fail	Pass	Fail	Pass
105	15	Fail	Pass	Fail	Pass
105	26	Fail	Pass	Fail	Pass
105	30	Pass	Fail	Fail	Fail
106	13	Fail	Pass	Fail	Pass
106	14	Fail	Pass	Fail	Pass
106	15	Fail	Pass	Fail	Pass
106	26	Fail	Pass	Fail	Pass
106	27	Fail	Fail	Fail	Fail
106	30	Pass	Pass	Fail	Pass
106	39	Pass	Fail	Pass	Fail
107	13	Pass	Pass	Fail	Pass
107	14	Pass	Pass	Fail	Pass
107	15	Pass	Pass	Fail	Pass
107	22	Fail	Pass	Fail	Pass
107	26	Fail	Pass	Fail	Pass
107	30	Pass	Pass	Fail	Pass
107	39	Pass	Pass	Pass	Pass
108	13	Pass	Pass	Fail	Pass
108	14	Pass	Pass	Fail	Pass
108	15	Pass	Pass	Fail	Pass
108	22	Fail	Pass	Fail	Pass
108	24	Fail	Fail	Fail	Fail
108	26	Fail	Pass	Fail	Pass
108	30	Pass	Pass	Fail	Pass
108	39	Pass	Fail	Pass	Fail
109	13	Pass	Pass	Fail	Pass
109	14	Pass	Pass	Fail	Pass
109	15	Pass	Pass	Fail	Pass
109	22	Fail	Pass	Fail	Pass
109	26	Fail	Pass	Fail	Pass
109	30	Pass	Fail	Pass	Fail
109	39	Pass	Pass	Pass	Pass
110	13	Pass	Pass	Fail	Pass
110	14	Pass	Pass	Fail	Pass
110	15	Pass	Pass	Fail	Pass
110	22	Fail	Pass	Fail	Pass
110	26	Fail	Pass	Fail	Pass
110	28	Fail	Fail	Fail	Fail
110	39	Pass	Fail	Pass	Fail
111	13	Pass	Pass	Fail	Pass
111	14	Pass	Pass	Fail	Pass
111	15	Pass	Pass	Fail	Pass
111	22	Fail	Pass	Fail	Pass

111	26	Fail	Pass	Fail	Pass
111	39	Pass	Fail	Pass	Fail
112	13	Pass	Pass	Pass	Pass
112	14	Pass	Pass	Pass	Pass
112	15	Pass	Pass	Fail	Pass
112	22	Pass	Fail	Fail	Fail
112	26	Pass	Pass	Fail	Pass
112	39	Pass	Fail	Pass	Fail
113	13	Pass	Pass	Pass	Pass
113	14	Pass	Pass	Pass	Pass
113	15	Pass	Pass	Pass	Pass
113	26	Pass	Pass	Fail	Pass
113	27	Pass	Fail	Fail	Fail
113	39	Pass	Pass	Pass	Pass
113	41	Fail	Fail	Fail	Fail
114	13	Pass	Pass	Pass	Pass
114	14	Pass	Pass	Pass	Pass
114	15	Pass	Pass	Pass	Pass
114	26	Pass	Pass	Fail	Pass
114	39	Pass	Pass	Pass	Pass
115	13	Pass	Pass	Pass	Pass
115	14	Pass	Pass	Pass	Pass
115	15	Pass	Pass	Pass	Pass
115	26	Pass	Pass	Fail	Pass
115	39	Pass	Pass	Pass	Pass
116	13	Pass	Pass	Pass	Pass
116	14	Pass	Pass	Pass	Pass
116	15	Pass	Pass	Pass	Pass
116	26	Pass	Fail	Fail	Fail
116	28	Fail	Fail	Fail	Fail
116	39	Pass	Pass	Pass	Pass
117	13	Pass	Pass	Pass	Pass
117	14	Pass	Pass	Pass	Pass
117	15	Pass	Pass	Pass	Pass
117	26	Pass	Fail	Fail	Fail
117	39	Pass	Pass	Pass	Pass
118	13	Pass	Pass	Pass	Pass
118	14	Pass	Pass	Pass	Pass
118	15	Pass	Pass	Pass	Pass
118	20	Pass	Fail	Pass	Fail
118	26	Pass	Pass	Pass	Pass
118	39	Pass	Pass	Pass	Pass
119	13	Pass	Pass	Pass	Pass
119	14	Pass	Pass	Pass	Pass
119	15	Pass	Pass	Pass	Pass
119	20	Pass	Pass	Pass	Pass
119	26	Pass	Pass	Pass	Pass
119	39	Pass	Pass	Pass	Pass
120	13	Pass	Pass	Pass	Pass
120	14	Pass	Pass	Pass	Pass
120	15	Pass	Fail	Pass	Fail
120	16	Pass	Fail	Pass	Fail
120	26	Pass	Fail	Pass	Fail
120	39	Pass	Pass	Pass	Pass
121	13	Pass	Pass	Pass	Pass
121	14	Pass	Pass	Pass	Pass
121	26	Pass	Fail	Pass	Fail

121	39	Pass	Pass	Pass	Pass
122	13	Pass	Pass	Pass	Pass
122	14	Pass	Pass	Pass	Pass
122	26	Pass	Fail	Pass	Fail
122	39	Pass	Pass	Pass	Pass
122	41	Fail	Fail	Fail	Fail
123	13	Pass	Pass	Pass	Pass
123	14	Pass	Pass	Pass	Pass
123	15	Pass	Fail	Pass	Fail
123	16	Pass	Pass	Pass	Pass
123	17	Pass	Pass	Pass	Pass
123	18	Pass	Pass	Pass	Pass
123	19	Pass	Pass	Pass	Pass
123	20	Pass	Pass	Pass	Pass
123	21	Pass	Pass	Pass	Pass
123	22	Pass	Pass	Pass	Pass
123	23	Pass	Pass	Pass	Pass
123	24	Pass	Pass	Pass	Pass
123	25	Pass	Pass	Pass	Pass
123	26	Pass	Pass	Pass	Pass
123	27	Pass	Pass	Pass	Pass
123	28	Pass	Pass	Pass	Pass
123	29	Pass	Fail	Pass	Fail
123	30	Pass	Fail	Pass	Fail
123	31	Pass	Fail	Pass	Fail
123	32	Pass	Fail	Pass	Fail
123	33	Pass	Fail	Pass	Fail
123	34	Pass	Pass	Pass	Pass
123	35	Pass	Pass	Pass	Pass
123	36	Pass	Pass	Pass	Pass
123	37	Pass	Pass	Pass	Pass
123	38	Pass	Fail	Pass	Fail
123	39	Pass	Fail	Pass	Fail
124	13	Pass	Pass	Pass	Pass
124	14	Pass	Pass	Pass	Pass
124	23	Pass	Pass	Pass	Pass
125	13	Pass	Pass	Pass	Pass
125	14	Pass	Pass	Pass	Pass
125	23	Pass	Pass	Pass	Pass
125	28	Fail	Fail	Fail	Fail
125	33	Fail	Fail	Fail	Fail
126	13	Pass	Pass	Pass	Pass
126	14	Pass	Pass	Pass	Pass
126	23	Pass	Pass	Pass	Pass
127	13	Pass	Pass	Pass	Pass
127	14	Pass	Pass	Pass	Pass
127	23	Pass	Pass	Pass	Pass
128	13	Pass	Pass	Pass	Pass
128	14	Pass	Pass	Pass	Pass
128	23	Pass	Pass	Pass	Pass
129	13	Pass	Pass	Pass	Pass
129	14	Pass	Pass	Pass	Pass
129	23	Pass	Pass	Pass	Pass
130	8	Pass	Fail	Pass	Fail
130	9	Pass	Fail	Pass	Fail
130	10	Pass	Fail	Pass	Fail
130	11	Pass	Fail	Pass	Fail

130	12	Pass	Fail	Pass	Fail
130	13	Pass	Fail	Pass	Fail
130	14	Pass	Pass	Pass	Pass
130	23	Pass	Pass	Pass	Pass
131	14	Pass	Pass	Pass	Pass
131	23	Pass	Pass	Pass	Pass
132	14	Pass	Pass	Pass	Pass
132	23	Pass	Pass	Pass	Pass
133	14	Pass	Pass	Pass	Pass
133	23	Pass	Pass	Pass	Pass
134	14	Pass	Pass	Pass	Pass
134	23	Pass	Fail	Pass	Fail
135	14	Pass	Pass	Pass	Pass
136	14	Pass	Pass	Pass	Pass
137	14	Pass	Pass	Pass	Pass
138	14	Pass	Pass	Pass	Pass

2. Table C.6.2 Striped Bass spawning D.O. , Salinity, and Velocity criteria passing for existing and deepening (4 ft) scenarios within the analyzed period April 1 - April 30, 1997

HABITAT REQUIREMENTS:
RM 10-31; Surface Layer
D.O. April (MG/L):n/a
Salinity 90th %ile <= 1 ppt
Mean Velocity >= 30 cm/s

Savannah Harbor Estuary

Segments J	Segments I	Baseline Scenario Salinity	Baseline Scenario Velocity	Project Scenario Salinity	Project Scenario Velocity
47	13	Fail	Pass	Fail	Pass
47	14	Fail	Pass	Fail	Pass
47	15	Fail	Pass	Fail	Pass
47	16	Fail	Pass	Fail	Pass
47	17	Fail	Fail	Fail	Fail
48	13	Fail	Pass	Fail	Pass
48	14	Fail	Pass	Fail	Pass
48	15	Fail	Pass	Fail	Pass
48	16	Fail	Pass	Fail	Pass
48	17	Fail	Pass	Fail	Pass
49	13	Fail	Pass	Fail	Pass
49	14	Fail	Pass	Fail	Pass
49	15	Fail	Pass	Fail	Pass
49	16	Fail	Pass	Fail	Pass
49	17	Fail	Pass	Fail	Pass
50	13	Fail	Pass	Fail	Pass
50	14	Fail	Pass	Fail	Pass
50	15	Fail	Pass	Fail	Pass
50	16	Fail	Pass	Fail	Pass
50	17	Fail	Pass	Fail	Pass
50	18	Fail	Fail	Fail	Fail
51	13	Fail	Pass	Fail	Pass
51	14	Fail	Pass	Fail	Pass
51	15	Fail	Pass	Fail	Pass
52	13	Fail	Pass	Fail	Pass
52	14	Fail	Pass	Fail	Pass
52	15	Fail	Pass	Fail	Pass
53	13	Fail	Pass	Fail	Pass
53	14	Fail	Pass	Fail	Pass
53	15	Fail	Pass	Fail	Pass
54	13	Fail	Pass	Fail	Pass
54	14	Fail	Pass	Fail	Pass
54	15	Fail	Pass	Fail	Pass
55	13	Fail	Pass	Fail	Pass
55	14	Fail	Pass	Fail	Pass
55	15	Fail	Pass	Fail	Pass
56	13	Fail	Pass	Fail	Pass
56	14	Fail	Pass	Fail	Pass

56	15	Fail	Pass	Fail	Pass
57	13	Fail	Pass	Fail	Pass
57	14	Fail	Pass	Fail	Pass
57	15	Fail	Pass	Fail	Pass
58	13	Fail	Pass	Fail	Pass
58	14	Fail	Pass	Fail	Pass
58	15	Fail	Pass	Fail	Pass
59	13	Fail	Pass	Fail	Pass
59	14	Fail	Pass	Fail	Pass
59	15	Fail	Pass	Fail	Pass
59	30	Fail	Pass	Fail	Pass
59	31	Fail	Pass	Fail	Pass
59	32	Fail	Fail	Fail	Fail
60	13	Fail	Pass	Fail	Pass
60	14	Fail	Pass	Fail	Pass
60	15	Fail	Pass	Fail	Pass
60	30	Fail	Fail	Fail	Fail
60	31	Fail	Pass	Fail	Pass
60	32	Fail	Fail	Fail	Fail
61	13	Fail	Pass	Fail	Pass
61	14	Fail	Pass	Fail	Pass
61	15	Fail	Pass	Fail	Pass
61	30	Fail	Fail	Fail	Fail
61	31	Fail	Pass	Fail	Pass
61	32	Fail	Fail	Fail	Fail
62	13	Fail	Pass	Fail	Pass
62	14	Fail	Pass	Fail	Pass
62	15	Fail	Pass	Fail	Pass
62	30	Fail	Fail	Fail	Fail
62	31	Fail	Pass	Fail	Pass
62	32	Fail	Fail	Fail	Fail
63	13	Fail	Pass	Fail	Pass
63	14	Fail	Pass	Fail	Pass
63	15	Fail	Pass	Fail	Pass
63	31	Fail	Pass	Fail	Pass
64	13	Fail	Pass	Fail	Pass
64	14	Fail	Pass	Fail	Pass
64	15	Fail	Pass	Fail	Pass
64	30	Fail	Fail	Fail	Fail
64	31	Fail	Pass	Fail	Pass
64	32	Fail	Fail	Fail	Fail
65	13	Fail	Pass	Fail	Pass
65	14	Fail	Pass	Fail	Pass
65	15	Fail	Pass	Fail	Pass
65	30	Fail	Pass	Fail	Pass
65	31	Fail	Pass	Fail	Pass
65	32	Fail	Pass	Fail	Pass
65	33	Fail	Fail	Fail	Fail
66	13	Fail	Pass	Fail	Pass
66	14	Fail	Pass	Fail	Pass
66	15	Fail	Pass	Fail	Pass
66	30	Fail	Pass	Fail	Pass
66	31	Fail	Pass	Fail	Pass
66	32	Fail	Pass	Fail	Pass
66	36	Fail	Pass	Fail	Pass
66	38	Fail	Fail	Fail	Fail
67	13	Fail	Pass	Fail	Pass

67	14	Fail	Pass	Fail	Pass
67	15	Fail	Pass	Fail	Pass
67	30	Fail	Pass	Fail	Pass
67	31	Fail	Pass	Fail	Pass
67	32	Fail	Pass	Fail	Pass
67	36	Fail	Fail	Fail	Fail
68	13	Fail	Pass	Fail	Pass
68	14	Fail	Pass	Fail	Pass
68	15	Fail	Pass	Fail	Pass
68	30	Fail	Pass	Fail	Pass
68	31	Fail	Pass	Fail	Pass
68	32	Fail	Pass	Fail	Pass
68	36	Fail	Fail	Fail	Fail
68	38	Fail	Fail	Fail	Fail
69	13	Fail	Pass	Fail	Pass
69	14	Fail	Pass	Fail	Pass
69	15	Fail	Pass	Fail	Pass
69	30	Fail	Pass	Fail	Pass
69	31	Fail	Pass	Fail	Pass
69	32	Fail	Fail	Fail	Fail
69	36	Fail	Fail	Fail	Fail
70	13	Fail	Pass	Fail	Pass
70	14	Fail	Pass	Fail	Pass
70	15	Fail	Pass	Fail	Pass
70	30	Fail	Pass	Fail	Pass
70	31	Fail	Pass	Fail	Pass
70	32	Fail	Fail	Fail	Fail
70	33	Fail	Fail	Fail	Fail
71	13	Fail	Pass	Fail	Pass
71	14	Fail	Pass	Fail	Pass
71	15	Fail	Pass	Fail	Pass
71	30	Fail	Pass	Fail	Pass
71	31	Fail	Pass	Fail	Pass
71	32	Fail	Fail	Fail	Fail
72	13	Fail	Pass	Fail	Pass
72	14	Fail	Pass	Fail	Pass
72	15	Fail	Pass	Fail	Pass
72	30	Fail	Pass	Fail	Pass
72	31	Fail	Pass	Fail	Pass
72	32	Fail	Fail	Fail	Fail
73	13	Fail	Pass	Fail	Pass
73	14	Fail	Pass	Fail	Pass
73	15	Fail	Pass	Fail	Pass
73	30	Fail	Fail	Fail	Pass
73	31	Fail	Pass	Fail	Pass
74	13	Fail	Pass	Fail	Pass
74	14	Fail	Pass	Fail	Pass
74	15	Fail	Pass	Fail	Pass
74	30	Fail	Fail	Fail	Fail
74	31	Fail	Pass	Fail	Pass
75	13	Fail	Pass	Fail	Pass
75	14	Fail	Pass	Fail	Pass
75	15	Fail	Pass	Fail	Pass
75	30	Fail	Pass	Fail	Pass
75	31	Fail	Pass	Fail	Pass
76	13	Fail	Pass	Fail	Pass
76	14	Fail	Pass	Fail	Pass

76	15	Fail	Fail	Fail	Fail
76	16	Fail	Fail	Fail	Fail
76	17	Fail	Fail	Fail	Fail
76	30	Fail	Pass	Fail	Pass
76	31	Fail	Pass	Fail	Pass
76	33	Fail	Fail	Fail	Fail
77	13	Fail	Pass	Fail	Pass
77	14	Fail	Pass	Fail	Pass
77	15	Fail	Fail	Fail	Fail
77	16	Fail	Fail	Fail	Fail
77	17	Fail	Fail	Fail	Fail
77	30	Fail	Fail	Fail	Fail
77	31	Fail	Fail	Fail	Fail
78	13	Fail	Pass	Fail	Pass
78	14	Fail	Pass	Fail	Pass
78	15	Fail	Fail	Fail	Fail
78	16	Fail	Fail	Fail	Fail
78	17	Fail	Fail	Fail	Fail
78	30	Fail	Fail	Fail	Pass
78	31	Fail	Fail	Fail	Fail
79	13	Fail	Pass	Fail	Pass
79	14	Fail	Pass	Fail	Pass
79	15	Fail	Pass	Fail	Pass
79	30	Fail	Pass	Fail	Pass
79	31	Fail	Fail	Fail	Fail
80	13	Fail	Pass	Fail	Pass
80	14	Fail	Pass	Fail	Pass
80	15	Fail	Pass	Fail	Pass
80	30	Fail	Pass	Fail	Pass
80	31	Fail	Fail	Fail	Fail
81	13	Fail	Pass	Fail	Pass
81	14	Fail	Pass	Fail	Pass
81	15	Fail	Pass	Fail	Pass
81	30	Fail	Pass	Fail	Pass
81	31	Fail	Fail	Fail	Fail
82	13	Fail	Pass	Fail	Pass
82	14	Fail	Pass	Fail	Pass
82	15	Fail	Pass	Fail	Pass
82	16	Fail	Fail	Fail	Fail
82	17	Fail	Fail	Fail	Fail
82	18	Fail	Pass	Fail	Pass
82	19	Fail	Fail	Fail	Fail
82	20	Fail	Fail	Fail	Fail
82	21	Fail	Fail	Fail	Fail
82	29	Fail	Fail	Fail	Fail
82	30	Fail	Pass	Fail	Pass
82	31	Fail	Fail	Fail	Fail
83	13	Fail	Pass	Fail	Pass
83	14	Fail	Pass	Fail	Pass
83	15	Fail	Pass	Fail	Pass
83	21	Fail	Pass	Fail	Pass
83	30	Fail	Fail	Fail	Pass
83	31	Fail	Fail	Fail	Fail
84	13	Fail	Pass	Fail	Pass
84	14	Fail	Pass	Fail	Pass
84	15	Fail	Pass	Fail	Pass
84	21	Fail	Pass	Fail	Pass

84	30	Fail	Fail	Fail	Fail
84	31	Fail	Fail	Fail	Fail
85	13	Fail	Pass	Fail	Pass
85	14	Fail	Pass	Fail	Pass
85	15	Fail	Pass	Fail	Pass
85	21	Fail	Pass	Fail	Pass
85	30	Fail	Fail	Fail	Fail
86	13	Fail	Pass	Fail	Pass
86	14	Fail	Pass	Fail	Pass
86	15	Fail	Pass	Fail	Pass
86	17	Fail	Fail	Fail	Fail
86	21	Fail	Pass	Fail	Pass
86	30	Fail	Pass	Fail	Pass
87	13	Fail	Pass	Fail	Pass
87	14	Fail	Pass	Fail	Pass
87	15	Fail	Pass	Fail	Pass
87	30	Fail	Pass	Fail	Pass
87	32	Fail	Fail	Fail	Fail
88	13	Fail	Pass	Fail	Pass
88	14	Fail	Pass	Fail	Pass
88	15	Fail	Pass	Fail	Pass
88	30	Fail	Fail	Fail	Fail
89	13	Fail	Pass	Fail	Pass
89	14	Fail	Pass	Fail	Pass
89	15	Fail	Pass	Fail	Pass
89	30	Fail	Fail	Fail	Fail
90	13	Fail	Pass	Fail	Pass
90	14	Fail	Pass	Fail	Pass
90	15	Fail	Pass	Fail	Pass
90	30	Fail	Fail	Fail	Fail
91	13	Fail	Pass	Fail	Pass
91	14	Fail	Pass	Fail	Pass
91	15	Fail	Pass	Fail	Pass
91	16	Fail	Fail	Fail	Fail
91	30	Fail	Fail	Fail	Fail
92	13	Fail	Pass	Fail	Pass
92	14	Fail	Pass	Fail	Pass
92	15	Fail	Pass	Fail	Pass
92	16	Fail	Pass	Fail	Fail
92	30	Fail	Fail	Fail	Fail
92	32	Fail	Fail	Fail	Fail
93	13	Fail	Pass	Fail	Pass
93	14	Fail	Pass	Fail	Pass
93	15	Fail	Pass	Fail	Pass
93	16	Fail	Pass	Fail	Pass
93	30	Fail	Fail	Fail	Fail
94	13	Fail	Pass	Fail	Pass
94	14	Fail	Pass	Fail	Pass
94	15	Fail	Pass	Fail	Pass
94	16	Fail	Pass	Fail	Pass
94	26	Fail	Pass	Fail	Pass
94	30	Fail	Fail	Fail	Fail
95	13	Fail	Pass	Fail	Pass
95	14	Fail	Pass	Fail	Pass
95	15	Fail	Pass	Fail	Pass
95	16	Fail	Fail	Fail	Fail
95	26	Fail	Pass	Fail	Pass

95	28	Fail	Fail	Fail	Fail
95	30	Fail	Fail	Fail	Fail
96	11	Fail	Fail	Fail	Fail
96	13	Fail	Pass	Fail	Pass
96	14	Fail	Pass	Fail	Pass
96	15	Fail	Pass	Fail	Pass
96	26	Fail	Pass	Fail	Pass
96	30	Fail	Fail	Fail	Fail
97	13	Fail	Pass	Fail	Pass
97	14	Fail	Pass	Fail	Pass
97	15	Fail	Pass	Fail	Pass
97	26	Fail	Pass	Fail	Pass
97	30	Pass	Fail	Fail	Fail
98	13	Fail	Pass	Fail	Pass
98	14	Fail	Pass	Fail	Pass
98	15	Fail	Pass	Fail	Pass
98	26	Fail	Pass	Fail	Pass
98	27	Fail	Pass	Fail	Pass
98	28	Fail	Pass	Fail	Pass
98	29	Fail	Pass	Fail	Pass
98	30	Fail	Fail	Fail	Fail
99	13	Fail	Pass	Fail	Pass
99	14	Fail	Pass	Fail	Pass
99	15	Fail	Pass	Fail	Pass
99	16	Fail	Fail	Fail	Fail
99	17	Fail	Fail	Fail	Fail
99	18	Fail	Fail	Fail	Fail
99	19	Fail	Fail	Fail	Fail
99	20	Fail	Fail	Fail	Fail
99	21	Fail	Fail	Fail	Fail
99	22	Fail	Fail	Fail	Fail
99	23	Fail	Fail	Fail	Fail
99	26	Fail	Fail	Fail	Fail
99	30	Fail	Fail	Fail	Fail
100	13	Fail	Pass	Fail	Pass
100	14	Fail	Pass	Fail	Pass
100	15	Fail	Pass	Fail	Pass
100	23	Fail	Fail	Fail	Fail
100	24	Fail	Fail	Fail	Fail
100	25	Fail	Fail	Fail	Fail
100	26	Fail	Pass	Fail	Pass
100	30	Fail	Fail	Fail	Fail
101	13	Fail	Pass	Fail	Pass
101	14	Fail	Pass	Fail	Pass
101	15	Fail	Pass	Fail	Pass
101	16	Fail	Fail	Fail	Fail
101	17	Fail	Fail	Fail	Fail
101	18	Fail	Fail	Fail	Fail
101	19	Fail	Fail	Fail	Fail
101	20	Fail	Fail	Fail	Fail
101	21	Fail	Fail	Fail	Fail
101	22	Fail	Fail	Fail	Fail
101	23	Fail	Fail	Fail	Fail
101	26	Fail	Pass	Fail	Pass
101	30	Pass	Pass	Fail	Pass
102	13	Fail	Pass	Fail	Pass
102	14	Fail	Pass	Fail	Pass

102	15	Fail	Pass	Fail	Pass
102	26	Fail	Pass	Fail	Pass
102	30	Pass	Pass	Fail	Pass
103	13	Fail	Pass	Fail	Pass
103	14	Fail	Pass	Fail	Pass
103	15	Fail	Pass	Fail	Pass
103	26	Fail	Pass	Fail	Pass
103	30	Pass	Pass	Fail	Pass
104	11	Fail	Fail	Fail	Fail
104	13	Fail	Pass	Fail	Pass
104	14	Fail	Pass	Fail	Pass
104	15	Fail	Pass	Fail	Pass
104	26	Fail	Pass	Fail	Pass
104	30	Pass	Pass	Fail	Pass
105	13	Fail	Pass	Fail	Pass
105	14	Fail	Pass	Fail	Pass
105	15	Fail	Pass	Fail	Pass
105	26	Fail	Pass	Fail	Pass
105	30	Pass	Fail	Fail	Fail
106	13	Fail	Pass	Fail	Pass
106	14	Fail	Pass	Fail	Pass
106	15	Fail	Pass	Fail	Pass
106	26	Fail	Pass	Fail	Pass
106	27	Fail	Fail	Fail	Fail
106	30	Pass	Pass	Fail	Pass
106	39	Pass	Fail	Pass	Fail
107	13	Pass	Pass	Fail	Pass
107	14	Pass	Pass	Fail	Pass
107	15	Pass	Pass	Fail	Pass
107	22	Fail	Pass	Fail	Pass
107	26	Fail	Pass	Fail	Pass
107	30	Pass	Pass	Pass	Pass
107	39	Pass	Pass	Pass	Pass
108	13	Pass	Pass	Fail	Pass
108	14	Pass	Pass	Fail	Pass
108	15	Pass	Pass	Fail	Pass
108	22	Fail	Pass	Fail	Pass
108	24	Fail	Fail	Fail	Fail
108	26	Fail	Pass	Fail	Pass
108	30	Pass	Pass	Pass	Pass
108	39	Pass	Fail	Pass	Fail
109	13	Pass	Pass	Fail	Pass
109	14	Pass	Pass	Fail	Pass
109	15	Pass	Pass	Fail	Pass
109	22	Fail	Pass	Fail	Pass
109	26	Fail	Pass	Fail	Pass
109	30	Pass	Fail	Pass	Fail
109	39	Pass	Pass	Pass	Pass
110	13	Pass	Pass	Pass	Pass
110	14	Pass	Pass	Fail	Pass
110	15	Pass	Pass	Fail	Pass
110	22	Fail	Pass	Fail	Pass
110	26	Fail	Pass	Fail	Pass
110	28	Fail	Fail	Fail	Fail
110	39	Pass	Fail	Pass	Fail
111	13	Pass	Pass	Pass	Pass
111	14	Pass	Pass	Pass	Pass

111	15	Pass	Pass	Pass	Pass
111	22	Fail	Pass	Fail	Pass
111	26	Fail	Pass	Fail	Pass
111	39	Pass	Fail	Pass	Fail
112	13	Pass	Pass	Pass	Pass
112	14	Pass	Pass	Pass	Pass
112	15	Pass	Pass	Pass	Pass
112	22	Pass	Fail	Fail	Fail
112	26	Pass	Pass	Fail	Pass
112	39	Pass	Fail	Pass	Fail
113	13	Pass	Pass	Pass	Pass
113	14	Pass	Pass	Pass	Pass
113	15	Pass	Pass	Pass	Pass
113	26	Pass	Pass	Fail	Pass
113	27	Pass	Fail	Fail	Fail
113	39	Pass	Pass	Pass	Pass
113	41	Fail	Fail	Fail	Fail
114	13	Pass	Pass	Pass	Pass
114	14	Pass	Pass	Pass	Pass
114	15	Pass	Pass	Pass	Pass
114	26	Pass	Pass	Fail	Pass
114	39	Pass	Pass	Pass	Pass
115	13	Pass	Pass	Pass	Pass
115	14	Pass	Pass	Pass	Pass
115	15	Pass	Pass	Pass	Pass
115	26	Pass	Pass	Fail	Pass
115	39	Pass	Pass	Pass	Pass
116	13	Pass	Pass	Pass	Pass
116	14	Pass	Pass	Pass	Pass
116	15	Pass	Pass	Pass	Pass
116	26	Pass	Fail	Fail	Fail
116	28	Fail	Fail	Fail	Fail
116	39	Pass	Pass	Pass	Pass
117	13	Pass	Pass	Pass	Pass
117	14	Pass	Pass	Pass	Pass
117	15	Pass	Pass	Pass	Pass
117	26	Pass	Fail	Pass	Fail
117	39	Pass	Pass	Pass	Pass
118	13	Pass	Pass	Pass	Pass
118	14	Pass	Pass	Pass	Pass
118	15	Pass	Pass	Pass	Pass
118	20	Pass	Fail	Pass	Fail
118	26	Pass	Pass	Pass	Pass
118	39	Pass	Pass	Pass	Pass
119	13	Pass	Pass	Pass	Pass
119	14	Pass	Pass	Pass	Pass
119	15	Pass	Pass	Pass	Pass
119	20	Pass	Pass	Pass	Pass
119	26	Pass	Pass	Pass	Pass
119	39	Pass	Pass	Pass	Pass
120	13	Pass	Pass	Pass	Pass
120	14	Pass	Pass	Pass	Pass
120	15	Pass	Fail	Pass	Fail
120	16	Pass	Fail	Pass	Fail
120	26	Pass	Fail	Pass	Fail
120	39	Pass	Pass	Pass	Pass
121	13	Pass	Pass	Pass	Pass

121	14	Pass	Pass	Pass	Pass
121	26	Pass	Fail	Pass	Fail
121	39	Pass	Pass	Pass	Pass
122	13	Pass	Pass	Pass	Pass
122	14	Pass	Pass	Pass	Pass
122	26	Pass	Fail	Pass	Fail
122	39	Pass	Pass	Pass	Pass
122	41	Fail	Fail	Fail	Fail
123	13	Pass	Pass	Pass	Pass
123	14	Pass	Pass	Pass	Pass
123	15	Pass	Fail	Pass	Fail
123	16	Pass	Pass	Pass	Pass
123	17	Pass	Pass	Pass	Pass
123	18	Pass	Pass	Pass	Pass
123	19	Pass	Pass	Pass	Pass
123	20	Pass	Pass	Pass	Pass
123	21	Pass	Pass	Pass	Pass
123	22	Pass	Pass	Pass	Pass
123	23	Pass	Pass	Pass	Pass
123	24	Pass	Pass	Pass	Pass
123	25	Pass	Pass	Pass	Pass
123	26	Pass	Pass	Pass	Pass
123	27	Pass	Pass	Pass	Pass
123	28	Pass	Pass	Pass	Pass
123	29	Pass	Fail	Pass	Fail
123	30	Pass	Fail	Pass	Fail
123	31	Pass	Fail	Pass	Fail
123	32	Pass	Fail	Pass	Fail
123	33	Pass	Fail	Pass	Fail
123	34	Pass	Pass	Pass	Pass
123	35	Pass	Pass	Pass	Pass
123	36	Pass	Pass	Pass	Pass
123	37	Pass	Pass	Pass	Pass
123	38	Pass	Fail	Pass	Fail
123	39	Pass	Fail	Pass	Fail
124	13	Pass	Pass	Pass	Pass
124	14	Pass	Pass	Pass	Pass
124	23	Pass	Pass	Pass	Pass
125	13	Pass	Pass	Pass	Pass
125	14	Pass	Pass	Pass	Pass
125	23	Pass	Pass	Pass	Pass
125	28	Fail	Fail	Fail	Fail
125	33	Fail	Fail	Fail	Fail
126	13	Pass	Pass	Pass	Pass
126	14	Pass	Pass	Pass	Pass
126	23	Pass	Pass	Pass	Pass
127	13	Pass	Pass	Pass	Pass
127	14	Pass	Pass	Pass	Pass
127	23	Pass	Pass	Pass	Pass
128	13	Pass	Pass	Pass	Pass
128	14	Pass	Pass	Pass	Pass
128	23	Pass	Pass	Pass	Pass
129	13	Pass	Pass	Pass	Pass
129	14	Pass	Pass	Pass	Pass
129	23	Pass	Pass	Pass	Pass
130	8	Pass	Fail	Pass	Fail
130	9	Pass	Fail	Pass	Fail

130	10	Pass	Fail	Pass	Fail
130	11	Pass	Fail	Pass	Fail
130	12	Pass	Fail	Pass	Fail
130	13	Pass	Fail	Pass	Fail
130	14	Pass	Pass	Pass	Pass
130	23	Pass	Pass	Pass	Pass
131	14	Pass	Pass	Pass	Pass
131	23	Pass	Pass	Pass	Pass
132	14	Pass	Pass	Pass	Pass
132	23	Pass	Pass	Pass	Pass
133	14	Pass	Pass	Pass	Pass
133	23	Pass	Pass	Pass	Pass
134	14	Pass	Pass	Pass	Pass
134	23	Pass	Fail	Pass	Fail
135	14	Pass	Pass	Pass	Pass
136	14	Pass	Pass	Pass	Pass
137	14	Pass	Pass	Pass	Pass
138	14	Pass	Pass	Pass	Pass

3. Table C.6.3 Striped Bass spawning D.O. , Salinity, and Velocity criteria passing for existing and deepening (3 ft) scenarios within the analyzed period April 1 - April 30, 1997

HABITAT REQUIREMENTS:
RM 10-31; Surface Layer
D.O. April (MG/L):n/a
Salinity 90th %ile <= 1 ppt
Mean Velocity >= 30 cm/s

Savannah Harbor Estuary

Segments J	Segments I	Baseline Scenario Salinity	Baseline Scenario Velocity	Project Scenario Salinity	Project Scenario Velocity
47	13	Fail	Pass	Fail	Pass
47	14	Fail	Pass	Fail	Pass
47	15	Fail	Pass	Fail	Pass
47	16	Fail	Pass	Fail	Pass
47	17	Fail	Fail	Fail	Fail
48	13	Fail	Pass	Fail	Pass
48	14	Fail	Pass	Fail	Pass
48	15	Fail	Pass	Fail	Pass
48	16	Fail	Pass	Fail	Pass
48	17	Fail	Pass	Fail	Pass
49	13	Fail	Pass	Fail	Pass
49	14	Fail	Pass	Fail	Pass
49	15	Fail	Pass	Fail	Pass
49	16	Fail	Pass	Fail	Pass
49	17	Fail	Pass	Fail	Pass
50	13	Fail	Pass	Fail	Pass
50	14	Fail	Pass	Fail	Pass
50	15	Fail	Pass	Fail	Pass
50	16	Fail	Pass	Fail	Pass
50	17	Fail	Pass	Fail	Pass
50	18	Fail	Fail	Fail	Fail
51	13	Fail	Pass	Fail	Pass
51	14	Fail	Pass	Fail	Pass
51	15	Fail	Pass	Fail	Pass
52	13	Fail	Pass	Fail	Pass
52	14	Fail	Pass	Fail	Pass
52	15	Fail	Pass	Fail	Pass
53	13	Fail	Pass	Fail	Pass
53	14	Fail	Pass	Fail	Pass
53	15	Fail	Pass	Fail	Pass
54	13	Fail	Pass	Fail	Pass
54	14	Fail	Pass	Fail	Pass
54	15	Fail	Pass	Fail	Pass
55	13	Fail	Pass	Fail	Pass
55	14	Fail	Pass	Fail	Pass
55	15	Fail	Pass	Fail	Pass
56	13	Fail	Pass	Fail	Pass
56	14	Fail	Pass	Fail	Pass
56	15	Fail	Pass	Fail	Pass

57	13	Fail	Pass	Fail	Pass
57	14	Fail	Pass	Fail	Pass
57	15	Fail	Pass	Fail	Pass
58	13	Fail	Pass	Fail	Pass
58	14	Fail	Pass	Fail	Pass
58	15	Fail	Pass	Fail	Pass
59	13	Fail	Pass	Fail	Pass
59	14	Fail	Pass	Fail	Pass
59	15	Fail	Pass	Fail	Pass
59	30	Fail	Pass	Fail	Pass
59	31	Fail	Pass	Fail	Pass
59	32	Fail	Fail	Fail	Fail
60	13	Fail	Pass	Fail	Pass
60	14	Fail	Pass	Fail	Pass
60	15	Fail	Pass	Fail	Pass
60	30	Fail	Fail	Fail	Fail
60	31	Fail	Pass	Fail	Pass
60	32	Fail	Fail	Fail	Fail
61	13	Fail	Pass	Fail	Pass
61	14	Fail	Pass	Fail	Pass
61	15	Fail	Pass	Fail	Pass
61	30	Fail	Fail	Fail	Fail
61	31	Fail	Pass	Fail	Pass
61	32	Fail	Fail	Fail	Fail
62	13	Fail	Pass	Fail	Pass
62	14	Fail	Pass	Fail	Pass
62	15	Fail	Pass	Fail	Pass
62	30	Fail	Fail	Fail	Fail
62	31	Fail	Pass	Fail	Pass
62	32	Fail	Fail	Fail	Fail
63	13	Fail	Pass	Fail	Pass
63	14	Fail	Pass	Fail	Pass
63	15	Fail	Pass	Fail	Pass
63	31	Fail	Pass	Fail	Pass
64	13	Fail	Pass	Fail	Pass
64	14	Fail	Pass	Fail	Pass
64	15	Fail	Pass	Fail	Pass
64	30	Fail	Fail	Fail	Fail
64	31	Fail	Pass	Fail	Pass
64	32	Fail	Fail	Fail	Fail
65	13	Fail	Pass	Fail	Pass
65	14	Fail	Pass	Fail	Pass
65	15	Fail	Pass	Fail	Pass
65	30	Fail	Pass	Fail	Pass
65	31	Fail	Pass	Fail	Pass
65	32	Fail	Pass	Fail	Pass
65	33	Fail	Fail	Fail	Fail
66	13	Fail	Pass	Fail	Pass
66	14	Fail	Pass	Fail	Pass
66	15	Fail	Pass	Fail	Pass
66	30	Fail	Pass	Fail	Pass
66	31	Fail	Pass	Fail	Pass
66	32	Fail	Pass	Fail	Pass
66	36	Fail	Pass	Fail	Pass
66	38	Fail	Fail	Fail	Fail
67	13	Fail	Pass	Fail	Pass
67	14	Fail	Pass	Fail	Pass

67	15	Fail	Pass	Fail	Pass
67	30	Fail	Pass	Fail	Pass
67	31	Fail	Pass	Fail	Pass
67	32	Fail	Pass	Fail	Pass
67	36	Fail	Fail	Fail	Fail
68	13	Fail	Pass	Fail	Pass
68	14	Fail	Pass	Fail	Pass
68	15	Fail	Pass	Fail	Pass
68	30	Fail	Pass	Fail	Pass
68	31	Fail	Pass	Fail	Pass
68	32	Fail	Pass	Fail	Pass
68	36	Fail	Fail	Fail	Fail
68	38	Fail	Fail	Fail	Fail
69	13	Fail	Pass	Fail	Pass
69	14	Fail	Pass	Fail	Pass
69	15	Fail	Pass	Fail	Pass
69	30	Fail	Pass	Fail	Pass
69	31	Fail	Pass	Fail	Pass
69	32	Fail	Fail	Fail	Fail
69	36	Fail	Fail	Fail	Fail
70	13	Fail	Pass	Fail	Pass
70	14	Fail	Pass	Fail	Pass
70	15	Fail	Pass	Fail	Pass
70	30	Fail	Pass	Fail	Pass
70	31	Fail	Pass	Fail	Pass
70	32	Fail	Fail	Fail	Fail
70	33	Fail	Fail	Fail	Fail
71	13	Fail	Pass	Fail	Pass
71	14	Fail	Pass	Fail	Pass
71	15	Fail	Pass	Fail	Pass
71	30	Fail	Pass	Fail	Pass
71	31	Fail	Pass	Fail	Pass
71	32	Fail	Fail	Fail	Fail
72	13	Fail	Pass	Fail	Pass
72	14	Fail	Pass	Fail	Pass
72	15	Fail	Pass	Fail	Pass
72	30	Fail	Pass	Fail	Pass
72	31	Fail	Pass	Fail	Pass
72	32	Fail	Fail	Fail	Fail
73	13	Fail	Pass	Fail	Pass
73	14	Fail	Pass	Fail	Pass
73	15	Fail	Pass	Fail	Pass
73	30	Fail	Fail	Fail	Pass
73	31	Fail	Pass	Fail	Pass
74	13	Fail	Pass	Fail	Pass
74	14	Fail	Pass	Fail	Pass
74	15	Fail	Pass	Fail	Pass
74	30	Fail	Fail	Fail	Fail
74	31	Fail	Pass	Fail	Pass
75	13	Fail	Pass	Fail	Pass
75	14	Fail	Pass	Fail	Pass
75	15	Fail	Pass	Fail	Pass
75	30	Fail	Pass	Fail	Pass
75	31	Fail	Pass	Fail	Pass
76	13	Fail	Pass	Fail	Pass
76	14	Fail	Pass	Fail	Pass
76	15	Fail	Fail	Fail	Fail

76	16	Fail	Fail	Fail	Fail
76	17	Fail	Fail	Fail	Fail
76	30	Fail	Pass	Fail	Pass
76	31	Fail	Pass	Fail	Pass
76	33	Fail	Fail	Fail	Fail
77	13	Fail	Pass	Fail	Pass
77	14	Fail	Pass	Fail	Pass
77	15	Fail	Fail	Fail	Fail
77	16	Fail	Fail	Fail	Fail
77	17	Fail	Fail	Fail	Fail
77	30	Fail	Fail	Fail	Fail
77	31	Fail	Fail	Fail	Fail
78	13	Fail	Pass	Fail	Pass
78	14	Fail	Pass	Fail	Pass
78	15	Fail	Fail	Fail	Fail
78	16	Fail	Fail	Fail	Fail
78	17	Fail	Fail	Fail	Fail
78	30	Fail	Fail	Fail	Pass
78	31	Fail	Fail	Fail	Fail
79	13	Fail	Pass	Fail	Pass
79	14	Fail	Pass	Fail	Pass
79	15	Fail	Pass	Fail	Pass
79	30	Fail	Pass	Fail	Pass
79	31	Fail	Fail	Fail	Fail
80	13	Fail	Pass	Fail	Pass
80	14	Fail	Pass	Fail	Pass
80	15	Fail	Pass	Fail	Pass
80	30	Fail	Pass	Fail	Pass
80	31	Fail	Fail	Fail	Fail
81	13	Fail	Pass	Fail	Pass
81	14	Fail	Pass	Fail	Pass
81	15	Fail	Pass	Fail	Pass
81	30	Fail	Pass	Fail	Pass
81	31	Fail	Fail	Fail	Fail
82	13	Fail	Pass	Fail	Pass
82	14	Fail	Pass	Fail	Pass
82	15	Fail	Pass	Fail	Pass
82	16	Fail	Fail	Fail	Fail
82	17	Fail	Fail	Fail	Fail
82	18	Fail	Pass	Fail	Pass
82	19	Fail	Fail	Fail	Fail
82	20	Fail	Fail	Fail	Fail
82	21	Fail	Fail	Fail	Fail
82	29	Fail	Fail	Fail	Fail
82	30	Fail	Pass	Fail	Pass
82	31	Fail	Fail	Fail	Fail
83	13	Fail	Pass	Fail	Pass
83	14	Fail	Pass	Fail	Pass
83	15	Fail	Pass	Fail	Pass
83	21	Fail	Pass	Fail	Pass
83	30	Fail	Fail	Fail	Pass
83	31	Fail	Fail	Fail	Fail
84	13	Fail	Pass	Fail	Pass
84	14	Fail	Pass	Fail	Pass
84	15	Fail	Pass	Fail	Pass
84	21	Fail	Pass	Fail	Pass
84	30	Fail	Fail	Fail	Fail

84	31	Fail	Fail	Fail	Fail
85	13	Fail	Pass	Fail	Pass
85	14	Fail	Pass	Fail	Pass
85	15	Fail	Pass	Fail	Pass
85	21	Fail	Pass	Fail	Pass
85	30	Fail	Fail	Fail	Fail
86	13	Fail	Pass	Fail	Pass
86	14	Fail	Pass	Fail	Pass
86	15	Fail	Pass	Fail	Pass
86	17	Fail	Fail	Fail	Fail
86	21	Fail	Pass	Fail	Pass
86	30	Fail	Pass	Fail	Pass
87	13	Fail	Pass	Fail	Pass
87	14	Fail	Pass	Fail	Pass
87	15	Fail	Pass	Fail	Pass
87	30	Fail	Pass	Fail	Pass
87	32	Fail	Fail	Fail	Fail
88	13	Fail	Pass	Fail	Pass
88	14	Fail	Pass	Fail	Pass
88	15	Fail	Pass	Fail	Pass
88	30	Fail	Fail	Fail	Fail
89	13	Fail	Pass	Fail	Pass
89	14	Fail	Pass	Fail	Pass
89	15	Fail	Pass	Fail	Pass
89	30	Fail	Fail	Fail	Fail
90	13	Fail	Pass	Fail	Pass
90	14	Fail	Pass	Fail	Pass
90	15	Fail	Pass	Fail	Pass
90	30	Fail	Fail	Fail	Fail
91	13	Fail	Pass	Fail	Pass
91	14	Fail	Pass	Fail	Pass
91	15	Fail	Pass	Fail	Pass
91	16	Fail	Fail	Fail	Fail
91	30	Fail	Fail	Fail	Fail
92	13	Fail	Pass	Fail	Pass
92	14	Fail	Pass	Fail	Pass
92	15	Fail	Pass	Fail	Pass
92	16	Fail	Pass	Fail	Pass
92	30	Fail	Fail	Fail	Fail
92	32	Fail	Fail	Fail	Fail
93	13	Fail	Pass	Fail	Pass
93	14	Fail	Pass	Fail	Pass
93	15	Fail	Pass	Fail	Pass
93	16	Fail	Pass	Fail	Pass
93	30	Fail	Fail	Fail	Fail
94	13	Fail	Pass	Fail	Pass
94	14	Fail	Pass	Fail	Pass
94	15	Fail	Pass	Fail	Pass
94	16	Fail	Pass	Fail	Pass
94	26	Fail	Pass	Fail	Pass
94	30	Fail	Fail	Fail	Fail
95	13	Fail	Pass	Fail	Pass
95	14	Fail	Pass	Fail	Pass
95	15	Fail	Pass	Fail	Pass
95	16	Fail	Fail	Fail	Fail
95	26	Fail	Pass	Fail	Pass
95	28	Fail	Fail	Fail	Fail

95	30	Fail	Fail	Fail	Fail
96	11	Fail	Fail	Fail	Fail
96	13	Fail	Pass	Fail	Pass
96	14	Fail	Pass	Fail	Pass
96	15	Fail	Pass	Fail	Pass
96	26	Fail	Pass	Fail	Pass
96	30	Fail	Fail	Fail	Fail
97	13	Fail	Pass	Fail	Pass
97	14	Fail	Pass	Fail	Pass
97	15	Fail	Pass	Fail	Pass
97	26	Fail	Pass	Fail	Pass
97	30	Pass	Fail	Fail	Fail
98	13	Fail	Pass	Fail	Pass
98	14	Fail	Pass	Fail	Pass
98	15	Fail	Pass	Fail	Pass
98	26	Fail	Pass	Fail	Pass
98	27	Fail	Pass	Fail	Pass
98	28	Fail	Pass	Fail	Pass
98	29	Fail	Pass	Fail	Pass
98	30	Fail	Fail	Fail	Fail
99	13	Fail	Pass	Fail	Pass
99	14	Fail	Pass	Fail	Pass
99	15	Fail	Pass	Fail	Pass
99	16	Fail	Fail	Fail	Fail
99	17	Fail	Fail	Fail	Fail
99	18	Fail	Fail	Fail	Fail
99	19	Fail	Fail	Fail	Fail
99	20	Fail	Fail	Fail	Fail
99	21	Fail	Fail	Fail	Fail
99	22	Fail	Fail	Fail	Fail
99	23	Fail	Fail	Fail	Fail
99	26	Fail	Fail	Fail	Fail
99	30	Fail	Fail	Fail	Fail
100	13	Fail	Pass	Fail	Pass
100	14	Fail	Pass	Fail	Pass
100	15	Fail	Pass	Fail	Pass
100	23	Fail	Fail	Fail	Fail
100	24	Fail	Fail	Fail	Fail
100	25	Fail	Fail	Fail	Fail
100	26	Fail	Pass	Fail	Pass
100	30	Fail	Fail	Fail	Fail
101	13	Fail	Pass	Fail	Pass
101	14	Fail	Pass	Fail	Pass
101	15	Fail	Pass	Fail	Pass
101	16	Fail	Fail	Fail	Fail
101	17	Fail	Fail	Fail	Fail
101	18	Fail	Fail	Fail	Fail
101	19	Fail	Fail	Fail	Fail
101	20	Fail	Fail	Fail	Fail
101	21	Fail	Fail	Fail	Fail
101	22	Fail	Fail	Fail	Fail
101	23	Fail	Fail	Fail	Fail
101	26	Fail	Pass	Fail	Pass
101	30	Pass	Pass	Fail	Pass
102	13	Fail	Pass	Fail	Pass
102	14	Fail	Pass	Fail	Pass
102	15	Fail	Pass	Fail	Pass

102	26	Fail	Pass	Fail	Pass
102	30	Pass	Pass	Fail	Pass
103	13	Fail	Pass	Fail	Pass
103	14	Fail	Pass	Fail	Pass
103	15	Fail	Pass	Fail	Pass
103	26	Fail	Pass	Fail	Pass
103	30	Pass	Pass	Fail	Pass
104	11	Fail	Fail	Fail	Fail
104	13	Fail	Pass	Fail	Pass
104	14	Fail	Pass	Fail	Pass
104	15	Fail	Pass	Fail	Pass
104	26	Fail	Pass	Fail	Pass
104	30	Pass	Pass	Fail	Pass
105	13	Fail	Pass	Fail	Pass
105	14	Fail	Pass	Fail	Pass
105	15	Fail	Pass	Fail	Pass
105	26	Fail	Pass	Fail	Pass
105	30	Pass	Fail	Pass	Fail
106	13	Fail	Pass	Fail	Pass
106	14	Fail	Pass	Fail	Pass
106	15	Fail	Pass	Fail	Pass
106	26	Fail	Pass	Fail	Pass
106	27	Fail	Fail	Fail	Fail
106	30	Pass	Pass	Pass	Pass
106	39	Pass	Fail	Pass	Fail
107	13	Pass	Pass	Fail	Pass
107	14	Pass	Pass	Fail	Pass
107	15	Pass	Pass	Fail	Pass
107	22	Fail	Pass	Fail	Pass
107	26	Fail	Pass	Fail	Pass
107	30	Pass	Pass	Pass	Pass
107	39	Pass	Pass	Pass	Pass
108	13	Pass	Pass	Fail	Pass
108	14	Pass	Pass	Fail	Pass
108	15	Pass	Pass	Fail	Pass
108	22	Fail	Pass	Fail	Pass
108	24	Fail	Fail	Fail	Fail
108	26	Fail	Pass	Fail	Pass
108	30	Pass	Pass	Pass	Pass
108	39	Pass	Fail	Pass	Fail
109	13	Pass	Pass	Pass	Pass
109	14	Pass	Pass	Fail	Pass
109	15	Pass	Pass	Fail	Pass
109	22	Fail	Pass	Fail	Pass
109	26	Fail	Pass	Fail	Pass
109	30	Pass	Fail	Pass	Fail
109	39	Pass	Pass	Pass	Pass
110	13	Pass	Pass	Pass	Pass
110	14	Pass	Pass	Pass	Pass
110	15	Pass	Pass	Pass	Pass
110	22	Fail	Pass	Fail	Pass
110	26	Fail	Pass	Fail	Pass
110	28	Fail	Fail	Fail	Fail
110	39	Pass	Fail	Pass	Fail
111	13	Pass	Pass	Pass	Pass
111	14	Pass	Pass	Pass	Pass
111	15	Pass	Pass	Pass	Pass

111	22	Fail	Pass	Fail	Pass
111	26	Fail	Pass	Fail	Pass
111	39	Pass	Fail	Pass	Fail
112	13	Pass	Pass	Pass	Pass
112	14	Pass	Pass	Pass	Pass
112	15	Pass	Pass	Pass	Pass
112	22	Pass	Fail	Fail	Fail
112	26	Pass	Pass	Fail	Pass
112	39	Pass	Fail	Pass	Fail
113	13	Pass	Pass	Pass	Pass
113	14	Pass	Pass	Pass	Pass
113	15	Pass	Pass	Pass	Pass
113	26	Pass	Pass	Fail	Pass
113	27	Pass	Fail	Fail	Fail
113	39	Pass	Pass	Pass	Pass
113	41	Fail	Fail	Fail	Fail
114	13	Pass	Pass	Pass	Pass
114	14	Pass	Pass	Pass	Pass
114	15	Pass	Pass	Pass	Pass
114	26	Pass	Pass	Fail	Pass
114	39	Pass	Pass	Pass	Pass
115	13	Pass	Pass	Pass	Pass
115	14	Pass	Pass	Pass	Pass
115	15	Pass	Pass	Pass	Pass
115	26	Pass	Pass	Fail	Pass
115	39	Pass	Pass	Pass	Pass
116	13	Pass	Pass	Pass	Pass
116	14	Pass	Pass	Pass	Pass
116	15	Pass	Pass	Pass	Pass
116	26	Pass	Fail	Pass	Fail
116	28	Fail	Fail	Fail	Fail
116	39	Pass	Pass	Pass	Pass
117	13	Pass	Pass	Pass	Pass
117	14	Pass	Pass	Pass	Pass
117	15	Pass	Pass	Pass	Pass
117	26	Pass	Fail	Pass	Fail
117	39	Pass	Pass	Pass	Pass
118	13	Pass	Pass	Pass	Pass
118	14	Pass	Pass	Pass	Pass
118	15	Pass	Pass	Pass	Pass
118	20	Pass	Fail	Pass	Fail
118	26	Pass	Pass	Pass	Pass
118	39	Pass	Pass	Pass	Pass
119	13	Pass	Pass	Pass	Pass
119	14	Pass	Pass	Pass	Pass
119	15	Pass	Pass	Pass	Pass
119	20	Pass	Pass	Pass	Pass
119	26	Pass	Pass	Pass	Pass
119	39	Pass	Pass	Pass	Pass
120	13	Pass	Pass	Pass	Pass
120	14	Pass	Pass	Pass	Pass
120	15	Pass	Fail	Pass	Fail
120	16	Pass	Fail	Pass	Fail
120	26	Pass	Fail	Pass	Fail
120	39	Pass	Pass	Pass	Pass
121	13	Pass	Pass	Pass	Pass
121	14	Pass	Pass	Pass	Pass

121	26	Pass	Fail	Pass	Fail
121	39	Pass	Pass	Pass	Pass
122	13	Pass	Pass	Pass	Pass
122	14	Pass	Pass	Pass	Pass
122	26	Pass	Fail	Pass	Fail
122	39	Pass	Pass	Pass	Pass
122	41	Fail	Fail	Fail	Fail
123	13	Pass	Pass	Pass	Pass
123	14	Pass	Pass	Pass	Pass
123	15	Pass	Fail	Pass	Fail
123	16	Pass	Pass	Pass	Pass
123	17	Pass	Pass	Pass	Pass
123	18	Pass	Pass	Pass	Pass
123	19	Pass	Pass	Pass	Pass
123	20	Pass	Pass	Pass	Pass
123	21	Pass	Pass	Pass	Pass
123	22	Pass	Pass	Pass	Pass
123	23	Pass	Pass	Pass	Pass
123	24	Pass	Pass	Pass	Pass
123	25	Pass	Pass	Pass	Pass
123	26	Pass	Pass	Pass	Pass
123	27	Pass	Pass	Pass	Pass
123	28	Pass	Pass	Pass	Pass
123	29	Pass	Fail	Pass	Fail
123	30	Pass	Fail	Pass	Fail
123	31	Pass	Fail	Pass	Fail
123	32	Pass	Fail	Pass	Fail
123	33	Pass	Fail	Pass	Fail
123	34	Pass	Pass	Pass	Pass
123	35	Pass	Pass	Pass	Pass
123	36	Pass	Pass	Pass	Pass
123	37	Pass	Pass	Pass	Pass
123	38	Pass	Fail	Pass	Fail
123	39	Pass	Fail	Pass	Fail
124	13	Pass	Pass	Pass	Pass
124	14	Pass	Pass	Pass	Pass
124	23	Pass	Pass	Pass	Pass
125	13	Pass	Pass	Pass	Pass
125	14	Pass	Pass	Pass	Pass
125	23	Pass	Pass	Pass	Pass
125	28	Fail	Fail	Fail	Fail
125	33	Fail	Fail	Fail	Fail
126	13	Pass	Pass	Pass	Pass
126	14	Pass	Pass	Pass	Pass
126	23	Pass	Pass	Pass	Pass
127	13	Pass	Pass	Pass	Pass
127	14	Pass	Pass	Pass	Pass
127	23	Pass	Pass	Pass	Pass
128	13	Pass	Pass	Pass	Pass
128	14	Pass	Pass	Pass	Pass
128	23	Pass	Pass	Pass	Pass
129	13	Pass	Pass	Pass	Pass
129	14	Pass	Pass	Pass	Pass
129	23	Pass	Pass	Pass	Pass
130	8	Pass	Fail	Pass	Fail
130	9	Pass	Fail	Pass	Fail
130	10	Pass	Fail	Pass	Fail

130	11	Pass	Fail	Pass	Fail
130	12	Pass	Fail	Pass	Fail
130	13	Pass	Fail	Pass	Fail
130	14	Pass	Pass	Pass	Pass
130	23	Pass	Pass	Pass	Pass
131	14	Pass	Pass	Pass	Pass
131	23	Pass	Pass	Pass	Pass
132	14	Pass	Pass	Pass	Pass
132	23	Pass	Pass	Pass	Pass
133	14	Pass	Pass	Pass	Pass
133	23	Pass	Pass	Pass	Pass
134	14	Pass	Pass	Pass	Pass
134	23	Pass	Fail	Pass	Fail
135	14	Pass	Pass	Pass	Pass
136	14	Pass	Pass	Pass	Pass
137	14	Pass	Pass	Pass	Pass
138	14	Pass	Pass	Pass	Pass

4. Table C.6.4 Striped Bass spawning D.O. , Salinity, and Velocity criteria passing for existing and deepening (2 ft) scenarios within the analyzed period April 1 - April 30, 1997

HABITAT REQUIREMENTS:
RM 10-31; Surface Layer
D.O. April (MG/L):n/a
Salinity 90th %ile <= 1 ppt
Mean Velocity >= 30 cm/s

Savannah Harbor Estuary

Segments J	Segments I	Baseline Scenario Salinity	Baseline Scenario Velocity	Project Scenario Salinity	Project Scenario Velocity
47	13	Fail	Pass	Fail	Pass
47	14	Fail	Pass	Fail	Pass
47	15	Fail	Pass	Fail	Pass
47	16	Fail	Pass	Fail	Pass
47	17	Fail	Fail	Fail	Fail
48	13	Fail	Pass	Fail	Pass
48	14	Fail	Pass	Fail	Pass
48	15	Fail	Pass	Fail	Pass
48	16	Fail	Pass	Fail	Pass
48	17	Fail	Pass	Fail	Pass
49	13	Fail	Pass	Fail	Pass
49	14	Fail	Pass	Fail	Pass
49	15	Fail	Pass	Fail	Pass
49	16	Fail	Pass	Fail	Pass
49	17	Fail	Pass	Fail	Pass
50	13	Fail	Pass	Fail	Pass
50	14	Fail	Pass	Fail	Pass
50	15	Fail	Pass	Fail	Pass
50	16	Fail	Pass	Fail	Pass
50	17	Fail	Pass	Fail	Pass
50	18	Fail	Fail	Fail	Fail
51	13	Fail	Pass	Fail	Pass
51	14	Fail	Pass	Fail	Pass
51	15	Fail	Pass	Fail	Pass
52	13	Fail	Pass	Fail	Pass
52	14	Fail	Pass	Fail	Pass
52	15	Fail	Pass	Fail	Pass
53	13	Fail	Pass	Fail	Pass
53	14	Fail	Pass	Fail	Pass
53	15	Fail	Pass	Fail	Pass
54	13	Fail	Pass	Fail	Pass
54	14	Fail	Pass	Fail	Pass
54	15	Fail	Pass	Fail	Pass
55	13	Fail	Pass	Fail	Pass
55	14	Fail	Pass	Fail	Pass
55	15	Fail	Pass	Fail	Pass

56	13	Fail	Pass	Fail	Pass
56	14	Fail	Pass	Fail	Pass
56	15	Fail	Pass	Fail	Pass
57	13	Fail	Pass	Fail	Pass
57	14	Fail	Pass	Fail	Pass
57	15	Fail	Pass	Fail	Pass
58	13	Fail	Pass	Fail	Pass
58	14	Fail	Pass	Fail	Pass
58	15	Fail	Pass	Fail	Pass
59	13	Fail	Pass	Fail	Pass
59	14	Fail	Pass	Fail	Pass
59	15	Fail	Pass	Fail	Pass
59	30	Fail	Pass	Fail	Pass
59	31	Fail	Pass	Fail	Pass
59	32	Fail	Fail	Fail	Fail
60	13	Fail	Pass	Fail	Pass
60	14	Fail	Pass	Fail	Pass
60	15	Fail	Pass	Fail	Pass
60	30	Fail	Fail	Fail	Fail
60	31	Fail	Pass	Fail	Pass
60	32	Fail	Fail	Fail	Fail
61	13	Fail	Pass	Fail	Pass
61	14	Fail	Pass	Fail	Pass
61	15	Fail	Pass	Fail	Pass
61	30	Fail	Fail	Fail	Fail
61	31	Fail	Pass	Fail	Pass
61	32	Fail	Fail	Fail	Fail
62	13	Fail	Pass	Fail	Pass
62	14	Fail	Pass	Fail	Pass
62	15	Fail	Pass	Fail	Pass
62	30	Fail	Fail	Fail	Fail
62	31	Fail	Pass	Fail	Pass
62	32	Fail	Fail	Fail	Fail
63	13	Fail	Pass	Fail	Pass
63	14	Fail	Pass	Fail	Pass
63	15	Fail	Pass	Fail	Pass
63	31	Fail	Pass	Fail	Pass
64	13	Fail	Pass	Fail	Pass
64	14	Fail	Pass	Fail	Pass
64	15	Fail	Pass	Fail	Pass
64	30	Fail	Fail	Fail	Fail
64	31	Fail	Pass	Fail	Pass
64	32	Fail	Fail	Fail	Fail
65	13	Fail	Pass	Fail	Pass
65	14	Fail	Pass	Fail	Pass
65	15	Fail	Pass	Fail	Pass
65	30	Fail	Pass	Fail	Pass
65	31	Fail	Pass	Fail	Pass
65	32	Fail	Pass	Fail	Pass
65	33	Fail	Fail	Fail	Fail
66	13	Fail	Pass	Fail	Pass
66	14	Fail	Pass	Fail	Pass
66	15	Fail	Pass	Fail	Pass
66	30	Fail	Pass	Fail	Pass
66	31	Fail	Pass	Fail	Pass
66	32	Fail	Pass	Fail	Pass
66	36	Fail	Pass	Fail	Pass

66	38	Fail	Fail	Fail	Fail
67	13	Fail	Pass	Fail	Pass
67	14	Fail	Pass	Fail	Pass
67	15	Fail	Pass	Fail	Pass
67	30	Fail	Pass	Fail	Pass
67	31	Fail	Pass	Fail	Pass
67	32	Fail	Pass	Fail	Pass
67	36	Fail	Fail	Fail	Fail
68	13	Fail	Pass	Fail	Pass
68	14	Fail	Pass	Fail	Pass
68	15	Fail	Pass	Fail	Pass
68	30	Fail	Pass	Fail	Pass
68	31	Fail	Pass	Fail	Pass
68	32	Fail	Pass	Fail	Pass
68	36	Fail	Fail	Fail	Fail
68	38	Fail	Fail	Fail	Fail
69	13	Fail	Pass	Fail	Pass
69	14	Fail	Pass	Fail	Pass
69	15	Fail	Pass	Fail	Pass
69	30	Fail	Pass	Fail	Pass
69	31	Fail	Pass	Fail	Pass
69	32	Fail	Fail	Fail	Fail
69	36	Fail	Fail	Fail	Fail
70	13	Fail	Pass	Fail	Pass
70	14	Fail	Pass	Fail	Pass
70	15	Fail	Pass	Fail	Pass
70	30	Fail	Pass	Fail	Pass
70	31	Fail	Pass	Fail	Pass
70	32	Fail	Fail	Fail	Fail
70	33	Fail	Fail	Fail	Fail
71	13	Fail	Pass	Fail	Pass
71	14	Fail	Pass	Fail	Pass
71	15	Fail	Pass	Fail	Pass
71	30	Fail	Pass	Fail	Pass
71	31	Fail	Pass	Fail	Pass
71	32	Fail	Fail	Fail	Fail
72	13	Fail	Pass	Fail	Pass
72	14	Fail	Pass	Fail	Pass
72	15	Fail	Pass	Fail	Pass
72	30	Fail	Pass	Fail	Pass
72	31	Fail	Pass	Fail	Pass
72	32	Fail	Fail	Fail	Fail
73	13	Fail	Pass	Fail	Pass
73	14	Fail	Pass	Fail	Pass
73	15	Fail	Pass	Fail	Pass
73	30	Fail	Fail	Fail	Pass
73	31	Fail	Pass	Fail	Pass
74	13	Fail	Pass	Fail	Pass
74	14	Fail	Pass	Fail	Pass
74	15	Fail	Pass	Fail	Pass
74	30	Fail	Fail	Fail	Fail
74	31	Fail	Pass	Fail	Pass
75	13	Fail	Pass	Fail	Pass
75	14	Fail	Pass	Fail	Pass
75	15	Fail	Pass	Fail	Pass
75	30	Fail	Pass	Fail	Pass
75	31	Fail	Pass	Fail	Pass

76	13	Fail	Pass	Fail	Pass
76	14	Fail	Pass	Fail	Pass
76	15	Fail	Fail	Fail	Fail
76	16	Fail	Fail	Fail	Fail
76	17	Fail	Fail	Fail	Fail
76	30	Fail	Pass	Fail	Pass
76	31	Fail	Pass	Fail	Pass
76	33	Fail	Fail	Fail	Fail
77	13	Fail	Pass	Fail	Pass
77	14	Fail	Pass	Fail	Pass
77	15	Fail	Fail	Fail	Fail
77	16	Fail	Fail	Fail	Fail
77	17	Fail	Fail	Fail	Fail
77	30	Fail	Fail	Fail	Fail
77	31	Fail	Fail	Fail	Fail
78	13	Fail	Pass	Fail	Pass
78	14	Fail	Pass	Fail	Pass
78	15	Fail	Fail	Fail	Fail
78	16	Fail	Fail	Fail	Fail
78	17	Fail	Fail	Fail	Fail
78	30	Fail	Fail	Fail	Pass
78	31	Fail	Fail	Fail	Fail
79	13	Fail	Pass	Fail	Pass
79	14	Fail	Pass	Fail	Pass
79	15	Fail	Pass	Fail	Pass
79	30	Fail	Pass	Fail	Pass
79	31	Fail	Fail	Fail	Fail
80	13	Fail	Pass	Fail	Pass
80	14	Fail	Pass	Fail	Pass
80	15	Fail	Pass	Fail	Pass
80	30	Fail	Pass	Fail	Pass
80	31	Fail	Fail	Fail	Fail
81	13	Fail	Pass	Fail	Pass
81	14	Fail	Pass	Fail	Pass
81	15	Fail	Pass	Fail	Pass
81	30	Fail	Pass	Fail	Pass
81	31	Fail	Fail	Fail	Fail
82	13	Fail	Pass	Fail	Pass
82	14	Fail	Pass	Fail	Pass
82	15	Fail	Pass	Fail	Pass
82	16	Fail	Fail	Fail	Fail
82	17	Fail	Fail	Fail	Fail
82	18	Fail	Pass	Fail	Pass
82	19	Fail	Fail	Fail	Fail
82	20	Fail	Fail	Fail	Fail
82	21	Fail	Fail	Fail	Fail
82	29	Fail	Fail	Fail	Fail
82	30	Fail	Pass	Fail	Pass
82	31	Fail	Fail	Fail	Fail
83	13	Fail	Pass	Fail	Pass
83	14	Fail	Pass	Fail	Pass
83	15	Fail	Pass	Fail	Pass
83	21	Fail	Pass	Fail	Pass
83	30	Fail	Fail	Fail	Pass
83	31	Fail	Fail	Fail	Fail
84	13	Fail	Pass	Fail	Pass
84	14	Fail	Pass	Fail	Pass

84	15	Fail	Pass	Fail	Pass
84	21	Fail	Pass	Fail	Pass
84	30	Fail	Fail	Fail	Fail
84	31	Fail	Fail	Fail	Fail
85	13	Fail	Pass	Fail	Pass
85	14	Fail	Pass	Fail	Pass
85	15	Fail	Pass	Fail	Pass
85	21	Fail	Pass	Fail	Pass
85	30	Fail	Fail	Fail	Fail
86	13	Fail	Pass	Fail	Pass
86	14	Fail	Pass	Fail	Pass
86	15	Fail	Pass	Fail	Pass
86	17	Fail	Fail	Fail	Fail
86	21	Fail	Pass	Fail	Pass
86	30	Fail	Pass	Fail	Pass
87	13	Fail	Pass	Fail	Pass
87	14	Fail	Pass	Fail	Pass
87	15	Fail	Pass	Fail	Pass
87	30	Fail	Pass	Fail	Pass
87	32	Fail	Fail	Fail	Fail
88	13	Fail	Pass	Fail	Pass
88	14	Fail	Pass	Fail	Pass
88	15	Fail	Pass	Fail	Pass
88	30	Fail	Fail	Fail	Fail
89	13	Fail	Pass	Fail	Pass
89	14	Fail	Pass	Fail	Pass
89	15	Fail	Pass	Fail	Pass
89	30	Fail	Fail	Fail	Fail
90	13	Fail	Pass	Fail	Pass
90	14	Fail	Pass	Fail	Pass
90	15	Fail	Pass	Fail	Pass
90	30	Fail	Fail	Fail	Fail
91	13	Fail	Pass	Fail	Pass
91	14	Fail	Pass	Fail	Pass
91	15	Fail	Pass	Fail	Pass
91	16	Fail	Fail	Fail	Fail
91	30	Fail	Fail	Fail	Fail
92	13	Fail	Pass	Fail	Pass
92	14	Fail	Pass	Fail	Pass
92	15	Fail	Pass	Fail	Pass
92	16	Fail	Pass	Fail	Pass
92	30	Fail	Fail	Fail	Fail
92	32	Fail	Fail	Fail	Fail
93	13	Fail	Pass	Fail	Pass
93	14	Fail	Pass	Fail	Pass
93	15	Fail	Pass	Fail	Pass
93	16	Fail	Pass	Fail	Pass
93	30	Fail	Fail	Fail	Fail
94	13	Fail	Pass	Fail	Pass
94	14	Fail	Pass	Fail	Pass
94	15	Fail	Pass	Fail	Pass
94	16	Fail	Pass	Fail	Pass
94	26	Fail	Pass	Fail	Pass
94	30	Fail	Fail	Fail	Fail
95	13	Fail	Pass	Fail	Pass
95	14	Fail	Pass	Fail	Pass
95	15	Fail	Pass	Fail	Pass

95	16	Fail	Fail	Fail	Fail
95	26	Fail	Pass	Fail	Pass
95	28	Fail	Fail	Fail	Fail
95	30	Fail	Fail	Fail	Fail
96	11	Fail	Fail	Fail	Fail
96	13	Fail	Pass	Fail	Pass
96	14	Fail	Pass	Fail	Pass
96	15	Fail	Pass	Fail	Pass
96	26	Fail	Pass	Fail	Pass
96	30	Fail	Fail	Fail	Fail
97	13	Fail	Pass	Fail	Pass
97	14	Fail	Pass	Fail	Pass
97	15	Fail	Pass	Fail	Pass
97	26	Fail	Pass	Fail	Pass
97	30	Pass	Fail	Fail	Fail
98	13	Fail	Pass	Fail	Pass
98	14	Fail	Pass	Fail	Pass
98	15	Fail	Pass	Fail	Pass
98	26	Fail	Pass	Fail	Pass
98	27	Fail	Pass	Fail	Pass
98	28	Fail	Pass	Fail	Pass
98	29	Fail	Pass	Fail	Pass
98	30	Fail	Fail	Fail	Fail
99	13	Fail	Pass	Fail	Pass
99	14	Fail	Pass	Fail	Pass
99	15	Fail	Pass	Fail	Pass
99	16	Fail	Fail	Fail	Fail
99	17	Fail	Fail	Fail	Fail
99	18	Fail	Fail	Fail	Fail
99	19	Fail	Fail	Fail	Fail
99	20	Fail	Fail	Fail	Fail
99	21	Fail	Fail	Fail	Fail
99	22	Fail	Fail	Fail	Fail
99	23	Fail	Fail	Fail	Fail
99	26	Fail	Fail	Fail	Fail
99	30	Fail	Fail	Fail	Fail
100	13	Fail	Pass	Fail	Pass
100	14	Fail	Pass	Fail	Pass
100	15	Fail	Pass	Fail	Pass
100	23	Fail	Fail	Fail	Fail
100	24	Fail	Fail	Fail	Fail
100	25	Fail	Fail	Fail	Fail
100	26	Fail	Pass	Fail	Pass
100	30	Fail	Fail	Fail	Fail
101	13	Fail	Pass	Fail	Pass
101	14	Fail	Pass	Fail	Pass
101	15	Fail	Pass	Fail	Pass
101	16	Fail	Fail	Fail	Fail
101	17	Fail	Fail	Fail	Fail
101	18	Fail	Fail	Fail	Fail
101	19	Fail	Fail	Fail	Fail
101	20	Fail	Fail	Fail	Fail
101	21	Fail	Fail	Fail	Fail
101	22	Fail	Fail	Fail	Fail
101	23	Fail	Fail	Fail	Fail
101	26	Fail	Pass	Fail	Pass
101	30	Pass	Pass	Fail	Pass

102	13	Fail	Pass	Fail	Pass
102	14	Fail	Pass	Fail	Pass
102	15	Fail	Pass	Fail	Pass
102	26	Fail	Pass	Fail	Pass
102	30	Pass	Pass	Fail	Pass
103	13	Fail	Pass	Fail	Pass
103	14	Fail	Pass	Fail	Pass
103	15	Fail	Pass	Fail	Pass
103	26	Fail	Pass	Fail	Pass
103	30	Pass	Pass	Pass	Pass
104	11	Fail	Fail	Fail	Fail
104	13	Fail	Pass	Fail	Pass
104	14	Fail	Pass	Fail	Pass
104	15	Fail	Pass	Fail	Pass
104	26	Fail	Pass	Fail	Pass
104	30	Pass	Pass	Pass	Pass
105	13	Fail	Pass	Fail	Pass
105	14	Fail	Pass	Fail	Pass
105	15	Fail	Pass	Fail	Pass
105	26	Fail	Pass	Fail	Pass
105	30	Pass	Fail	Pass	Fail
106	13	Fail	Pass	Fail	Pass
106	14	Fail	Pass	Fail	Pass
106	15	Fail	Pass	Fail	Pass
106	26	Fail	Pass	Fail	Pass
106	27	Fail	Fail	Fail	Fail
106	30	Pass	Pass	Pass	Pass
106	39	Pass	Fail	Pass	Fail
107	13	Pass	Pass	Fail	Pass
107	14	Pass	Pass	Fail	Pass
107	15	Pass	Pass	Fail	Pass
107	22	Fail	Pass	Fail	Pass
107	26	Fail	Pass	Fail	Pass
107	30	Pass	Pass	Pass	Pass
107	39	Pass	Pass	Pass	Pass
108	13	Pass	Pass	Fail	Pass
108	14	Pass	Pass	Fail	Pass
108	15	Pass	Pass	Fail	Pass
108	22	Fail	Pass	Fail	Pass
108	24	Fail	Fail	Fail	Fail
108	26	Fail	Pass	Fail	Pass
108	30	Pass	Pass	Pass	Pass
108	39	Pass	Fail	Pass	Fail
109	13	Pass	Pass	Pass	Pass
109	14	Pass	Pass	Pass	Pass
109	15	Pass	Pass	Pass	Pass
109	22	Fail	Pass	Fail	Pass
109	26	Fail	Pass	Fail	Pass
109	30	Pass	Fail	Pass	Fail
109	39	Pass	Pass	Pass	Pass
110	13	Pass	Pass	Pass	Pass
110	14	Pass	Pass	Pass	Pass
110	15	Pass	Pass	Pass	Pass
110	22	Fail	Pass	Fail	Pass
110	26	Fail	Pass	Fail	Pass
110	28	Fail	Fail	Fail	Fail
110	39	Pass	Fail	Pass	Fail

111	13	Pass	Pass	Pass	Pass
111	14	Pass	Pass	Pass	Pass
111	15	Pass	Pass	Pass	Pass
111	22	Fail	Pass	Fail	Pass
111	26	Fail	Pass	Fail	Pass
111	39	Pass	Fail	Pass	Fail
112	13	Pass	Pass	Pass	Pass
112	14	Pass	Pass	Pass	Pass
112	15	Pass	Pass	Pass	Pass
112	22	Pass	Fail	Fail	Fail
112	26	Pass	Pass	Fail	Pass
112	39	Pass	Fail	Pass	Fail
113	13	Pass	Pass	Pass	Pass
113	14	Pass	Pass	Pass	Pass
113	15	Pass	Pass	Pass	Pass
113	26	Pass	Pass	Fail	Pass
113	27	Pass	Fail	Fail	Fail
113	39	Pass	Pass	Pass	Pass
113	41	Fail	Fail	Fail	Fail
114	13	Pass	Pass	Pass	Pass
114	14	Pass	Pass	Pass	Pass
114	15	Pass	Pass	Pass	Pass
114	26	Pass	Pass	Fail	Pass
114	39	Pass	Pass	Pass	Pass
115	13	Pass	Pass	Pass	Pass
115	14	Pass	Pass	Pass	Pass
115	15	Pass	Pass	Pass	Pass
115	26	Pass	Pass	Pass	Pass
115	39	Pass	Pass	Pass	Pass
116	13	Pass	Pass	Pass	Pass
116	14	Pass	Pass	Pass	Pass
116	15	Pass	Pass	Pass	Pass
116	26	Pass	Fail	Pass	Fail
116	28	Fail	Fail	Fail	Fail
116	39	Pass	Pass	Pass	Pass
117	13	Pass	Pass	Pass	Pass
117	14	Pass	Pass	Pass	Pass
117	15	Pass	Pass	Pass	Pass
117	26	Pass	Fail	Pass	Fail
117	39	Pass	Pass	Pass	Pass
118	13	Pass	Pass	Pass	Pass
118	14	Pass	Pass	Pass	Pass
118	15	Pass	Pass	Pass	Pass
118	20	Pass	Fail	Pass	Fail
118	26	Pass	Pass	Pass	Pass
118	39	Pass	Pass	Pass	Pass
119	13	Pass	Pass	Pass	Pass
119	14	Pass	Pass	Pass	Pass
119	15	Pass	Pass	Pass	Pass
119	20	Pass	Pass	Pass	Pass
119	26	Pass	Pass	Pass	Pass
119	39	Pass	Pass	Pass	Pass
120	13	Pass	Pass	Pass	Pass
120	14	Pass	Pass	Pass	Pass
120	15	Pass	Fail	Pass	Fail
120	16	Pass	Fail	Pass	Fail
120	26	Pass	Fail	Pass	Fail

120	39	Pass	Pass	Pass	Pass
121	13	Pass	Pass	Pass	Pass
121	14	Pass	Pass	Pass	Pass
121	26	Pass	Fail	Pass	Fail
121	39	Pass	Pass	Pass	Pass
122	13	Pass	Pass	Pass	Pass
122	14	Pass	Pass	Pass	Pass
122	26	Pass	Fail	Pass	Fail
122	39	Pass	Pass	Pass	Pass
122	41	Fail	Fail	Fail	Fail
123	13	Pass	Pass	Pass	Pass
123	14	Pass	Pass	Pass	Pass
123	15	Pass	Fail	Pass	Fail
123	16	Pass	Pass	Pass	Pass
123	17	Pass	Pass	Pass	Pass
123	18	Pass	Pass	Pass	Pass
123	19	Pass	Pass	Pass	Pass
123	20	Pass	Pass	Pass	Pass
123	21	Pass	Pass	Pass	Pass
123	22	Pass	Pass	Pass	Pass
123	23	Pass	Pass	Pass	Pass
123	24	Pass	Pass	Pass	Pass
123	25	Pass	Pass	Pass	Pass
123	26	Pass	Pass	Pass	Pass
123	27	Pass	Pass	Pass	Pass
123	28	Pass	Pass	Pass	Pass
123	29	Pass	Fail	Pass	Fail
123	30	Pass	Fail	Pass	Fail
123	31	Pass	Fail	Pass	Fail
123	32	Pass	Fail	Pass	Fail
123	33	Pass	Fail	Pass	Fail
123	34	Pass	Pass	Pass	Pass
123	35	Pass	Pass	Pass	Pass
123	36	Pass	Pass	Pass	Pass
123	37	Pass	Pass	Pass	Pass
123	38	Pass	Fail	Pass	Fail
123	39	Pass	Fail	Pass	Fail
124	13	Pass	Pass	Pass	Pass
124	14	Pass	Pass	Pass	Pass
124	23	Pass	Pass	Pass	Pass
125	13	Pass	Pass	Pass	Pass
125	14	Pass	Pass	Pass	Pass
125	23	Pass	Pass	Pass	Pass
125	28	Fail	Fail	Fail	Fail
125	33	Fail	Fail	Fail	Fail
126	13	Pass	Pass	Pass	Pass
126	14	Pass	Pass	Pass	Pass
126	23	Pass	Pass	Pass	Pass
127	13	Pass	Pass	Pass	Pass
127	14	Pass	Pass	Pass	Pass
127	23	Pass	Pass	Pass	Pass
128	13	Pass	Pass	Pass	Pass
128	14	Pass	Pass	Pass	Pass
128	23	Pass	Pass	Pass	Pass
129	13	Pass	Pass	Pass	Pass
129	14	Pass	Pass	Pass	Pass
129	23	Pass	Pass	Pass	Pass

130	8	Pass	Fail	Pass	Fail
130	9	Pass	Fail	Pass	Fail
130	10	Pass	Fail	Pass	Fail
130	11	Pass	Fail	Pass	Fail
130	12	Pass	Fail	Pass	Fail
130	13	Pass	Fail	Pass	Fail
130	14	Pass	Pass	Pass	Pass
130	23	Pass	Pass	Pass	Pass
131	14	Pass	Pass	Pass	Pass
131	23	Pass	Pass	Pass	Pass
132	14	Pass	Pass	Pass	Pass
132	23	Pass	Pass	Pass	Pass
133	14	Pass	Pass	Pass	Pass
133	23	Pass	Pass	Pass	Pass
134	14	Pass	Pass	Pass	Pass
134	23	Pass	Fail	Pass	Fail
135	14	Pass	Pass	Pass	Pass
136	14	Pass	Pass	Pass	Pass
137	14	Pass	Pass	Pass	Pass
138	14	Pass	Pass	Pass	Pass

Appendix C-2

Tables of Criteria Passing for Striped Bass Eggs Habitat Suitability

April 1997

20th %ile of Clyo Flow

Fisheries Review Group

1. Table C.7.1 Striped Bass eggs D.O. , Salinity, and Velocity criteria passing for existing and deepening (6 ft) scenarios within the analyzed period April 1 - April 30, 1997

HABITAT REQUIREMENTS:
RM 10-31; Depth Average
D.O. April (MG/L):10th %ile >=4.5
Salinity 50th %ile <= 9 ppt
Mean Velocity >= 30 cm/s

Savannah Harbor Estuary

Segments		Baseline Scenario			Project Scenario		
J	I	Salinity	Velocity	D.O.	Salinity	Velocity	D.O.
47	13	Fail	Pass	Pass	Fail	Pass	Pass
47	14	Fail	Pass	Pass	Fail	Pass	Pass
47	15	Fail	Pass	Pass	Fail	Pass	Pass
47	16	Fail	Pass	Pass	Fail	Pass	Pass
47	17	Fail	Fail	Pass	Fail	Fail	Pass
48	13	Fail	Pass	Pass	Fail	Pass	Pass
48	14	Fail	Pass	Pass	Fail	Pass	Pass
48	15	Fail	Pass	Pass	Fail	Pass	Pass
48	16	Fail	Pass	Pass	Fail	Pass	Pass
48	17	Fail	Pass	Pass	Fail	Pass	Pass
49	13	Fail	Pass	Pass	Fail	Pass	Pass
49	14	Fail	Pass	Pass	Fail	Pass	Pass
49	15	Fail	Pass	Pass	Fail	Pass	Pass
49	16	Fail	Pass	Pass	Fail	Pass	Pass
49	17	Fail	Pass	Pass	Fail	Pass	Pass
50	13	Fail	Pass	Pass	Fail	Pass	Pass
50	14	Fail	Pass	Pass	Fail	Pass	Pass
50	15	Fail	Fail	Pass	Fail	Fail	Pass
50	16	Fail	Fail	Pass	Fail	Fail	Pass
50	17	Fail	Fail	Pass	Fail	Fail	Pass
50	18	Fail	Fail	Pass	Fail	Fail	Pass
51	13	Fail	Pass	Pass	Fail	Pass	Pass
51	14	Fail	Pass	Pass	Fail	Pass	Pass
51	15	Fail	Pass	Pass	Fail	Pass	Pass
52	13	Fail	Pass	Pass	Fail	Pass	Pass
52	14	Fail	Pass	Pass	Fail	Pass	Pass
52	15	Fail	Pass	Pass	Fail	Pass	Pass
53	13	Fail	Pass	Pass	Fail	Pass	Pass
53	14	Fail	Pass	Pass	Fail	Pass	Pass
53	15	Fail	Pass	Pass	Fail	Pass	Pass
54	13	Fail	Pass	Pass	Fail	Pass	Pass
54	14	Fail	Pass	Pass	Fail	Pass	Pass
54	15	Fail	Pass	Pass	Fail	Pass	Pass
55	13	Fail	Pass	Pass	Fail	Pass	Pass
55	14	Fail	Pass	Pass	Fail	Pass	Pass
55	15	Fail	Pass	Pass	Fail	Pass	Pass
56	13	Fail	Pass	Pass	Fail	Pass	Pass
56	14	Fail	Pass	Pass	Fail	Pass	Pass
56	15	Fail	Pass	Pass	Fail	Pass	Pass
57	13	Fail	Pass	Pass	Fail	Pass	Pass

57	14	Fail	Pass	Pass	Fail	Pass	Pass
57	15	Fail	Pass	Pass	Fail	Pass	Pass
58	13	Pass	Pass	Pass	Fail	Pass	Pass
58	14	Fail	Pass	Pass	Fail	Pass	Pass
58	15	Pass	Pass	Pass	Fail	Pass	Pass
59	13	Pass	Pass	Pass	Fail	Pass	Pass
59	14	Fail	Pass	Pass	Fail	Pass	Pass
59	15	Pass	Pass	Pass	Fail	Pass	Pass
59	30	Fail	Fail	Pass	Fail	Fail	Pass
59	31	Fail	Fail	Pass	Fail	Fail	Pass
59	32	Fail	Fail	Pass	Fail	Fail	Pass
60	13	Pass	Pass	Pass	Fail	Pass	Pass
60	14	Fail	Pass	Pass	Fail	Pass	Pass
60	15	Pass	Pass	Pass	Fail	Pass	Pass
60	30	Fail	Fail	Pass	Fail	Fail	Pass
60	31	Fail	Fail	Pass	Fail	Fail	Pass
60	32	Fail	Fail	Pass	Fail	Fail	Pass
61	13	Pass	Pass	Pass	Fail	Pass	Pass
61	14	Fail	Pass	Pass	Fail	Pass	Pass
61	15	Pass	Pass	Pass	Pass	Pass	Pass
61	30	Fail	Fail	Pass	Fail	Fail	Pass
61	31	Fail	Fail	Pass	Fail	Fail	Pass
61	32	Fail	Fail	Pass	Fail	Fail	Pass
62	13	Pass	Pass	Pass	Fail	Pass	Pass
62	14	Fail	Pass	Pass	Fail	Pass	Pass
62	15	Pass	Pass	Pass	Pass	Pass	Pass
62	30	Fail	Fail	Pass	Fail	Fail	Pass
62	31	Fail	Fail	Pass	Fail	Fail	Pass
62	32	Fail	Fail	Pass	Fail	Fail	Pass
63	13	Pass	Pass	Pass	Fail	Pass	Pass
63	14	Fail	Pass	Pass	Fail	Pass	Pass
63	15	Pass	Pass	Pass	Pass	Pass	Pass
63	31	Fail	Pass	Pass	Fail	Pass	Pass
64	13	Pass	Pass	Pass	Fail	Pass	Pass
64	14	Fail	Pass	Pass	Fail	Pass	Pass
64	15	Pass	Pass	Pass	Pass	Pass	Pass
64	30	Fail	Fail	Pass	Fail	Fail	Pass
64	31	Fail	Pass	Pass	Fail	Pass	Pass
64	32	Fail	Fail	Pass	Fail	Fail	Pass
65	13	Pass	Pass	Pass	Pass	Pass	Pass
65	14	Fail	Pass	Pass	Fail	Pass	Pass
65	15	Pass	Pass	Pass	Pass	Pass	Pass
65	30	Fail	Fail	Pass	Fail	Fail	Pass
65	31	Fail	Pass	Pass	Fail	Pass	Pass
65	32	Fail	Fail	Pass	Fail	Fail	Pass
65	33	Fail	Fail	Pass	Fail	Fail	Pass
66	13	Pass	Pass	Pass	Pass	Pass	Pass
66	14	Fail	Pass	Pass	Fail	Pass	Pass
66	15	Pass	Pass	Pass	Pass	Fail	Pass
66	30	Fail	Fail	Pass	Fail	Fail	Pass
66	31	Fail	Pass	Pass	Fail	Pass	Pass
66	32	Fail	Fail	Pass	Fail	Fail	Pass
66	36	Fail	Fail	Pass	Fail	Fail	Pass
66	38	Fail	Fail	Fail	Fail	Fail	Fail
67	13	Pass	Pass	Pass	Pass	Pass	Pass
67	14	Fail	Pass	Pass	Fail	Pass	Pass
67	15	Pass	Fail	Pass	Pass	Fail	Pass

67	30	Fail	Fail	Pass	Fail	Fail	Pass
67	31	Fail	Pass	Pass	Fail	Pass	Pass
67	32	Fail	Fail	Pass	Fail	Fail	Pass
67	36	Fail	Fail	Pass	Fail	Fail	Pass
68	13	Pass	Pass	Pass	Pass	Pass	Pass
68	14	Fail	Pass	Pass	Fail	Pass	Pass
68	15	Pass	Fail	Pass	Pass	Fail	Pass
68	30	Pass	Fail	Pass	Fail	Fail	Pass
68	31	Pass	Pass	Pass	Fail	Pass	Pass
68	32	Pass	Fail	Pass	Fail	Fail	Pass
68	36	Fail	Fail	Pass	Fail	Fail	Pass
68	38	Fail	Fail	Fail	Fail	Fail	Fail
69	13	Pass	Pass	Pass	Pass	Pass	Pass
69	14	Pass	Pass	Pass	Fail	Pass	Pass
69	15	Pass	Fail	Pass	Pass	Fail	Pass
69	30	Pass	Pass	Pass	Fail	Pass	Pass
69	31	Pass	Pass	Pass	Fail	Pass	Pass
69	32	Pass	Fail	Pass	Fail	Fail	Pass
69	36	Fail	Fail	Pass	Fail	Fail	Pass
70	13	Pass	Pass	Pass	Pass	Pass	Pass
70	14	Pass	Pass	Pass	Fail	Pass	Pass
70	15	Pass	Fail	Pass	Pass	Fail	Pass
70	30	Pass	Fail	Pass	Fail	Fail	Pass
70	31	Pass	Fail	Pass	Fail	Fail	Pass
70	32	Pass	Fail	Pass	Fail	Fail	Pass
70	33	Pass	Fail	Pass	Fail	Fail	Pass
71	13	Pass	Pass	Pass	Pass	Pass	Pass
71	14	Pass	Pass	Pass	Fail	Pass	Pass
71	15	Pass	Pass	Pass	Pass	Pass	Pass
71	30	Pass	Fail	Pass	Fail	Fail	Pass
71	31	Pass	Fail	Pass	Fail	Fail	Pass
71	32	Pass	Fail	Pass	Pass	Fail	Pass
72	13	Pass	Pass	Pass	Pass	Pass	Pass
72	14	Pass	Pass	Pass	Fail	Pass	Pass
72	15	Pass	Pass	Pass	Pass	Pass	Pass
72	30	Pass	Fail	Pass	Pass	Fail	Pass
72	31	Pass	Fail	Pass	Fail	Fail	Pass
72	32	Pass	Fail	Pass	Fail	Fail	Pass
73	13	Pass	Pass	Pass	Pass	Pass	Pass
73	14	Pass	Pass	Pass	Fail	Pass	Pass
73	15	Pass	Pass	Pass	Pass	Pass	Pass
73	30	Pass	Fail	Pass	Pass	Fail	Pass
73	31	Pass	Fail	Pass	Fail	Fail	Pass
74	13	Pass	Pass	Pass	Pass	Pass	Pass
74	14	Pass	Pass	Pass	Fail	Pass	Pass
74	15	Pass	Pass	Pass	Pass	Pass	Pass
74	30	Pass	Fail	Pass	Pass	Fail	Pass
74	31	Pass	Fail	Pass	Pass	Fail	Pass
75	13	Pass	Pass	Pass	Pass	Pass	Pass
75	14	Pass	Pass	Pass	Fail	Pass	Pass
75	15	Pass	Pass	Pass	Pass	Pass	Pass
75	30	Pass	Fail	Pass	Pass	Fail	Pass
75	31	Pass	Fail	Pass	Pass	Fail	Pass
76	13	Pass	Pass	Pass	Pass	Pass	Pass
76	14	Pass	Pass	Pass	Fail	Pass	Pass
76	15	Pass	Fail	Pass	Fail	Fail	Pass
76	16	Pass	Fail	Pass	Fail	Fail	Pass

76	17	Pass	Fail	Pass	Fail	Fail	Pass
76	30	Pass	Fail	Pass	Pass	Fail	Pass
76	31	Pass	Fail	Pass	Pass	Fail	Pass
76	33	Fail	Fail	Fail	Fail	Fail	Fail
77	13	Pass	Fail	Pass	Pass	Fail	Pass
77	14	Pass	Pass	Pass	Fail	Pass	Pass
77	15	Pass	Fail	Pass	Fail	Fail	Pass
77	16	Pass	Fail	Pass	Fail	Fail	Pass
77	17	Pass	Fail	Pass	Fail	Fail	Pass
77	30	Pass	Fail	Pass	Pass	Fail	Pass
77	31	Pass	Fail	Pass	Pass	Fail	Pass
78	13	Pass	Fail	Pass	Pass	Fail	Pass
78	14	Pass	Pass	Pass	Fail	Pass	Pass
78	15	Pass	Fail	Pass	Fail	Fail	Pass
78	16	Pass	Fail	Pass	Fail	Fail	Pass
78	17	Pass	Fail	Pass	Fail	Fail	Pass
78	30	Pass	Fail	Pass	Pass	Fail	Pass
78	31	Pass	Fail	Pass	Pass	Fail	Pass
79	13	Pass	Pass	Pass	Pass	Pass	Pass
79	14	Pass	Pass	Pass	Fail	Pass	Pass
79	15	Pass	Fail	Pass	Pass	Fail	Pass
79	30	Pass	Fail	Pass	Pass	Fail	Pass
79	31	Pass	Fail	Pass	Pass	Fail	Pass
80	13	Pass	Pass	Pass	Pass	Pass	Pass
80	14	Pass	Pass	Pass	Fail	Pass	Pass
80	15	Pass	Fail	Pass	Pass	Fail	Pass
80	30	Pass	Fail	Pass	Pass	Fail	Pass
80	31	Pass	Fail	Pass	Pass	Fail	Pass
81	13	Pass	Pass	Pass	Pass	Pass	Pass
81	14	Pass	Pass	Pass	Fail	Pass	Pass
81	15	Pass	Fail	Pass	Pass	Fail	Pass
81	30	Pass	Fail	Pass	Pass	Fail	Pass
81	31	Pass	Fail	Pass	Pass	Fail	Pass
82	13	Pass	Pass	Pass	Pass	Pass	Pass
82	14	Pass	Pass	Pass	Pass	Pass	Pass
82	15	Pass	Pass	Pass	Pass	Pass	Pass
82	16	Pass	Fail	Pass	Pass	Fail	Pass
82	17	Pass	Fail	Pass	Pass	Fail	Pass
82	18	Pass	Fail	Pass	Pass	Fail	Pass
82	19	Pass	Fail	Pass	Pass	Fail	Pass
82	20	Pass	Fail	Pass	Pass	Fail	Pass
82	21	Pass	Fail	Pass	Pass	Fail	Pass
82	29	Pass	Fail	Pass	Pass	Fail	Pass
82	30	Pass	Fail	Pass	Pass	Fail	Pass
82	31	Pass	Fail	Pass	Pass	Fail	Pass
83	13	Pass	Pass	Pass	Pass	Pass	Pass
83	14	Pass	Pass	Pass	Pass	Pass	Pass
83	15	Pass	Pass	Pass	Pass	Pass	Pass
83	21	Pass	Fail	Pass	Pass	Fail	Pass
83	30	Pass	Fail	Pass	Pass	Fail	Pass
83	31	Pass	Fail	Pass	Pass	Fail	Pass
84	13	Pass	Pass	Pass	Pass	Pass	Pass
84	14	Pass	Pass	Pass	Pass	Pass	Pass
84	15	Pass	Pass	Pass	Pass	Pass	Pass
84	21	Pass	Fail	Pass	Pass	Fail	Pass
84	30	Pass	Fail	Pass	Pass	Fail	Pass
84	31	Pass	Fail	Pass	Pass	Fail	Pass

85	13	Pass	Pass	Pass	Pass	Pass	Pass
85	14	Pass	Pass	Pass	Pass	Pass	Pass
85	15	Pass	Pass	Pass	Pass	Pass	Pass
85	21	Pass	Fail	Pass	Pass	Fail	Pass
85	30	Pass	Fail	Pass	Pass	Fail	Pass
86	13	Pass	Pass	Pass	Pass	Pass	Pass
86	14	Pass	Pass	Pass	Pass	Pass	Pass
86	15	Pass	Pass	Pass	Pass	Pass	Pass
86	17	Fail	Fail	Fail	Fail	Fail	Fail
86	21	Pass	Fail	Pass	Pass	Fail	Pass
86	30	Pass	Pass	Pass	Pass	Pass	Pass
87	13	Pass	Pass	Pass	Pass	Pass	Pass
87	14	Pass	Pass	Pass	Pass	Pass	Pass
87	15	Pass	Pass	Pass	Pass	Pass	Pass
87	30	Pass	Fail	Pass	Pass	Fail	Pass
87	32	Fail	Fail	Fail	Fail	Fail	Fail
88	13	Pass	Pass	Pass	Pass	Pass	Pass
88	14	Pass	Pass	Pass	Pass	Pass	Pass
88	15	Pass	Pass	Pass	Pass	Pass	Pass
88	30	Pass	Fail	Pass	Pass	Fail	Pass
89	13	Pass	Pass	Pass	Pass	Pass	Pass
89	14	Pass	Pass	Pass	Pass	Pass	Pass
89	15	Pass	Pass	Pass	Pass	Pass	Pass
89	30	Pass	Fail	Pass	Pass	Fail	Pass
90	13	Pass	Pass	Pass	Pass	Pass	Pass
90	14	Pass	Pass	Pass	Pass	Pass	Pass
90	15	Pass	Pass	Pass	Pass	Fail	Pass
90	30	Pass	Fail	Pass	Pass	Fail	Pass
91	13	Pass	Pass	Pass	Pass	Pass	Pass
91	14	Pass	Pass	Pass	Pass	Pass	Pass
91	15	Pass	Pass	Pass	Pass	Fail	Pass
91	16	Pass	Fail	Pass	Pass	Fail	Pass
91	30	Pass	Fail	Pass	Pass	Fail	Pass
92	13	Pass	Pass	Pass	Pass	Pass	Pass
92	14	Pass	Pass	Pass	Pass	Pass	Pass
92	15	Pass	Pass	Pass	Pass	Pass	Pass
92	16	Pass	Fail	Pass	Pass	Fail	Pass
92	30	Pass	Fail	Pass	Pass	Fail	Pass
92	32	Fail	Fail	Fail	Fail	Fail	Fail
93	13	Pass	Pass	Pass	Pass	Pass	Pass
93	14	Pass	Pass	Pass	Pass	Pass	Pass
93	15	Pass	Pass	Pass	Pass	Pass	Pass
93	16	Pass	Pass	Pass	Pass	Pass	Pass
93	30	Pass	Fail	Pass	Pass	Fail	Pass
94	13	Pass	Pass	Pass	Pass	Pass	Pass
94	14	Pass	Pass	Pass	Pass	Pass	Pass
94	15	Pass	Pass	Pass	Pass	Pass	Pass
94	16	Pass	Fail	Pass	Pass	Fail	Pass
94	26	Pass	Pass	Pass	Pass	Pass	Pass
94	30	Pass	Fail	Pass	Pass	Fail	Pass
95	13	Pass	Pass	Pass	Pass	Pass	Pass
95	14	Pass	Pass	Pass	Pass	Pass	Pass
95	15	Pass	Pass	Pass	Pass	Pass	Pass
95	16	Pass	Fail	Pass	Pass	Fail	Pass
95	26	Pass	Fail	Pass	Pass	Fail	Pass
95	28	Fail	Fail	Fail	Fail	Fail	Fail
95	30	Pass	Fail	Pass	Pass	Fail	Pass

96	11	Fail	Fail	Fail	Fail	Fail	Fail
96	13	Pass	Pass	Pass	Pass	Pass	Pass
96	14	Pass	Pass	Pass	Pass	Pass	Pass
96	15	Pass	Pass	Pass	Pass	Pass	Pass
96	26	Pass	Fail	Pass	Pass	Fail	Pass
96	30	Pass	Fail	Pass	Pass	Fail	Pass
97	13	Pass	Pass	Pass	Pass	Pass	Pass
97	14	Pass	Pass	Pass	Pass	Pass	Pass
97	15	Pass	Fail	Pass	Pass	Fail	Pass
97	26	Pass	Fail	Pass	Pass	Fail	Pass
97	30	Pass	Fail	Pass	Pass	Fail	Pass
98	13	Pass	Fail	Pass	Pass	Fail	Pass
98	14	Pass	Pass	Pass	Pass	Pass	Pass
98	15	Pass	Fail	Pass	Pass	Fail	Pass
98	26	Pass	Fail	Pass	Pass	Fail	Pass
98	27	Pass	Pass	Pass	Pass	Pass	Pass
98	28	Pass	Pass	Pass	Pass	Pass	Pass
98	29	Pass	Pass	Pass	Pass	Pass	Pass
98	30	Pass	Fail	Pass	Pass	Fail	Pass
99	13	Pass	Pass	Pass	Pass	Pass	Pass
99	14	Pass	Pass	Pass	Pass	Pass	Pass
99	15	Pass	Fail	Pass	Pass	Fail	Pass
99	16	Pass	Fail	Pass	Pass	Fail	Pass
99	17	Pass	Fail	Pass	Pass	Fail	Pass
99	18	Pass	Fail	Pass	Pass	Fail	Pass
99	19	Pass	Fail	Pass	Pass	Fail	Pass
99	20	Pass	Fail	Pass	Pass	Fail	Pass
99	21	Pass	Fail	Pass	Pass	Fail	Pass
99	22	Pass	Fail	Pass	Pass	Fail	Pass
99	23	Pass	Fail	Pass	Pass	Fail	Pass
99	26	Pass	Fail	Pass	Pass	Fail	Pass
99	30	Pass	Fail	Pass	Pass	Fail	Pass
100	13	Pass	Pass	Pass	Pass	Pass	Pass
100	14	Pass	Pass	Pass	Pass	Pass	Pass
100	15	Pass	Pass	Pass	Pass	Pass	Pass
100	23	Pass	Fail	Pass	Pass	Fail	Pass
100	24	Pass	Fail	Pass	Pass	Fail	Pass
100	25	Pass	Fail	Pass	Pass	Fail	Pass
100	26	Pass	Fail	Pass	Pass	Fail	Pass
100	30	Pass	Fail	Pass	Pass	Fail	Pass
101	13	Pass	Pass	Pass	Pass	Pass	Pass
101	14	Pass	Pass	Pass	Pass	Pass	Pass
101	15	Pass	Pass	Pass	Pass	Pass	Pass
101	16	Pass	Fail	Pass	Pass	Fail	Pass
101	17	Pass	Fail	Pass	Pass	Fail	Pass
101	18	Pass	Fail	Pass	Pass	Fail	Pass
101	19	Pass	Fail	Pass	Pass	Fail	Pass
101	20	Pass	Fail	Pass	Pass	Fail	Pass
101	21	Pass	Fail	Pass	Pass	Fail	Pass
101	22	Pass	Fail	Pass	Pass	Fail	Pass
101	23	Pass	Fail	Pass	Pass	Fail	Pass
101	26	Pass	Pass	Pass	Pass	Pass	Pass
101	30	Pass	Fail	Pass	Pass	Fail	Pass
102	13	Pass	Pass	Pass	Pass	Pass	Pass
102	14	Pass	Pass	Pass	Pass	Pass	Pass
102	15	Pass	Pass	Pass	Pass	Pass	Pass
102	26	Pass	Pass	Pass	Pass	Pass	Pass

102	30	Pass	Fail	Pass	Pass	Fail	Pass
103	13	Pass	Pass	Pass	Pass	Pass	Pass
103	14	Pass	Pass	Pass	Pass	Pass	Pass
103	15	Pass	Pass	Pass	Pass	Pass	Pass
103	26	Pass	Pass	Pass	Pass	Pass	Pass
103	30	Pass	Pass	Pass	Pass	Pass	Pass
104	11	Fail	Fail	Fail	Fail	Fail	Fail
104	13	Pass	Fail	Pass	Pass	Pass	Pass
104	14	Pass	Pass	Pass	Pass	Pass	Pass
104	15	Pass	Pass	Pass	Pass	Pass	Pass
104	26	Pass	Pass	Pass	Pass	Pass	Pass
104	30	Pass	Fail	Pass	Pass	Fail	Pass
105	13	Pass	Fail	Pass	Pass	Fail	Pass
105	14	Pass	Pass	Pass	Pass	Pass	Pass
105	15	Pass	Pass	Pass	Pass	Pass	Pass
105	26	Pass	Pass	Pass	Pass	Pass	Pass
105	30	Pass	Fail	Pass	Pass	Fail	Pass
106	13	Pass	Fail	Pass	Pass	Pass	Pass
106	14	Pass	Pass	Pass	Pass	Pass	Pass
106	15	Pass	Pass	Pass	Pass	Pass	Pass
106	26	Pass	Pass	Pass	Pass	Pass	Pass
106	27	Pass	Fail	Pass	Pass	Fail	Pass
106	30	Pass	Fail	Pass	Pass	Fail	Pass
106	39	Pass	Fail	Pass	Pass	Fail	Pass
107	13	Pass	Pass	Pass	Pass	Pass	Pass
107	14	Pass	Pass	Pass	Pass	Pass	Pass
107	15	Pass	Fail	Pass	Pass	Pass	Pass
107	22	Pass	Fail	Pass	Pass	Fail	Pass
107	26	Pass	Fail	Pass	Pass	Fail	Pass
107	30	Pass	Fail	Pass	Pass	Fail	Pass
107	39	Pass	Fail	Pass	Pass	Fail	Pass
108	13	Pass	Pass	Pass	Pass	Pass	Pass
108	14	Pass	Pass	Pass	Pass	Pass	Pass
108	15	Pass	Pass	Pass	Pass	Pass	Pass
108	22	Pass	Pass	Pass	Pass	Pass	Pass
108	24	Fail	Fail	Fail	Fail	Fail	Fail
108	26	Pass	Fail	Pass	Pass	Fail	Pass
108	30	Pass	Fail	Pass	Pass	Fail	Pass
108	39	Pass	Fail	Pass	Pass	Fail	Pass
109	13	Pass	Pass	Pass	Pass	Pass	Pass
109	14	Pass	Pass	Pass	Pass	Pass	Pass
109	15	Pass	Pass	Pass	Pass	Pass	Pass
109	22	Pass	Fail	Pass	Pass	Fail	Pass
109	26	Pass	Pass	Pass	Pass	Pass	Pass
109	30	Pass	Fail	Pass	Pass	Fail	Pass
109	39	Pass	Pass	Pass	Pass	Pass	Pass
110	13	Pass	Pass	Pass	Pass	Pass	Pass
110	14	Pass	Pass	Pass	Pass	Pass	Pass
110	15	Pass	Pass	Pass	Pass	Pass	Pass
110	22	Pass	Pass	Pass	Pass	Pass	Pass
110	26	Pass	Pass	Pass	Pass	Pass	Pass
110	28	Fail	Fail	Fail	Fail	Fail	Fail
110	39	Pass	Fail	Pass	Pass	Fail	Pass
111	13	Pass	Pass	Pass	Pass	Pass	Pass
111	14	Pass	Pass	Pass	Pass	Pass	Pass
111	15	Pass	Pass	Pass	Pass	Pass	Pass
111	22	Pass	Fail	Pass	Pass	Fail	Pass

111	26	Pass	Pass	Pass	Pass	Pass	Pass
111	39	Pass	Fail	Pass	Pass	Fail	Pass
112	13	Pass	Fail	Pass	Pass	Fail	Pass
112	14	Pass	Pass	Pass	Pass	Pass	Pass
112	15	Pass	Pass	Pass	Pass	Pass	Pass
112	22	Pass	Fail	Pass	Pass	Fail	Pass
112	26	Pass	Fail	Pass	Pass	Fail	Pass
112	39	Pass	Fail	Pass	Pass	Fail	Pass
113	13	Pass	Fail	Pass	Pass	Pass	Pass
113	14	Pass	Pass	Pass	Pass	Pass	Pass
113	15	Pass	Pass	Pass	Pass	Pass	Pass
113	26	Pass	Fail	Pass	Pass	Fail	Pass
113	27	Pass	Fail	Pass	Pass	Fail	Pass
113	39	Pass	Pass	Pass	Pass	Pass	Pass
113	41	Fail	Fail	Fail	Fail	Fail	Fail
114	13	Pass	Pass	Pass	Pass	Pass	Pass
114	14	Pass	Pass	Pass	Pass	Pass	Pass
114	15	Pass	Pass	Pass	Pass	Pass	Pass
114	26	Pass	Fail	Pass	Pass	Fail	Pass
114	39	Pass	Pass	Pass	Pass	Pass	Pass
115	13	Pass	Pass	Pass	Pass	Pass	Pass
115	14	Pass	Pass	Pass	Pass	Pass	Pass
115	15	Pass	Pass	Pass	Pass	Pass	Pass
115	26	Pass	Fail	Pass	Pass	Fail	Pass
115	39	Pass	Pass	Pass	Pass	Pass	Pass
116	13	Pass	Pass	Pass	Pass	Pass	Pass
116	14	Pass	Pass	Pass	Pass	Pass	Pass
116	15	Pass	Pass	Pass	Pass	Pass	Pass
116	26	Pass	Fail	Pass	Pass	Fail	Pass
116	28	Fail	Fail	Fail	Fail	Fail	Fail
116	39	Pass	Pass	Pass	Pass	Pass	Pass
117	13	Pass	Pass	Pass	Pass	Pass	Pass
117	14	Pass	Pass	Pass	Pass	Pass	Pass
117	15	Pass	Pass	Pass	Pass	Pass	Pass
117	26	Pass	Fail	Pass	Pass	Fail	Pass
117	39	Pass	Pass	Pass	Pass	Pass	Pass
118	13	Pass	Pass	Pass	Pass	Pass	Pass
118	14	Pass	Pass	Pass	Pass	Pass	Pass
118	15	Pass	Fail	Pass	Pass	Pass	Pass
118	20	Pass	Fail	Pass	Pass	Fail	Pass
118	26	Pass	Fail	Pass	Pass	Fail	Pass
118	39	Pass	Pass	Pass	Pass	Pass	Pass
119	13	Pass	Pass	Pass	Pass	Pass	Pass
119	14	Pass	Pass	Pass	Pass	Pass	Pass
119	15	Pass	Pass	Pass	Pass	Pass	Pass
119	20	Pass	Fail	Pass	Pass	Fail	Pass
119	26	Pass	Fail	Pass	Pass	Fail	Pass
119	39	Pass	Pass	Pass	Pass	Pass	Pass
120	13	Pass	Pass	Pass	Pass	Pass	Pass
120	14	Pass	Pass	Pass	Pass	Pass	Pass
120	15	Pass	Fail	Pass	Pass	Fail	Pass
120	16	Pass	Fail	Pass	Pass	Fail	Pass
120	26	Pass	Fail	Pass	Pass	Fail	Pass
120	39	Pass	Pass	Pass	Pass	Pass	Pass
121	13	Pass	Pass	Pass	Pass	Pass	Pass
121	14	Pass	Pass	Pass	Pass	Pass	Pass
121	26	Pass	Fail	Pass	Pass	Fail	Pass

121	39	Pass	Pass	Pass	Pass	Pass	Pass
122	13	Pass	Pass	Pass	Pass	Pass	Pass
122	14	Pass	Pass	Pass	Pass	Pass	Pass
122	26	Pass	Fail	Pass	Pass	Fail	Pass
122	39	Pass	Pass	Pass	Pass	Pass	Pass
122	41	Fail	Fail	Fail	Fail	Fail	Fail
123	13	Pass	Pass	Pass	Pass	Pass	Pass
123	14	Pass	Pass	Pass	Pass	Pass	Pass
123	15	Pass	Fail	Pass	Pass	Fail	Pass
123	16	Pass	Pass	Pass	Pass	Pass	Pass
123	17	Pass	Pass	Pass	Pass	Pass	Pass
123	18	Pass	Pass	Pass	Pass	Pass	Pass
123	19	Pass	Pass	Pass	Pass	Pass	Pass
123	20	Pass	Pass	Pass	Pass	Pass	Pass
123	21	Pass	Pass	Pass	Pass	Pass	Pass
123	22	Pass	Pass	Pass	Pass	Pass	Pass
123	23	Pass	Pass	Pass	Pass	Pass	Pass
123	24	Pass	Fail	Pass	Pass	Pass	Pass
123	25	Pass	Fail	Pass	Pass	Fail	Pass
123	26	Pass	Pass	Pass	Pass	Pass	Pass
123	27	Pass	Pass	Pass	Pass	Pass	Pass
123	28	Pass	Pass	Pass	Pass	Pass	Pass
123	29	Pass	Fail	Pass	Pass	Fail	Pass
123	30	Pass	Fail	Pass	Pass	Fail	Pass
123	31	Pass	Fail	Pass	Pass	Fail	Pass
123	32	Pass	Fail	Pass	Pass	Fail	Pass
123	33	Pass	Fail	Pass	Pass	Fail	Pass
123	34	Pass	Pass	Pass	Pass	Pass	Pass
123	35	Pass	Pass	Pass	Pass	Pass	Pass
123	36	Pass	Pass	Pass	Pass	Pass	Pass
123	37	Pass	Fail	Pass	Pass	Fail	Pass
123	38	Pass	Fail	Pass	Pass	Fail	Pass
123	39	Pass	Fail	Pass	Pass	Fail	Pass
124	13	Pass	Fail	Pass	Pass	Fail	Pass
124	14	Pass	Pass	Pass	Pass	Pass	Pass
124	23	Pass	Fail	Pass	Pass	Fail	Pass
125	13	Pass	Fail	Pass	Pass	Fail	Pass
125	14	Pass	Fail	Pass	Pass	Fail	Pass
125	23	Pass	Pass	Pass	Pass	Pass	Pass
125	28	Fail	Fail	Fail	Fail	Fail	Fail
125	33	Fail	Fail	Fail	Fail	Fail	Fail
126	13	Pass	Fail	Pass	Pass	Fail	Pass
126	14	Pass	Fail	Pass	Pass	Fail	Pass
126	23	Pass	Pass	Pass	Pass	Pass	Pass
127	13	Pass	Fail	Pass	Pass	Fail	Pass
127	14	Pass	Pass	Pass	Pass	Pass	Pass
127	23	Pass	Pass	Pass	Pass	Pass	Pass
128	13	Pass	Pass	Pass	Pass	Pass	Pass
128	14	Pass	Pass	Pass	Pass	Pass	Pass
128	23	Pass	Pass	Pass	Pass	Pass	Pass
129	13	Pass	Fail	Pass	Pass	Fail	Pass
129	14	Pass	Pass	Pass	Pass	Pass	Pass
129	23	Pass	Pass	Pass	Pass	Pass	Pass
130	8	Pass	Fail	Pass	Pass	Fail	Pass
130	9	Pass	Fail	Pass	Pass	Fail	Pass
130	10	Pass	Fail	Pass	Pass	Fail	Pass
130	11	Pass	Fail	Pass	Pass	Fail	Pass

130	12	Pass	Fail	Pass	Pass	Fail	Pass
130	13	Pass	Fail	Pass	Pass	Fail	Pass
130	14	Pass	Pass	Pass	Pass	Pass	Pass
130	23	Pass	Pass	Pass	Pass	Pass	Pass
131	14	Pass	Fail	Pass	Pass	Fail	Pass
131	23	Pass	Pass	Pass	Pass	Pass	Pass
132	14	Pass	Pass	Pass	Pass	Pass	Pass
132	23	Pass	Pass	Pass	Pass	Pass	Pass
133	14	Pass	Pass	Pass	Pass	Pass	Pass
133	23	Pass	Pass	Pass	Pass	Pass	Pass
134	14	Pass	Pass	Pass	Pass	Pass	Pass
134	23	Pass	Fail	Pass	Pass	Fail	Pass
135	14	Pass	Fail	Pass	Pass	Fail	Pass
136	14	Pass	Pass	Pass	Pass	Pass	Pass
137	14	Pass	Pass	Pass	Pass	Pass	Pass
138	14	Pass	Pass	Pass	Pass	Pass	Pass

2. Table C.7.2 Striped Bass eggs D.O. , Salinity, and Velocity criteria passing for existing and deepening (4 ft) scenarios within the analyzed period April 1 - April 30, 1997

HABITAT REQUIREMENTS:
RM 10-31; Depth Average
D.O. April (MG/L):10th %ile >=4.5
Salinity 50th %ile <= 9 ppt
Mean Velocity >= 30 cm/s

Savannah Harbor Estuary

Segments		Baseline Scenario			Project Scenario		
J	I	Salinity	Velocity	D.O.	Salinity	Velocity	D.O.
47	13	Fail	Pass	Pass	Fail	Pass	Pass
47	14	Fail	Pass	Pass	Fail	Pass	Pass
47	15	Fail	Pass	Pass	Fail	Pass	Pass
47	16	Fail	Pass	Pass	Fail	Pass	Pass
47	17	Fail	Fail	Pass	Fail	Fail	Pass
48	13	Fail	Pass	Pass	Fail	Pass	Pass
48	14	Fail	Pass	Pass	Fail	Pass	Pass
48	15	Fail	Pass	Pass	Fail	Pass	Pass
48	16	Fail	Pass	Pass	Fail	Pass	Pass
48	17	Fail	Pass	Pass	Fail	Pass	Pass
49	13	Fail	Pass	Pass	Fail	Pass	Pass
49	14	Fail	Pass	Pass	Fail	Pass	Pass
49	15	Fail	Pass	Pass	Fail	Pass	Pass
49	16	Fail	Pass	Pass	Fail	Pass	Pass
49	17	Fail	Pass	Pass	Fail	Pass	Pass
50	13	Fail	Pass	Pass	Fail	Pass	Pass
50	14	Fail	Pass	Pass	Fail	Pass	Pass
50	15	Fail	Fail	Pass	Fail	Fail	Pass
50	16	Fail	Fail	Pass	Fail	Fail	Pass
50	17	Fail	Fail	Pass	Fail	Fail	Pass
50	18	Fail	Fail	Pass	Fail	Fail	Pass
51	13	Fail	Pass	Pass	Fail	Pass	Pass
51	14	Fail	Pass	Pass	Fail	Pass	Pass
51	15	Fail	Pass	Pass	Fail	Pass	Pass
52	13	Fail	Pass	Pass	Fail	Pass	Pass
52	14	Fail	Pass	Pass	Fail	Pass	Pass
52	15	Fail	Pass	Pass	Fail	Pass	Pass
53	13	Fail	Pass	Pass	Fail	Pass	Pass
53	14	Fail	Pass	Pass	Fail	Pass	Pass
53	15	Fail	Pass	Pass	Fail	Pass	Pass
54	13	Fail	Pass	Pass	Fail	Pass	Pass
54	14	Fail	Pass	Pass	Fail	Pass	Pass
54	15	Fail	Pass	Pass	Fail	Pass	Pass
55	13	Fail	Pass	Pass	Fail	Pass	Pass
55	14	Fail	Pass	Pass	Fail	Pass	Pass
55	15	Fail	Pass	Pass	Fail	Pass	Pass
56	13	Fail	Pass	Pass	Fail	Pass	Pass
56	14	Fail	Pass	Pass	Fail	Pass	Pass

56	15	Fail	Pass	Pass	Fail	Pass	Pass
57	13	Fail	Pass	Pass	Fail	Pass	Pass
57	14	Fail	Pass	Pass	Fail	Pass	Pass
57	15	Fail	Pass	Pass	Fail	Pass	Pass
58	13	Pass	Pass	Pass	Fail	Pass	Pass
58	14	Fail	Pass	Pass	Fail	Pass	Pass
58	15	Pass	Pass	Pass	Fail	Pass	Pass
59	13	Pass	Pass	Pass	Fail	Pass	Pass
59	14	Fail	Pass	Pass	Fail	Pass	Pass
59	15	Pass	Pass	Pass	Fail	Pass	Pass
59	30	Fail	Fail	Pass	Fail	Fail	Pass
59	31	Fail	Fail	Pass	Fail	Fail	Pass
59	32	Fail	Fail	Pass	Fail	Fail	Pass
60	13	Pass	Pass	Pass	Fail	Pass	Pass
60	14	Fail	Pass	Pass	Fail	Pass	Pass
60	15	Pass	Pass	Pass	Pass	Pass	Pass
60	30	Fail	Fail	Pass	Fail	Fail	Pass
60	31	Fail	Fail	Pass	Fail	Fail	Pass
60	32	Fail	Fail	Pass	Fail	Fail	Pass
61	13	Pass	Pass	Pass	Fail	Pass	Pass
61	14	Fail	Pass	Pass	Fail	Pass	Pass
61	15	Pass	Pass	Pass	Pass	Pass	Pass
61	30	Fail	Fail	Pass	Fail	Fail	Pass
61	31	Fail	Fail	Pass	Fail	Fail	Pass
61	32	Fail	Fail	Pass	Fail	Fail	Pass
62	13	Pass	Pass	Pass	Fail	Pass	Pass
62	14	Fail	Pass	Pass	Fail	Pass	Pass
62	15	Pass	Pass	Pass	Pass	Pass	Pass
62	30	Fail	Fail	Pass	Fail	Fail	Pass
62	31	Fail	Fail	Pass	Fail	Fail	Pass
62	32	Fail	Fail	Pass	Fail	Fail	Pass
63	13	Pass	Pass	Pass	Fail	Pass	Pass
63	14	Fail	Pass	Pass	Fail	Pass	Pass
63	15	Pass	Pass	Pass	Pass	Pass	Pass
63	31	Fail	Pass	Pass	Fail	Pass	Pass
64	13	Pass	Pass	Pass	Fail	Pass	Pass
64	14	Fail	Pass	Pass	Fail	Pass	Pass
64	15	Pass	Pass	Pass	Pass	Pass	Pass
64	30	Fail	Fail	Pass	Fail	Fail	Pass
64	31	Fail	Pass	Pass	Fail	Pass	Pass
64	32	Fail	Fail	Pass	Fail	Fail	Pass
65	13	Pass	Pass	Pass	Pass	Pass	Pass
65	14	Fail	Pass	Pass	Fail	Pass	Pass
65	15	Pass	Pass	Pass	Pass	Pass	Pass
65	30	Fail	Fail	Pass	Fail	Fail	Pass
65	31	Fail	Pass	Pass	Fail	Pass	Pass
65	32	Fail	Fail	Pass	Fail	Fail	Pass
65	33	Fail	Fail	Pass	Fail	Fail	Pass
66	13	Pass	Pass	Pass	Pass	Pass	Pass
66	14	Fail	Pass	Pass	Fail	Pass	Pass
66	15	Pass	Pass	Pass	Pass	Fail	Pass
66	30	Fail	Fail	Pass	Fail	Fail	Pass
66	31	Fail	Pass	Pass	Fail	Pass	Pass
66	32	Fail	Fail	Pass	Fail	Fail	Pass
66	36	Fail	Fail	Pass	Fail	Fail	Pass
66	38	Fail	Fail	Fail	Fail	Fail	Fail
67	13	Pass	Pass	Pass	Pass	Pass	Pass

67	14	Fail	Pass	Pass	Fail	Pass	Pass
67	15	Pass	Fail	Pass	Pass	Fail	Pass
67	30	Fail	Fail	Pass	Fail	Fail	Pass
67	31	Fail	Pass	Pass	Fail	Pass	Pass
67	32	Fail	Fail	Pass	Fail	Fail	Pass
67	36	Fail	Fail	Pass	Fail	Fail	Pass
68	13	Pass	Pass	Pass	Pass	Pass	Pass
68	14	Fail	Pass	Pass	Fail	Pass	Pass
68	15	Pass	Fail	Pass	Pass	Fail	Pass
68	30	Pass	Fail	Pass	Fail	Fail	Pass
68	31	Pass	Pass	Pass	Fail	Pass	Pass
68	32	Pass	Fail	Pass	Fail	Fail	Pass
68	36	Fail	Fail	Pass	Fail	Fail	Pass
68	38	Fail	Fail	Fail	Fail	Fail	Fail
69	13	Pass	Pass	Pass	Pass	Pass	Pass
69	14	Pass	Pass	Pass	Fail	Pass	Pass
69	15	Pass	Fail	Pass	Pass	Fail	Pass
69	30	Pass	Pass	Pass	Fail	Pass	Pass
69	31	Pass	Pass	Pass	Fail	Pass	Pass
69	32	Pass	Fail	Pass	Fail	Fail	Pass
69	36	Fail	Fail	Pass	Fail	Fail	Pass
70	13	Pass	Pass	Pass	Pass	Pass	Pass
70	14	Pass	Pass	Pass	Fail	Pass	Pass
70	15	Pass	Fail	Pass	Pass	Fail	Pass
70	30	Pass	Fail	Pass	Fail	Fail	Pass
70	31	Pass	Fail	Pass	Fail	Fail	Pass
70	32	Pass	Fail	Pass	Pass	Fail	Pass
70	33	Pass	Fail	Pass	Fail	Fail	Pass
71	13	Pass	Pass	Pass	Pass	Pass	Pass
71	14	Pass	Pass	Pass	Fail	Pass	Pass
71	15	Pass	Pass	Pass	Pass	Pass	Pass
71	30	Pass	Fail	Pass	Fail	Fail	Pass
71	31	Pass	Fail	Pass	Pass	Fail	Pass
71	32	Pass	Fail	Pass	Pass	Fail	Pass
72	13	Pass	Pass	Pass	Pass	Pass	Pass
72	14	Pass	Pass	Pass	Fail	Pass	Pass
72	15	Pass	Pass	Pass	Pass	Pass	Pass
72	30	Pass	Fail	Pass	Pass	Fail	Pass
72	31	Pass	Fail	Pass	Fail	Fail	Pass
72	32	Pass	Fail	Pass	Pass	Fail	Pass
73	13	Pass	Pass	Pass	Pass	Pass	Pass
73	14	Pass	Pass	Pass	Fail	Pass	Pass
73	15	Pass	Pass	Pass	Pass	Pass	Pass
73	30	Pass	Fail	Pass	Pass	Fail	Pass
73	31	Pass	Fail	Pass	Pass	Fail	Pass
74	13	Pass	Pass	Pass	Pass	Pass	Pass
74	14	Pass	Pass	Pass	Fail	Pass	Pass
74	15	Pass	Pass	Pass	Pass	Pass	Pass
74	30	Pass	Fail	Pass	Pass	Fail	Pass
74	31	Pass	Fail	Pass	Pass	Fail	Pass
75	13	Pass	Pass	Pass	Pass	Pass	Pass
75	14	Pass	Pass	Pass	Fail	Pass	Pass
75	15	Pass	Pass	Pass	Pass	Pass	Pass
75	30	Pass	Fail	Pass	Pass	Fail	Pass
75	31	Pass	Fail	Pass	Pass	Fail	Pass
76	13	Pass	Pass	Pass	Pass	Pass	Pass
76	14	Pass	Pass	Pass	Pass	Pass	Pass

76	15	Pass	Fail	Pass	Pass	Fail	Pass
76	16	Pass	Fail	Pass	Pass	Fail	Pass
76	17	Pass	Fail	Pass	Pass	Fail	Pass
76	30	Pass	Fail	Pass	Pass	Fail	Pass
76	31	Pass	Fail	Pass	Pass	Fail	Pass
76	33	Fail	Fail	Fail	Fail	Fail	Fail
77	13	Pass	Fail	Pass	Pass	Fail	Pass
77	14	Pass	Pass	Pass	Pass	Pass	Pass
77	15	Pass	Fail	Pass	Fail	Fail	Pass
77	16	Pass	Fail	Pass	Pass	Fail	Pass
77	17	Pass	Fail	Pass	Pass	Fail	Pass
77	30	Pass	Fail	Pass	Pass	Fail	Pass
77	31	Pass	Fail	Pass	Pass	Fail	Pass
78	13	Pass	Fail	Pass	Pass	Fail	Pass
78	14	Pass	Pass	Pass	Pass	Pass	Pass
78	15	Pass	Fail	Pass	Fail	Fail	Pass
78	16	Pass	Fail	Pass	Fail	Fail	Pass
78	17	Pass	Fail	Pass	Pass	Fail	Pass
78	30	Pass	Fail	Pass	Pass	Fail	Pass
78	31	Pass	Fail	Pass	Pass	Fail	Pass
79	13	Pass	Pass	Pass	Pass	Pass	Pass
79	14	Pass	Pass	Pass	Pass	Pass	Pass
79	15	Pass	Fail	Pass	Pass	Fail	Pass
79	30	Pass	Fail	Pass	Pass	Fail	Pass
79	31	Pass	Fail	Pass	Pass	Fail	Pass
80	13	Pass	Pass	Pass	Pass	Pass	Pass
80	14	Pass	Pass	Pass	Pass	Pass	Pass
80	15	Pass	Fail	Pass	Pass	Fail	Pass
80	30	Pass	Fail	Pass	Pass	Fail	Pass
80	31	Pass	Fail	Pass	Pass	Fail	Pass
81	13	Pass	Pass	Pass	Pass	Pass	Pass
81	14	Pass	Pass	Pass	Pass	Pass	Pass
81	15	Pass	Fail	Pass	Pass	Fail	Pass
81	30	Pass	Fail	Pass	Pass	Fail	Pass
81	31	Pass	Fail	Pass	Pass	Fail	Pass
82	13	Pass	Pass	Pass	Pass	Pass	Pass
82	14	Pass	Pass	Pass	Pass	Pass	Pass
82	15	Pass	Pass	Pass	Pass	Pass	Pass
82	16	Pass	Fail	Pass	Pass	Fail	Pass
82	17	Pass	Fail	Pass	Pass	Fail	Pass
82	18	Pass	Fail	Pass	Pass	Fail	Pass
82	19	Pass	Fail	Pass	Pass	Fail	Pass
82	20	Pass	Fail	Pass	Pass	Fail	Pass
82	21	Pass	Fail	Pass	Pass	Fail	Pass
82	29	Pass	Fail	Pass	Pass	Fail	Pass
82	30	Pass	Fail	Pass	Pass	Fail	Pass
82	31	Pass	Fail	Pass	Pass	Fail	Pass
83	13	Pass	Pass	Pass	Pass	Pass	Pass
83	14	Pass	Pass	Pass	Pass	Pass	Pass
83	15	Pass	Pass	Pass	Pass	Pass	Pass
83	21	Pass	Fail	Pass	Pass	Fail	Pass
83	30	Pass	Fail	Pass	Pass	Fail	Pass
83	31	Pass	Fail	Pass	Pass	Fail	Pass
84	13	Pass	Pass	Pass	Pass	Pass	Pass
84	14	Pass	Pass	Pass	Pass	Pass	Pass
84	15	Pass	Pass	Pass	Pass	Pass	Pass
84	21	Pass	Fail	Pass	Pass	Fail	Pass

84	30	Pass	Fail	Pass	Pass	Fail	Pass
84	31	Pass	Fail	Pass	Pass	Fail	Pass
85	13	Pass	Pass	Pass	Pass	Pass	Pass
85	14	Pass	Pass	Pass	Pass	Pass	Pass
85	15	Pass	Pass	Pass	Pass	Pass	Pass
85	21	Pass	Fail	Pass	Pass	Fail	Pass
85	30	Pass	Fail	Pass	Pass	Fail	Pass
86	13	Pass	Pass	Pass	Pass	Pass	Pass
86	14	Pass	Pass	Pass	Pass	Pass	Pass
86	15	Pass	Pass	Pass	Pass	Pass	Pass
86	17	Fail	Fail	Fail	Fail	Fail	Fail
86	21	Pass	Fail	Pass	Pass	Fail	Pass
86	30	Pass	Pass	Pass	Pass	Pass	Pass
87	13	Pass	Pass	Pass	Pass	Pass	Pass
87	14	Pass	Pass	Pass	Pass	Pass	Pass
87	15	Pass	Pass	Pass	Pass	Pass	Pass
87	30	Pass	Fail	Pass	Pass	Fail	Pass
87	32	Fail	Fail	Fail	Fail	Fail	Fail
88	13	Pass	Pass	Pass	Pass	Pass	Pass
88	14	Pass	Pass	Pass	Pass	Pass	Pass
88	15	Pass	Pass	Pass	Pass	Pass	Pass
88	30	Pass	Fail	Pass	Pass	Fail	Pass
89	13	Pass	Pass	Pass	Pass	Pass	Pass
89	14	Pass	Pass	Pass	Pass	Pass	Pass
89	15	Pass	Pass	Pass	Pass	Pass	Pass
89	30	Pass	Fail	Pass	Pass	Fail	Pass
90	13	Pass	Pass	Pass	Pass	Pass	Pass
90	14	Pass	Pass	Pass	Pass	Pass	Pass
90	15	Pass	Pass	Pass	Pass	Pass	Pass
90	30	Pass	Fail	Pass	Pass	Fail	Pass
91	13	Pass	Pass	Pass	Pass	Pass	Pass
91	14	Pass	Pass	Pass	Pass	Pass	Pass
91	15	Pass	Pass	Pass	Pass	Pass	Pass
91	16	Pass	Fail	Pass	Pass	Fail	Pass
91	30	Pass	Fail	Pass	Pass	Fail	Pass
92	13	Pass	Pass	Pass	Pass	Pass	Pass
92	14	Pass	Pass	Pass	Pass	Pass	Pass
92	15	Pass	Pass	Pass	Pass	Pass	Pass
92	16	Pass	Fail	Pass	Pass	Fail	Pass
92	30	Pass	Fail	Pass	Pass	Fail	Pass
92	32	Fail	Fail	Fail	Fail	Fail	Fail
93	13	Pass	Pass	Pass	Pass	Pass	Pass
93	14	Pass	Pass	Pass	Pass	Pass	Pass
93	15	Pass	Pass	Pass	Pass	Pass	Pass
93	16	Pass	Pass	Pass	Pass	Pass	Pass
93	30	Pass	Fail	Pass	Pass	Fail	Pass
94	13	Pass	Pass	Pass	Pass	Pass	Pass
94	14	Pass	Pass	Pass	Pass	Pass	Pass
94	15	Pass	Pass	Pass	Pass	Pass	Pass
94	16	Pass	Fail	Pass	Pass	Fail	Pass
94	26	Pass	Pass	Pass	Pass	Pass	Pass
94	30	Pass	Fail	Pass	Pass	Fail	Pass
95	13	Pass	Pass	Pass	Pass	Pass	Pass
95	14	Pass	Pass	Pass	Pass	Pass	Pass
95	15	Pass	Pass	Pass	Pass	Pass	Pass
95	16	Pass	Fail	Pass	Pass	Fail	Pass
95	26	Pass	Fail	Pass	Pass	Fail	Pass

95	28	Fail	Fail	Fail	Fail	Fail	Fail
95	30	Pass	Fail	Pass	Pass	Fail	Pass
96	11	Fail	Fail	Fail	Fail	Fail	Fail
96	13	Pass	Pass	Pass	Pass	Pass	Pass
96	14	Pass	Pass	Pass	Pass	Pass	Pass
96	15	Pass	Pass	Pass	Pass	Pass	Pass
96	26	Pass	Fail	Pass	Pass	Fail	Pass
96	30	Pass	Fail	Pass	Pass	Fail	Pass
97	13	Pass	Pass	Pass	Pass	Pass	Pass
97	14	Pass	Pass	Pass	Pass	Pass	Pass
97	15	Pass	Fail	Pass	Pass	Fail	Pass
97	26	Pass	Fail	Pass	Pass	Fail	Pass
97	30	Pass	Fail	Pass	Pass	Fail	Pass
98	13	Pass	Fail	Pass	Pass	Fail	Pass
98	14	Pass	Pass	Pass	Pass	Pass	Pass
98	15	Pass	Fail	Pass	Pass	Fail	Pass
98	26	Pass	Fail	Pass	Pass	Fail	Pass
98	27	Pass	Pass	Pass	Pass	Pass	Pass
98	28	Pass	Pass	Pass	Pass	Pass	Pass
98	29	Pass	Pass	Pass	Pass	Pass	Pass
98	30	Pass	Fail	Pass	Pass	Fail	Pass
99	13	Pass	Pass	Pass	Pass	Pass	Pass
99	14	Pass	Pass	Pass	Pass	Pass	Pass
99	15	Pass	Fail	Pass	Pass	Fail	Pass
99	16	Pass	Fail	Pass	Pass	Fail	Pass
99	17	Pass	Fail	Pass	Pass	Fail	Pass
99	18	Pass	Fail	Pass	Pass	Fail	Pass
99	19	Pass	Fail	Pass	Pass	Fail	Pass
99	20	Pass	Fail	Pass	Pass	Fail	Pass
99	21	Pass	Fail	Pass	Pass	Fail	Pass
99	22	Pass	Fail	Pass	Pass	Fail	Pass
99	23	Pass	Fail	Pass	Pass	Fail	Pass
99	26	Pass	Fail	Pass	Pass	Fail	Pass
99	30	Pass	Fail	Pass	Pass	Fail	Pass
100	13	Pass	Pass	Pass	Pass	Pass	Pass
100	14	Pass	Pass	Pass	Pass	Pass	Pass
100	15	Pass	Pass	Pass	Pass	Pass	Pass
100	23	Pass	Fail	Pass	Pass	Fail	Pass
100	24	Pass	Fail	Pass	Pass	Fail	Pass
100	25	Pass	Fail	Pass	Pass	Fail	Pass
100	26	Pass	Fail	Pass	Pass	Fail	Pass
100	30	Pass	Fail	Pass	Pass	Fail	Pass
101	13	Pass	Pass	Pass	Pass	Pass	Pass
101	14	Pass	Pass	Pass	Pass	Pass	Pass
101	15	Pass	Pass	Pass	Pass	Pass	Pass
101	16	Pass	Fail	Pass	Pass	Fail	Pass
101	17	Pass	Fail	Pass	Pass	Fail	Pass
101	18	Pass	Fail	Pass	Pass	Fail	Pass
101	19	Pass	Fail	Pass	Pass	Fail	Pass
101	20	Pass	Fail	Pass	Pass	Fail	Pass
101	21	Pass	Fail	Pass	Pass	Fail	Pass
101	22	Pass	Fail	Pass	Pass	Fail	Pass
101	23	Pass	Fail	Pass	Pass	Fail	Pass
101	26	Pass	Pass	Pass	Pass	Pass	Pass
101	30	Pass	Fail	Pass	Pass	Fail	Pass
102	13	Pass	Pass	Pass	Pass	Pass	Pass
102	14	Pass	Pass	Pass	Pass	Pass	Pass

102	15	Pass	Pass	Pass	Pass	Pass	Pass
102	26	Pass	Pass	Pass	Pass	Pass	Pass
102	30	Pass	Fail	Pass	Pass	Fail	Pass
103	13	Pass	Pass	Pass	Pass	Pass	Pass
103	14	Pass	Pass	Pass	Pass	Pass	Pass
103	15	Pass	Pass	Pass	Pass	Pass	Pass
103	26	Pass	Pass	Pass	Pass	Pass	Pass
103	30	Pass	Pass	Pass	Pass	Pass	Pass
104	11	Fail	Fail	Fail	Fail	Fail	Fail
104	13	Pass	Fail	Pass	Pass	Pass	Pass
104	14	Pass	Pass	Pass	Pass	Pass	Pass
104	15	Pass	Pass	Pass	Pass	Pass	Pass
104	26	Pass	Pass	Pass	Pass	Pass	Pass
104	30	Pass	Fail	Pass	Pass	Fail	Pass
105	13	Pass	Fail	Pass	Pass	Fail	Pass
105	14	Pass	Pass	Pass	Pass	Pass	Pass
105	15	Pass	Pass	Pass	Pass	Pass	Pass
105	26	Pass	Pass	Pass	Pass	Pass	Pass
105	30	Pass	Fail	Pass	Pass	Fail	Pass
106	13	Pass	Fail	Pass	Pass	Pass	Pass
106	14	Pass	Pass	Pass	Pass	Pass	Pass
106	15	Pass	Pass	Pass	Pass	Pass	Pass
106	26	Pass	Pass	Pass	Pass	Pass	Pass
106	27	Pass	Fail	Pass	Pass	Fail	Pass
106	30	Pass	Fail	Pass	Pass	Fail	Pass
106	39	Pass	Fail	Pass	Pass	Fail	Pass
107	13	Pass	Pass	Pass	Pass	Pass	Pass
107	14	Pass	Pass	Pass	Pass	Pass	Pass
107	15	Pass	Fail	Pass	Pass	Pass	Pass
107	22	Pass	Fail	Pass	Pass	Fail	Pass
107	26	Pass	Fail	Pass	Pass	Fail	Pass
107	30	Pass	Fail	Pass	Pass	Fail	Pass
107	39	Pass	Fail	Pass	Pass	Fail	Pass
108	13	Pass	Pass	Pass	Pass	Pass	Pass
108	14	Pass	Pass	Pass	Pass	Pass	Pass
108	15	Pass	Pass	Pass	Pass	Pass	Pass
108	22	Pass	Pass	Pass	Pass	Pass	Pass
108	24	Fail	Fail	Fail	Fail	Fail	Fail
108	26	Pass	Fail	Pass	Pass	Fail	Pass
108	30	Pass	Fail	Pass	Pass	Fail	Pass
108	39	Pass	Fail	Pass	Pass	Fail	Pass
109	13	Pass	Pass	Pass	Pass	Pass	Pass
109	14	Pass	Pass	Pass	Pass	Pass	Pass
109	15	Pass	Pass	Pass	Pass	Pass	Pass
109	22	Pass	Fail	Pass	Pass	Fail	Pass
109	26	Pass	Pass	Pass	Pass	Pass	Pass
109	30	Pass	Fail	Pass	Pass	Fail	Pass
109	39	Pass	Pass	Pass	Pass	Pass	Pass
110	13	Pass	Pass	Pass	Pass	Pass	Pass
110	14	Pass	Pass	Pass	Pass	Pass	Pass
110	15	Pass	Pass	Pass	Pass	Pass	Pass
110	22	Pass	Pass	Pass	Pass	Pass	Pass
110	26	Pass	Pass	Pass	Pass	Pass	Pass
110	28	Fail	Fail	Fail	Fail	Fail	Fail
110	39	Pass	Fail	Pass	Pass	Fail	Pass
111	13	Pass	Pass	Pass	Pass	Pass	Pass
111	14	Pass	Pass	Pass	Pass	Pass	Pass

111	15	Pass	Pass	Pass	Pass	Pass	Pass
111	22	Pass	Fail	Pass	Pass	Fail	Pass
111	26	Pass	Pass	Pass	Pass	Pass	Pass
111	39	Pass	Fail	Pass	Pass	Fail	Pass
112	13	Pass	Fail	Pass	Pass	Fail	Pass
112	14	Pass	Pass	Pass	Pass	Pass	Pass
112	15	Pass	Pass	Pass	Pass	Pass	Pass
112	22	Pass	Fail	Pass	Pass	Fail	Pass
112	26	Pass	Fail	Pass	Pass	Fail	Pass
112	39	Pass	Fail	Pass	Pass	Fail	Pass
113	13	Pass	Fail	Pass	Pass	Pass	Pass
113	14	Pass	Pass	Pass	Pass	Pass	Pass
113	15	Pass	Pass	Pass	Pass	Pass	Pass
113	26	Pass	Fail	Pass	Pass	Fail	Pass
113	27	Pass	Fail	Pass	Pass	Fail	Pass
113	39	Pass	Pass	Pass	Pass	Pass	Pass
113	41	Fail	Fail	Fail	Fail	Fail	Fail
114	13	Pass	Pass	Pass	Pass	Pass	Pass
114	14	Pass	Pass	Pass	Pass	Pass	Pass
114	15	Pass	Pass	Pass	Pass	Pass	Pass
114	26	Pass	Fail	Pass	Pass	Fail	Pass
114	39	Pass	Pass	Pass	Pass	Pass	Pass
115	13	Pass	Pass	Pass	Pass	Pass	Pass
115	14	Pass	Pass	Pass	Pass	Pass	Pass
115	15	Pass	Pass	Pass	Pass	Pass	Pass
115	26	Pass	Fail	Pass	Pass	Fail	Pass
115	39	Pass	Pass	Pass	Pass	Pass	Pass
116	13	Pass	Pass	Pass	Pass	Pass	Pass
116	14	Pass	Pass	Pass	Pass	Pass	Pass
116	15	Pass	Pass	Pass	Pass	Pass	Pass
116	26	Pass	Fail	Pass	Pass	Fail	Pass
116	28	Fail	Fail	Fail	Fail	Fail	Fail
116	39	Pass	Pass	Pass	Pass	Pass	Pass
117	13	Pass	Pass	Pass	Pass	Pass	Pass
117	14	Pass	Pass	Pass	Pass	Pass	Pass
117	15	Pass	Pass	Pass	Pass	Pass	Pass
117	26	Pass	Fail	Pass	Pass	Fail	Pass
117	39	Pass	Pass	Pass	Pass	Pass	Pass
118	13	Pass	Pass	Pass	Pass	Pass	Pass
118	14	Pass	Pass	Pass	Pass	Pass	Pass
118	15	Pass	Fail	Pass	Pass	Pass	Pass
118	20	Pass	Fail	Pass	Pass	Fail	Pass
118	26	Pass	Fail	Pass	Pass	Fail	Pass
118	39	Pass	Pass	Pass	Pass	Pass	Pass
119	13	Pass	Pass	Pass	Pass	Pass	Pass
119	14	Pass	Pass	Pass	Pass	Pass	Pass
119	15	Pass	Pass	Pass	Pass	Pass	Pass
119	20	Pass	Fail	Pass	Pass	Fail	Pass
119	26	Pass	Fail	Pass	Pass	Fail	Pass
119	39	Pass	Pass	Pass	Pass	Pass	Pass
120	13	Pass	Pass	Pass	Pass	Pass	Pass
120	14	Pass	Pass	Pass	Pass	Pass	Pass
120	15	Pass	Fail	Pass	Pass	Fail	Pass
120	16	Pass	Fail	Pass	Pass	Fail	Pass
120	26	Pass	Fail	Pass	Pass	Fail	Pass
120	39	Pass	Pass	Pass	Pass	Pass	Pass
121	13	Pass	Pass	Pass	Pass	Pass	Pass

121	14	Pass	Pass	Pass	Pass	Pass	Pass
121	26	Pass	Fail	Pass	Pass	Fail	Pass
121	39	Pass	Pass	Pass	Pass	Pass	Pass
122	13	Pass	Pass	Pass	Pass	Pass	Pass
122	14	Pass	Pass	Pass	Pass	Pass	Pass
122	26	Pass	Fail	Pass	Pass	Fail	Pass
122	39	Pass	Pass	Pass	Pass	Pass	Pass
122	41	Fail	Fail	Fail	Fail	Fail	Fail
123	13	Pass	Pass	Pass	Pass	Pass	Pass
123	14	Pass	Pass	Pass	Pass	Pass	Pass
123	15	Pass	Fail	Pass	Pass	Fail	Pass
123	16	Pass	Pass	Pass	Pass	Pass	Pass
123	17	Pass	Pass	Pass	Pass	Pass	Pass
123	18	Pass	Pass	Pass	Pass	Pass	Pass
123	19	Pass	Pass	Pass	Pass	Pass	Pass
123	20	Pass	Pass	Pass	Pass	Pass	Pass
123	21	Pass	Pass	Pass	Pass	Pass	Pass
123	22	Pass	Pass	Pass	Pass	Pass	Pass
123	23	Pass	Pass	Pass	Pass	Pass	Pass
123	24	Pass	Fail	Pass	Pass	Pass	Pass
123	25	Pass	Fail	Pass	Pass	Fail	Pass
123	26	Pass	Pass	Pass	Pass	Pass	Pass
123	27	Pass	Pass	Pass	Pass	Pass	Pass
123	28	Pass	Pass	Pass	Pass	Pass	Pass
123	29	Pass	Fail	Pass	Pass	Fail	Pass
123	30	Pass	Fail	Pass	Pass	Fail	Pass
123	31	Pass	Fail	Pass	Pass	Fail	Pass
123	32	Pass	Fail	Pass	Pass	Fail	Pass
123	33	Pass	Fail	Pass	Pass	Fail	Pass
123	34	Pass	Pass	Pass	Pass	Pass	Pass
123	35	Pass	Pass	Pass	Pass	Pass	Pass
123	36	Pass	Pass	Pass	Pass	Pass	Pass
123	37	Pass	Fail	Pass	Pass	Fail	Pass
123	38	Pass	Fail	Pass	Pass	Fail	Pass
123	39	Pass	Fail	Pass	Pass	Fail	Pass
124	13	Pass	Fail	Pass	Pass	Fail	Pass
124	14	Pass	Pass	Pass	Pass	Pass	Pass
124	23	Pass	Fail	Pass	Pass	Fail	Pass
125	13	Pass	Fail	Pass	Pass	Fail	Pass
125	14	Pass	Fail	Pass	Pass	Fail	Pass
125	23	Pass	Pass	Pass	Pass	Pass	Pass
125	28	Fail	Fail	Fail	Fail	Fail	Fail
125	33	Fail	Fail	Fail	Fail	Fail	Fail
126	13	Pass	Fail	Pass	Pass	Fail	Pass
126	14	Pass	Fail	Pass	Pass	Fail	Pass
126	23	Pass	Pass	Pass	Pass	Pass	Pass
127	13	Pass	Fail	Pass	Pass	Fail	Pass
127	14	Pass	Pass	Pass	Pass	Pass	Pass
127	23	Pass	Pass	Pass	Pass	Pass	Pass
128	13	Pass	Pass	Pass	Pass	Pass	Pass
128	14	Pass	Pass	Pass	Pass	Pass	Pass
128	23	Pass	Pass	Pass	Pass	Pass	Pass
129	13	Pass	Fail	Pass	Pass	Fail	Pass
129	14	Pass	Pass	Pass	Pass	Pass	Pass
129	23	Pass	Pass	Pass	Pass	Pass	Pass
130	8	Pass	Fail	Pass	Pass	Fail	Pass
130	9	Pass	Fail	Pass	Pass	Fail	Pass

130	10	Pass	Fail	Pass	Pass	Fail	Pass
130	11	Pass	Fail	Pass	Pass	Fail	Pass
130	12	Pass	Fail	Pass	Pass	Fail	Pass
130	13	Pass	Fail	Pass	Pass	Fail	Pass
130	14	Pass	Pass	Pass	Pass	Pass	Pass
130	23	Pass	Pass	Pass	Pass	Pass	Pass
131	14	Pass	Fail	Pass	Pass	Fail	Pass
131	23	Pass	Pass	Pass	Pass	Pass	Pass
132	14	Pass	Pass	Pass	Pass	Pass	Pass
132	23	Pass	Pass	Pass	Pass	Pass	Pass
133	14	Pass	Pass	Pass	Pass	Pass	Pass
133	23	Pass	Pass	Pass	Pass	Pass	Pass
134	14	Pass	Pass	Pass	Pass	Pass	Pass
134	23	Pass	Fail	Pass	Pass	Fail	Pass
135	14	Pass	Fail	Pass	Pass	Fail	Pass
136	14	Pass	Pass	Pass	Pass	Pass	Pass
137	14	Pass	Pass	Pass	Pass	Pass	Pass
138	14	Pass	Pass	Pass	Pass	Pass	Pass

3. Table C.7.3 Striped Bass eggs D.O. , Salinity, and Velocity criteria passing for existing and deepening (3 ft) scenarios within the analyzed period April 1 - April 30, 1997

HABITAT REQUIREMENTS:
RM 10-31; Depth Average
D.O. April (MG/L):10th %ile >=4.5
Salinity 50th %ile <= 9 ppt
Mean Velocity >= 30 cm/s

Savannah Harbor Estuary

Segments		Baseline Scenario			Project Scenario		
J	I	Salinity	Velocity	D.O.	Salinity	Velocity	D.O.
47	13	Fail	Pass	Pass	Fail	Pass	Pass
47	14	Fail	Pass	Pass	Fail	Pass	Pass
47	15	Fail	Pass	Pass	Fail	Pass	Pass
47	16	Fail	Pass	Pass	Fail	Pass	Pass
47	17	Fail	Fail	Pass	Fail	Fail	Pass
48	13	Fail	Pass	Pass	Fail	Pass	Pass
48	14	Fail	Pass	Pass	Fail	Pass	Pass
48	15	Fail	Pass	Pass	Fail	Pass	Pass
48	16	Fail	Pass	Pass	Fail	Pass	Pass
48	17	Fail	Pass	Pass	Fail	Pass	Pass
49	13	Fail	Pass	Pass	Fail	Pass	Pass
49	14	Fail	Pass	Pass	Fail	Pass	Pass
49	15	Fail	Pass	Pass	Fail	Pass	Pass
49	16	Fail	Pass	Pass	Fail	Pass	Pass
49	17	Fail	Pass	Pass	Fail	Pass	Pass
50	13	Fail	Pass	Pass	Fail	Pass	Pass
50	14	Fail	Pass	Pass	Fail	Pass	Pass
50	15	Fail	Fail	Pass	Fail	Fail	Pass
50	16	Fail	Fail	Pass	Fail	Fail	Pass
50	17	Fail	Fail	Pass	Fail	Fail	Pass
50	18	Fail	Fail	Pass	Fail	Fail	Pass
51	13	Fail	Pass	Pass	Fail	Pass	Pass
51	14	Fail	Pass	Pass	Fail	Pass	Pass
51	15	Fail	Pass	Pass	Fail	Pass	Pass
52	13	Fail	Pass	Pass	Fail	Pass	Pass
52	14	Fail	Pass	Pass	Fail	Pass	Pass
52	15	Fail	Pass	Pass	Fail	Pass	Pass
53	13	Fail	Pass	Pass	Fail	Pass	Pass
53	14	Fail	Pass	Pass	Fail	Pass	Pass
53	15	Fail	Pass	Pass	Fail	Pass	Pass
54	13	Fail	Pass	Pass	Fail	Pass	Pass
54	14	Fail	Pass	Pass	Fail	Pass	Pass
54	15	Fail	Pass	Pass	Fail	Pass	Pass
55	13	Fail	Pass	Pass	Fail	Pass	Pass
55	14	Fail	Pass	Pass	Fail	Pass	Pass
55	15	Fail	Pass	Pass	Fail	Pass	Pass
56	13	Fail	Pass	Pass	Fail	Pass	Pass
56	14	Fail	Pass	Pass	Fail	Pass	Pass
56	15	Fail	Pass	Pass	Fail	Pass	Pass

57	13	Fail	Pass	Pass	Fail	Pass	Pass
57	14	Fail	Pass	Pass	Fail	Pass	Pass
57	15	Fail	Pass	Pass	Fail	Pass	Pass
58	13	Pass	Pass	Pass	Fail	Pass	Pass
58	14	Fail	Pass	Pass	Fail	Pass	Pass
58	15	Pass	Pass	Pass	Fail	Pass	Pass
59	13	Pass	Pass	Pass	Fail	Pass	Pass
59	14	Fail	Pass	Pass	Fail	Pass	Pass
59	15	Pass	Pass	Pass	Pass	Pass	Pass
59	30	Fail	Fail	Pass	Fail	Fail	Pass
59	31	Fail	Fail	Pass	Fail	Fail	Pass
59	32	Fail	Fail	Pass	Fail	Fail	Pass
60	13	Pass	Pass	Pass	Fail	Pass	Pass
60	14	Fail	Pass	Pass	Fail	Pass	Pass
60	15	Pass	Pass	Pass	Pass	Pass	Pass
60	30	Fail	Fail	Pass	Fail	Fail	Pass
60	31	Fail	Fail	Pass	Fail	Fail	Pass
60	32	Fail	Fail	Pass	Fail	Fail	Pass
61	13	Pass	Pass	Pass	Fail	Pass	Pass
61	14	Fail	Pass	Pass	Fail	Pass	Pass
61	15	Pass	Pass	Pass	Pass	Pass	Pass
61	30	Fail	Fail	Pass	Fail	Fail	Pass
61	31	Fail	Fail	Pass	Fail	Fail	Pass
61	32	Fail	Fail	Pass	Fail	Fail	Pass
62	13	Pass	Pass	Pass	Pass	Pass	Pass
62	14	Fail	Pass	Pass	Fail	Pass	Pass
62	15	Pass	Pass	Pass	Pass	Pass	Pass
62	30	Fail	Fail	Pass	Fail	Fail	Pass
62	31	Fail	Fail	Pass	Fail	Fail	Pass
62	32	Fail	Fail	Pass	Fail	Fail	Pass
63	13	Pass	Pass	Pass	Fail	Pass	Pass
63	14	Fail	Pass	Pass	Fail	Pass	Pass
63	15	Pass	Pass	Pass	Pass	Pass	Pass
63	31	Fail	Pass	Pass	Fail	Pass	Pass
64	13	Pass	Pass	Pass	Pass	Pass	Pass
64	14	Fail	Pass	Pass	Fail	Pass	Pass
64	15	Pass	Pass	Pass	Pass	Pass	Pass
64	30	Fail	Fail	Pass	Fail	Fail	Pass
64	31	Fail	Pass	Pass	Fail	Pass	Pass
64	32	Fail	Fail	Pass	Fail	Fail	Pass
65	13	Pass	Pass	Pass	Pass	Pass	Pass
65	14	Fail	Pass	Pass	Fail	Pass	Pass
65	15	Pass	Pass	Pass	Pass	Pass	Pass
65	30	Fail	Fail	Pass	Fail	Fail	Pass
65	31	Fail	Pass	Pass	Fail	Pass	Pass
65	32	Fail	Fail	Pass	Fail	Fail	Pass
65	33	Fail	Fail	Pass	Fail	Fail	Pass
66	13	Pass	Pass	Pass	Pass	Pass	Pass
66	14	Fail	Pass	Pass	Fail	Pass	Pass
66	15	Pass	Pass	Pass	Pass	Fail	Pass
66	30	Fail	Fail	Pass	Fail	Fail	Pass
66	31	Fail	Pass	Pass	Fail	Pass	Pass
66	32	Fail	Fail	Pass	Fail	Fail	Pass
66	36	Fail	Fail	Pass	Fail	Fail	Pass
66	38	Fail	Fail	Fail	Fail	Fail	Fail
67	13	Pass	Pass	Pass	Pass	Pass	Pass
67	14	Fail	Pass	Pass	Fail	Pass	Pass

67	15	Pass	Fail	Pass	Pass	Fail	Pass
67	30	Fail	Fail	Pass	Fail	Fail	Pass
67	31	Fail	Pass	Pass	Fail	Pass	Pass
67	32	Fail	Fail	Pass	Fail	Fail	Pass
67	36	Fail	Fail	Pass	Fail	Fail	Pass
68	13	Pass	Pass	Pass	Pass	Pass	Pass
68	14	Fail	Pass	Pass	Fail	Pass	Pass
68	15	Pass	Fail	Pass	Pass	Fail	Pass
68	30	Pass	Fail	Pass	Fail	Fail	Pass
68	31	Pass	Pass	Pass	Fail	Pass	Pass
68	32	Pass	Fail	Pass	Fail	Fail	Pass
68	36	Fail	Fail	Pass	Fail	Fail	Pass
68	38	Fail	Fail	Fail	Fail	Fail	Fail
69	13	Pass	Pass	Pass	Pass	Pass	Pass
69	14	Pass	Pass	Pass	Fail	Pass	Pass
69	15	Pass	Fail	Pass	Pass	Fail	Pass
69	30	Pass	Pass	Pass	Fail	Pass	Pass
69	31	Pass	Pass	Pass	Fail	Pass	Pass
69	32	Pass	Fail	Pass	Fail	Fail	Pass
69	36	Fail	Fail	Pass	Fail	Fail	Pass
70	13	Pass	Pass	Pass	Pass	Pass	Pass
70	14	Pass	Pass	Pass	Fail	Pass	Pass
70	15	Pass	Fail	Pass	Pass	Fail	Pass
70	30	Pass	Fail	Pass	Fail	Fail	Pass
70	31	Pass	Fail	Pass	Pass	Fail	Pass
70	32	Pass	Fail	Pass	Pass	Fail	Pass
70	33	Pass	Fail	Pass	Fail	Fail	Pass
71	13	Pass	Pass	Pass	Pass	Pass	Pass
71	14	Pass	Pass	Pass	Fail	Pass	Pass
71	15	Pass	Pass	Pass	Pass	Pass	Pass
71	30	Pass	Fail	Pass	Pass	Fail	Pass
71	31	Pass	Fail	Pass	Pass	Fail	Pass
71	32	Pass	Fail	Pass	Pass	Fail	Pass
72	13	Pass	Pass	Pass	Pass	Pass	Pass
72	14	Pass	Pass	Pass	Fail	Pass	Pass
72	15	Pass	Pass	Pass	Pass	Pass	Pass
72	30	Pass	Fail	Pass	Pass	Fail	Pass
72	31	Pass	Fail	Pass	Pass	Fail	Pass
72	32	Pass	Fail	Pass	Pass	Fail	Pass
73	13	Pass	Pass	Pass	Pass	Pass	Pass
73	14	Pass	Pass	Pass	Fail	Pass	Pass
73	15	Pass	Pass	Pass	Pass	Pass	Pass
73	30	Pass	Fail	Pass	Pass	Fail	Pass
73	31	Pass	Fail	Pass	Pass	Fail	Pass
74	13	Pass	Pass	Pass	Pass	Pass	Pass
74	14	Pass	Pass	Pass	Fail	Pass	Pass
74	15	Pass	Pass	Pass	Pass	Pass	Pass
74	30	Pass	Fail	Pass	Pass	Fail	Pass
74	31	Pass	Fail	Pass	Pass	Fail	Pass
75	13	Pass	Pass	Pass	Pass	Pass	Pass
75	14	Pass	Pass	Pass	Pass	Pass	Pass
75	15	Pass	Pass	Pass	Pass	Pass	Pass
75	30	Pass	Fail	Pass	Pass	Fail	Pass
75	31	Pass	Fail	Pass	Pass	Fail	Pass
76	13	Pass	Pass	Pass	Pass	Pass	Pass
76	14	Pass	Pass	Pass	Pass	Pass	Pass
76	15	Pass	Fail	Pass	Pass	Fail	Pass

76	16	Pass	Fail	Pass	Pass	Fail	Pass
76	17	Pass	Fail	Pass	Pass	Fail	Pass
76	30	Pass	Fail	Pass	Pass	Fail	Pass
76	31	Pass	Fail	Pass	Pass	Fail	Pass
76	33	Fail	Fail	Fail	Fail	Fail	Fail
77	13	Pass	Fail	Pass	Pass	Fail	Pass
77	14	Pass	Pass	Pass	Pass	Pass	Pass
77	15	Pass	Fail	Pass	Pass	Fail	Pass
77	16	Pass	Fail	Pass	Pass	Fail	Pass
77	17	Pass	Fail	Pass	Pass	Fail	Pass
77	30	Pass	Fail	Pass	Pass	Fail	Pass
77	31	Pass	Fail	Pass	Pass	Fail	Pass
78	13	Pass	Fail	Pass	Pass	Fail	Pass
78	14	Pass	Pass	Pass	Pass	Pass	Pass
78	15	Pass	Fail	Pass	Pass	Fail	Pass
78	16	Pass	Fail	Pass	Pass	Fail	Pass
78	17	Pass	Fail	Pass	Pass	Fail	Pass
78	30	Pass	Fail	Pass	Pass	Fail	Pass
78	31	Pass	Fail	Pass	Pass	Fail	Pass
79	13	Pass	Pass	Pass	Pass	Pass	Pass
79	14	Pass	Pass	Pass	Pass	Pass	Pass
79	15	Pass	Fail	Pass	Pass	Fail	Pass
79	30	Pass	Fail	Pass	Pass	Fail	Pass
79	31	Pass	Fail	Pass	Pass	Fail	Pass
80	13	Pass	Pass	Pass	Pass	Pass	Pass
80	14	Pass	Pass	Pass	Pass	Pass	Pass
80	15	Pass	Fail	Pass	Pass	Fail	Pass
80	30	Pass	Fail	Pass	Pass	Fail	Pass
80	31	Pass	Fail	Pass	Pass	Fail	Pass
81	13	Pass	Pass	Pass	Pass	Pass	Pass
81	14	Pass	Pass	Pass	Pass	Pass	Pass
81	15	Pass	Fail	Pass	Pass	Fail	Pass
81	30	Pass	Fail	Pass	Pass	Fail	Pass
81	31	Pass	Fail	Pass	Pass	Fail	Pass
82	13	Pass	Pass	Pass	Pass	Pass	Pass
82	14	Pass	Pass	Pass	Pass	Pass	Pass
82	15	Pass	Pass	Pass	Pass	Pass	Pass
82	16	Pass	Fail	Pass	Pass	Fail	Pass
82	17	Pass	Fail	Pass	Pass	Fail	Pass
82	18	Pass	Fail	Pass	Pass	Fail	Pass
82	19	Pass	Fail	Pass	Pass	Fail	Pass
82	20	Pass	Fail	Pass	Pass	Fail	Pass
82	21	Pass	Fail	Pass	Pass	Fail	Pass
82	29	Pass	Fail	Pass	Pass	Fail	Pass
82	30	Pass	Fail	Pass	Pass	Fail	Pass
82	31	Pass	Fail	Pass	Pass	Fail	Pass
83	13	Pass	Pass	Pass	Pass	Pass	Pass
83	14	Pass	Pass	Pass	Pass	Pass	Pass
83	15	Pass	Pass	Pass	Pass	Pass	Pass
83	21	Pass	Fail	Pass	Pass	Fail	Pass
83	30	Pass	Fail	Pass	Pass	Fail	Pass
83	31	Pass	Fail	Pass	Pass	Fail	Pass
84	13	Pass	Pass	Pass	Pass	Pass	Pass
84	14	Pass	Pass	Pass	Pass	Pass	Pass
84	15	Pass	Pass	Pass	Pass	Pass	Pass
84	21	Pass	Fail	Pass	Pass	Fail	Pass
84	30	Pass	Fail	Pass	Pass	Fail	Pass

84	31	Pass	Fail	Pass	Pass	Fail	Pass
85	13	Pass	Pass	Pass	Pass	Pass	Pass
85	14	Pass	Pass	Pass	Pass	Pass	Pass
85	15	Pass	Pass	Pass	Pass	Pass	Pass
85	21	Pass	Fail	Pass	Pass	Fail	Pass
85	30	Pass	Fail	Pass	Pass	Fail	Pass
86	13	Pass	Pass	Pass	Pass	Pass	Pass
86	14	Pass	Pass	Pass	Pass	Pass	Pass
86	15	Pass	Pass	Pass	Pass	Pass	Pass
86	17	Fail	Fail	Fail	Fail	Fail	Fail
86	21	Pass	Fail	Pass	Pass	Fail	Pass
86	30	Pass	Pass	Pass	Pass	Pass	Pass
87	13	Pass	Pass	Pass	Pass	Pass	Pass
87	14	Pass	Pass	Pass	Pass	Pass	Pass
87	15	Pass	Pass	Pass	Pass	Pass	Pass
87	30	Pass	Fail	Pass	Pass	Fail	Pass
87	32	Fail	Fail	Fail	Fail	Fail	Fail
88	13	Pass	Pass	Pass	Pass	Pass	Pass
88	14	Pass	Pass	Pass	Pass	Pass	Pass
88	15	Pass	Pass	Pass	Pass	Pass	Pass
88	30	Pass	Fail	Pass	Pass	Fail	Pass
89	13	Pass	Pass	Pass	Pass	Pass	Pass
89	14	Pass	Pass	Pass	Pass	Pass	Pass
89	15	Pass	Pass	Pass	Pass	Pass	Pass
89	30	Pass	Fail	Pass	Pass	Fail	Pass
90	13	Pass	Pass	Pass	Pass	Pass	Pass
90	14	Pass	Pass	Pass	Pass	Pass	Pass
90	15	Pass	Pass	Pass	Pass	Pass	Pass
90	30	Pass	Fail	Pass	Pass	Fail	Pass
91	13	Pass	Pass	Pass	Pass	Pass	Pass
91	14	Pass	Pass	Pass	Pass	Pass	Pass
91	15	Pass	Pass	Pass	Pass	Pass	Pass
91	16	Pass	Fail	Pass	Pass	Fail	Pass
91	30	Pass	Fail	Pass	Pass	Fail	Pass
92	13	Pass	Pass	Pass	Pass	Pass	Pass
92	14	Pass	Pass	Pass	Pass	Pass	Pass
92	15	Pass	Pass	Pass	Pass	Pass	Pass
92	16	Pass	Fail	Pass	Pass	Fail	Pass
92	30	Pass	Fail	Pass	Pass	Fail	Pass
92	32	Fail	Fail	Fail	Fail	Fail	Fail
93	13	Pass	Pass	Pass	Pass	Pass	Pass
93	14	Pass	Pass	Pass	Pass	Pass	Pass
93	15	Pass	Pass	Pass	Pass	Pass	Pass
93	16	Pass	Pass	Pass	Pass	Pass	Pass
93	30	Pass	Fail	Pass	Pass	Fail	Pass
94	13	Pass	Pass	Pass	Pass	Pass	Pass
94	14	Pass	Pass	Pass	Pass	Pass	Pass
94	15	Pass	Pass	Pass	Pass	Pass	Pass
94	16	Pass	Fail	Pass	Pass	Fail	Pass
94	26	Pass	Pass	Pass	Pass	Pass	Pass
94	30	Pass	Fail	Pass	Pass	Fail	Pass
95	13	Pass	Pass	Pass	Pass	Pass	Pass
95	14	Pass	Pass	Pass	Pass	Pass	Pass
95	15	Pass	Pass	Pass	Pass	Pass	Pass
95	16	Pass	Fail	Pass	Pass	Fail	Pass
95	26	Pass	Fail	Pass	Pass	Fail	Pass
95	28	Fail	Fail	Fail	Fail	Fail	Fail

95	30	Pass	Fail	Pass	Pass	Fail	Pass
96	11	Fail	Fail	Fail	Fail	Fail	Fail
96	13	Pass	Pass	Pass	Pass	Pass	Pass
96	14	Pass	Pass	Pass	Pass	Pass	Pass
96	15	Pass	Pass	Pass	Pass	Pass	Pass
96	26	Pass	Fail	Pass	Pass	Fail	Pass
96	30	Pass	Fail	Pass	Pass	Fail	Pass
97	13	Pass	Pass	Pass	Pass	Pass	Pass
97	14	Pass	Pass	Pass	Pass	Pass	Pass
97	15	Pass	Fail	Pass	Pass	Fail	Pass
97	26	Pass	Fail	Pass	Pass	Fail	Pass
97	30	Pass	Fail	Pass	Pass	Fail	Pass
98	13	Pass	Fail	Pass	Pass	Fail	Pass
98	14	Pass	Pass	Pass	Pass	Pass	Pass
98	15	Pass	Fail	Pass	Pass	Fail	Pass
98	26	Pass	Fail	Pass	Pass	Fail	Pass
98	27	Pass	Pass	Pass	Pass	Pass	Pass
98	28	Pass	Pass	Pass	Pass	Pass	Pass
98	29	Pass	Pass	Pass	Pass	Pass	Pass
98	30	Pass	Fail	Pass	Pass	Fail	Pass
99	13	Pass	Pass	Pass	Pass	Pass	Pass
99	14	Pass	Pass	Pass	Pass	Pass	Pass
99	15	Pass	Fail	Pass	Pass	Fail	Pass
99	16	Pass	Fail	Pass	Pass	Fail	Pass
99	17	Pass	Fail	Pass	Pass	Fail	Pass
99	18	Pass	Fail	Pass	Pass	Fail	Pass
99	19	Pass	Fail	Pass	Pass	Fail	Pass
99	20	Pass	Fail	Pass	Pass	Fail	Pass
99	21	Pass	Fail	Pass	Pass	Fail	Pass
99	22	Pass	Fail	Pass	Pass	Fail	Pass
99	23	Pass	Fail	Pass	Pass	Fail	Pass
99	26	Pass	Fail	Pass	Pass	Fail	Pass
99	30	Pass	Fail	Pass	Pass	Fail	Pass
100	13	Pass	Pass	Pass	Pass	Pass	Pass
100	14	Pass	Pass	Pass	Pass	Pass	Pass
100	15	Pass	Pass	Pass	Pass	Pass	Pass
100	23	Pass	Fail	Pass	Pass	Fail	Pass
100	24	Pass	Fail	Pass	Pass	Fail	Pass
100	25	Pass	Fail	Pass	Pass	Fail	Pass
100	26	Pass	Fail	Pass	Pass	Fail	Pass
100	30	Pass	Fail	Pass	Pass	Fail	Pass
101	13	Pass	Pass	Pass	Pass	Pass	Pass
101	14	Pass	Pass	Pass	Pass	Pass	Pass
101	15	Pass	Pass	Pass	Pass	Pass	Pass
101	16	Pass	Fail	Pass	Pass	Fail	Pass
101	17	Pass	Fail	Pass	Pass	Fail	Pass
101	18	Pass	Fail	Pass	Pass	Fail	Pass
101	19	Pass	Fail	Pass	Pass	Fail	Pass
101	20	Pass	Fail	Pass	Pass	Fail	Pass
101	21	Pass	Fail	Pass	Pass	Fail	Pass
101	22	Pass	Fail	Pass	Pass	Fail	Pass
101	23	Pass	Fail	Pass	Pass	Fail	Pass
101	26	Pass	Pass	Pass	Pass	Pass	Pass
101	30	Pass	Fail	Pass	Pass	Fail	Pass
102	13	Pass	Pass	Pass	Pass	Pass	Pass
102	14	Pass	Pass	Pass	Pass	Pass	Pass
102	15	Pass	Pass	Pass	Pass	Pass	Pass

102	26	Pass	Pass	Pass	Pass	Pass	Pass
102	30	Pass	Fail	Pass	Pass	Fail	Pass
103	13	Pass	Pass	Pass	Pass	Pass	Pass
103	14	Pass	Pass	Pass	Pass	Pass	Pass
103	15	Pass	Pass	Pass	Pass	Pass	Pass
103	26	Pass	Pass	Pass	Pass	Pass	Pass
103	30	Pass	Pass	Pass	Pass	Pass	Pass
104	11	Fail	Fail	Fail	Fail	Fail	Fail
104	13	Pass	Fail	Pass	Pass	Pass	Pass
104	14	Pass	Pass	Pass	Pass	Pass	Pass
104	15	Pass	Pass	Pass	Pass	Pass	Pass
104	26	Pass	Pass	Pass	Pass	Pass	Pass
104	30	Pass	Fail	Pass	Pass	Fail	Pass
105	13	Pass	Fail	Pass	Pass	Fail	Pass
105	14	Pass	Pass	Pass	Pass	Pass	Pass
105	15	Pass	Pass	Pass	Pass	Pass	Pass
105	26	Pass	Pass	Pass	Pass	Pass	Pass
105	30	Pass	Fail	Pass	Pass	Fail	Pass
106	13	Pass	Fail	Pass	Pass	Pass	Pass
106	14	Pass	Pass	Pass	Pass	Pass	Pass
106	15	Pass	Pass	Pass	Pass	Pass	Pass
106	26	Pass	Pass	Pass	Pass	Pass	Pass
106	27	Pass	Fail	Pass	Pass	Fail	Pass
106	30	Pass	Fail	Pass	Pass	Fail	Pass
106	39	Pass	Fail	Pass	Pass	Fail	Pass
107	13	Pass	Pass	Pass	Pass	Pass	Pass
107	14	Pass	Pass	Pass	Pass	Pass	Pass
107	15	Pass	Fail	Pass	Pass	Pass	Pass
107	22	Pass	Fail	Pass	Pass	Fail	Pass
107	26	Pass	Fail	Pass	Pass	Fail	Pass
107	30	Pass	Fail	Pass	Pass	Fail	Pass
107	39	Pass	Fail	Pass	Pass	Fail	Pass
108	13	Pass	Pass	Pass	Pass	Pass	Pass
108	14	Pass	Pass	Pass	Pass	Pass	Pass
108	15	Pass	Pass	Pass	Pass	Pass	Pass
108	22	Pass	Pass	Pass	Pass	Pass	Pass
108	24	Fail	Fail	Fail	Fail	Fail	Fail
108	26	Pass	Fail	Pass	Pass	Fail	Pass
108	30	Pass	Fail	Pass	Pass	Fail	Pass
108	39	Pass	Fail	Pass	Pass	Fail	Pass
109	13	Pass	Pass	Pass	Pass	Pass	Pass
109	14	Pass	Pass	Pass	Pass	Pass	Pass
109	15	Pass	Pass	Pass	Pass	Pass	Pass
109	22	Pass	Fail	Pass	Pass	Fail	Pass
109	26	Pass	Pass	Pass	Pass	Pass	Pass
109	30	Pass	Fail	Pass	Pass	Fail	Pass
109	39	Pass	Pass	Pass	Pass	Pass	Pass
110	13	Pass	Pass	Pass	Pass	Pass	Pass
110	14	Pass	Pass	Pass	Pass	Pass	Pass
110	15	Pass	Pass	Pass	Pass	Pass	Pass
110	22	Pass	Pass	Pass	Pass	Pass	Pass
110	26	Pass	Pass	Pass	Pass	Pass	Pass
110	28	Fail	Fail	Fail	Fail	Fail	Fail
110	39	Pass	Fail	Pass	Pass	Fail	Pass
111	13	Pass	Pass	Pass	Pass	Pass	Pass
111	14	Pass	Pass	Pass	Pass	Pass	Pass
111	15	Pass	Pass	Pass	Pass	Pass	Pass

111	22	Pass	Fail	Pass	Pass	Fail	Pass
111	26	Pass	Pass	Pass	Pass	Pass	Pass
111	39	Pass	Fail	Pass	Pass	Fail	Pass
112	13	Pass	Fail	Pass	Pass	Fail	Pass
112	14	Pass	Pass	Pass	Pass	Pass	Pass
112	15	Pass	Pass	Pass	Pass	Pass	Pass
112	22	Pass	Fail	Pass	Pass	Fail	Pass
112	26	Pass	Fail	Pass	Pass	Fail	Pass
112	39	Pass	Fail	Pass	Pass	Fail	Pass
113	13	Pass	Fail	Pass	Pass	Fail	Pass
113	14	Pass	Pass	Pass	Pass	Pass	Pass
113	15	Pass	Pass	Pass	Pass	Pass	Pass
113	26	Pass	Fail	Pass	Pass	Fail	Pass
113	27	Pass	Fail	Pass	Pass	Fail	Pass
113	39	Pass	Pass	Pass	Pass	Pass	Pass
113	41	Fail	Fail	Fail	Fail	Fail	Fail
114	13	Pass	Pass	Pass	Pass	Pass	Pass
114	14	Pass	Pass	Pass	Pass	Pass	Pass
114	15	Pass	Pass	Pass	Pass	Pass	Pass
114	26	Pass	Fail	Pass	Pass	Fail	Pass
114	39	Pass	Pass	Pass	Pass	Pass	Pass
115	13	Pass	Pass	Pass	Pass	Pass	Pass
115	14	Pass	Pass	Pass	Pass	Pass	Pass
115	15	Pass	Pass	Pass	Pass	Pass	Pass
115	26	Pass	Fail	Pass	Pass	Fail	Pass
115	39	Pass	Pass	Pass	Pass	Pass	Pass
116	13	Pass	Pass	Pass	Pass	Pass	Pass
116	14	Pass	Pass	Pass	Pass	Pass	Pass
116	15	Pass	Pass	Pass	Pass	Pass	Pass
116	26	Pass	Fail	Pass	Pass	Fail	Pass
116	28	Fail	Fail	Fail	Fail	Fail	Fail
116	39	Pass	Pass	Pass	Pass	Pass	Pass
117	13	Pass	Pass	Pass	Pass	Pass	Pass
117	14	Pass	Pass	Pass	Pass	Pass	Pass
117	15	Pass	Pass	Pass	Pass	Pass	Pass
117	26	Pass	Fail	Pass	Pass	Fail	Pass
117	39	Pass	Pass	Pass	Pass	Pass	Pass
118	13	Pass	Pass	Pass	Pass	Pass	Pass
118	14	Pass	Pass	Pass	Pass	Pass	Pass
118	15	Pass	Fail	Pass	Pass	Pass	Pass
118	20	Pass	Fail	Pass	Pass	Fail	Pass
118	26	Pass	Fail	Pass	Pass	Fail	Pass
118	39	Pass	Pass	Pass	Pass	Pass	Pass
119	13	Pass	Pass	Pass	Pass	Pass	Pass
119	14	Pass	Pass	Pass	Pass	Pass	Pass
119	15	Pass	Pass	Pass	Pass	Pass	Pass
119	20	Pass	Fail	Pass	Pass	Fail	Pass
119	26	Pass	Fail	Pass	Pass	Fail	Pass
119	39	Pass	Pass	Pass	Pass	Pass	Pass
120	13	Pass	Pass	Pass	Pass	Pass	Pass
120	14	Pass	Pass	Pass	Pass	Pass	Pass
120	15	Pass	Fail	Pass	Pass	Fail	Pass
120	16	Pass	Fail	Pass	Pass	Fail	Pass
120	26	Pass	Fail	Pass	Pass	Fail	Pass
120	39	Pass	Pass	Pass	Pass	Pass	Pass
121	13	Pass	Pass	Pass	Pass	Pass	Pass
121	14	Pass	Pass	Pass	Pass	Pass	Pass

121	26	Pass	Fail	Pass	Pass	Fail	Pass
121	39	Pass	Pass	Pass	Pass	Pass	Pass
122	13	Pass	Pass	Pass	Pass	Pass	Pass
122	14	Pass	Pass	Pass	Pass	Pass	Pass
122	26	Pass	Fail	Pass	Pass	Fail	Pass
122	39	Pass	Pass	Pass	Pass	Pass	Pass
122	41	Fail	Fail	Fail	Fail	Fail	Fail
123	13	Pass	Pass	Pass	Pass	Pass	Pass
123	14	Pass	Pass	Pass	Pass	Pass	Pass
123	15	Pass	Fail	Pass	Pass	Fail	Pass
123	16	Pass	Pass	Pass	Pass	Pass	Pass
123	17	Pass	Pass	Pass	Pass	Pass	Pass
123	18	Pass	Pass	Pass	Pass	Pass	Pass
123	19	Pass	Pass	Pass	Pass	Pass	Pass
123	20	Pass	Pass	Pass	Pass	Pass	Pass
123	21	Pass	Pass	Pass	Pass	Pass	Pass
123	22	Pass	Pass	Pass	Pass	Pass	Pass
123	23	Pass	Pass	Pass	Pass	Pass	Pass
123	24	Pass	Fail	Pass	Pass	Fail	Pass
123	25	Pass	Fail	Pass	Pass	Fail	Pass
123	26	Pass	Pass	Pass	Pass	Pass	Pass
123	27	Pass	Pass	Pass	Pass	Pass	Pass
123	28	Pass	Pass	Pass	Pass	Pass	Pass
123	29	Pass	Fail	Pass	Pass	Fail	Pass
123	30	Pass	Fail	Pass	Pass	Fail	Pass
123	31	Pass	Fail	Pass	Pass	Fail	Pass
123	32	Pass	Fail	Pass	Pass	Fail	Pass
123	33	Pass	Fail	Pass	Pass	Fail	Pass
123	34	Pass	Pass	Pass	Pass	Pass	Pass
123	35	Pass	Pass	Pass	Pass	Pass	Pass
123	36	Pass	Pass	Pass	Pass	Pass	Pass
123	37	Pass	Fail	Pass	Pass	Fail	Pass
123	38	Pass	Fail	Pass	Pass	Fail	Pass
123	39	Pass	Fail	Pass	Pass	Fail	Pass
124	13	Pass	Fail	Pass	Pass	Fail	Pass
124	14	Pass	Pass	Pass	Pass	Pass	Pass
124	23	Pass	Fail	Pass	Pass	Fail	Pass
125	13	Pass	Fail	Pass	Pass	Fail	Pass
125	14	Pass	Fail	Pass	Pass	Fail	Pass
125	23	Pass	Pass	Pass	Pass	Pass	Pass
125	28	Fail	Fail	Fail	Fail	Fail	Fail
125	33	Fail	Fail	Fail	Fail	Fail	Fail
126	13	Pass	Fail	Pass	Pass	Fail	Pass
126	14	Pass	Fail	Pass	Pass	Fail	Pass
126	23	Pass	Pass	Pass	Pass	Pass	Pass
127	13	Pass	Fail	Pass	Pass	Fail	Pass
127	14	Pass	Pass	Pass	Pass	Pass	Pass
127	23	Pass	Pass	Pass	Pass	Pass	Pass
128	13	Pass	Pass	Pass	Pass	Pass	Pass
128	14	Pass	Pass	Pass	Pass	Pass	Pass
128	23	Pass	Pass	Pass	Pass	Pass	Pass
129	13	Pass	Fail	Pass	Pass	Fail	Pass
129	14	Pass	Pass	Pass	Pass	Pass	Pass
129	23	Pass	Pass	Pass	Pass	Pass	Pass
130	8	Pass	Fail	Pass	Pass	Fail	Pass
130	9	Pass	Fail	Pass	Pass	Fail	Pass
130	10	Pass	Fail	Pass	Pass	Fail	Pass

130	11	Pass	Fail	Pass	Pass	Fail	Pass
130	12	Pass	Fail	Pass	Pass	Fail	Pass
130	13	Pass	Fail	Pass	Pass	Fail	Pass
130	14	Pass	Pass	Pass	Pass	Pass	Pass
130	23	Pass	Pass	Pass	Pass	Pass	Pass
131	14	Pass	Fail	Pass	Pass	Fail	Pass
131	23	Pass	Pass	Pass	Pass	Pass	Pass
132	14	Pass	Pass	Pass	Pass	Pass	Pass
132	23	Pass	Pass	Pass	Pass	Pass	Pass
133	14	Pass	Pass	Pass	Pass	Pass	Pass
133	23	Pass	Pass	Pass	Pass	Pass	Pass
134	14	Pass	Pass	Pass	Pass	Pass	Pass
134	23	Pass	Fail	Pass	Pass	Fail	Pass
135	14	Pass	Fail	Pass	Pass	Fail	Pass
136	14	Pass	Pass	Pass	Pass	Pass	Pass
137	14	Pass	Pass	Pass	Pass	Pass	Pass
138	14	Pass	Pass	Pass	Pass	Pass	Pass

4. Table C.7.4 Striped Bass eggs D.O. , Salinity, and Velocity criteria passing for existing and deepening (2 ft) scenarios within the analyzed period April 1 - April 30, 1997

HABITAT REQUIREMENTS:
RM 10-31; Depth Average
D.O. April (MG/L):10th %ile >=4.5
Salinity 50th %ile <= 9 ppt
Mean Velocity >= 30 cm/s

Savannah Harbor Estuary

Segments		Baseline Scenario			Project Scenario		
J	I	Salinity	Velocity	D.O.	Salinity	Velocity	D.O.
47	13	Fail	Pass	Pass	Fail	Pass	Pass
47	14	Fail	Pass	Pass	Fail	Pass	Pass
47	15	Fail	Pass	Pass	Fail	Pass	Pass
47	16	Fail	Pass	Pass	Fail	Pass	Pass
47	17	Fail	Fail	Pass	Fail	Fail	Pass
48	13	Fail	Pass	Pass	Fail	Pass	Pass
48	14	Fail	Pass	Pass	Fail	Pass	Pass
48	15	Fail	Pass	Pass	Fail	Pass	Pass
48	16	Fail	Pass	Pass	Fail	Pass	Pass
48	17	Fail	Pass	Pass	Fail	Pass	Pass
49	13	Fail	Pass	Pass	Fail	Pass	Pass
49	14	Fail	Pass	Pass	Fail	Pass	Pass
49	15	Fail	Pass	Pass	Fail	Pass	Pass
49	16	Fail	Pass	Pass	Fail	Pass	Pass
49	17	Fail	Pass	Pass	Fail	Pass	Pass
50	13	Fail	Pass	Pass	Fail	Pass	Pass
50	14	Fail	Pass	Pass	Fail	Pass	Pass
50	15	Fail	Fail	Pass	Fail	Fail	Pass
50	16	Fail	Fail	Pass	Fail	Fail	Pass
50	17	Fail	Fail	Pass	Fail	Fail	Pass
50	18	Fail	Fail	Pass	Fail	Fail	Pass
51	13	Fail	Pass	Pass	Fail	Pass	Pass
51	14	Fail	Pass	Pass	Fail	Pass	Pass
51	15	Fail	Pass	Pass	Fail	Pass	Pass
52	13	Fail	Pass	Pass	Fail	Pass	Pass
52	14	Fail	Pass	Pass	Fail	Pass	Pass
52	15	Fail	Pass	Pass	Fail	Pass	Pass
53	13	Fail	Pass	Pass	Fail	Pass	Pass
53	14	Fail	Pass	Pass	Fail	Pass	Pass
53	15	Fail	Pass	Pass	Fail	Pass	Pass
54	13	Fail	Pass	Pass	Fail	Pass	Pass
54	14	Fail	Pass	Pass	Fail	Pass	Pass
54	15	Fail	Pass	Pass	Fail	Pass	Pass
55	13	Fail	Pass	Pass	Fail	Pass	Pass
55	14	Fail	Pass	Pass	Fail	Pass	Pass
55	15	Fail	Pass	Pass	Fail	Pass	Pass
56	13	Fail	Pass	Pass	Fail	Pass	Pass
56	14	Fail	Pass	Pass	Fail	Pass	Pass

56	15	Fail	Pass	Pass	Fail	Pass	Pass
57	13	Fail	Pass	Pass	Fail	Pass	Pass
57	14	Fail	Pass	Pass	Fail	Pass	Pass
57	15	Fail	Pass	Pass	Fail	Pass	Pass
58	13	Pass	Pass	Pass	Fail	Pass	Pass
58	14	Fail	Pass	Pass	Fail	Pass	Pass
58	15	Pass	Pass	Pass	Pass	Pass	Pass
59	13	Pass	Pass	Pass	Fail	Pass	Pass
59	14	Fail	Pass	Pass	Fail	Pass	Pass
59	15	Pass	Pass	Pass	Pass	Pass	Pass
59	30	Fail	Fail	Pass	Fail	Fail	Pass
59	31	Fail	Fail	Pass	Fail	Fail	Pass
59	32	Fail	Fail	Pass	Fail	Fail	Pass
60	13	Pass	Pass	Pass	Pass	Pass	Pass
60	14	Fail	Pass	Pass	Fail	Pass	Pass
60	15	Pass	Pass	Pass	Pass	Pass	Pass
60	30	Fail	Fail	Pass	Fail	Fail	Pass
60	31	Fail	Fail	Pass	Fail	Fail	Pass
60	32	Fail	Fail	Pass	Fail	Fail	Pass
61	13	Pass	Pass	Pass	Fail	Pass	Pass
61	14	Fail	Pass	Pass	Fail	Pass	Pass
61	15	Pass	Pass	Pass	Pass	Pass	Pass
61	30	Fail	Fail	Pass	Fail	Fail	Pass
61	31	Fail	Fail	Pass	Fail	Fail	Pass
61	32	Fail	Fail	Pass	Fail	Fail	Pass
62	13	Pass	Pass	Pass	Pass	Pass	Pass
62	14	Fail	Pass	Pass	Fail	Pass	Pass
62	15	Pass	Pass	Pass	Pass	Pass	Pass
62	30	Fail	Fail	Pass	Fail	Fail	Pass
62	31	Fail	Fail	Pass	Fail	Fail	Pass
62	32	Fail	Fail	Pass	Fail	Fail	Pass
63	13	Pass	Pass	Pass	Pass	Pass	Pass
63	14	Fail	Pass	Pass	Fail	Pass	Pass
63	15	Pass	Pass	Pass	Pass	Pass	Pass
63	31	Fail	Pass	Pass	Fail	Pass	Pass
64	13	Pass	Pass	Pass	Pass	Pass	Pass
64	14	Fail	Pass	Pass	Fail	Pass	Pass
64	15	Pass	Pass	Pass	Pass	Pass	Pass
64	30	Fail	Fail	Pass	Fail	Fail	Pass
64	31	Fail	Pass	Pass	Fail	Pass	Pass
64	32	Fail	Fail	Pass	Fail	Fail	Pass
65	13	Pass	Pass	Pass	Pass	Pass	Pass
65	14	Fail	Pass	Pass	Fail	Pass	Pass
65	15	Pass	Pass	Pass	Pass	Pass	Pass
65	30	Fail	Fail	Pass	Fail	Fail	Pass
65	31	Fail	Pass	Pass	Fail	Pass	Pass
65	32	Fail	Fail	Pass	Fail	Fail	Pass
65	33	Fail	Fail	Pass	Fail	Fail	Pass
66	13	Pass	Pass	Pass	Pass	Pass	Pass
66	14	Fail	Pass	Pass	Fail	Pass	Pass
66	15	Pass	Pass	Pass	Pass	Fail	Pass
66	30	Fail	Fail	Pass	Fail	Fail	Pass
66	31	Fail	Pass	Pass	Fail	Pass	Pass
66	32	Fail	Fail	Pass	Fail	Fail	Pass
66	36	Fail	Fail	Pass	Fail	Fail	Pass
66	38	Fail	Fail	Fail	Fail	Fail	Fail
67	13	Pass	Pass	Pass	Pass	Pass	Pass

67	14	Fail	Pass	Pass	Fail	Pass	Pass
67	15	Pass	Fail	Pass	Pass	Fail	Pass
67	30	Fail	Fail	Pass	Fail	Fail	Pass
67	31	Fail	Pass	Pass	Fail	Pass	Pass
67	32	Fail	Fail	Pass	Fail	Fail	Pass
67	36	Fail	Fail	Pass	Fail	Fail	Pass
68	13	Pass	Pass	Pass	Pass	Pass	Pass
68	14	Fail	Pass	Pass	Fail	Pass	Pass
68	15	Pass	Fail	Pass	Pass	Fail	Pass
68	30	Pass	Fail	Pass	Fail	Fail	Pass
68	31	Pass	Pass	Pass	Fail	Pass	Pass
68	32	Pass	Fail	Pass	Fail	Fail	Pass
68	36	Fail	Fail	Pass	Fail	Fail	Pass
68	38	Fail	Fail	Fail	Fail	Fail	Fail
69	13	Pass	Pass	Pass	Pass	Pass	Pass
69	14	Pass	Pass	Pass	Fail	Pass	Pass
69	15	Pass	Fail	Pass	Pass	Fail	Pass
69	30	Pass	Pass	Pass	Fail	Pass	Pass
69	31	Pass	Pass	Pass	Fail	Pass	Pass
69	32	Pass	Fail	Pass	Pass	Fail	Pass
69	36	Fail	Fail	Pass	Fail	Fail	Pass
70	13	Pass	Pass	Pass	Pass	Pass	Pass
70	14	Pass	Pass	Pass	Fail	Pass	Pass
70	15	Pass	Fail	Pass	Pass	Fail	Pass
70	30	Pass	Fail	Pass	Pass	Fail	Pass
70	31	Pass	Fail	Pass	Pass	Fail	Pass
70	32	Pass	Fail	Pass	Pass	Fail	Pass
70	33	Pass	Fail	Pass	Fail	Fail	Pass
71	13	Pass	Pass	Pass	Pass	Pass	Pass
71	14	Pass	Pass	Pass	Fail	Pass	Pass
71	15	Pass	Pass	Pass	Pass	Pass	Pass
71	30	Pass	Fail	Pass	Pass	Fail	Pass
71	31	Pass	Fail	Pass	Pass	Fail	Pass
71	32	Pass	Fail	Pass	Pass	Fail	Pass
72	13	Pass	Pass	Pass	Pass	Pass	Pass
72	14	Pass	Pass	Pass	Fail	Pass	Pass
72	15	Pass	Pass	Pass	Pass	Pass	Pass
72	30	Pass	Fail	Pass	Pass	Fail	Pass
72	31	Pass	Fail	Pass	Pass	Fail	Pass
72	32	Pass	Fail	Pass	Pass	Fail	Pass
73	13	Pass	Pass	Pass	Pass	Pass	Pass
73	14	Pass	Pass	Pass	Fail	Pass	Pass
73	15	Pass	Pass	Pass	Pass	Pass	Pass
73	30	Pass	Fail	Pass	Pass	Fail	Pass
73	31	Pass	Fail	Pass	Pass	Fail	Pass
74	13	Pass	Pass	Pass	Pass	Pass	Pass
74	14	Pass	Pass	Pass	Pass	Pass	Pass
74	15	Pass	Pass	Pass	Pass	Pass	Pass
74	30	Pass	Fail	Pass	Pass	Fail	Pass
74	31	Pass	Fail	Pass	Pass	Fail	Pass
75	13	Pass	Pass	Pass	Pass	Pass	Pass
75	14	Pass	Pass	Pass	Pass	Pass	Pass
75	15	Pass	Pass	Pass	Pass	Pass	Pass
75	30	Pass	Fail	Pass	Pass	Fail	Pass
75	31	Pass	Fail	Pass	Pass	Fail	Pass
76	13	Pass	Pass	Pass	Pass	Pass	Pass
76	14	Pass	Pass	Pass	Pass	Pass	Pass

76	15	Pass	Fail	Pass	Pass	Fail	Pass
76	16	Pass	Fail	Pass	Pass	Fail	Pass
76	17	Pass	Fail	Pass	Pass	Fail	Pass
76	30	Pass	Fail	Pass	Pass	Fail	Pass
76	31	Pass	Fail	Pass	Pass	Fail	Pass
76	33	Fail	Fail	Fail	Fail	Fail	Fail
77	13	Pass	Fail	Pass	Pass	Fail	Pass
77	14	Pass	Pass	Pass	Pass	Pass	Pass
77	15	Pass	Fail	Pass	Pass	Fail	Pass
77	16	Pass	Fail	Pass	Pass	Fail	Pass
77	17	Pass	Fail	Pass	Pass	Fail	Pass
77	30	Pass	Fail	Pass	Pass	Fail	Pass
77	31	Pass	Fail	Pass	Pass	Fail	Pass
78	13	Pass	Fail	Pass	Pass	Fail	Pass
78	14	Pass	Pass	Pass	Pass	Pass	Pass
78	15	Pass	Fail	Pass	Pass	Fail	Pass
78	16	Pass	Fail	Pass	Pass	Fail	Pass
78	17	Pass	Fail	Pass	Pass	Fail	Pass
78	30	Pass	Fail	Pass	Pass	Fail	Pass
78	31	Pass	Fail	Pass	Pass	Fail	Pass
79	13	Pass	Pass	Pass	Pass	Pass	Pass
79	14	Pass	Pass	Pass	Pass	Pass	Pass
79	15	Pass	Fail	Pass	Pass	Fail	Pass
79	30	Pass	Fail	Pass	Pass	Fail	Pass
79	31	Pass	Fail	Pass	Pass	Fail	Pass
80	13	Pass	Pass	Pass	Pass	Pass	Pass
80	14	Pass	Pass	Pass	Pass	Pass	Pass
80	15	Pass	Fail	Pass	Pass	Fail	Pass
80	30	Pass	Fail	Pass	Pass	Fail	Pass
80	31	Pass	Fail	Pass	Pass	Fail	Pass
81	13	Pass	Pass	Pass	Pass	Pass	Pass
81	14	Pass	Pass	Pass	Pass	Pass	Pass
81	15	Pass	Fail	Pass	Pass	Fail	Pass
81	30	Pass	Fail	Pass	Pass	Fail	Pass
81	31	Pass	Fail	Pass	Pass	Fail	Pass
82	13	Pass	Pass	Pass	Pass	Pass	Pass
82	14	Pass	Pass	Pass	Pass	Pass	Pass
82	15	Pass	Pass	Pass	Pass	Pass	Pass
82	16	Pass	Fail	Pass	Pass	Fail	Pass
82	17	Pass	Fail	Pass	Pass	Fail	Pass
82	18	Pass	Fail	Pass	Pass	Fail	Pass
82	19	Pass	Fail	Pass	Pass	Fail	Pass
82	20	Pass	Fail	Pass	Pass	Fail	Pass
82	21	Pass	Fail	Pass	Pass	Fail	Pass
82	29	Pass	Fail	Pass	Pass	Fail	Pass
82	30	Pass	Fail	Pass	Pass	Fail	Pass
82	31	Pass	Fail	Pass	Pass	Fail	Pass
83	13	Pass	Pass	Pass	Pass	Pass	Pass
83	14	Pass	Pass	Pass	Pass	Pass	Pass
83	15	Pass	Pass	Pass	Pass	Pass	Pass
83	21	Pass	Fail	Pass	Pass	Fail	Pass
83	30	Pass	Fail	Pass	Pass	Fail	Pass
83	31	Pass	Fail	Pass	Pass	Fail	Pass
84	13	Pass	Pass	Pass	Pass	Pass	Pass
84	14	Pass	Pass	Pass	Pass	Pass	Pass
84	15	Pass	Pass	Pass	Pass	Pass	Pass
84	21	Pass	Fail	Pass	Pass	Fail	Pass

84	30	Pass	Fail	Pass	Pass	Fail	Pass
84	31	Pass	Fail	Pass	Pass	Fail	Pass
85	13	Pass	Pass	Pass	Pass	Pass	Pass
85	14	Pass	Pass	Pass	Pass	Pass	Pass
85	15	Pass	Pass	Pass	Pass	Pass	Pass
85	21	Pass	Fail	Pass	Pass	Fail	Pass
85	30	Pass	Fail	Pass	Pass	Fail	Pass
86	13	Pass	Pass	Pass	Pass	Pass	Pass
86	14	Pass	Pass	Pass	Pass	Pass	Pass
86	15	Pass	Pass	Pass	Pass	Pass	Pass
86	17	Fail	Fail	Fail	Fail	Fail	Fail
86	21	Pass	Fail	Pass	Pass	Fail	Pass
86	30	Pass	Pass	Pass	Pass	Pass	Pass
87	13	Pass	Pass	Pass	Pass	Pass	Pass
87	14	Pass	Pass	Pass	Pass	Pass	Pass
87	15	Pass	Pass	Pass	Pass	Pass	Pass
87	30	Pass	Fail	Pass	Pass	Fail	Pass
87	32	Fail	Fail	Fail	Fail	Fail	Fail
88	13	Pass	Pass	Pass	Pass	Pass	Pass
88	14	Pass	Pass	Pass	Pass	Pass	Pass
88	15	Pass	Pass	Pass	Pass	Pass	Pass
88	30	Pass	Fail	Pass	Pass	Fail	Pass
89	13	Pass	Pass	Pass	Pass	Pass	Pass
89	14	Pass	Pass	Pass	Pass	Pass	Pass
89	15	Pass	Pass	Pass	Pass	Pass	Pass
89	30	Pass	Fail	Pass	Pass	Fail	Pass
90	13	Pass	Pass	Pass	Pass	Pass	Pass
90	14	Pass	Pass	Pass	Pass	Pass	Pass
90	15	Pass	Pass	Pass	Pass	Pass	Pass
90	30	Pass	Fail	Pass	Pass	Fail	Pass
91	13	Pass	Pass	Pass	Pass	Pass	Pass
91	14	Pass	Pass	Pass	Pass	Pass	Pass
91	15	Pass	Pass	Pass	Pass	Pass	Pass
91	16	Pass	Fail	Pass	Pass	Fail	Pass
91	30	Pass	Fail	Pass	Pass	Fail	Pass
92	13	Pass	Pass	Pass	Pass	Pass	Pass
92	14	Pass	Pass	Pass	Pass	Pass	Pass
92	15	Pass	Pass	Pass	Pass	Pass	Pass
92	16	Pass	Fail	Pass	Pass	Fail	Pass
92	30	Pass	Fail	Pass	Pass	Fail	Pass
92	32	Fail	Fail	Fail	Fail	Fail	Fail
93	13	Pass	Pass	Pass	Pass	Pass	Pass
93	14	Pass	Pass	Pass	Pass	Pass	Pass
93	15	Pass	Pass	Pass	Pass	Pass	Pass
93	16	Pass	Pass	Pass	Pass	Pass	Pass
93	30	Pass	Fail	Pass	Pass	Fail	Pass
94	13	Pass	Pass	Pass	Pass	Pass	Pass
94	14	Pass	Pass	Pass	Pass	Pass	Pass
94	15	Pass	Pass	Pass	Pass	Pass	Pass
94	16	Pass	Fail	Pass	Pass	Fail	Pass
94	26	Pass	Pass	Pass	Pass	Pass	Pass
94	30	Pass	Fail	Pass	Pass	Fail	Pass
95	13	Pass	Pass	Pass	Pass	Pass	Pass
95	14	Pass	Pass	Pass	Pass	Pass	Pass
95	15	Pass	Pass	Pass	Pass	Pass	Pass
95	16	Pass	Fail	Pass	Pass	Fail	Pass
95	26	Pass	Fail	Pass	Pass	Fail	Pass

95	28	Fail	Fail	Fail	Fail	Fail	Fail
95	30	Pass	Fail	Pass	Pass	Fail	Pass
96	11	Fail	Fail	Fail	Fail	Fail	Fail
96	13	Pass	Pass	Pass	Pass	Pass	Pass
96	14	Pass	Pass	Pass	Pass	Pass	Pass
96	15	Pass	Pass	Pass	Pass	Pass	Pass
96	26	Pass	Fail	Pass	Pass	Fail	Pass
96	30	Pass	Fail	Pass	Pass	Fail	Pass
97	13	Pass	Pass	Pass	Pass	Pass	Pass
97	14	Pass	Pass	Pass	Pass	Pass	Pass
97	15	Pass	Fail	Pass	Pass	Fail	Pass
97	26	Pass	Fail	Pass	Pass	Fail	Pass
97	30	Pass	Fail	Pass	Pass	Fail	Pass
98	13	Pass	Fail	Pass	Pass	Fail	Pass
98	14	Pass	Pass	Pass	Pass	Pass	Pass
98	15	Pass	Fail	Pass	Pass	Fail	Pass
98	26	Pass	Fail	Pass	Pass	Fail	Pass
98	27	Pass	Pass	Pass	Pass	Pass	Pass
98	28	Pass	Pass	Pass	Pass	Pass	Pass
98	29	Pass	Pass	Pass	Pass	Pass	Pass
98	30	Pass	Fail	Pass	Pass	Fail	Pass
99	13	Pass	Pass	Pass	Pass	Pass	Pass
99	14	Pass	Pass	Pass	Pass	Pass	Pass
99	15	Pass	Fail	Pass	Pass	Fail	Pass
99	16	Pass	Fail	Pass	Pass	Fail	Pass
99	17	Pass	Fail	Pass	Pass	Fail	Pass
99	18	Pass	Fail	Pass	Pass	Fail	Pass
99	19	Pass	Fail	Pass	Pass	Fail	Pass
99	20	Pass	Fail	Pass	Pass	Fail	Pass
99	21	Pass	Fail	Pass	Pass	Fail	Pass
99	22	Pass	Fail	Pass	Pass	Fail	Pass
99	23	Pass	Fail	Pass	Pass	Fail	Pass
99	26	Pass	Fail	Pass	Pass	Fail	Pass
99	30	Pass	Fail	Pass	Pass	Fail	Pass
100	13	Pass	Pass	Pass	Pass	Pass	Pass
100	14	Pass	Pass	Pass	Pass	Pass	Pass
100	15	Pass	Pass	Pass	Pass	Pass	Pass
100	23	Pass	Fail	Pass	Pass	Fail	Pass
100	24	Pass	Fail	Pass	Pass	Fail	Pass
100	25	Pass	Fail	Pass	Pass	Fail	Pass
100	26	Pass	Fail	Pass	Pass	Fail	Pass
100	30	Pass	Fail	Pass	Pass	Fail	Pass
101	13	Pass	Pass	Pass	Pass	Pass	Pass
101	14	Pass	Pass	Pass	Pass	Pass	Pass
101	15	Pass	Pass	Pass	Pass	Pass	Pass
101	16	Pass	Fail	Pass	Pass	Fail	Pass
101	17	Pass	Fail	Pass	Pass	Fail	Pass
101	18	Pass	Fail	Pass	Pass	Fail	Pass
101	19	Pass	Fail	Pass	Pass	Fail	Pass
101	20	Pass	Fail	Pass	Pass	Fail	Pass
101	21	Pass	Fail	Pass	Pass	Fail	Pass
101	22	Pass	Fail	Pass	Pass	Fail	Pass
101	23	Pass	Fail	Pass	Pass	Fail	Pass
101	26	Pass	Pass	Pass	Pass	Pass	Pass
101	30	Pass	Fail	Pass	Pass	Fail	Pass
102	13	Pass	Pass	Pass	Pass	Pass	Pass
102	14	Pass	Pass	Pass	Pass	Pass	Pass

102	15	Pass	Pass	Pass	Pass	Pass	Pass
102	26	Pass	Pass	Pass	Pass	Pass	Pass
102	30	Pass	Fail	Pass	Pass	Fail	Pass
103	13	Pass	Pass	Pass	Pass	Pass	Pass
103	14	Pass	Pass	Pass	Pass	Pass	Pass
103	15	Pass	Pass	Pass	Pass	Pass	Pass
103	26	Pass	Pass	Pass	Pass	Pass	Pass
103	30	Pass	Pass	Pass	Pass	Pass	Pass
104	11	Fail	Fail	Fail	Fail	Fail	Fail
104	13	Pass	Fail	Pass	Pass	Pass	Pass
104	14	Pass	Pass	Pass	Pass	Pass	Pass
104	15	Pass	Pass	Pass	Pass	Pass	Pass
104	26	Pass	Pass	Pass	Pass	Pass	Pass
104	30	Pass	Fail	Pass	Pass	Fail	Pass
105	13	Pass	Fail	Pass	Pass	Fail	Pass
105	14	Pass	Pass	Pass	Pass	Pass	Pass
105	15	Pass	Pass	Pass	Pass	Pass	Pass
105	26	Pass	Pass	Pass	Pass	Pass	Pass
105	30	Pass	Fail	Pass	Pass	Fail	Pass
106	13	Pass	Fail	Pass	Pass	Fail	Pass
106	14	Pass	Pass	Pass	Pass	Pass	Pass
106	15	Pass	Pass	Pass	Pass	Pass	Pass
106	26	Pass	Pass	Pass	Pass	Pass	Pass
106	27	Pass	Fail	Pass	Pass	Fail	Pass
106	30	Pass	Fail	Pass	Pass	Fail	Pass
106	39	Pass	Fail	Pass	Pass	Fail	Pass
107	13	Pass	Pass	Pass	Pass	Pass	Pass
107	14	Pass	Pass	Pass	Pass	Pass	Pass
107	15	Pass	Fail	Pass	Pass	Pass	Pass
107	22	Pass	Fail	Pass	Pass	Fail	Pass
107	26	Pass	Fail	Pass	Pass	Fail	Pass
107	30	Pass	Fail	Pass	Pass	Fail	Pass
107	39	Pass	Fail	Pass	Pass	Fail	Pass
108	13	Pass	Pass	Pass	Pass	Pass	Pass
108	14	Pass	Pass	Pass	Pass	Pass	Pass
108	15	Pass	Pass	Pass	Pass	Pass	Pass
108	22	Pass	Pass	Pass	Pass	Pass	Pass
108	24	Fail	Fail	Fail	Fail	Fail	Fail
108	26	Pass	Fail	Pass	Pass	Fail	Pass
108	30	Pass	Fail	Pass	Pass	Fail	Pass
108	39	Pass	Fail	Pass	Pass	Fail	Pass
109	13	Pass	Pass	Pass	Pass	Pass	Pass
109	14	Pass	Pass	Pass	Pass	Pass	Pass
109	15	Pass	Pass	Pass	Pass	Pass	Pass
109	22	Pass	Fail	Pass	Pass	Fail	Pass
109	26	Pass	Pass	Pass	Pass	Pass	Pass
109	30	Pass	Fail	Pass	Pass	Fail	Pass
109	39	Pass	Pass	Pass	Pass	Pass	Pass
110	13	Pass	Pass	Pass	Pass	Pass	Pass
110	14	Pass	Pass	Pass	Pass	Pass	Pass
110	15	Pass	Pass	Pass	Pass	Pass	Pass
110	22	Pass	Pass	Pass	Pass	Pass	Pass
110	26	Pass	Pass	Pass	Pass	Pass	Pass
110	28	Fail	Fail	Fail	Fail	Fail	Fail
110	39	Pass	Fail	Pass	Pass	Fail	Pass
111	13	Pass	Pass	Pass	Pass	Pass	Pass
111	14	Pass	Pass	Pass	Pass	Pass	Pass

111	15	Pass	Pass	Pass	Pass	Pass	Pass
111	22	Pass	Fail	Pass	Pass	Fail	Pass
111	26	Pass	Pass	Pass	Pass	Pass	Pass
111	39	Pass	Fail	Pass	Pass	Fail	Pass
112	13	Pass	Fail	Pass	Pass	Fail	Pass
112	14	Pass	Pass	Pass	Pass	Pass	Pass
112	15	Pass	Pass	Pass	Pass	Pass	Pass
112	22	Pass	Fail	Pass	Pass	Fail	Pass
112	26	Pass	Fail	Pass	Pass	Fail	Pass
112	39	Pass	Fail	Pass	Pass	Fail	Pass
113	13	Pass	Fail	Pass	Pass	Fail	Pass
113	14	Pass	Pass	Pass	Pass	Pass	Pass
113	15	Pass	Pass	Pass	Pass	Pass	Pass
113	26	Pass	Fail	Pass	Pass	Fail	Pass
113	27	Pass	Fail	Pass	Pass	Fail	Pass
113	39	Pass	Pass	Pass	Pass	Pass	Pass
113	41	Fail	Fail	Fail	Fail	Fail	Fail
114	13	Pass	Pass	Pass	Pass	Pass	Pass
114	14	Pass	Pass	Pass	Pass	Pass	Pass
114	15	Pass	Pass	Pass	Pass	Pass	Pass
114	26	Pass	Fail	Pass	Pass	Fail	Pass
114	39	Pass	Pass	Pass	Pass	Pass	Pass
115	13	Pass	Pass	Pass	Pass	Pass	Pass
115	14	Pass	Pass	Pass	Pass	Pass	Pass
115	15	Pass	Pass	Pass	Pass	Pass	Pass
115	26	Pass	Fail	Pass	Pass	Fail	Pass
115	39	Pass	Pass	Pass	Pass	Pass	Pass
116	13	Pass	Pass	Pass	Pass	Pass	Pass
116	14	Pass	Pass	Pass	Pass	Pass	Pass
116	15	Pass	Pass	Pass	Pass	Pass	Pass
116	26	Pass	Fail	Pass	Pass	Fail	Pass
116	28	Fail	Fail	Fail	Fail	Fail	Fail
116	39	Pass	Pass	Pass	Pass	Pass	Pass
117	13	Pass	Pass	Pass	Pass	Pass	Pass
117	14	Pass	Pass	Pass	Pass	Pass	Pass
117	15	Pass	Pass	Pass	Pass	Pass	Pass
117	26	Pass	Fail	Pass	Pass	Fail	Pass
117	39	Pass	Pass	Pass	Pass	Pass	Pass
118	13	Pass	Pass	Pass	Pass	Pass	Pass
118	14	Pass	Pass	Pass	Pass	Pass	Pass
118	15	Pass	Fail	Pass	Pass	Pass	Pass
118	20	Pass	Fail	Pass	Pass	Fail	Pass
118	26	Pass	Fail	Pass	Pass	Fail	Pass
118	39	Pass	Pass	Pass	Pass	Pass	Pass
119	13	Pass	Pass	Pass	Pass	Pass	Pass
119	14	Pass	Pass	Pass	Pass	Pass	Pass
119	15	Pass	Pass	Pass	Pass	Pass	Pass
119	20	Pass	Fail	Pass	Pass	Fail	Pass
119	26	Pass	Fail	Pass	Pass	Fail	Pass
119	39	Pass	Pass	Pass	Pass	Pass	Pass
120	13	Pass	Pass	Pass	Pass	Pass	Pass
120	14	Pass	Pass	Pass	Pass	Pass	Pass
120	15	Pass	Fail	Pass	Pass	Fail	Pass
120	16	Pass	Fail	Pass	Pass	Fail	Pass
120	26	Pass	Fail	Pass	Pass	Fail	Pass
120	39	Pass	Pass	Pass	Pass	Pass	Pass
121	13	Pass	Pass	Pass	Pass	Pass	Pass

121	14	Pass	Pass	Pass	Pass	Pass	Pass
121	26	Pass	Fail	Pass	Pass	Fail	Pass
121	39	Pass	Pass	Pass	Pass	Pass	Pass
122	13	Pass	Pass	Pass	Pass	Pass	Pass
122	14	Pass	Pass	Pass	Pass	Pass	Pass
122	26	Pass	Fail	Pass	Pass	Fail	Pass
122	39	Pass	Pass	Pass	Pass	Pass	Pass
122	41	Fail	Fail	Fail	Fail	Fail	Fail
123	13	Pass	Pass	Pass	Pass	Pass	Pass
123	14	Pass	Pass	Pass	Pass	Pass	Pass
123	15	Pass	Fail	Pass	Pass	Fail	Pass
123	16	Pass	Pass	Pass	Pass	Pass	Pass
123	17	Pass	Pass	Pass	Pass	Pass	Pass
123	18	Pass	Pass	Pass	Pass	Pass	Pass
123	19	Pass	Pass	Pass	Pass	Pass	Pass
123	20	Pass	Pass	Pass	Pass	Pass	Pass
123	21	Pass	Pass	Pass	Pass	Pass	Pass
123	22	Pass	Pass	Pass	Pass	Pass	Pass
123	23	Pass	Pass	Pass	Pass	Pass	Pass
123	24	Pass	Fail	Pass	Pass	Fail	Pass
123	25	Pass	Fail	Pass	Pass	Fail	Pass
123	26	Pass	Pass	Pass	Pass	Pass	Pass
123	27	Pass	Pass	Pass	Pass	Pass	Pass
123	28	Pass	Pass	Pass	Pass	Pass	Pass
123	29	Pass	Fail	Pass	Pass	Fail	Pass
123	30	Pass	Fail	Pass	Pass	Fail	Pass
123	31	Pass	Fail	Pass	Pass	Fail	Pass
123	32	Pass	Fail	Pass	Pass	Fail	Pass
123	33	Pass	Fail	Pass	Pass	Fail	Pass
123	34	Pass	Pass	Pass	Pass	Pass	Pass
123	35	Pass	Pass	Pass	Pass	Pass	Pass
123	36	Pass	Pass	Pass	Pass	Pass	Pass
123	37	Pass	Fail	Pass	Pass	Fail	Pass
123	38	Pass	Fail	Pass	Pass	Fail	Pass
123	39	Pass	Fail	Pass	Pass	Fail	Pass
124	13	Pass	Fail	Pass	Pass	Fail	Pass
124	14	Pass	Pass	Pass	Pass	Pass	Pass
124	23	Pass	Fail	Pass	Pass	Fail	Pass
125	13	Pass	Fail	Pass	Pass	Fail	Pass
125	14	Pass	Fail	Pass	Pass	Fail	Pass
125	23	Pass	Pass	Pass	Pass	Pass	Pass
125	28	Fail	Fail	Fail	Fail	Fail	Fail
125	33	Fail	Fail	Fail	Fail	Fail	Fail
126	13	Pass	Fail	Pass	Pass	Fail	Pass
126	14	Pass	Fail	Pass	Pass	Fail	Pass
126	23	Pass	Pass	Pass	Pass	Pass	Pass
127	13	Pass	Fail	Pass	Pass	Fail	Pass
127	14	Pass	Pass	Pass	Pass	Pass	Pass
127	23	Pass	Pass	Pass	Pass	Pass	Pass
128	13	Pass	Pass	Pass	Pass	Pass	Pass
128	14	Pass	Pass	Pass	Pass	Pass	Pass
128	23	Pass	Pass	Pass	Pass	Pass	Pass
129	13	Pass	Fail	Pass	Pass	Fail	Pass
129	14	Pass	Pass	Pass	Pass	Pass	Pass
129	23	Pass	Pass	Pass	Pass	Pass	Pass
130	8	Pass	Fail	Pass	Pass	Fail	Pass
130	9	Pass	Fail	Pass	Pass	Fail	Pass

130	10	Pass	Fail	Pass	Pass	Fail	Pass
130	11	Pass	Fail	Pass	Pass	Fail	Pass
130	12	Pass	Fail	Pass	Pass	Fail	Pass
130	13	Pass	Fail	Pass	Pass	Fail	Pass
130	14	Pass	Pass	Pass	Pass	Pass	Pass
130	23	Pass	Pass	Pass	Pass	Pass	Pass
131	14	Pass	Fail	Pass	Pass	Fail	Pass
131	23	Pass	Pass	Pass	Pass	Pass	Pass
132	14	Pass	Pass	Pass	Pass	Pass	Pass
132	23	Pass	Pass	Pass	Pass	Pass	Pass
133	14	Pass	Pass	Pass	Pass	Pass	Pass
133	23	Pass	Pass	Pass	Pass	Pass	Pass
134	14	Pass	Pass	Pass	Pass	Pass	Pass
134	23	Pass	Fail	Pass	Pass	Fail	Pass
135	14	Pass	Fail	Pass	Pass	Fail	Pass
136	14	Pass	Pass	Pass	Pass	Pass	Pass
137	14	Pass	Pass	Pass	Pass	Pass	Pass
138	14	Pass	Pass	Pass	Pass	Pass	Pass

Appendix D

APRIL 1997

50th %ile of Clyo Flow

Habitat Analysis Output

Fisheries Review Group

1. Table D.1. Comparisons of Bass Spawning and Bass Eggs habitat areas for existing and deepening (6 ft) scenarios and 50 %ile Clyo Flow within the analyzed period April 1 – April 30, 1997

	Baseline Scenario		Project Scenario		% Change
Bass Spawning	4.316113	km2	3.466420	km2	-19.7
Bass Eggs	7.201050	km2	5.439429	km2	-24.5

2. Table D.2. Comparisons of Bass Spawning and Bass Eggs habitat areas for existing and deepening (4 ft) scenarios and 50 %ile Clyo Flow within the analyzed period April 1 – April 30, 1997

	Baseline Scenario		Project Scenario		% Change
Bass Spawning	4.316113	km2	3.755361	km2	-13.0
Bass Eggs	7.201050	km2	6.057779	km2	-15.9

3. Table D.3. Comparisons of Bass Spawning and Bass Eggs habitat areas for existing and deepening (3 ft) scenarios and 50 %ile Clyo Flow within the analyzed period April 1 – April 30, 1997

	Baseline Scenario		Project Scenario		% Change
Bass Spawning	4.316113	km2	3.791609	km2	-12.2
Bass Eggs	7.201050	km2	6.394063	km2	-11.2

4. Table D.4. Comparisons of Bass Spawning and Bass Eggs habitat areas for existing and deepening (2 ft) scenarios and 50 %ile Clyo flow within the analyzed period April 1 – April 30, 1997

	Baseline Scenario		Project Scenario		% Change
Bass Spawning	4.316113	km2	3.969974	km2	-8.0
Bass Eggs	7.201050	km2	6.500726	km2	-9.7

5. Table D.6.1 Striped Bass spawning D.O. , Salinity, and Velocity criteria passing for existing and deepening (6 ft) scenarios within the analyzed period April 1 - April 30, 1997

(See Appendix D-1)

6. Table D.6.2 Striped Bass spawning D.O. , Salinity, and Velocity criteria passing for existing and deepening (4 ft) scenarios within the analyzed period April 1 - April 30, 1997

(See Appendix D-1)

7. Table D.6.3 Striped Bass spawning D.O. , Salinity, and Velocity criteria passing for existing and deepening (3 ft) scenarios within the analyzed period April 1 - April 30, 1997

(See Appendix D-1)

8. Table D.6.4 Striped Bass spawning D.O. , Salinity, and Velocity criteria passing for existing and deepening (2 ft) scenarios within the analyzed period April 1 - April 30, 1997

(See Appendix D-1)

9. Table D.7.1 Striped Bass eggs D.O. , Salinity, and Velocity criteria passing for existing and deepening (6 ft) scenarios within the analyzed period April 1 - April 30, 1997

(See Appendix D-2)

10. Table D.7.2 Striped Bass eggs D.O. , Salinity, and Velocity criteria passing for existing and deepening (4 ft) scenarios within the analyzed period April 1 - April 30, 1997

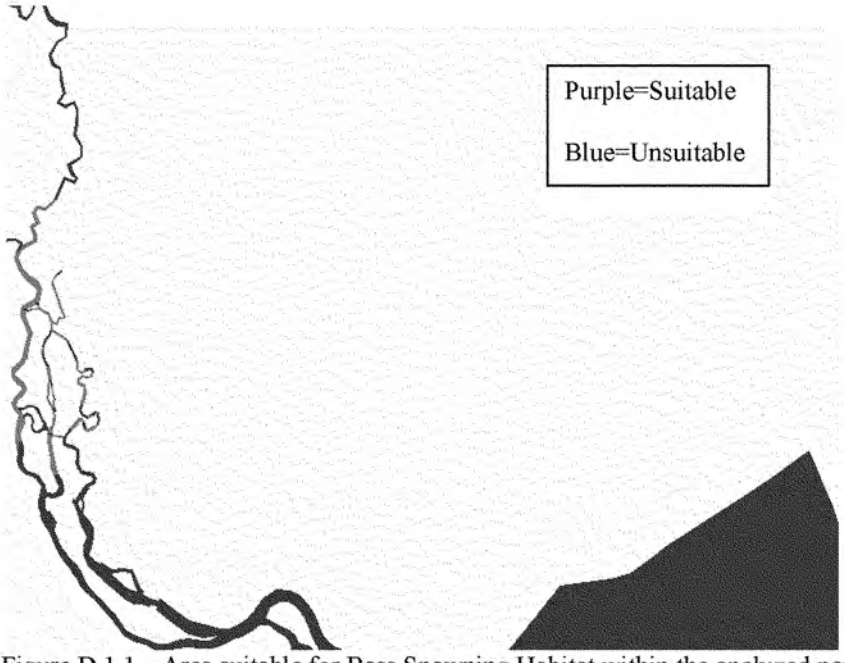
(See Appendix D-2)

11. Table D.7.3 Striped Bass eggs D.O. , Salinity, and Velocity criteria passing for existing and deepening (3 ft) scenarios within the analyzed period April 1 - April 30, 1997

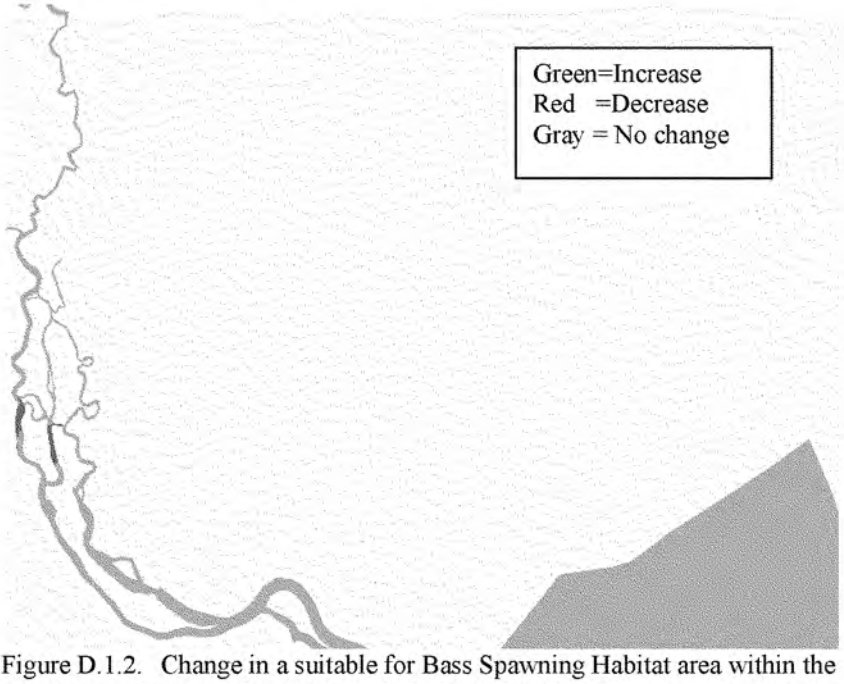
(See Appendix D-2)

12. Table D.7.4 Striped Bass eggs D.O. , Salinity, and Velocity criteria passing for existing and deepening (2 ft) scenarios within the analyzed period April 1 - April 30, 1997

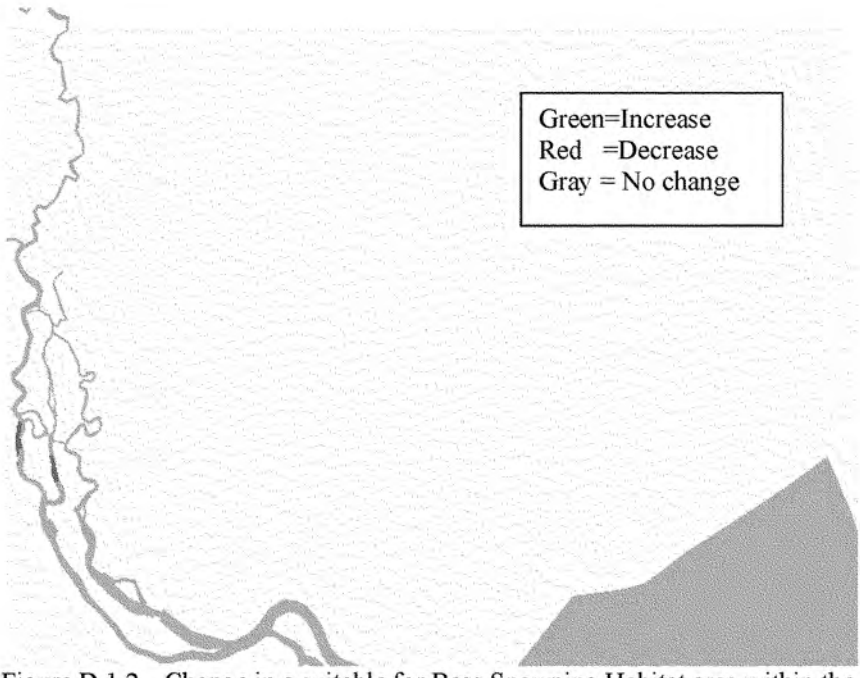
(See Appendix D-2)



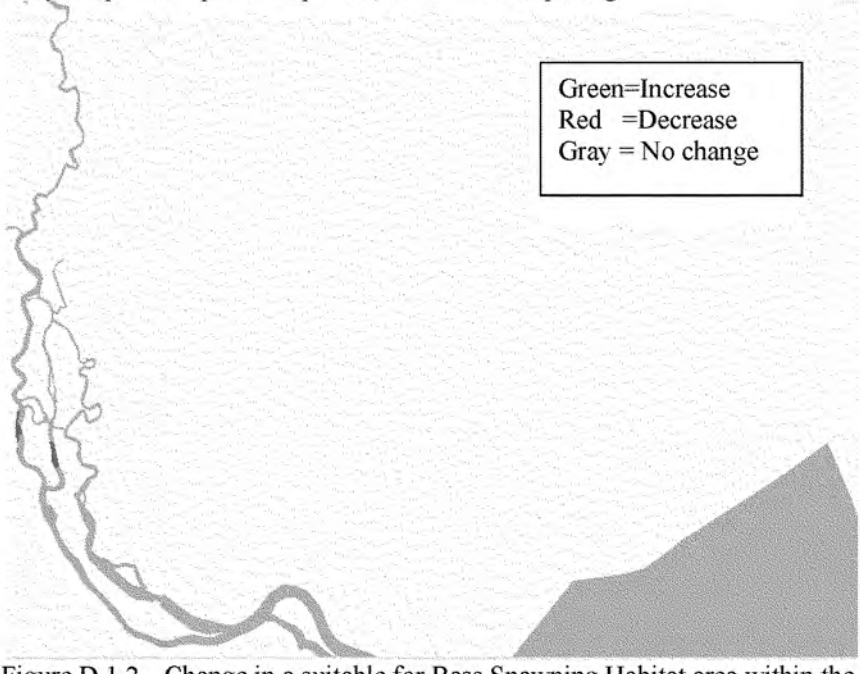
13. Figure D.1.1. Area suitable for Bass Spawning Habitat within the analyzed period April 1 – April 30, 1997: Existing bathymetry



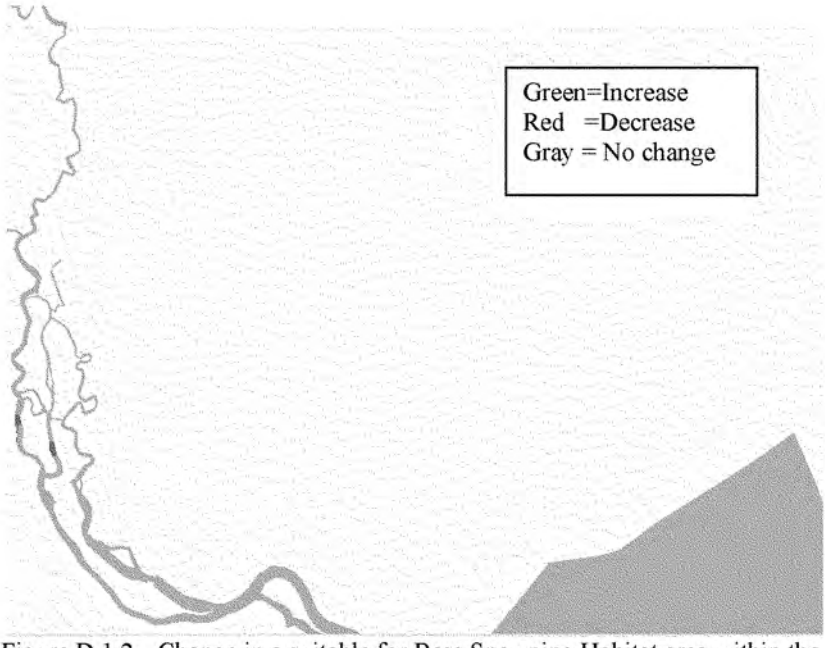
14. Figure D.1.2. Change in a suitable for Bass Spawning Habitat area within the analyzed period April 1 - April 30, 1999 : 6 ft deepening



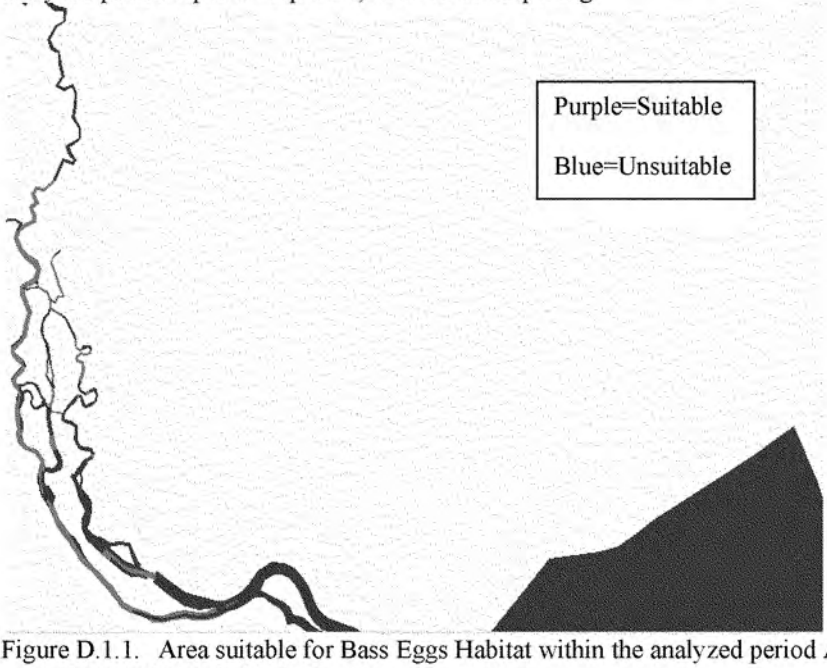
15. Figure D.1.2. Change in a suitable for Bass Spawning Habitat area within the analyzed period April 1 - April 30, 1999 : 4 ft deepening



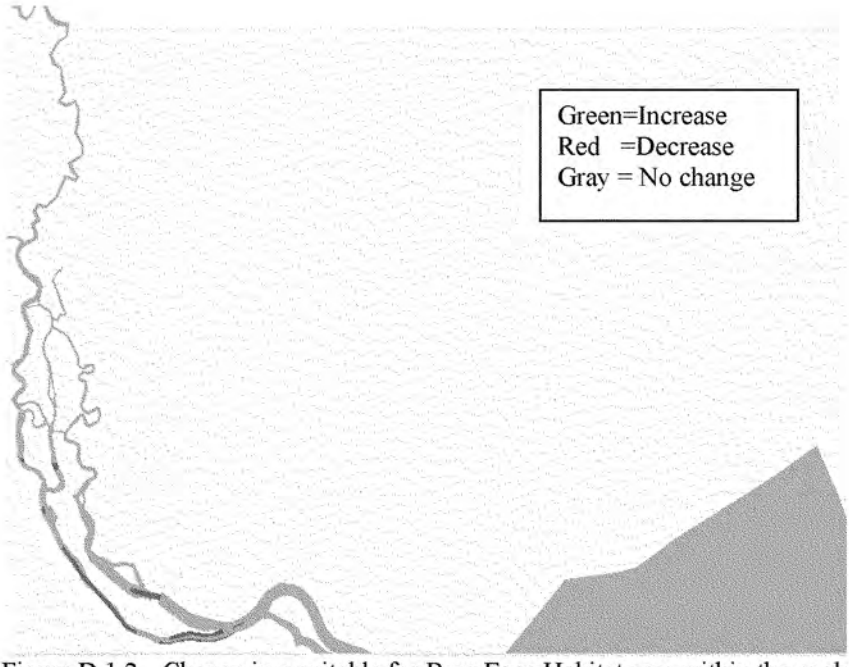
16. Figure D.1.2. Change in a suitable for Bass Spawning Habitat area within the analyzed period April 1 - April 30, 1999 : 3 ft deepening



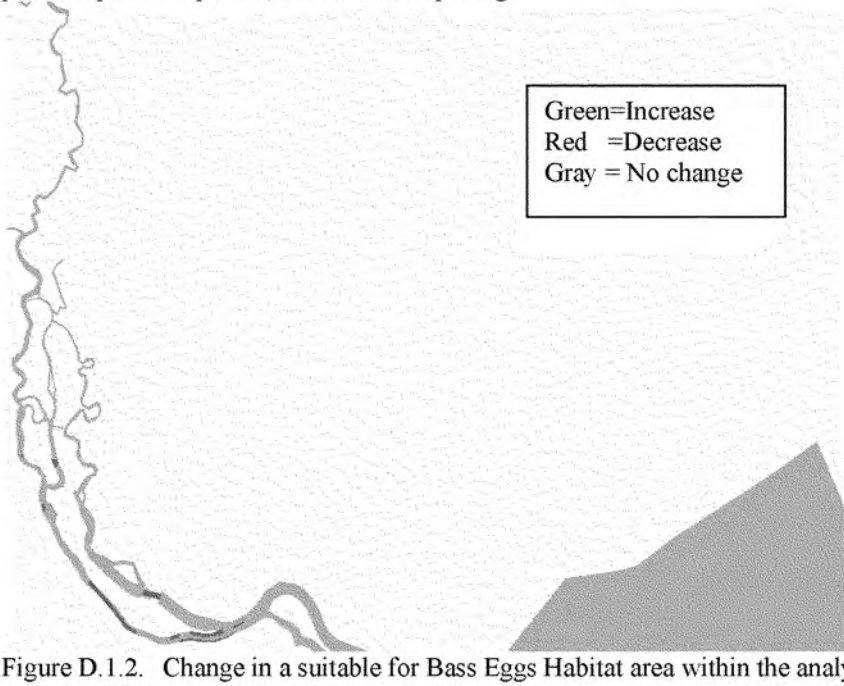
17. Figure D.1.2. Change in a suitable for Bass Spawning Habitat area within the analyzed period April 1 - April 30, 1999 : 2 ft deepening



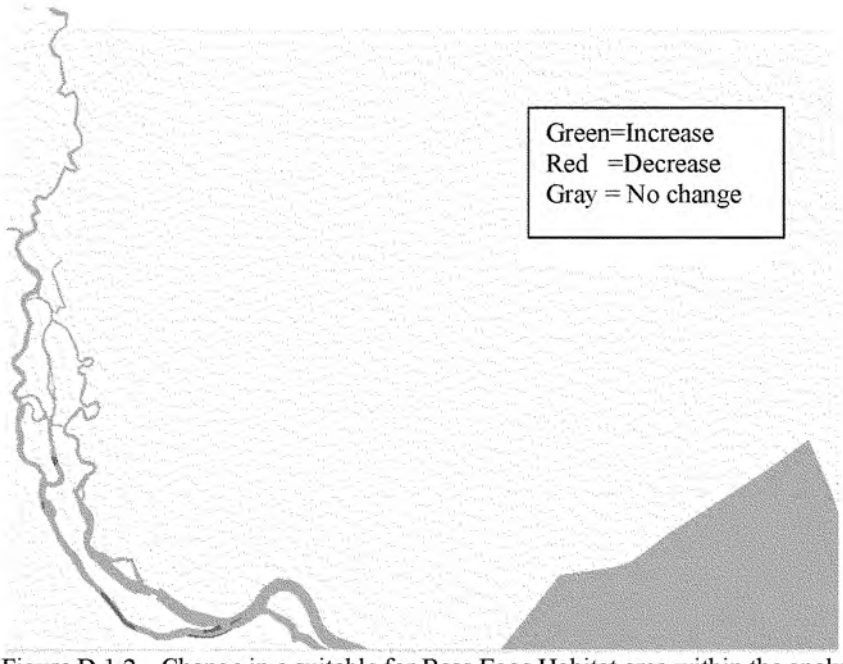
18. Figure D.1.1. Area suitable for Bass Eggs Habitat within the analyzed period April 1 – April 30, 1997: Existing bathymetry



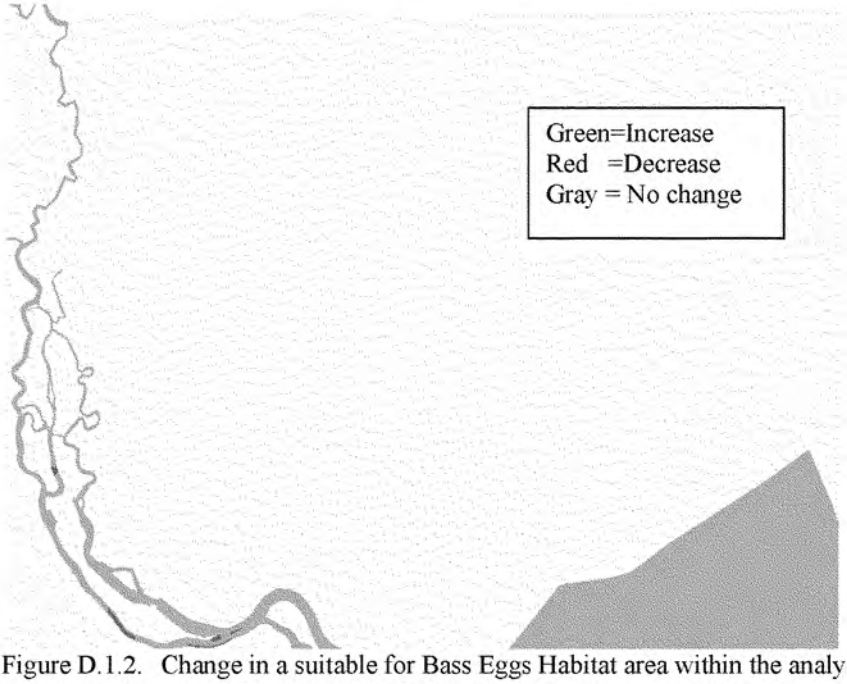
19. Figure D.1.2. Change in a suitable for Bass Eggs Habitat area within the analyzed period April 1 - April 30, 1999 : 6 ft deepening



20. Figure D.1.2. Change in a suitable for Bass Eggs Habitat area within the analyzed period April 1 - April 30, 1999 : 4 ft deepening



21. Figure D.1.2. Change in a suitable for Bass Eggs Habitat area within the analyzed period April 1 - April 30, 1999 : 3 ft deepening



22. Figure D.1.2. Change in a suitable for Bass Eggs Habitat area within the analyzed period April 1 - April 30, 1999 : 2 ft deepening

Appendix D-1

Tables of Criteria Passing for Striped Bass Spawning Habitat Suitability

April 1997

50th %ile of Clyo Flow

Fisheries Review Group

1. Table D.6.1 Striped Bass spawning D.O. , Salinity, and Velocity criteria passing for existing and deepening (6 ft) scenarios within the analyzed period April 1 - April 30, 1997

HABITAT REQUIREMENTS:
RM 10-31; Surface Layer
D.O. April (MG/L):n/a
Salinity 90th %ile <= 1 ppt
Mean Velocity >= 30 cm/s

Savannah Harbor Estuary

Segments J	Segments I	Baseline Scenario Salinity	Baseline Scenario Velocity	Project Scenario Salinity	Project Scenario Velocity
47	13	Fail	Pass	Fail	Pass
47	14	Fail	Pass	Fail	Pass
47	15	Fail	Pass	Fail	Pass
47	16	Fail	Pass	Fail	Pass
47	17	Fail	Fail	Fail	Fail
48	13	Fail	Pass	Fail	Pass
48	14	Fail	Pass	Fail	Pass
48	15	Fail	Pass	Fail	Pass
48	16	Fail	Pass	Fail	Pass
48	17	Fail	Pass	Fail	Pass
49	13	Fail	Pass	Fail	Pass
49	14	Fail	Pass	Fail	Pass
49	15	Fail	Pass	Fail	Pass
49	16	Fail	Pass	Fail	Pass
49	17	Fail	Pass	Fail	Pass
50	13	Fail	Pass	Fail	Pass
50	14	Fail	Pass	Fail	Pass
50	15	Fail	Pass	Fail	Pass
50	16	Fail	Pass	Fail	Pass
50	17	Fail	Pass	Fail	Pass
50	18	Fail	Fail	Fail	Fail
51	13	Fail	Pass	Fail	Pass
51	14	Fail	Pass	Fail	Pass
51	15	Fail	Pass	Fail	Pass
52	13	Fail	Pass	Fail	Pass
52	14	Fail	Pass	Fail	Pass
52	15	Fail	Pass	Fail	Pass
53	13	Fail	Pass	Fail	Pass
53	14	Fail	Pass	Fail	Pass
53	15	Fail	Pass	Fail	Pass
54	13	Fail	Pass	Fail	Pass
54	14	Fail	Pass	Fail	Pass
54	15	Fail	Pass	Fail	Pass
55	13	Fail	Pass	Fail	Pass
55	14	Fail	Pass	Fail	Pass
55	15	Fail	Pass	Fail	Pass
56	13	Fail	Pass	Fail	Pass
56	14	Fail	Pass	Fail	Pass
56	15	Fail	Pass	Fail	Pass
57	13	Fail	Pass	Fail	Pass

57	14	Fail	Pass	Fail	Pass
57	15	Fail	Pass	Fail	Pass
58	13	Fail	Pass	Fail	Pass
58	14	Fail	Pass	Fail	Pass
58	15	Fail	Pass	Fail	Pass
59	13	Fail	Pass	Fail	Pass
59	14	Fail	Pass	Fail	Pass
59	15	Fail	Pass	Fail	Pass
59	30	Fail	Pass	Fail	Pass
59	31	Fail	Pass	Fail	Pass
59	32	Fail	Fail	Fail	Fail
60	13	Fail	Pass	Fail	Pass
60	14	Fail	Pass	Fail	Pass
60	15	Fail	Pass	Fail	Pass
60	30	Fail	Fail	Fail	Fail
60	31	Fail	Pass	Fail	Fail
60	32	Fail	Fail	Fail	Fail
61	13	Fail	Pass	Fail	Pass
61	14	Fail	Pass	Fail	Pass
61	15	Fail	Pass	Fail	Pass
61	30	Fail	Fail	Fail	Fail
61	31	Fail	Pass	Fail	Fail
61	32	Fail	Fail	Fail	Fail
62	13	Fail	Pass	Fail	Pass
62	14	Fail	Pass	Fail	Pass
62	15	Fail	Pass	Fail	Pass
62	30	Fail	Fail	Fail	Fail
62	31	Fail	Pass	Fail	Pass
62	32	Fail	Fail	Fail	Fail
63	13	Fail	Pass	Fail	Pass
63	14	Fail	Pass	Fail	Pass
63	15	Fail	Pass	Fail	Pass
63	31	Fail	Pass	Fail	Pass
64	13	Fail	Pass	Fail	Pass
64	14	Fail	Pass	Fail	Pass
64	15	Fail	Pass	Fail	Pass
64	30	Fail	Fail	Fail	Fail
64	31	Fail	Pass	Fail	Pass
64	32	Fail	Fail	Fail	Fail
65	13	Fail	Pass	Fail	Pass
65	14	Fail	Pass	Fail	Pass
65	15	Fail	Pass	Fail	Pass
65	30	Fail	Pass	Fail	Pass
65	31	Fail	Pass	Fail	Pass
65	32	Fail	Pass	Fail	Pass
65	33	Fail	Fail	Fail	Fail
66	13	Fail	Pass	Fail	Pass
66	14	Fail	Pass	Fail	Pass
66	15	Fail	Pass	Fail	Pass
66	30	Fail	Pass	Fail	Pass
66	31	Fail	Pass	Fail	Pass
66	32	Fail	Pass	Fail	Pass
66	36	Fail	Pass	Fail	Pass
66	38	Fail	Fail	Fail	Fail
67	13	Fail	Pass	Fail	Pass
67	14	Fail	Pass	Fail	Pass
67	15	Fail	Pass	Fail	Pass

67	30	Fail	Pass	Fail	Pass
67	31	Fail	Pass	Fail	Pass
67	32	Fail	Pass	Fail	Pass
67	36	Fail	Fail	Fail	Fail
68	13	Fail	Pass	Fail	Pass
68	14	Fail	Pass	Fail	Pass
68	15	Fail	Pass	Fail	Pass
68	30	Fail	Pass	Fail	Pass
68	31	Fail	Pass	Fail	Pass
68	32	Fail	Pass	Fail	Pass
68	36	Fail	Fail	Fail	Fail
68	38	Fail	Fail	Fail	Fail
69	13	Fail	Pass	Fail	Pass
69	14	Fail	Pass	Fail	Pass
69	15	Fail	Pass	Fail	Pass
69	30	Fail	Pass	Fail	Pass
69	31	Fail	Pass	Fail	Pass
69	32	Fail	Fail	Fail	Pass
69	36	Fail	Fail	Fail	Fail
70	13	Fail	Pass	Fail	Pass
70	14	Fail	Pass	Fail	Pass
70	15	Fail	Pass	Fail	Pass
70	30	Fail	Pass	Fail	Pass
70	31	Fail	Pass	Fail	Pass
70	32	Fail	Fail	Fail	Fail
70	33	Fail	Fail	Fail	Fail
71	13	Fail	Pass	Fail	Pass
71	14	Fail	Pass	Fail	Pass
71	15	Fail	Pass	Fail	Pass
71	30	Fail	Pass	Fail	Pass
71	31	Fail	Pass	Fail	Pass
71	32	Fail	Fail	Fail	Fail
72	13	Fail	Pass	Fail	Pass
72	14	Fail	Pass	Fail	Pass
72	15	Fail	Pass	Fail	Pass
72	30	Fail	Pass	Fail	Pass
72	31	Fail	Pass	Fail	Pass
72	32	Fail	Fail	Fail	Fail
73	13	Fail	Pass	Fail	Pass
73	14	Fail	Pass	Fail	Pass
73	15	Fail	Pass	Fail	Pass
73	30	Fail	Fail	Fail	Pass
73	31	Fail	Pass	Fail	Pass
74	13	Fail	Pass	Fail	Pass
74	14	Fail	Pass	Fail	Pass
74	15	Fail	Pass	Fail	Pass
74	30	Fail	Fail	Fail	Fail
74	31	Fail	Pass	Fail	Pass
75	13	Fail	Pass	Fail	Pass
75	14	Fail	Pass	Fail	Pass
75	15	Fail	Pass	Fail	Pass
75	30	Fail	Pass	Fail	Pass
75	31	Fail	Pass	Fail	Pass
76	13	Fail	Pass	Fail	Pass
76	14	Fail	Pass	Fail	Pass
76	15	Fail	Fail	Fail	Fail
76	16	Fail	Fail	Fail	Fail

76	17	Fail	Fail	Fail	Fail
76	30	Fail	Fail	Fail	Pass
76	31	Fail	Pass	Fail	Pass
76	33	Fail	Fail	Fail	Fail
77	13	Fail	Fail	Fail	Pass
77	14	Fail	Pass	Fail	Pass
77	15	Fail	Fail	Fail	Fail
77	16	Fail	Fail	Fail	Fail
77	17	Fail	Fail	Fail	Fail
77	30	Fail	Fail	Fail	Fail
77	31	Fail	Fail	Fail	Fail
78	13	Fail	Fail	Fail	Pass
78	14	Fail	Pass	Fail	Pass
78	15	Fail	Fail	Fail	Fail
78	16	Fail	Fail	Fail	Fail
78	17	Fail	Fail	Fail	Fail
78	30	Fail	Fail	Fail	Fail
78	31	Fail	Fail	Fail	Fail
79	13	Fail	Pass	Fail	Pass
79	14	Fail	Pass	Fail	Pass
79	15	Fail	Pass	Fail	Pass
79	30	Fail	Pass	Fail	Pass
79	31	Fail	Fail	Fail	Fail
80	13	Fail	Pass	Fail	Pass
80	14	Fail	Pass	Fail	Pass
80	15	Fail	Pass	Fail	Pass
80	30	Fail	Pass	Fail	Pass
80	31	Fail	Fail	Fail	Fail
81	13	Fail	Pass	Fail	Pass
81	14	Fail	Pass	Fail	Pass
81	15	Fail	Pass	Fail	Pass
81	30	Fail	Pass	Fail	Pass
81	31	Fail	Fail	Fail	Fail
82	13	Fail	Pass	Fail	Pass
82	14	Fail	Pass	Fail	Pass
82	15	Fail	Pass	Fail	Pass
82	16	Fail	Fail	Fail	Fail
82	17	Fail	Fail	Fail	Fail
82	18	Fail	Pass	Fail	Pass
82	19	Fail	Fail	Fail	Fail
82	20	Fail	Fail	Fail	Fail
82	21	Fail	Fail	Fail	Fail
82	29	Fail	Fail	Fail	Fail
82	30	Fail	Pass	Fail	Pass
82	31	Fail	Fail	Fail	Fail
83	13	Fail	Pass	Fail	Pass
83	14	Fail	Pass	Fail	Pass
83	15	Fail	Pass	Fail	Pass
83	21	Fail	Pass	Fail	Pass
83	30	Fail	Fail	Fail	Fail
83	31	Fail	Fail	Fail	Fail
84	13	Fail	Pass	Fail	Pass
84	14	Fail	Pass	Fail	Pass
84	15	Fail	Pass	Fail	Pass
84	21	Fail	Pass	Fail	Pass
84	30	Fail	Fail	Fail	Fail
84	31	Fail	Fail	Fail	Fail

85	13	Fail	Pass	Fail	Pass
85	14	Fail	Pass	Fail	Pass
85	15	Fail	Pass	Fail	Pass
85	21	Fail	Pass	Fail	Pass
85	30	Fail	Fail	Fail	Fail
86	13	Fail	Pass	Fail	Pass
86	14	Fail	Pass	Fail	Pass
86	15	Fail	Pass	Fail	Pass
86	17	Fail	Fail	Fail	Fail
86	21	Pass	Pass	Fail	Pass
86	30	Fail	Pass	Fail	Pass
87	13	Fail	Pass	Fail	Pass
87	14	Fail	Pass	Fail	Pass
87	15	Fail	Pass	Fail	Pass
87	30	Fail	Pass	Fail	Pass
87	32	Fail	Fail	Fail	Fail
88	13	Fail	Pass	Fail	Pass
88	14	Fail	Pass	Fail	Pass
88	15	Fail	Pass	Fail	Pass
88	30	Fail	Fail	Fail	Fail
89	13	Fail	Pass	Fail	Pass
89	14	Fail	Pass	Fail	Pass
89	15	Fail	Pass	Fail	Pass
89	30	Pass	Fail	Fail	Fail
90	13	Fail	Pass	Fail	Pass
90	14	Fail	Pass	Fail	Pass
90	15	Fail	Pass	Fail	Pass
90	30	Pass	Fail	Fail	Fail
91	13	Fail	Pass	Fail	Pass
91	14	Fail	Pass	Fail	Pass
91	15	Fail	Pass	Fail	Pass
91	16	Fail	Fail	Fail	Fail
91	30	Pass	Fail	Fail	Fail
92	13	Fail	Pass	Fail	Pass
92	14	Fail	Pass	Fail	Pass
92	15	Fail	Pass	Fail	Pass
92	16	Fail	Pass	Fail	Fail
92	30	Pass	Fail	Pass	Fail
92	32	Fail	Fail	Fail	Fail
93	13	Pass	Pass	Fail	Pass
93	14	Fail	Pass	Fail	Pass
93	15	Fail	Pass	Fail	Pass
93	16	Fail	Pass	Fail	Pass
93	30	Pass	Fail	Pass	Fail
94	13	Pass	Pass	Fail	Pass
94	14	Fail	Pass	Fail	Pass
94	15	Fail	Pass	Fail	Pass
94	16	Fail	Fail	Fail	Fail
94	26	Pass	Pass	Fail	Pass
94	30	Pass	Fail	Pass	Fail
95	13	Pass	Pass	Fail	Pass
95	14	Pass	Pass	Fail	Pass
95	15	Pass	Pass	Fail	Pass
95	16	Fail	Fail	Fail	Fail
95	26	Pass	Pass	Fail	Pass
95	28	Fail	Fail	Fail	Fail
95	30	Pass	Fail	Pass	Fail

96	11	Fail	Fail	Fail	Fail
96	13	Pass	Pass	Fail	Pass
96	14	Pass	Pass	Fail	Pass
96	15	Pass	Pass	Fail	Pass
96	26	Pass	Pass	Fail	Pass
96	30	Pass	Fail	Pass	Fail
97	13	Pass	Pass	Fail	Pass
97	14	Pass	Pass	Fail	Pass
97	15	Pass	Pass	Fail	Pass
97	26	Pass	Pass	Fail	Pass
97	30	Pass	Fail	Pass	Fail
98	13	Pass	Pass	Fail	Pass
98	14	Pass	Pass	Fail	Pass
98	15	Pass	Pass	Fail	Pass
98	26	Pass	Pass	Pass	Pass
98	27	Pass	Pass	Fail	Pass
98	28	Pass	Pass	Fail	Pass
98	29	Pass	Pass	Fail	Pass
98	30	Pass	Fail	Pass	Fail
99	13	Pass	Pass	Fail	Pass
99	14	Pass	Pass	Fail	Pass
99	15	Pass	Pass	Fail	Pass
99	16	Pass	Fail	Fail	Fail
99	17	Fail	Fail	Fail	Fail
99	18	Fail	Fail	Fail	Fail
99	19	Fail	Fail	Fail	Fail
99	20	Fail	Fail	Fail	Fail
99	21	Fail	Fail	Fail	Fail
99	22	Fail	Fail	Fail	Fail
99	23	Fail	Fail	Fail	Fail
99	26	Pass	Fail	Pass	Fail
99	30	Pass	Fail	Pass	Fail
100	13	Pass	Pass	Pass	Pass
100	14	Pass	Pass	Pass	Pass
100	15	Pass	Pass	Fail	Pass
100	23	Pass	Fail	Fail	Fail
100	24	Pass	Fail	Fail	Fail
100	25	Pass	Fail	Fail	Fail
100	26	Pass	Pass	Pass	Pass
100	30	Pass	Fail	Pass	Fail
101	13	Pass	Pass	Pass	Pass
101	14	Pass	Pass	Pass	Pass
101	15	Pass	Pass	Fail	Pass
101	16	Pass	Fail	Fail	Fail
101	17	Pass	Fail	Fail	Fail
101	18	Pass	Fail	Fail	Fail
101	19	Fail	Fail	Fail	Fail
101	20	Fail	Fail	Fail	Fail
101	21	Fail	Fail	Fail	Fail
101	22	Pass	Fail	Fail	Fail
101	23	Pass	Fail	Fail	Fail
101	26	Pass	Pass	Pass	Pass
101	30	Pass	Pass	Pass	Pass
102	13	Pass	Pass	Pass	Pass
102	14	Pass	Pass	Pass	Pass
102	15	Pass	Pass	Pass	Pass
102	26	Pass	Pass	Pass	Pass

102	30	Pass	Pass	Pass	Pass
103	13	Pass	Pass	Pass	Pass
103	14	Pass	Pass	Pass	Pass
103	15	Pass	Pass	Pass	Pass
103	26	Pass	Pass	Pass	Pass
103	30	Pass	Pass	Pass	Pass
104	11	Fail	Fail	Fail	Fail
104	13	Pass	Pass	Pass	Pass
104	14	Pass	Pass	Pass	Pass
104	15	Pass	Pass	Pass	Pass
104	26	Pass	Pass	Pass	Pass
104	30	Pass	Pass	Pass	Pass
105	13	Pass	Pass	Pass	Pass
105	14	Pass	Pass	Pass	Pass
105	15	Pass	Pass	Pass	Pass
105	26	Pass	Pass	Pass	Pass
105	30	Pass	Fail	Pass	Fail
106	13	Pass	Pass	Pass	Pass
106	14	Pass	Pass	Pass	Pass
106	15	Pass	Pass	Pass	Pass
106	26	Pass	Pass	Pass	Pass
106	27	Pass	Fail	Pass	Fail
106	30	Pass	Pass	Pass	Pass
106	39	Pass	Fail	Pass	Fail
107	13	Pass	Pass	Pass	Pass
107	14	Pass	Pass	Pass	Pass
107	15	Pass	Pass	Pass	Pass
107	22	Pass	Pass	Pass	Pass
107	26	Pass	Pass	Pass	Pass
107	30	Pass	Pass	Pass	Pass
107	39	Pass	Pass	Pass	Pass
108	13	Pass	Pass	Pass	Pass
108	14	Pass	Pass	Pass	Pass
108	15	Pass	Pass	Pass	Pass
108	22	Pass	Pass	Pass	Pass
108	24	Fail	Fail	Fail	Fail
108	26	Pass	Pass	Pass	Pass
108	30	Pass	Pass	Pass	Pass
108	39	Pass	Fail	Pass	Fail
109	13	Pass	Pass	Pass	Pass
109	14	Pass	Pass	Pass	Pass
109	15	Pass	Pass	Pass	Pass
109	22	Pass	Fail	Pass	Fail
109	26	Pass	Pass	Pass	Pass
109	30	Pass	Fail	Pass	Fail
109	39	Pass	Pass	Pass	Pass
110	13	Pass	Pass	Pass	Pass
110	14	Pass	Pass	Pass	Pass
110	15	Pass	Pass	Pass	Pass
110	22	Pass	Pass	Pass	Pass
110	26	Pass	Pass	Pass	Pass
110	28	Fail	Fail	Fail	Fail
110	39	Pass	Fail	Pass	Fail
111	13	Pass	Pass	Pass	Pass
111	14	Pass	Pass	Pass	Pass
111	15	Pass	Pass	Pass	Pass
111	22	Pass	Pass	Pass	Pass

111	26	Pass	Pass	Pass	Pass
111	39	Pass	Fail	Pass	Fail
112	13	Pass	Pass	Pass	Pass
112	14	Pass	Pass	Pass	Pass
112	15	Pass	Pass	Pass	Pass
112	22	Pass	Fail	Pass	Fail
112	26	Pass	Pass	Pass	Pass
112	39	Pass	Fail	Pass	Fail
113	13	Pass	Pass	Pass	Pass
113	14	Pass	Pass	Pass	Pass
113	15	Pass	Pass	Pass	Pass
113	26	Pass	Pass	Pass	Pass
113	27	Pass	Fail	Pass	Fail
113	39	Pass	Pass	Pass	Pass
113	41	Fail	Fail	Fail	Fail
114	13	Pass	Pass	Pass	Pass
114	14	Pass	Pass	Pass	Pass
114	15	Pass	Pass	Pass	Pass
114	26	Pass	Pass	Pass	Pass
114	39	Pass	Pass	Pass	Pass
115	13	Pass	Pass	Pass	Pass
115	14	Pass	Pass	Pass	Pass
115	15	Pass	Pass	Pass	Pass
115	26	Pass	Pass	Pass	Pass
115	39	Pass	Pass	Pass	Pass
116	13	Pass	Pass	Pass	Pass
116	14	Pass	Pass	Pass	Pass
116	15	Pass	Pass	Pass	Pass
116	26	Pass	Fail	Pass	Fail
116	28	Fail	Fail	Fail	Fail
116	39	Pass	Pass	Pass	Pass
117	13	Pass	Pass	Pass	Pass
117	14	Pass	Pass	Pass	Pass
117	15	Pass	Pass	Pass	Pass
117	26	Pass	Fail	Pass	Fail
117	39	Pass	Pass	Pass	Pass
118	13	Pass	Pass	Pass	Pass
118	14	Pass	Pass	Pass	Pass
118	15	Pass	Pass	Pass	Pass
118	20	Pass	Fail	Pass	Fail
118	26	Pass	Pass	Pass	Pass
118	39	Pass	Pass	Pass	Pass
119	13	Pass	Pass	Pass	Pass
119	14	Pass	Pass	Pass	Pass
119	15	Pass	Pass	Pass	Pass
119	20	Pass	Pass	Pass	Pass
119	26	Pass	Fail	Pass	Fail
119	39	Pass	Pass	Pass	Pass
120	13	Pass	Pass	Pass	Pass
120	14	Pass	Pass	Pass	Pass
120	15	Pass	Fail	Pass	Fail
120	16	Pass	Fail	Pass	Fail
120	26	Pass	Fail	Pass	Fail
120	39	Pass	Pass	Pass	Pass
121	13	Pass	Pass	Pass	Pass
121	14	Pass	Pass	Pass	Pass
121	26	Pass	Fail	Pass	Fail

121	39	Pass	Pass	Pass	Pass
122	13	Pass	Pass	Pass	Pass
122	14	Pass	Pass	Pass	Pass
122	26	Pass	Fail	Pass	Fail
122	39	Pass	Pass	Pass	Pass
122	41	Fail	Fail	Fail	Fail
123	13	Pass	Pass	Pass	Pass
123	14	Pass	Pass	Pass	Pass
123	15	Pass	Fail	Pass	Fail
123	16	Pass	Pass	Pass	Pass
123	17	Pass	Pass	Pass	Pass
123	18	Pass	Pass	Pass	Pass
123	19	Pass	Pass	Pass	Pass
123	20	Pass	Pass	Pass	Pass
123	21	Pass	Pass	Pass	Pass
123	22	Pass	Pass	Pass	Pass
123	23	Pass	Pass	Pass	Pass
123	24	Pass	Pass	Pass	Pass
123	25	Pass	Pass	Pass	Pass
123	26	Pass	Pass	Pass	Pass
123	27	Pass	Pass	Pass	Pass
123	28	Pass	Pass	Pass	Pass
123	29	Pass	Pass	Pass	Pass
123	30	Pass	Fail	Pass	Fail
123	31	Pass	Fail	Pass	Fail
123	32	Pass	Fail	Pass	Fail
123	33	Pass	Fail	Pass	Fail
123	34	Pass	Pass	Pass	Pass
123	35	Pass	Pass	Pass	Pass
123	36	Pass	Pass	Pass	Pass
123	37	Pass	Pass	Pass	Pass
123	38	Pass	Fail	Pass	Fail
123	39	Pass	Fail	Pass	Fail
124	13	Pass	Pass	Pass	Pass
124	14	Pass	Pass	Pass	Pass
124	23	Pass	Pass	Pass	Pass
125	13	Pass	Pass	Pass	Pass
125	14	Pass	Pass	Pass	Pass
125	23	Pass	Pass	Pass	Pass
125	28	Fail	Fail	Fail	Fail
125	33	Fail	Fail	Fail	Fail
126	13	Pass	Pass	Pass	Pass
126	14	Pass	Pass	Pass	Pass
126	23	Pass	Pass	Pass	Pass
127	13	Pass	Pass	Pass	Pass
127	14	Pass	Pass	Pass	Pass
127	23	Pass	Pass	Pass	Pass
128	13	Pass	Pass	Pass	Pass
128	14	Pass	Pass	Pass	Pass
128	23	Pass	Pass	Pass	Pass
129	13	Pass	Pass	Pass	Pass
129	14	Pass	Pass	Pass	Pass
129	23	Pass	Pass	Pass	Pass
130	8	Pass	Fail	Pass	Fail
130	9	Pass	Fail	Pass	Fail
130	10	Pass	Fail	Pass	Fail
130	11	Pass	Fail	Pass	Fail

130	12	Pass	Fail	Pass	Fail
130	13	Pass	Fail	Pass	Fail
130	14	Pass	Pass	Pass	Pass
130	23	Pass	Pass	Pass	Pass
131	14	Pass	Pass	Pass	Pass
131	23	Pass	Pass	Pass	Pass
132	14	Pass	Pass	Pass	Pass
132	23	Pass	Pass	Pass	Pass
133	14	Pass	Pass	Pass	Pass
133	23	Pass	Pass	Pass	Pass
134	14	Pass	Pass	Pass	Pass
134	23	Pass	Fail	Pass	Fail
135	14	Pass	Pass	Pass	Pass
136	14	Pass	Pass	Pass	Pass
137	14	Pass	Pass	Pass	Pass
138	14	Pass	Pass	Pass	Pass

2. Table D.6.2 Striped Bass spawning D.O. , Salinity, and Velocity criteria passing for existing and deepening (4 ft) scenarios within the analyzed period April 1 - April 30, 1997

HABITAT REQUIREMENTS:
RM 10-31; Surface Layer
D.O. April (MG/L):n/a
Salinity 90th %ile <= 1 ppt
Mean Velocity >= 30 cm/s

Savannah Harbor Estuary

Segments		Baseline Scenario		Project Scenario	
J	I	Salinity	Velocity	Salinity	Velocity
47	13	Fail	Pass	Fail	Pass
47	14	Fail	Pass	Fail	Pass
47	15	Fail	Pass	Fail	Pass
47	16	Fail	Pass	Fail	Pass
47	17	Fail	Fail	Fail	Fail
48	13	Fail	Pass	Fail	Pass
48	14	Fail	Pass	Fail	Pass
48	15	Fail	Pass	Fail	Pass
48	16	Fail	Pass	Fail	Pass
48	17	Fail	Pass	Fail	Pass
49	13	Fail	Pass	Fail	Pass
49	14	Fail	Pass	Fail	Pass
49	15	Fail	Pass	Fail	Pass
49	16	Fail	Pass	Fail	Pass
49	17	Fail	Pass	Fail	Pass
50	13	Fail	Pass	Fail	Pass
50	14	Fail	Pass	Fail	Pass
50	15	Fail	Pass	Fail	Pass
50	16	Fail	Pass	Fail	Pass
50	17	Fail	Pass	Fail	Pass
50	18	Fail	Fail	Fail	Fail
51	13	Fail	Pass	Fail	Pass
51	14	Fail	Pass	Fail	Pass
51	15	Fail	Pass	Fail	Pass
52	13	Fail	Pass	Fail	Pass
52	14	Fail	Pass	Fail	Pass
52	15	Fail	Pass	Fail	Pass
53	13	Fail	Pass	Fail	Pass
53	14	Fail	Pass	Fail	Pass
53	15	Fail	Pass	Fail	Pass
54	13	Fail	Pass	Fail	Pass
54	14	Fail	Pass	Fail	Pass
54	15	Fail	Pass	Fail	Pass
55	13	Fail	Pass	Fail	Pass
55	14	Fail	Pass	Fail	Pass
55	15	Fail	Pass	Fail	Pass
56	13	Fail	Pass	Fail	Pass
56	14	Fail	Pass	Fail	Pass
56	15	Fail	Pass	Fail	Pass

57	13	Fail	Pass	Fail	Pass
57	14	Fail	Pass	Fail	Pass
57	15	Fail	Pass	Fail	Pass
58	13	Fail	Pass	Fail	Pass
58	14	Fail	Pass	Fail	Pass
58	15	Fail	Pass	Fail	Pass
59	13	Fail	Pass	Fail	Pass
59	14	Fail	Pass	Fail	Pass
59	15	Fail	Pass	Fail	Pass
59	30	Fail	Pass	Fail	Pass
59	31	Fail	Pass	Fail	Pass
59	32	Fail	Fail	Fail	Fail
60	13	Fail	Pass	Fail	Pass
60	14	Fail	Pass	Fail	Pass
60	15	Fail	Pass	Fail	Pass
60	30	Fail	Fail	Fail	Fail
60	31	Fail	Pass	Fail	Pass
60	32	Fail	Fail	Fail	Fail
61	13	Fail	Pass	Fail	Pass
61	14	Fail	Pass	Fail	Pass
61	15	Fail	Pass	Fail	Pass
61	30	Fail	Fail	Fail	Fail
61	31	Fail	Pass	Fail	Pass
61	32	Fail	Fail	Fail	Fail
62	13	Fail	Pass	Fail	Pass
62	14	Fail	Pass	Fail	Pass
62	15	Fail	Pass	Fail	Pass
62	30	Fail	Fail	Fail	Fail
62	31	Fail	Pass	Fail	Pass
62	32	Fail	Fail	Fail	Fail
63	13	Fail	Pass	Fail	Pass
63	14	Fail	Pass	Fail	Pass
63	15	Fail	Pass	Fail	Pass
63	31	Fail	Pass	Fail	Pass
64	13	Fail	Pass	Fail	Pass
64	14	Fail	Pass	Fail	Pass
64	15	Fail	Pass	Fail	Pass
64	30	Fail	Fail	Fail	Fail
64	31	Fail	Pass	Fail	Pass
64	32	Fail	Fail	Fail	Fail
65	13	Fail	Pass	Fail	Pass
65	14	Fail	Pass	Fail	Pass
65	15	Fail	Pass	Fail	Pass
65	30	Fail	Pass	Fail	Pass
65	31	Fail	Pass	Fail	Pass
65	32	Fail	Pass	Fail	Pass
65	33	Fail	Fail	Fail	Fail
66	13	Fail	Pass	Fail	Pass
66	14	Fail	Pass	Fail	Pass
66	15	Fail	Pass	Fail	Pass
66	30	Fail	Pass	Fail	Pass
66	31	Fail	Pass	Fail	Pass
66	32	Fail	Pass	Fail	Pass
66	36	Fail	Pass	Fail	Pass
66	38	Fail	Fail	Fail	Fail
67	13	Fail	Pass	Fail	Pass
67	14	Fail	Pass	Fail	Pass

67	15	Fail	Pass	Fail	Pass
67	30	Fail	Pass	Fail	Pass
67	31	Fail	Pass	Fail	Pass
67	32	Fail	Pass	Fail	Pass
67	36	Fail	Fail	Fail	Fail
68	13	Fail	Pass	Fail	Pass
68	14	Fail	Pass	Fail	Pass
68	15	Fail	Pass	Fail	Pass
68	30	Fail	Pass	Fail	Pass
68	31	Fail	Pass	Fail	Pass
68	32	Fail	Pass	Fail	Pass
68	36	Fail	Fail	Fail	Fail
68	38	Fail	Fail	Fail	Fail
69	13	Fail	Pass	Fail	Pass
69	14	Fail	Pass	Fail	Pass
69	15	Fail	Pass	Fail	Pass
69	30	Fail	Pass	Fail	Pass
69	31	Fail	Pass	Fail	Pass
69	32	Fail	Fail	Fail	Fail
69	36	Fail	Fail	Fail	Fail
70	13	Fail	Pass	Fail	Pass
70	14	Fail	Pass	Fail	Pass
70	15	Fail	Pass	Fail	Pass
70	30	Fail	Pass	Fail	Pass
70	31	Fail	Pass	Fail	Pass
70	32	Fail	Fail	Fail	Fail
70	33	Fail	Fail	Fail	Fail
71	13	Fail	Pass	Fail	Pass
71	14	Fail	Pass	Fail	Pass
71	15	Fail	Pass	Fail	Pass
71	30	Fail	Pass	Fail	Pass
71	31	Fail	Pass	Fail	Pass
71	32	Fail	Fail	Fail	Fail
72	13	Fail	Pass	Fail	Pass
72	14	Fail	Pass	Fail	Pass
72	15	Fail	Pass	Fail	Pass
72	30	Fail	Pass	Fail	Pass
72	31	Fail	Pass	Fail	Pass
72	32	Fail	Fail	Fail	Fail
73	13	Fail	Pass	Fail	Pass
73	14	Fail	Pass	Fail	Pass
73	15	Fail	Pass	Fail	Pass
73	30	Fail	Fail	Fail	Fail
73	31	Fail	Pass	Fail	Pass
74	13	Fail	Pass	Fail	Pass
74	14	Fail	Pass	Fail	Pass
74	15	Fail	Pass	Fail	Pass
74	30	Fail	Fail	Fail	Fail
74	31	Fail	Pass	Fail	Pass
75	13	Fail	Pass	Fail	Pass
75	14	Fail	Pass	Fail	Pass
75	15	Fail	Pass	Fail	Pass
75	30	Fail	Pass	Fail	Pass
75	31	Fail	Pass	Fail	Pass
76	13	Fail	Pass	Fail	Pass
76	14	Fail	Pass	Fail	Pass
76	15	Fail	Fail	Fail	Fail

76	16	Fail	Fail	Fail	Fail
76	17	Fail	Fail	Fail	Fail
76	30	Fail	Fail	Fail	Pass
76	31	Fail	Pass	Fail	Pass
76	33	Fail	Fail	Fail	Fail
77	13	Fail	Fail	Fail	Fail
77	14	Fail	Pass	Fail	Pass
77	15	Fail	Fail	Fail	Fail
77	16	Fail	Fail	Fail	Fail
77	17	Fail	Fail	Fail	Fail
77	30	Fail	Fail	Fail	Fail
77	31	Fail	Fail	Fail	Fail
78	13	Fail	Fail	Fail	Pass
78	14	Fail	Pass	Fail	Pass
78	15	Fail	Fail	Fail	Fail
78	16	Fail	Fail	Fail	Fail
78	17	Fail	Fail	Fail	Fail
78	30	Fail	Fail	Fail	Fail
78	31	Fail	Fail	Fail	Fail
79	13	Fail	Pass	Fail	Pass
79	14	Fail	Pass	Fail	Pass
79	15	Fail	Pass	Fail	Pass
79	30	Fail	Pass	Fail	Pass
79	31	Fail	Fail	Fail	Fail
80	13	Fail	Pass	Fail	Pass
80	14	Fail	Pass	Fail	Pass
80	15	Fail	Pass	Fail	Pass
80	30	Fail	Pass	Fail	Pass
80	31	Fail	Fail	Fail	Fail
81	13	Fail	Pass	Fail	Pass
81	14	Fail	Pass	Fail	Pass
81	15	Fail	Pass	Fail	Pass
81	30	Fail	Pass	Fail	Pass
81	31	Fail	Fail	Fail	Fail
82	13	Fail	Pass	Fail	Pass
82	14	Fail	Pass	Fail	Pass
82	15	Fail	Pass	Fail	Pass
82	16	Fail	Fail	Fail	Fail
82	17	Fail	Fail	Fail	Fail
82	18	Fail	Pass	Fail	Pass
82	19	Fail	Fail	Fail	Fail
82	20	Fail	Fail	Fail	Fail
82	21	Fail	Fail	Fail	Fail
82	29	Fail	Fail	Fail	Fail
82	30	Fail	Pass	Fail	Pass
82	31	Fail	Fail	Fail	Fail
83	13	Fail	Pass	Fail	Pass
83	14	Fail	Pass	Fail	Pass
83	15	Fail	Pass	Fail	Pass
83	21	Fail	Pass	Fail	Pass
83	30	Fail	Fail	Fail	Fail
83	31	Fail	Fail	Fail	Fail
84	13	Fail	Pass	Fail	Pass
84	14	Fail	Pass	Fail	Pass
84	15	Fail	Pass	Fail	Pass
84	21	Fail	Pass	Fail	Pass
84	30	Fail	Fail	Fail	Fail

84	31	Fail	Fail	Fail	Fail
85	13	Fail	Pass	Fail	Pass
85	14	Fail	Pass	Fail	Pass
85	15	Fail	Pass	Fail	Pass
85	21	Fail	Pass	Fail	Pass
85	30	Fail	Fail	Fail	Fail
86	13	Fail	Pass	Fail	Pass
86	14	Fail	Pass	Fail	Pass
86	15	Fail	Pass	Fail	Pass
86	17	Fail	Fail	Fail	Fail
86	21	Pass	Pass	Fail	Pass
86	30	Fail	Pass	Fail	Pass
87	13	Fail	Pass	Fail	Pass
87	14	Fail	Pass	Fail	Pass
87	15	Fail	Pass	Fail	Pass
87	30	Fail	Pass	Fail	Pass
87	32	Fail	Fail	Fail	Fail
88	13	Fail	Pass	Fail	Pass
88	14	Fail	Pass	Fail	Pass
88	15	Fail	Pass	Fail	Pass
88	30	Fail	Fail	Fail	Fail
89	13	Fail	Pass	Fail	Pass
89	14	Fail	Pass	Fail	Pass
89	15	Fail	Pass	Fail	Pass
89	30	Pass	Fail	Fail	Fail
90	13	Fail	Pass	Fail	Pass
90	14	Fail	Pass	Fail	Pass
90	15	Fail	Pass	Fail	Pass
90	30	Pass	Fail	Fail	Fail
91	13	Fail	Pass	Fail	Pass
91	14	Fail	Pass	Fail	Pass
91	15	Fail	Pass	Fail	Pass
91	16	Fail	Fail	Fail	Fail
91	30	Pass	Fail	Pass	Fail
92	13	Fail	Pass	Fail	Pass
92	14	Fail	Pass	Fail	Pass
92	15	Fail	Pass	Fail	Pass
92	16	Fail	Pass	Fail	Fail
92	30	Pass	Fail	Pass	Fail
92	32	Fail	Fail	Fail	Fail
93	13	Pass	Pass	Fail	Pass
93	14	Fail	Pass	Fail	Pass
93	15	Fail	Pass	Fail	Pass
93	16	Fail	Pass	Fail	Pass
93	30	Pass	Fail	Pass	Fail
94	13	Pass	Pass	Fail	Pass
94	14	Fail	Pass	Fail	Pass
94	15	Fail	Pass	Fail	Pass
94	16	Fail	Fail	Fail	Fail
94	26	Pass	Pass	Fail	Pass
94	30	Pass	Fail	Pass	Fail
95	13	Pass	Pass	Fail	Pass
95	14	Pass	Pass	Fail	Pass
95	15	Pass	Pass	Fail	Pass
95	16	Fail	Fail	Fail	Fail
95	26	Pass	Pass	Fail	Pass
95	28	Fail	Fail	Fail	Fail

95	30	Pass	Fail	Pass	Fail
96	11	Fail	Fail	Fail	Fail
96	13	Pass	Pass	Fail	Pass
96	14	Pass	Pass	Fail	Pass
96	15	Pass	Pass	Fail	Pass
96	26	Pass	Pass	Pass	Pass
96	30	Pass	Fail	Pass	Fail
97	13	Pass	Pass	Fail	Pass
97	14	Pass	Pass	Fail	Pass
97	15	Pass	Pass	Pass	Pass
97	26	Pass	Pass	Pass	Pass
97	30	Pass	Fail	Pass	Fail
98	13	Pass	Pass	Fail	Pass
98	14	Pass	Pass	Pass	Pass
98	15	Pass	Pass	Pass	Pass
98	26	Pass	Pass	Pass	Pass
98	27	Pass	Pass	Pass	Pass
98	28	Pass	Pass	Pass	Pass
98	29	Pass	Pass	Pass	Pass
98	30	Pass	Fail	Pass	Fail
99	13	Pass	Pass	Pass	Pass
99	14	Pass	Pass	Pass	Pass
99	15	Pass	Pass	Pass	Pass
99	16	Pass	Fail	Fail	Fail
99	17	Fail	Fail	Fail	Fail
99	18	Fail	Fail	Fail	Fail
99	19	Fail	Fail	Fail	Fail
99	20	Fail	Fail	Fail	Fail
99	21	Fail	Fail	Fail	Fail
99	22	Fail	Fail	Fail	Fail
99	23	Fail	Fail	Fail	Fail
99	26	Pass	Fail	Pass	Fail
99	30	Pass	Fail	Pass	Fail
100	13	Pass	Pass	Pass	Pass
100	14	Pass	Pass	Pass	Pass
100	15	Pass	Pass	Pass	Pass
100	23	Pass	Fail	Fail	Fail
100	24	Pass	Fail	Fail	Fail
100	25	Pass	Fail	Fail	Fail
100	26	Pass	Pass	Pass	Pass
100	30	Pass	Fail	Pass	Fail
101	13	Pass	Pass	Pass	Pass
101	14	Pass	Pass	Pass	Pass
101	15	Pass	Pass	Pass	Pass
101	16	Pass	Fail	Fail	Fail
101	17	Pass	Fail	Fail	Fail
101	18	Pass	Fail	Fail	Fail
101	19	Fail	Fail	Fail	Fail
101	20	Fail	Fail	Fail	Fail
101	21	Fail	Fail	Fail	Fail
101	22	Pass	Fail	Fail	Fail
101	23	Pass	Fail	Fail	Fail
101	26	Pass	Pass	Pass	Pass
101	30	Pass	Pass	Pass	Pass
102	13	Pass	Pass	Pass	Pass
102	14	Pass	Pass	Pass	Pass
102	15	Pass	Pass	Pass	Pass

102	26	Pass	Pass	Pass	Pass
102	30	Pass	Pass	Pass	Pass
103	13	Pass	Pass	Pass	Pass
103	14	Pass	Pass	Pass	Pass
103	15	Pass	Pass	Pass	Pass
103	26	Pass	Pass	Pass	Pass
103	30	Pass	Pass	Pass	Pass
104	11	Fail	Fail	Fail	Fail
104	13	Pass	Pass	Pass	Pass
104	14	Pass	Pass	Pass	Pass
104	15	Pass	Pass	Pass	Pass
104	26	Pass	Pass	Pass	Pass
104	30	Pass	Pass	Pass	Pass
105	13	Pass	Pass	Pass	Pass
105	14	Pass	Pass	Pass	Pass
105	15	Pass	Pass	Pass	Pass
105	26	Pass	Pass	Pass	Pass
105	30	Pass	Fail	Pass	Fail
106	13	Pass	Pass	Pass	Pass
106	14	Pass	Pass	Pass	Pass
106	15	Pass	Pass	Pass	Pass
106	26	Pass	Pass	Pass	Pass
106	27	Pass	Fail	Pass	Fail
106	30	Pass	Pass	Pass	Pass
106	39	Pass	Fail	Pass	Fail
107	13	Pass	Pass	Pass	Pass
107	14	Pass	Pass	Pass	Pass
107	15	Pass	Pass	Pass	Pass
107	22	Pass	Pass	Pass	Pass
107	26	Pass	Pass	Pass	Pass
107	30	Pass	Pass	Pass	Pass
107	39	Pass	Pass	Pass	Pass
108	13	Pass	Pass	Pass	Pass
108	14	Pass	Pass	Pass	Pass
108	15	Pass	Pass	Pass	Pass
108	22	Pass	Pass	Pass	Pass
108	24	Fail	Fail	Fail	Fail
108	26	Pass	Pass	Pass	Pass
108	30	Pass	Pass	Pass	Pass
108	39	Pass	Fail	Pass	Fail
109	13	Pass	Pass	Pass	Pass
109	14	Pass	Pass	Pass	Pass
109	15	Pass	Pass	Pass	Pass
109	22	Pass	Fail	Pass	Fail
109	26	Pass	Pass	Pass	Pass
109	30	Pass	Fail	Pass	Fail
109	39	Pass	Pass	Pass	Pass
110	13	Pass	Pass	Pass	Pass
110	14	Pass	Pass	Pass	Pass
110	15	Pass	Pass	Pass	Pass
110	22	Pass	Pass	Pass	Pass
110	26	Pass	Pass	Pass	Pass
110	28	Fail	Fail	Fail	Fail
110	39	Pass	Fail	Pass	Fail
111	13	Pass	Pass	Pass	Pass
111	14	Pass	Pass	Pass	Pass
111	15	Pass	Pass	Pass	Pass

111	22	Pass	Pass	Pass	Pass
111	26	Pass	Pass	Pass	Pass
111	39	Pass	Fail	Pass	Fail
112	13	Pass	Pass	Pass	Pass
112	14	Pass	Pass	Pass	Pass
112	15	Pass	Pass	Pass	Pass
112	22	Pass	Fail	Pass	Fail
112	26	Pass	Pass	Pass	Pass
112	39	Pass	Fail	Pass	Fail
113	13	Pass	Pass	Pass	Pass
113	14	Pass	Pass	Pass	Pass
113	15	Pass	Pass	Pass	Pass
113	26	Pass	Pass	Pass	Pass
113	27	Pass	Fail	Pass	Fail
113	39	Pass	Pass	Pass	Pass
113	41	Fail	Fail	Fail	Fail
114	13	Pass	Pass	Pass	Pass
114	14	Pass	Pass	Pass	Pass
114	15	Pass	Pass	Pass	Pass
114	26	Pass	Pass	Pass	Pass
114	39	Pass	Pass	Pass	Pass
115	13	Pass	Pass	Pass	Pass
115	14	Pass	Pass	Pass	Pass
115	15	Pass	Pass	Pass	Pass
115	26	Pass	Pass	Pass	Pass
115	39	Pass	Pass	Pass	Pass
116	13	Pass	Pass	Pass	Pass
116	14	Pass	Pass	Pass	Pass
116	15	Pass	Pass	Pass	Pass
116	26	Pass	Fail	Pass	Fail
116	28	Fail	Fail	Fail	Fail
116	39	Pass	Pass	Pass	Pass
117	13	Pass	Pass	Pass	Pass
117	14	Pass	Pass	Pass	Pass
117	15	Pass	Pass	Pass	Pass
117	26	Pass	Fail	Pass	Fail
117	39	Pass	Pass	Pass	Pass
118	13	Pass	Pass	Pass	Pass
118	14	Pass	Pass	Pass	Pass
118	15	Pass	Pass	Pass	Pass
118	20	Pass	Fail	Pass	Fail
118	26	Pass	Pass	Pass	Pass
118	39	Pass	Pass	Pass	Pass
119	13	Pass	Pass	Pass	Pass
119	14	Pass	Pass	Pass	Pass
119	15	Pass	Pass	Pass	Pass
119	20	Pass	Pass	Pass	Pass
119	26	Pass	Fail	Pass	Fail
119	39	Pass	Pass	Pass	Pass
120	13	Pass	Pass	Pass	Pass
120	14	Pass	Pass	Pass	Pass
120	15	Pass	Fail	Pass	Fail
120	16	Pass	Fail	Pass	Fail
120	26	Pass	Fail	Pass	Fail
120	39	Pass	Pass	Pass	Pass
121	13	Pass	Pass	Pass	Pass
121	14	Pass	Pass	Pass	Pass

121	26	Pass	Fail	Pass	Fail
121	39	Pass	Pass	Pass	Pass
122	13	Pass	Pass	Pass	Pass
122	14	Pass	Pass	Pass	Pass
122	26	Pass	Fail	Pass	Fail
122	39	Pass	Pass	Pass	Pass
122	41	Fail	Fail	Fail	Fail
123	13	Pass	Pass	Pass	Pass
123	14	Pass	Pass	Pass	Pass
123	15	Pass	Fail	Pass	Fail
123	16	Pass	Pass	Pass	Pass
123	17	Pass	Pass	Pass	Pass
123	18	Pass	Pass	Pass	Pass
123	19	Pass	Pass	Pass	Pass
123	20	Pass	Pass	Pass	Pass
123	21	Pass	Pass	Pass	Pass
123	22	Pass	Pass	Pass	Pass
123	23	Pass	Pass	Pass	Pass
123	24	Pass	Pass	Pass	Pass
123	25	Pass	Pass	Pass	Pass
123	26	Pass	Pass	Pass	Pass
123	27	Pass	Pass	Pass	Pass
123	28	Pass	Pass	Pass	Pass
123	29	Pass	Pass	Pass	Pass
123	30	Pass	Fail	Pass	Fail
123	31	Pass	Fail	Pass	Fail
123	32	Pass	Fail	Pass	Fail
123	33	Pass	Fail	Pass	Fail
123	34	Pass	Pass	Pass	Pass
123	35	Pass	Pass	Pass	Pass
123	36	Pass	Pass	Pass	Pass
123	37	Pass	Pass	Pass	Pass
123	38	Pass	Fail	Pass	Fail
123	39	Pass	Fail	Pass	Fail
124	13	Pass	Pass	Pass	Pass
124	14	Pass	Pass	Pass	Pass
124	23	Pass	Pass	Pass	Pass
125	13	Pass	Pass	Pass	Pass
125	14	Pass	Pass	Pass	Pass
125	23	Pass	Pass	Pass	Pass
125	28	Fail	Fail	Fail	Fail
125	33	Fail	Fail	Fail	Fail
126	13	Pass	Pass	Pass	Pass
126	14	Pass	Pass	Pass	Pass
126	23	Pass	Pass	Pass	Pass
127	13	Pass	Pass	Pass	Pass
127	14	Pass	Pass	Pass	Pass
127	23	Pass	Pass	Pass	Pass
128	13	Pass	Pass	Pass	Pass
128	14	Pass	Pass	Pass	Pass
128	23	Pass	Pass	Pass	Pass
129	13	Pass	Pass	Pass	Pass
129	14	Pass	Pass	Pass	Pass
129	23	Pass	Pass	Pass	Pass
130	8	Pass	Fail	Pass	Fail
130	9	Pass	Fail	Pass	Fail
130	10	Pass	Fail	Pass	Fail

130	11	Pass	Fail	Pass	Fail
130	12	Pass	Fail	Pass	Fail
130	13	Pass	Fail	Pass	Fail
130	14	Pass	Pass	Pass	Pass
130	23	Pass	Pass	Pass	Pass
131	14	Pass	Pass	Pass	Pass
131	23	Pass	Pass	Pass	Pass
132	14	Pass	Pass	Pass	Pass
132	23	Pass	Pass	Pass	Pass
133	14	Pass	Pass	Pass	Pass
133	23	Pass	Pass	Pass	Pass
134	14	Pass	Pass	Pass	Pass
134	23	Pass	Fail	Pass	Fail
135	14	Pass	Pass	Pass	Pass
136	14	Pass	Pass	Pass	Pass
137	14	Pass	Pass	Pass	Pass
138	14	Pass	Pass	Pass	Pass

3. Table D.6.3 Striped Bass spawning D.O. , Salinity, and Velocity criteria passing for existing and deepening (3 ft) scenarios within the analyzed period April 1 - April 30, 1997

```
HABITAT REQUIREMENTS:
RM 10-31; Surface Layer
D.O. April (MG/L):n/a
Salinity 90th %ile <= 1 ppt
Mean Velocity >= 30 cm/s
```

Savannah Harbor Estuary

Segments J	Segments I	Baseline Scenario Salinity	Baseline Scenario Velocity	Project Scenario Salinity	Project Scenario Velocity
47	13	Fail	Pass	Fail	Pass
47	14	Fail	Pass	Fail	Pass
47	15	Fail	Pass	Fail	Pass
47	16	Fail	Pass	Fail	Pass
47	17	Fail	Fail	Fail	Fail
48	13	Fail	Pass	Fail	Pass
48	14	Fail	Pass	Fail	Pass
48	15	Fail	Pass	Fail	Pass
48	16	Fail	Pass	Fail	Pass
48	17	Fail	Pass	Fail	Pass
49	13	Fail	Pass	Fail	Pass
49	14	Fail	Pass	Fail	Pass
49	15	Fail	Pass	Fail	Pass
49	16	Fail	Pass	Fail	Pass
49	17	Fail	Pass	Fail	Pass
50	13	Fail	Pass	Fail	Pass
50	14	Fail	Pass	Fail	Pass
50	15	Fail	Pass	Fail	Pass
50	16	Fail	Pass	Fail	Pass
50	17	Fail	Pass	Fail	Pass
50	18	Fail	Fail	Fail	Fail
51	13	Fail	Pass	Fail	Pass
51	14	Fail	Pass	Fail	Pass
51	15	Fail	Pass	Fail	Pass
52	13	Fail	Pass	Fail	Pass
52	14	Fail	Pass	Fail	Pass
52	15	Fail	Pass	Fail	Pass
53	13	Fail	Pass	Fail	Pass
53	14	Fail	Pass	Fail	Pass
53	15	Fail	Pass	Fail	Pass
54	13	Fail	Pass	Fail	Pass
54	14	Fail	Pass	Fail	Pass
54	15	Fail	Pass	Fail	Pass
55	13	Fail	Pass	Fail	Pass
55	14	Fail	Pass	Fail	Pass
55	15	Fail	Pass	Fail	Pass
56	13	Fail	Pass	Fail	Pass
56	14	Fail	Pass	Fail	Pass
56	15	Fail	Pass	Fail	Pass
57	13	Fail	Pass	Fail	Pass

57	14	Fail	Pass	Fail	Pass
57	15	Fail	Pass	Fail	Pass
58	13	Fail	Pass	Fail	Pass
58	14	Fail	Pass	Fail	Pass
58	15	Fail	Pass	Fail	Pass
59	13	Fail	Pass	Fail	Pass
59	14	Fail	Pass	Fail	Pass
59	15	Fail	Pass	Fail	Pass
59	30	Fail	Pass	Fail	Pass
59	31	Fail	Pass	Fail	Pass
59	32	Fail	Fail	Fail	Fail
60	13	Fail	Pass	Fail	Pass
60	14	Fail	Pass	Fail	Pass
60	15	Fail	Pass	Fail	Pass
60	30	Fail	Fail	Fail	Fail
60	31	Fail	Pass	Fail	Pass
60	32	Fail	Fail	Fail	Fail
61	13	Fail	Pass	Fail	Pass
61	14	Fail	Pass	Fail	Pass
61	15	Fail	Pass	Fail	Pass
61	30	Fail	Fail	Fail	Fail
61	31	Fail	Pass	Fail	Pass
61	32	Fail	Fail	Fail	Fail
62	13	Fail	Pass	Fail	Pass
62	14	Fail	Pass	Fail	Pass
62	15	Fail	Pass	Fail	Pass
62	30	Fail	Fail	Fail	Fail
62	31	Fail	Pass	Fail	Pass
62	32	Fail	Fail	Fail	Fail
63	13	Fail	Pass	Fail	Pass
63	14	Fail	Pass	Fail	Pass
63	15	Fail	Pass	Fail	Pass
63	31	Fail	Pass	Fail	Pass
64	13	Fail	Pass	Fail	Pass
64	14	Fail	Pass	Fail	Pass
64	15	Fail	Pass	Fail	Pass
64	30	Fail	Fail	Fail	Fail
64	31	Fail	Pass	Fail	Pass
64	32	Fail	Fail	Fail	Fail
65	13	Fail	Pass	Fail	Pass
65	14	Fail	Pass	Fail	Pass
65	15	Fail	Pass	Fail	Pass
65	30	Fail	Pass	Fail	Pass
65	31	Fail	Pass	Fail	Pass
65	32	Fail	Pass	Fail	Pass
65	33	Fail	Fail	Fail	Fail
66	13	Fail	Pass	Fail	Pass
66	14	Fail	Pass	Fail	Pass
66	15	Fail	Pass	Fail	Pass
66	30	Fail	Pass	Fail	Pass
66	31	Fail	Pass	Fail	Pass
66	32	Fail	Pass	Fail	Pass
66	36	Fail	Pass	Fail	Pass
66	38	Fail	Fail	Fail	Fail
67	13	Fail	Pass	Fail	Pass
67	14	Fail	Pass	Fail	Pass
67	15	Fail	Pass	Fail	Pass

67	30	Fail	Pass	Fail	Pass
67	31	Fail	Pass	Fail	Pass
67	32	Fail	Pass	Fail	Pass
67	36	Fail	Fail	Fail	Fail
68	13	Fail	Pass	Fail	Pass
68	14	Fail	Pass	Fail	Pass
68	15	Fail	Pass	Fail	Pass
68	30	Fail	Pass	Fail	Pass
68	31	Fail	Pass	Fail	Pass
68	32	Fail	Pass	Fail	Pass
68	36	Fail	Fail	Fail	Fail
68	38	Fail	Fail	Fail	Fail
69	13	Fail	Pass	Fail	Pass
69	14	Fail	Pass	Fail	Pass
69	15	Fail	Pass	Fail	Pass
69	30	Fail	Pass	Fail	Pass
69	31	Fail	Pass	Fail	Pass
69	32	Fail	Fail	Fail	Fail
69	36	Fail	Fail	Fail	Fail
70	13	Fail	Pass	Fail	Pass
70	14	Fail	Pass	Fail	Pass
70	15	Fail	Pass	Fail	Pass
70	30	Fail	Pass	Fail	Pass
70	31	Fail	Pass	Fail	Pass
70	32	Fail	Fail	Fail	Fail
70	33	Fail	Fail	Fail	Fail
71	13	Fail	Pass	Fail	Pass
71	14	Fail	Pass	Fail	Pass
71	15	Fail	Pass	Fail	Pass
71	30	Fail	Pass	Fail	Pass
71	31	Fail	Pass	Fail	Pass
71	32	Fail	Fail	Fail	Fail
72	13	Fail	Pass	Fail	Pass
72	14	Fail	Pass	Fail	Pass
72	15	Fail	Pass	Fail	Pass
72	30	Fail	Pass	Fail	Pass
72	31	Fail	Pass	Fail	Pass
72	32	Fail	Fail	Fail	Fail
73	13	Fail	Pass	Fail	Pass
73	14	Fail	Pass	Fail	Pass
73	15	Fail	Pass	Fail	Pass
73	30	Fail	Fail	Fail	Fail
73	31	Fail	Pass	Fail	Pass
74	13	Fail	Pass	Fail	Pass
74	14	Fail	Pass	Fail	Pass
74	15	Fail	Pass	Fail	Pass
74	30	Fail	Fail	Fail	Fail
74	31	Fail	Pass	Fail	Pass
75	13	Fail	Pass	Fail	Pass
75	14	Fail	Pass	Fail	Pass
75	15	Fail	Pass	Fail	Pass
75	30	Fail	Pass	Fail	Pass
75	31	Fail	Pass	Fail	Pass
76	13	Fail	Pass	Fail	Pass
76	14	Fail	Pass	Fail	Pass
76	15	Fail	Fail	Fail	Fail
76	16	Fail	Fail	Fail	Fail

76	17	Fail	Fail	Fail	Fail
76	30	Fail	Fail	Fail	Pass
76	31	Fail	Pass	Fail	Pass
76	33	Fail	Fail	Fail	Fail
77	13	Fail	Fail	Fail	Fail
77	14	Fail	Pass	Fail	Pass
77	15	Fail	Fail	Fail	Fail
77	16	Fail	Fail	Fail	Fail
77	17	Fail	Fail	Fail	Fail
77	30	Fail	Fail	Fail	Fail
77	31	Fail	Fail	Fail	Fail
78	13	Fail	Fail	Fail	Pass
78	14	Fail	Pass	Fail	Pass
78	15	Fail	Fail	Fail	Fail
78	16	Fail	Fail	Fail	Fail
78	17	Fail	Fail	Fail	Fail
78	30	Fail	Fail	Fail	Fail
78	31	Fail	Fail	Fail	Fail
79	13	Fail	Pass	Fail	Pass
79	14	Fail	Pass	Fail	Pass
79	15	Fail	Pass	Fail	Pass
79	30	Fail	Pass	Fail	Pass
79	31	Fail	Fail	Fail	Fail
80	13	Fail	Pass	Fail	Pass
80	14	Fail	Pass	Fail	Pass
80	15	Fail	Pass	Fail	Pass
80	30	Fail	Pass	Fail	Pass
80	31	Fail	Fail	Fail	Fail
81	13	Fail	Pass	Fail	Pass
81	14	Fail	Pass	Fail	Pass
81	15	Fail	Pass	Fail	Pass
81	30	Fail	Pass	Fail	Pass
81	31	Fail	Fail	Fail	Fail
82	13	Fail	Pass	Fail	Pass
82	14	Fail	Pass	Fail	Pass
82	15	Fail	Pass	Fail	Pass
82	16	Fail	Fail	Fail	Fail
82	17	Fail	Fail	Fail	Fail
82	18	Fail	Pass	Fail	Pass
82	19	Fail	Fail	Fail	Fail
82	20	Fail	Fail	Fail	Fail
82	21	Fail	Fail	Fail	Fail
82	29	Fail	Fail	Fail	Fail
82	30	Fail	Pass	Fail	Pass
82	31	Fail	Fail	Fail	Fail
83	13	Fail	Pass	Fail	Pass
83	14	Fail	Pass	Fail	Pass
83	15	Fail	Pass	Fail	Pass
83	21	Fail	Pass	Fail	Pass
83	30	Fail	Fail	Fail	Fail
83	31	Fail	Fail	Fail	Fail
84	13	Fail	Pass	Fail	Pass
84	14	Fail	Pass	Fail	Pass
84	15	Fail	Pass	Fail	Pass
84	21	Fail	Pass	Fail	Pass
84	30	Fail	Fail	Fail	Fail
84	31	Fail	Fail	Fail	Fail

85	13	Fail	Pass	Fail	Pass
85	14	Fail	Pass	Fail	Pass
85	15	Fail	Pass	Fail	Pass
85	21	Fail	Pass	Fail	Pass
85	30	Fail	Fail	Fail	Fail
86	13	Fail	Pass	Fail	Pass
86	14	Fail	Pass	Fail	Pass
86	15	Fail	Pass	Fail	Pass
86	17	Fail	Fail	Fail	Fail
86	21	Pass	Pass	Fail	Pass
86	30	Fail	Pass	Fail	Pass
87	13	Fail	Pass	Fail	Pass
87	14	Fail	Pass	Fail	Pass
87	15	Fail	Pass	Fail	Pass
87	30	Fail	Pass	Fail	Pass
87	32	Fail	Fail	Fail	Fail
88	13	Fail	Pass	Fail	Pass
88	14	Fail	Pass	Fail	Pass
88	15	Fail	Pass	Fail	Pass
88	30	Fail	Fail	Fail	Fail
89	13	Fail	Pass	Fail	Pass
89	14	Fail	Pass	Fail	Pass
89	15	Fail	Pass	Fail	Pass
89	30	Pass	Fail	Fail	Fail
90	13	Fail	Pass	Fail	Pass
90	14	Fail	Pass	Fail	Pass
90	15	Fail	Pass	Fail	Pass
90	30	Pass	Fail	Fail	Fail
91	13	Fail	Pass	Fail	Pass
91	14	Fail	Pass	Fail	Pass
91	15	Fail	Pass	Fail	Pass
91	16	Fail	Fail	Fail	Fail
91	30	Pass	Fail	Pass	Fail
92	13	Fail	Pass	Fail	Pass
92	14	Fail	Pass	Fail	Pass
92	15	Fail	Pass	Fail	Pass
92	16	Fail	Pass	Fail	Fail
92	30	Pass	Fail	Pass	Fail
92	32	Fail	Fail	Fail	Fail
93	13	Pass	Pass	Fail	Pass
93	14	Fail	Pass	Fail	Pass
93	15	Fail	Pass	Fail	Pass
93	16	Fail	Pass	Fail	Pass
93	30	Pass	Fail	Pass	Fail
94	13	Pass	Pass	Fail	Pass
94	14	Fail	Pass	Fail	Pass
94	15	Fail	Pass	Fail	Pass
94	16	Fail	Fail	Fail	Fail
94	26	Pass	Pass	Fail	Pass
94	30	Pass	Fail	Pass	Fail
95	13	Pass	Pass	Fail	Pass
95	14	Pass	Pass	Fail	Pass
95	15	Pass	Pass	Fail	Pass
95	16	Fail	Fail	Fail	Fail
95	26	Pass	Pass	Fail	Pass
95	28	Fail	Fail	Fail	Fail
95	30	Pass	Fail	Pass	Fail

96	11	Fail	Fail	Fail	Fail
96	13	Pass	Pass	Fail	Pass
96	14	Pass	Pass	Fail	Pass
96	15	Pass	Pass	Fail	Pass
96	26	Pass	Pass	Pass	Pass
96	30	Pass	Fail	Pass	Fail
97	13	Pass	Pass	Fail	Pass
97	14	Pass	Pass	Pass	Pass
97	15	Pass	Pass	Pass	Pass
97	26	Pass	Pass	Pass	Pass
97	30	Pass	Fail	Pass	Fail
98	13	Pass	Pass	Fail	Pass
98	14	Pass	Pass	Pass	Pass
98	15	Pass	Pass	Pass	Pass
98	26	Pass	Pass	Pass	Pass
98	27	Pass	Pass	Pass	Pass
98	28	Pass	Pass	Pass	Pass
98	29	Pass	Pass	Pass	Pass
98	30	Pass	Fail	Pass	Fail
99	13	Pass	Pass	Pass	Pass
99	14	Pass	Pass	Pass	Pass
99	15	Pass	Pass	Pass	Pass
99	16	Pass	Fail	Fail	Fail
99	17	Fail	Fail	Fail	Fail
99	18	Fail	Fail	Fail	Fail
99	19	Fail	Fail	Fail	Fail
99	20	Fail	Fail	Fail	Fail
99	21	Fail	Fail	Fail	Fail
99	22	Fail	Fail	Fail	Fail
99	23	Fail	Fail	Fail	Fail
99	26	Pass	Fail	Pass	Fail
99	30	Pass	Fail	Pass	Fail
100	13	Pass	Pass	Pass	Pass
100	14	Pass	Pass	Pass	Pass
100	15	Pass	Pass	Pass	Pass
100	23	Pass	Fail	Fail	Fail
100	24	Pass	Fail	Pass	Fail
100	25	Pass	Fail	Pass	Fail
100	26	Pass	Pass	Pass	Pass
100	30	Pass	Fail	Pass	Fail
101	13	Pass	Pass	Pass	Pass
101	14	Pass	Pass	Pass	Pass
101	15	Pass	Pass	Pass	Pass
101	16	Pass	Fail	Fail	Fail
101	17	Pass	Fail	Fail	Fail
101	18	Pass	Fail	Fail	Fail
101	19	Fail	Fail	Fail	Fail
101	20	Fail	Fail	Fail	Fail
101	21	Fail	Fail	Fail	Fail
101	22	Pass	Fail	Fail	Fail
101	23	Pass	Fail	Fail	Fail
101	26	Pass	Pass	Pass	Pass
101	30	Pass	Pass	Pass	Pass
102	13	Pass	Pass	Pass	Pass
102	14	Pass	Pass	Pass	Pass
102	15	Pass	Pass	Pass	Pass
102	26	Pass	Pass	Pass	Pass

102	30	Pass	Pass	Pass	Pass
103	13	Pass	Pass	Pass	Pass
103	14	Pass	Pass	Pass	Pass
103	15	Pass	Pass	Pass	Pass
103	26	Pass	Pass	Pass	Pass
103	30	Pass	Pass	Pass	Pass
104	11	Fail	Fail	Fail	Fail
104	13	Pass	Pass	Pass	Pass
104	14	Pass	Pass	Pass	Pass
104	15	Pass	Pass	Pass	Pass
104	26	Pass	Pass	Pass	Pass
104	30	Pass	Pass	Pass	Pass
105	13	Pass	Pass	Pass	Pass
105	14	Pass	Pass	Pass	Pass
105	15	Pass	Pass	Pass	Pass
105	26	Pass	Pass	Pass	Pass
105	30	Pass	Fail	Pass	Fail
106	13	Pass	Pass	Pass	Pass
106	14	Pass	Pass	Pass	Pass
106	15	Pass	Pass	Pass	Pass
106	26	Pass	Pass	Pass	Pass
106	27	Pass	Fail	Pass	Fail
106	30	Pass	Pass	Pass	Pass
106	39	Pass	Fail	Pass	Fail
107	13	Pass	Pass	Pass	Pass
107	14	Pass	Pass	Pass	Pass
107	15	Pass	Pass	Pass	Pass
107	22	Pass	Pass	Pass	Pass
107	26	Pass	Pass	Pass	Pass
107	30	Pass	Pass	Pass	Pass
107	39	Pass	Pass	Pass	Pass
108	13	Pass	Pass	Pass	Pass
108	14	Pass	Pass	Pass	Pass
108	15	Pass	Pass	Pass	Pass
108	22	Pass	Pass	Pass	Pass
108	24	Fail	Fail	Fail	Fail
108	26	Pass	Pass	Pass	Pass
108	30	Pass	Pass	Pass	Pass
108	39	Pass	Fail	Pass	Fail
109	13	Pass	Pass	Pass	Pass
109	14	Pass	Pass	Pass	Pass
109	15	Pass	Pass	Pass	Pass
109	22	Pass	Fail	Pass	Fail
109	26	Pass	Pass	Pass	Pass
109	30	Pass	Fail	Pass	Fail
109	39	Pass	Pass	Pass	Pass
110	13	Pass	Pass	Pass	Pass
110	14	Pass	Pass	Pass	Pass
110	15	Pass	Pass	Pass	Pass
110	22	Pass	Pass	Pass	Pass
110	26	Pass	Pass	Pass	Pass
110	28	Fail	Fail	Fail	Fail
110	39	Pass	Fail	Pass	Fail
111	13	Pass	Pass	Pass	Pass
111	14	Pass	Pass	Pass	Pass
111	15	Pass	Pass	Pass	Pass
111	22	Pass	Pass	Pass	Pass

111	26	Pass	Pass	Pass	Pass
111	39	Pass	Fail	Pass	Fail
112	13	Pass	Pass	Pass	Pass
112	14	Pass	Pass	Pass	Pass
112	15	Pass	Pass	Pass	Pass
112	22	Pass	Fail	Pass	Fail
112	26	Pass	Pass	Pass	Pass
112	39	Pass	Fail	Pass	Fail
113	13	Pass	Pass	Pass	Pass
113	14	Pass	Pass	Pass	Pass
113	15	Pass	Pass	Pass	Pass
113	26	Pass	Pass	Pass	Pass
113	27	Pass	Fail	Pass	Fail
113	39	Pass	Pass	Pass	Pass
113	41	Fail	Fail	Fail	Fail
114	13	Pass	Pass	Pass	Pass
114	14	Pass	Pass	Pass	Pass
114	15	Pass	Pass	Pass	Pass
114	26	Pass	Pass	Pass	Pass
114	39	Pass	Pass	Pass	Pass
115	13	Pass	Pass	Pass	Pass
115	14	Pass	Pass	Pass	Pass
115	15	Pass	Pass	Pass	Pass
115	26	Pass	Pass	Pass	Pass
115	39	Pass	Pass	Pass	Pass
116	13	Pass	Pass	Pass	Pass
116	14	Pass	Pass	Pass	Pass
116	15	Pass	Pass	Pass	Pass
116	26	Pass	Fail	Pass	Fail
116	28	Fail	Fail	Fail	Fail
116	39	Pass	Pass	Pass	Pass
117	13	Pass	Pass	Pass	Pass
117	14	Pass	Pass	Pass	Pass
117	15	Pass	Pass	Pass	Pass
117	26	Pass	Fail	Pass	Fail
117	39	Pass	Pass	Pass	Pass
118	13	Pass	Pass	Pass	Pass
118	14	Pass	Pass	Pass	Pass
118	15	Pass	Pass	Pass	Pass
118	20	Pass	Fail	Pass	Fail
118	26	Pass	Pass	Pass	Pass
118	39	Pass	Pass	Pass	Pass
119	13	Pass	Pass	Pass	Pass
119	14	Pass	Pass	Pass	Pass
119	15	Pass	Pass	Pass	Pass
119	20	Pass	Pass	Pass	Pass
119	26	Pass	Fail	Pass	Fail
119	39	Pass	Pass	Pass	Pass
120	13	Pass	Pass	Pass	Pass
120	14	Pass	Pass	Pass	Pass
120	15	Pass	Fail	Pass	Fail
120	16	Pass	Fail	Pass	Fail
120	26	Pass	Fail	Pass	Fail
120	39	Pass	Pass	Pass	Pass
121	13	Pass	Pass	Pass	Pass
121	14	Pass	Pass	Pass	Pass
121	26	Pass	Fail	Pass	Fail

121	39	Pass	Pass	Pass	Pass
122	13	Pass	Pass	Pass	Pass
122	14	Pass	Pass	Pass	Pass
122	26	Pass	Fail	Pass	Fail
122	39	Pass	Pass	Pass	Pass
122	41	Fail	Fail	Fail	Fail
123	13	Pass	Pass	Pass	Pass
123	14	Pass	Pass	Pass	Pass
123	15	Pass	Fail	Pass	Fail
123	16	Pass	Pass	Pass	Pass
123	17	Pass	Pass	Pass	Pass
123	18	Pass	Pass	Pass	Pass
123	19	Pass	Pass	Pass	Pass
123	20	Pass	Pass	Pass	Pass
123	21	Pass	Pass	Pass	Pass
123	22	Pass	Pass	Pass	Pass
123	23	Pass	Pass	Pass	Pass
123	24	Pass	Pass	Pass	Pass
123	25	Pass	Pass	Pass	Pass
123	26	Pass	Pass	Pass	Pass
123	27	Pass	Pass	Pass	Pass
123	28	Pass	Pass	Pass	Pass
123	29	Pass	Pass	Pass	Pass
123	30	Pass	Fail	Pass	Fail
123	31	Pass	Fail	Pass	Fail
123	32	Pass	Fail	Pass	Fail
123	33	Pass	Fail	Pass	Fail
123	34	Pass	Pass	Pass	Pass
123	35	Pass	Pass	Pass	Pass
123	36	Pass	Pass	Pass	Pass
123	37	Pass	Pass	Pass	Pass
123	38	Pass	Fail	Pass	Fail
123	39	Pass	Fail	Pass	Fail
124	13	Pass	Pass	Pass	Pass
124	14	Pass	Pass	Pass	Pass
124	23	Pass	Pass	Pass	Pass
125	13	Pass	Pass	Pass	Pass
125	14	Pass	Pass	Pass	Pass
125	23	Pass	Pass	Pass	Pass
125	28	Fail	Fail	Fail	Fail
125	33	Fail	Fail	Fail	Fail
126	13	Pass	Pass	Pass	Pass
126	14	Pass	Pass	Pass	Pass
126	23	Pass	Pass	Pass	Pass
127	13	Pass	Pass	Pass	Pass
127	14	Pass	Pass	Pass	Pass
127	23	Pass	Pass	Pass	Pass
128	13	Pass	Pass	Pass	Pass
128	14	Pass	Pass	Pass	Pass
128	23	Pass	Pass	Pass	Pass
129	13	Pass	Pass	Pass	Pass
129	14	Pass	Pass	Pass	Pass
129	23	Pass	Pass	Pass	Pass
130	8	Pass	Fail	Pass	Fail
130	9	Pass	Fail	Pass	Fail
130	10	Pass	Fail	Pass	Fail
130	11	Pass	Fail	Pass	Fail

130	12	Pass	Fail	Pass	Fail
130	13	Pass	Fail	Pass	Fail
130	14	Pass	Pass	Pass	Pass
130	23	Pass	Pass	Pass	Pass
131	14	Pass	Pass	Pass	Pass
131	23	Pass	Pass	Pass	Pass
132	14	Pass	Pass	Pass	Pass
132	23	Pass	Pass	Pass	Pass
133	14	Pass	Pass	Pass	Pass
133	23	Pass	Pass	Pass	Pass
134	14	Pass	Pass	Pass	Pass
134	23	Pass	Fail	Pass	Fail
135	14	Pass	Pass	Pass	Pass
136	14	Pass	Pass	Pass	Pass
137	14	Pass	Pass	Pass	Pass
138	14	Pass	Pass	Pass	Pass

4. Table D.6.4 Striped Bass spawning D.O. , Salinity, and Velocity criteria passing for existing and deepening (2 ft) scenarios within the analyzed period April 1 - April 30, 1997

HABITAT REQUIREMENTS:
RM 10-31; Surface Layer
D.O. April (MG/L):n/a
Salinity 90th %ile <= 1 ppt
Mean Velocity >= 30 cm/s

Savannah Harbor Estuary

Segments		Baseline Scenario		Project Scenario	
J	I	Salinity	Velocity	Salinity	Velocity
47	13	Fail	Pass	Fail	Pass
47	14	Fail	Pass	Fail	Pass
47	15	Fail	Pass	Fail	Pass
47	16	Fail	Pass	Fail	Pass
47	17	Fail	Fail	Fail	Fail
48	13	Fail	Pass	Fail	Pass
48	14	Fail	Pass	Fail	Pass
48	15	Fail	Pass	Fail	Pass
48	16	Fail	Pass	Fail	Pass
48	17	Fail	Pass	Fail	Pass
49	13	Fail	Pass	Fail	Pass
49	14	Fail	Pass	Fail	Pass
49	15	Fail	Pass	Fail	Pass
49	16	Fail	Pass	Fail	Pass
49	17	Fail	Pass	Fail	Pass
50	13	Fail	Pass	Fail	Pass
50	14	Fail	Pass	Fail	Pass
50	15	Fail	Pass	Fail	Pass
50	16	Fail	Pass	Fail	Pass
50	17	Fail	Pass	Fail	Pass
50	18	Fail	Fail	Fail	Fail
51	13	Fail	Pass	Fail	Pass
51	14	Fail	Pass	Fail	Pass
51	15	Fail	Pass	Fail	Pass
52	13	Fail	Pass	Fail	Pass
52	14	Fail	Pass	Fail	Pass
52	15	Fail	Pass	Fail	Pass
53	13	Fail	Pass	Fail	Pass
53	14	Fail	Pass	Fail	Pass
53	15	Fail	Pass	Fail	Pass
54	13	Fail	Pass	Fail	Pass
54	14	Fail	Pass	Fail	Pass
54	15	Fail	Pass	Fail	Pass
55	13	Fail	Pass	Fail	Pass
55	14	Fail	Pass	Fail	Pass
55	15	Fail	Pass	Fail	Pass
56	13	Fail	Pass	Fail	Pass
56	14	Fail	Pass	Fail	Pass
56	15	Fail	Pass	Fail	Pass

57	13	Fail	Pass	Fail	Pass
57	14	Fail	Pass	Fail	Pass
57	15	Fail	Pass	Fail	Pass
58	13	Fail	Pass	Fail	Pass
58	14	Fail	Pass	Fail	Pass
58	15	Fail	Pass	Fail	Pass
59	13	Fail	Pass	Fail	Pass
59	14	Fail	Pass	Fail	Pass
59	15	Fail	Pass	Fail	Pass
59	30	Fail	Pass	Fail	Pass
59	31	Fail	Pass	Fail	Pass
59	32	Fail	Fail	Fail	Fail
60	13	Fail	Pass	Fail	Pass
60	14	Fail	Pass	Fail	Pass
60	15	Fail	Pass	Fail	Pass
60	30	Fail	Fail	Fail	Fail
60	31	Fail	Pass	Fail	Pass
60	32	Fail	Fail	Fail	Fail
61	13	Fail	Pass	Fail	Pass
61	14	Fail	Pass	Fail	Pass
61	15	Fail	Pass	Fail	Pass
61	30	Fail	Fail	Fail	Fail
61	31	Fail	Pass	Fail	Pass
61	32	Fail	Fail	Fail	Fail
62	13	Fail	Pass	Fail	Pass
62	14	Fail	Pass	Fail	Pass
62	15	Fail	Pass	Fail	Pass
62	30	Fail	Fail	Fail	Fail
62	31	Fail	Pass	Fail	Pass
62	32	Fail	Fail	Fail	Fail
63	13	Fail	Pass	Fail	Pass
63	14	Fail	Pass	Fail	Pass
63	15	Fail	Pass	Fail	Pass
63	31	Fail	Pass	Fail	Pass
64	13	Fail	Pass	Fail	Pass
64	14	Fail	Pass	Fail	Pass
64	15	Fail	Pass	Fail	Pass
64	30	Fail	Fail	Fail	Fail
64	31	Fail	Pass	Fail	Pass
64	32	Fail	Fail	Fail	Fail
65	13	Fail	Pass	Fail	Pass
65	14	Fail	Pass	Fail	Pass
65	15	Fail	Pass	Fail	Pass
65	30	Fail	Pass	Fail	Pass
65	31	Fail	Pass	Fail	Pass
65	32	Fail	Pass	Fail	Pass
65	33	Fail	Fail	Fail	Fail
66	13	Fail	Pass	Fail	Pass
66	14	Fail	Pass	Fail	Pass
66	15	Fail	Pass	Fail	Pass
66	30	Fail	Pass	Fail	Pass
66	31	Fail	Pass	Fail	Pass
66	32	Fail	Pass	Fail	Pass
66	36	Fail	Pass	Fail	Pass
66	38	Fail	Fail	Fail	Fail
67	13	Fail	Pass	Fail	Pass
67	14	Fail	Pass	Fail	Pass

67	15	Fail	Pass	Fail	Pass
67	30	Fail	Pass	Fail	Pass
67	31	Fail	Pass	Fail	Pass
67	32	Fail	Pass	Fail	Pass
67	36	Fail	Fail	Fail	Fail
68	13	Fail	Pass	Fail	Pass
68	14	Fail	Pass	Fail	Pass
68	15	Fail	Pass	Fail	Pass
68	30	Fail	Pass	Fail	Pass
68	31	Fail	Pass	Fail	Pass
68	32	Fail	Pass	Fail	Pass
68	36	Fail	Fail	Fail	Fail
68	38	Fail	Fail	Fail	Fail
69	13	Fail	Pass	Fail	Pass
69	14	Fail	Pass	Fail	Pass
69	15	Fail	Pass	Fail	Pass
69	30	Fail	Pass	Fail	Pass
69	31	Fail	Pass	Fail	Pass
69	32	Fail	Fail	Fail	Fail
69	36	Fail	Fail	Fail	Fail
70	13	Fail	Pass	Fail	Pass
70	14	Fail	Pass	Fail	Pass
70	15	Fail	Pass	Fail	Pass
70	30	Fail	Pass	Fail	Pass
70	31	Fail	Pass	Fail	Pass
70	32	Fail	Fail	Fail	Fail
70	33	Fail	Fail	Fail	Fail
71	13	Fail	Pass	Fail	Pass
71	14	Fail	Pass	Fail	Pass
71	15	Fail	Pass	Fail	Pass
71	30	Fail	Pass	Fail	Pass
71	31	Fail	Pass	Fail	Pass
71	32	Fail	Fail	Fail	Fail
72	13	Fail	Pass	Fail	Pass
72	14	Fail	Pass	Fail	Pass
72	15	Fail	Pass	Fail	Pass
72	30	Fail	Pass	Fail	Pass
72	31	Fail	Pass	Fail	Pass
72	32	Fail	Fail	Fail	Fail
73	13	Fail	Pass	Fail	Pass
73	14	Fail	Pass	Fail	Pass
73	15	Fail	Pass	Fail	Pass
73	30	Fail	Fail	Fail	Fail
73	31	Fail	Pass	Fail	Pass
74	13	Fail	Pass	Fail	Pass
74	14	Fail	Pass	Fail	Pass
74	15	Fail	Pass	Fail	Pass
74	30	Fail	Fail	Fail	Fail
74	31	Fail	Pass	Fail	Pass
75	13	Fail	Pass	Fail	Pass
75	14	Fail	Pass	Fail	Pass
75	15	Fail	Pass	Fail	Pass
75	30	Fail	Pass	Fail	Pass
75	31	Fail	Pass	Fail	Pass
76	13	Fail	Pass	Fail	Pass
76	14	Fail	Pass	Fail	Pass
76	15	Fail	Fail	Fail	Fail

76	16	Fail	Fail	Fail	Fail
76	17	Fail	Fail	Fail	Fail
76	30	Fail	Fail	Fail	Pass
76	31	Fail	Pass	Fail	Pass
76	33	Fail	Fail	Fail	Fail
77	13	Fail	Fail	Fail	Fail
77	14	Fail	Pass	Fail	Pass
77	15	Fail	Fail	Fail	Fail
77	16	Fail	Fail	Fail	Fail
77	17	Fail	Fail	Fail	Fail
77	30	Fail	Fail	Fail	Fail
77	31	Fail	Fail	Fail	Fail
78	13	Fail	Fail	Fail	Pass
78	14	Fail	Pass	Fail	Pass
78	15	Fail	Fail	Fail	Fail
78	16	Fail	Fail	Fail	Fail
78	17	Fail	Fail	Fail	Fail
78	30	Fail	Fail	Fail	Fail
78	31	Fail	Fail	Fail	Fail
79	13	Fail	Pass	Fail	Pass
79	14	Fail	Pass	Fail	Pass
79	15	Fail	Pass	Fail	Pass
79	30	Fail	Pass	Fail	Pass
79	31	Fail	Fail	Fail	Fail
80	13	Fail	Pass	Fail	Pass
80	14	Fail	Pass	Fail	Pass
80	15	Fail	Pass	Fail	Pass
80	30	Fail	Pass	Fail	Pass
80	31	Fail	Fail	Fail	Fail
81	13	Fail	Pass	Fail	Pass
81	14	Fail	Pass	Fail	Pass
81	15	Fail	Pass	Fail	Pass
81	30	Fail	Pass	Fail	Pass
81	31	Fail	Fail	Fail	Fail
82	13	Fail	Pass	Fail	Pass
82	14	Fail	Pass	Fail	Pass
82	15	Fail	Pass	Fail	Pass
82	16	Fail	Fail	Fail	Fail
82	17	Fail	Fail	Fail	Fail
82	18	Fail	Pass	Fail	Pass
82	19	Fail	Fail	Fail	Fail
82	20	Fail	Fail	Fail	Fail
82	21	Fail	Fail	Fail	Fail
82	29	Fail	Fail	Fail	Fail
82	30	Fail	Pass	Fail	Pass
82	31	Fail	Fail	Fail	Fail
83	13	Fail	Pass	Fail	Pass
83	14	Fail	Pass	Fail	Pass
83	15	Fail	Pass	Fail	Pass
83	21	Fail	Pass	Fail	Pass
83	30	Fail	Fail	Fail	Fail
83	31	Fail	Fail	Fail	Fail
84	13	Fail	Pass	Fail	Pass
84	14	Fail	Pass	Fail	Pass
84	15	Fail	Pass	Fail	Pass
84	21	Fail	Pass	Fail	Pass
84	30	Fail	Fail	Fail	Fail

84	31	Fail	Fail	Fail	Fail
85	13	Fail	Pass	Fail	Pass
85	14	Fail	Pass	Fail	Pass
85	15	Fail	Pass	Fail	Pass
85	21	Fail	Pass	Fail	Pass
85	30	Fail	Fail	Fail	Fail
86	13	Fail	Pass	Fail	Pass
86	14	Fail	Pass	Fail	Pass
86	15	Fail	Pass	Fail	Pass
86	17	Fail	Fail	Fail	Fail
86	21	Pass	Pass	Fail	Pass
86	30	Fail	Pass	Fail	Pass
87	13	Fail	Pass	Fail	Pass
87	14	Fail	Pass	Fail	Pass
87	15	Fail	Pass	Fail	Pass
87	30	Fail	Pass	Fail	Pass
87	32	Fail	Fail	Fail	Fail
88	13	Fail	Pass	Fail	Pass
88	14	Fail	Pass	Fail	Pass
88	15	Fail	Pass	Fail	Pass
88	30	Fail	Fail	Fail	Fail
89	13	Fail	Pass	Fail	Pass
89	14	Fail	Pass	Fail	Pass
89	15	Fail	Pass	Fail	Pass
89	30	Pass	Fail	Fail	Fail
90	13	Fail	Pass	Fail	Pass
90	14	Fail	Pass	Fail	Pass
90	15	Fail	Pass	Fail	Pass
90	30	Pass	Fail	Pass	Fail
91	13	Fail	Pass	Fail	Pass
91	14	Fail	Pass	Fail	Pass
91	15	Fail	Pass	Fail	Pass
91	16	Fail	Fail	Fail	Fail
91	30	Pass	Fail	Pass	Fail
92	13	Fail	Pass	Fail	Pass
92	14	Fail	Pass	Fail	Pass
92	15	Fail	Pass	Fail	Pass
92	16	Fail	Pass	Fail	Fail
92	30	Pass	Fail	Pass	Fail
92	32	Fail	Fail	Fail	Fail
93	13	Pass	Pass	Fail	Pass
93	14	Fail	Pass	Fail	Pass
93	15	Fail	Pass	Fail	Pass
93	16	Fail	Pass	Fail	Pass
93	30	Pass	Fail	Pass	Fail
94	13	Pass	Pass	Fail	Pass
94	14	Fail	Pass	Fail	Pass
94	15	Fail	Pass	Fail	Pass
94	16	Fail	Fail	Fail	Fail
94	26	Pass	Pass	Fail	Pass
94	30	Pass	Fail	Pass	Fail
95	13	Pass	Pass	Pass	Pass
95	14	Pass	Pass	Fail	Pass
95	15	Pass	Pass	Fail	Pass
95	16	Fail	Fail	Fail	Fail
95	26	Pass	Pass	Pass	Pass
95	28	Fail	Fail	Fail	Fail

95	30	Pass	Fail	Pass	Fail
96	11	Fail	Fail	Fail	Fail
96	13	Pass	Pass	Fail	Pass
96	14	Pass	Pass	Fail	Pass
96	15	Pass	Pass	Fail	Pass
96	26	Pass	Pass	Pass	Pass
96	30	Pass	Fail	Pass	Fail
97	13	Pass	Pass	Pass	Pass
97	14	Pass	Pass	Pass	Pass
97	15	Pass	Pass	Pass	Pass
97	26	Pass	Pass	Pass	Pass
97	30	Pass	Fail	Pass	Fail
98	13	Pass	Pass	Pass	Pass
98	14	Pass	Pass	Pass	Pass
98	15	Pass	Pass	Pass	Pass
98	26	Pass	Pass	Pass	Pass
98	27	Pass	Pass	Pass	Pass
98	28	Pass	Pass	Pass	Pass
98	29	Pass	Pass	Pass	Pass
98	30	Pass	Fail	Pass	Fail
99	13	Pass	Pass	Pass	Pass
99	14	Pass	Pass	Pass	Pass
99	15	Pass	Pass	Pass	Pass
99	16	Pass	Fail	Fail	Fail
99	17	Fail	Fail	Fail	Fail
99	18	Fail	Fail	Fail	Fail
99	19	Fail	Fail	Fail	Fail
99	20	Fail	Fail	Fail	Fail
99	21	Fail	Fail	Fail	Fail
99	22	Fail	Fail	Fail	Fail
99	23	Fail	Fail	Fail	Fail
99	26	Pass	Fail	Pass	Fail
99	30	Pass	Fail	Pass	Fail
100	13	Pass	Pass	Pass	Pass
100	14	Pass	Pass	Pass	Pass
100	15	Pass	Pass	Pass	Pass
100	23	Pass	Fail	Pass	Fail
100	24	Pass	Fail	Pass	Fail
100	25	Pass	Fail	Pass	Fail
100	26	Pass	Pass	Pass	Pass
100	30	Pass	Fail	Pass	Fail
101	13	Pass	Pass	Pass	Pass
101	14	Pass	Pass	Pass	Pass
101	15	Pass	Pass	Pass	Pass
101	16	Pass	Fail	Fail	Fail
101	17	Pass	Fail	Fail	Fail
101	18	Pass	Fail	Fail	Fail
101	19	Fail	Fail	Fail	Fail
101	20	Fail	Fail	Fail	Fail
101	21	Fail	Fail	Fail	Fail
101	22	Pass	Fail	Fail	Fail
101	23	Pass	Fail	Fail	Fail
101	26	Pass	Pass	Pass	Pass
101	30	Pass	Pass	Pass	Pass
102	13	Pass	Pass	Pass	Pass
102	14	Pass	Pass	Pass	Pass
102	15	Pass	Pass	Pass	Pass

102	26	Pass	Pass	Pass	Pass
102	30	Pass	Pass	Pass	Pass
103	13	Pass	Pass	Pass	Pass
103	14	Pass	Pass	Pass	Pass
103	15	Pass	Pass	Pass	Pass
103	26	Pass	Pass	Pass	Pass
103	30	Pass	Pass	Pass	Pass
104	11	Fail	Fail	Fail	Fail
104	13	Pass	Pass	Pass	Pass
104	14	Pass	Pass	Pass	Pass
104	15	Pass	Pass	Pass	Pass
104	26	Pass	Pass	Pass	Pass
104	30	Pass	Pass	Pass	Pass
105	13	Pass	Pass	Pass	Pass
105	14	Pass	Pass	Pass	Pass
105	15	Pass	Pass	Pass	Pass
105	26	Pass	Pass	Pass	Pass
105	30	Pass	Fail	Pass	Fail
106	13	Pass	Pass	Pass	Pass
106	14	Pass	Pass	Pass	Pass
106	15	Pass	Pass	Pass	Pass
106	26	Pass	Pass	Pass	Pass
106	27	Pass	Fail	Pass	Fail
106	30	Pass	Pass	Pass	Pass
106	39	Pass	Fail	Pass	Fail
107	13	Pass	Pass	Pass	Pass
107	14	Pass	Pass	Pass	Pass
107	15	Pass	Pass	Pass	Pass
107	22	Pass	Pass	Pass	Pass
107	26	Pass	Pass	Pass	Pass
107	30	Pass	Pass	Pass	Pass
107	39	Pass	Pass	Pass	Pass
108	13	Pass	Pass	Pass	Pass
108	14	Pass	Pass	Pass	Pass
108	15	Pass	Pass	Pass	Pass
108	22	Pass	Pass	Pass	Pass
108	24	Fail	Fail	Fail	Fail
108	26	Pass	Pass	Pass	Pass
108	30	Pass	Pass	Pass	Pass
108	39	Pass	Fail	Pass	Fail
109	13	Pass	Pass	Pass	Pass
109	14	Pass	Pass	Pass	Pass
109	15	Pass	Pass	Pass	Pass
109	22	Pass	Fail	Pass	Fail
109	26	Pass	Pass	Pass	Pass
109	30	Pass	Fail	Pass	Fail
109	39	Pass	Pass	Pass	Pass
110	13	Pass	Pass	Pass	Pass
110	14	Pass	Pass	Pass	Pass
110	15	Pass	Pass	Pass	Pass
110	22	Pass	Pass	Pass	Pass
110	26	Pass	Pass	Pass	Pass
110	28	Fail	Fail	Fail	Fail
110	39	Pass	Fail	Pass	Fail
111	13	Pass	Pass	Pass	Pass
111	14	Pass	Pass	Pass	Pass
111	15	Pass	Pass	Pass	Pass

111	22	Pass	Pass	Pass	Pass
111	26	Pass	Pass	Pass	Pass
111	39	Pass	Fail	Pass	Fail
112	13	Pass	Pass	Pass	Pass
112	14	Pass	Pass	Pass	Pass
112	15	Pass	Pass	Pass	Pass
112	22	Pass	Fail	Pass	Fail
112	26	Pass	Pass	Pass	Pass
112	39	Pass	Fail	Pass	Fail
113	13	Pass	Pass	Pass	Pass
113	14	Pass	Pass	Pass	Pass
113	15	Pass	Pass	Pass	Pass
113	26	Pass	Pass	Pass	Pass
113	27	Pass	Fail	Pass	Fail
113	39	Pass	Pass	Pass	Pass
113	41	Fail	Fail	Fail	Fail
114	13	Pass	Pass	Pass	Pass
114	14	Pass	Pass	Pass	Pass
114	15	Pass	Pass	Pass	Pass
114	26	Pass	Pass	Pass	Pass
114	39	Pass	Pass	Pass	Pass
115	13	Pass	Pass	Pass	Pass
115	14	Pass	Pass	Pass	Pass
115	15	Pass	Pass	Pass	Pass
115	26	Pass	Pass	Pass	Pass
115	39	Pass	Pass	Pass	Pass
116	13	Pass	Pass	Pass	Pass
116	14	Pass	Pass	Pass	Pass
116	15	Pass	Pass	Pass	Pass
116	26	Pass	Fail	Pass	Fail
116	28	Fail	Fail	Fail	Fail
116	39	Pass	Pass	Pass	Pass
117	13	Pass	Pass	Pass	Pass
117	14	Pass	Pass	Pass	Pass
117	15	Pass	Pass	Pass	Pass
117	26	Pass	Fail	Pass	Fail
117	39	Pass	Pass	Pass	Pass
118	13	Pass	Pass	Pass	Pass
118	14	Pass	Pass	Pass	Pass
118	15	Pass	Pass	Pass	Pass
118	20	Pass	Fail	Pass	Fail
118	26	Pass	Pass	Pass	Pass
118	39	Pass	Pass	Pass	Pass
119	13	Pass	Pass	Pass	Pass
119	14	Pass	Pass	Pass	Pass
119	15	Pass	Pass	Pass	Pass
119	20	Pass	Pass	Pass	Pass
119	26	Pass	Fail	Pass	Fail
119	39	Pass	Pass	Pass	Pass
120	13	Pass	Pass	Pass	Pass
120	14	Pass	Pass	Pass	Pass
120	15	Pass	Fail	Pass	Fail
120	16	Pass	Fail	Pass	Fail
120	26	Pass	Fail	Pass	Fail
120	39	Pass	Pass	Pass	Pass
121	13	Pass	Pass	Pass	Pass
121	14	Pass	Pass	Pass	Pass

121	26	Pass	Fail	Pass	Fail
121	39	Pass	Pass	Pass	Pass
122	13	Pass	Pass	Pass	Pass
122	14	Pass	Pass	Pass	Pass
122	26	Pass	Fail	Pass	Fail
122	39	Pass	Pass	Pass	Pass
122	41	Fail	Fail	Fail	Fail
123	13	Pass	Pass	Pass	Pass
123	14	Pass	Pass	Pass	Pass
123	15	Pass	Fail	Pass	Fail
123	16	Pass	Pass	Pass	Pass
123	17	Pass	Pass	Pass	Pass
123	18	Pass	Pass	Pass	Pass
123	19	Pass	Pass	Pass	Pass
123	20	Pass	Pass	Pass	Pass
123	21	Pass	Pass	Pass	Pass
123	22	Pass	Pass	Pass	Pass
123	23	Pass	Pass	Pass	Pass
123	24	Pass	Pass	Pass	Pass
123	25	Pass	Pass	Pass	Pass
123	26	Pass	Pass	Pass	Pass
123	27	Pass	Pass	Pass	Pass
123	28	Pass	Pass	Pass	Pass
123	29	Pass	Pass	Pass	Pass
123	30	Pass	Fail	Pass	Fail
123	31	Pass	Fail	Pass	Fail
123	32	Pass	Fail	Pass	Fail
123	33	Pass	Fail	Pass	Fail
123	34	Pass	Pass	Pass	Pass
123	35	Pass	Pass	Pass	Pass
123	36	Pass	Pass	Pass	Pass
123	37	Pass	Pass	Pass	Pass
123	38	Pass	Fail	Pass	Fail
123	39	Pass	Fail	Pass	Fail
124	13	Pass	Pass	Pass	Pass
124	14	Pass	Pass	Pass	Pass
124	23	Pass	Pass	Pass	Pass
125	13	Pass	Pass	Pass	Pass
125	14	Pass	Pass	Pass	Pass
125	23	Pass	Pass	Pass	Pass
125	28	Fail	Fail	Fail	Fail
125	33	Fail	Fail	Fail	Fail
126	13	Pass	Pass	Pass	Pass
126	14	Pass	Pass	Pass	Pass
126	23	Pass	Pass	Pass	Pass
127	13	Pass	Pass	Pass	Pass
127	14	Pass	Pass	Pass	Pass
127	23	Pass	Pass	Pass	Pass
128	13	Pass	Pass	Pass	Pass
128	14	Pass	Pass	Pass	Pass
128	23	Pass	Pass	Pass	Pass
129	13	Pass	Pass	Pass	Pass
129	14	Pass	Pass	Pass	Pass
129	23	Pass	Pass	Pass	Pass
130	8	Pass	Fail	Pass	Fail
130	9	Pass	Fail	Pass	Fail
130	10	Pass	Fail	Pass	Fail

130	11	Pass	Fail	Pass	Fail
130	12	Pass	Fail	Pass	Fail
130	13	Pass	Fail	Pass	Fail
130	14	Pass	Pass	Pass	Pass
130	23	Pass	Pass	Pass	Pass
131	14	Pass	Pass	Pass	Pass
131	23	Pass	Pass	Pass	Pass
132	14	Pass	Pass	Pass	Pass
132	23	Pass	Pass	Pass	Pass
133	14	Pass	Pass	Pass	Pass
133	23	Pass	Pass	Pass	Pass
134	14	Pass	Pass	Pass	Pass
134	23	Pass	Fail	Pass	Fail
135	14	Pass	Pass	Pass	Pass
136	14	Pass	Pass	Pass	Pass
137	14	Pass	Pass	Pass	Pass
138	14	Pass	Pass	Pass	Pass

Appendix D-2

Tables of Criteria Passing for Striped Bass Eggs Habitat Suitability

April 1997

50th %ile of Clyo Flow

Fisheries Review Group

1. Table D.7.1 Striped Bass eggs D.O. , Salinity, and Velocity criteria passing for existing and deepening (6 ft) scenarios within the analyzed period April 1 - April 30, 1997

```
HABITAT REQUIREMENTS:
RM 10-31; Depth Average
D.O. April (MG/L):10th %ile >=4.5
Salinity 50th %ile <= 9 ppt
Mean Velocity >= 30 cm/s
```

Savannah Harbor Estuary

Segments J	Segments I	Baseline Scenario Salinity	Baseline Scenario Velocity	Baseline Scenario D.O.	Project Scenario Salinity	Project Scenario Velocity	Project Scenario D.O.
47	13	Fail	Pass	Pass	Fail	Pass	Pass
47	14	Fail	Pass	Pass	Fail	Pass	Pass
47	15	Fail	Pass	Pass	Fail	Pass	Pass
47	16	Fail	Pass	Pass	Fail	Pass	Pass
47	17	Fail	Fail	Pass	Fail	Fail	Pass
48	13	Fail	Pass	Pass	Fail	Pass	Pass
48	14	Fail	Pass	Pass	Fail	Pass	Pass
48	15	Fail	Pass	Pass	Fail	Pass	Pass
48	16	Fail	Pass	Pass	Fail	Pass	Pass
48	17	Fail	Pass	Pass	Fail	Pass	Pass
49	13	Fail	Pass	Pass	Fail	Pass	Pass
49	14	Fail	Pass	Pass	Fail	Pass	Pass
49	15	Pass	Pass	Pass	Fail	Pass	Pass
49	16	Fail	Pass	Pass	Fail	Pass	Pass
49	17	Fail	Pass	Pass	Fail	Pass	Pass
50	13	Pass	Pass	Pass	Fail	Pass	Pass
50	14	Fail	Pass	Pass	Fail	Pass	Pass
50	15	Fail	Fail	Pass	Fail	Fail	Pass
50	16	Fail	Fail	Pass	Fail	Fail	Pass
50	17	Fail	Fail	Pass	Fail	Fail	Pass
50	18	Pass	Fail	Pass	Fail	Fail	Pass
51	13	Pass	Pass	Pass	Fail	Pass	Pass
51	14	Fail	Pass	Pass	Fail	Pass	Pass
51	15	Pass	Pass	Pass	Fail	Pass	Pass
52	13	Pass	Pass	Pass	Fail	Pass	Pass
52	14	Fail	Pass	Pass	Fail	Pass	Pass
52	15	Pass	Pass	Pass	Fail	Pass	Pass
53	13	Pass	Pass	Pass	Fail	Pass	Pass
53	14	Fail	Pass	Pass	Fail	Pass	Pass
53	15	Pass	Pass	Pass	Fail	Pass	Pass
54	13	Pass	Pass	Pass	Fail	Pass	Pass
54	14	Fail	Pass	Pass	Fail	Pass	Pass
54	15	Pass	Pass	Pass	Fail	Pass	Pass
55	13	Pass	Pass	Pass	Fail	Pass	Pass
55	14	Fail	Pass	Pass	Fail	Pass	Pass
55	15	Pass	Pass	Pass	Fail	Pass	Pass
56	13	Pass	Pass	Pass	Fail	Pass	Pass
56	14	Fail	Pass	Pass	Fail	Pass	Pass
56	15	Pass	Pass	Pass	Pass	Pass	Pass
57	13	Pass	Pass	Pass	Pass	Pass	Pass

57	14	Fail	Pass	Pass	Fail	Pass	Pass
57	15	Pass	Pass	Pass	Pass	Pass	Pass
58	13	Pass	Pass	Pass	Pass	Pass	Pass
58	14	Fail	Pass	Pass	Fail	Pass	Pass
58	15	Pass	Pass	Pass	Pass	Pass	Pass
59	13	Pass	Pass	Pass	Pass	Pass	Pass
59	14	Pass	Pass	Pass	Fail	Pass	Pass
59	15	Pass	Pass	Pass	Pass	Pass	Pass
59	30	Pass	Fail	Pass	Fail	Fail	Pass
59	31	Fail	Fail	Pass	Fail	Fail	Pass
59	32	Pass	Fail	Pass	Fail	Fail	Pass
60	13	Pass	Pass	Pass	Pass	Pass	Pass
60	14	Pass	Pass	Pass	Fail	Pass	Pass
60	15	Pass	Pass	Pass	Pass	Pass	Pass
60	30	Pass	Fail	Pass	Fail	Fail	Pass
60	31	Fail	Fail	Pass	Fail	Fail	Pass
60	32	Pass	Fail	Pass	Fail	Fail	Pass
61	13	Pass	Pass	Pass	Pass	Pass	Pass
61	14	Pass	Pass	Pass	Fail	Pass	Pass
61	15	Pass	Pass	Pass	Pass	Pass	Pass
61	30	Pass	Fail	Pass	Fail	Fail	Pass
61	31	Fail	Fail	Pass	Fail	Fail	Pass
61	32	Pass	Fail	Pass	Fail	Fail	Pass
62	13	Pass	Pass	Pass	Pass	Pass	Pass
62	14	Pass	Pass	Pass	Fail	Pass	Pass
62	15	Pass	Pass	Pass	Pass	Pass	Pass
62	30	Pass	Fail	Pass	Fail	Fail	Pass
62	31	Fail	Fail	Pass	Fail	Fail	Pass
62	32	Pass	Fail	Pass	Fail	Fail	Pass
63	13	Pass	Pass	Pass	Pass	Pass	Pass
63	14	Pass	Pass	Pass	Fail	Pass	Pass
63	15	Pass	Pass	Pass	Pass	Pass	Pass
63	31	Pass	Pass	Pass	Fail	Pass	Pass
64	13	Pass	Pass	Pass	Pass	Pass	Pass
64	14	Pass	Pass	Pass	Fail	Pass	Pass
64	15	Pass	Pass	Pass	Pass	Pass	Pass
64	30	Pass	Fail	Pass	Fail	Fail	Pass
64	31	Pass	Pass	Pass	Fail	Pass	Pass
64	32	Pass	Fail	Pass	Fail	Fail	Pass
65	13	Pass	Pass	Pass	Pass	Pass	Pass
65	14	Pass	Pass	Pass	Fail	Pass	Pass
65	15	Pass	Pass	Pass	Pass	Pass	Pass
65	30	Pass	Fail	Pass	Fail	Fail	Pass
65	31	Pass	Pass	Pass	Fail	Pass	Pass
65	32	Pass	Fail	Pass	Fail	Fail	Pass
65	33	Pass	Fail	Pass	Fail	Fail	Pass
66	13	Pass	Pass	Pass	Pass	Pass	Pass
66	14	Pass	Pass	Pass	Fail	Pass	Pass
66	15	Pass	Fail	Pass	Pass	Fail	Pass
66	30	Pass	Fail	Pass	Fail	Fail	Pass
66	31	Pass	Pass	Pass	Fail	Pass	Pass
66	32	Pass	Fail	Pass	Fail	Fail	Pass
66	36	Pass	Fail	Pass	Fail	Fail	Pass
66	38	Fail	Fail	Fail	Fail	Fail	Fail
67	13	Pass	Pass	Pass	Pass	Pass	Pass
67	14	Pass	Pass	Pass	Fail	Pass	Pass
67	15	Pass	Fail	Pass	Pass	Fail	Pass

67	30	Pass	Fail	Pass	Pass	Fail	Pass
67	31	Pass	Pass	Pass	Pass	Pass	Pass
67	32	Pass	Fail	Pass	Fail	Fail	Pass
67	36	Pass	Fail	Pass	Fail	Fail	Pass
68	13	Pass	Pass	Pass	Pass	Pass	Pass
68	14	Pass	Pass	Pass	Fail	Pass	Pass
68	15	Pass	Fail	Pass	Pass	Fail	Pass
68	30	Pass	Fail	Pass	Pass	Fail	Pass
68	31	Pass	Pass	Pass	Pass	Pass	Pass
68	32	Pass	Fail	Pass	Pass	Fail	Pass
68	36	Pass	Fail	Pass	Fail	Fail	Pass
68	38	Fail	Fail	Fail	Fail	Fail	Fail
69	13	Pass	Pass	Pass	Pass	Pass	Pass
69	14	Pass	Pass	Pass	Fail	Pass	Pass
69	15	Pass	Fail	Pass	Pass	Fail	Pass
69	30	Pass	Pass	Pass	Pass	Pass	Pass
69	31	Pass	Pass	Pass	Pass	Pass	Pass
69	32	Pass	Fail	Pass	Pass	Fail	Pass
69	36	Pass	Fail	Pass	Fail	Fail	Pass
70	13	Pass	Pass	Pass	Pass	Pass	Pass
70	14	Pass	Pass	Pass	Fail	Pass	Pass
70	15	Pass	Fail	Pass	Pass	Fail	Pass
70	30	Pass	Fail	Pass	Pass	Fail	Pass
70	31	Pass	Fail	Pass	Pass	Fail	Pass
70	32	Pass	Fail	Pass	Pass	Fail	Pass
70	33	Pass	Fail	Pass	Pass	Fail	Pass
71	13	Pass	Pass	Pass	Pass	Pass	Pass
71	14	Pass	Pass	Pass	Fail	Pass	Pass
71	15	Pass	Pass	Pass	Pass	Pass	Pass
71	30	Pass	Fail	Pass	Pass	Fail	Pass
71	31	Pass	Fail	Pass	Pass	Fail	Pass
71	32	Pass	Fail	Pass	Pass	Fail	Pass
72	13	Pass	Pass	Pass	Pass	Pass	Pass
72	14	Pass	Pass	Pass	Fail	Pass	Pass
72	15	Pass	Pass	Pass	Pass	Pass	Pass
72	30	Pass	Fail	Pass	Pass	Fail	Pass
72	31	Pass	Fail	Pass	Pass	Fail	Pass
72	32	Pass	Fail	Pass	Pass	Fail	Pass
73	13	Pass	Pass	Pass	Pass	Pass	Pass
73	14	Pass	Pass	Pass	Pass	Pass	Pass
73	15	Pass	Pass	Pass	Pass	Pass	Pass
73	30	Pass	Fail	Pass	Pass	Fail	Pass
73	31	Pass	Fail	Pass	Pass	Fail	Pass
74	13	Pass	Pass	Pass	Pass	Pass	Pass
74	14	Pass	Pass	Pass	Pass	Pass	Pass
74	15	Pass	Pass	Pass	Pass	Pass	Pass
74	30	Pass	Fail	Pass	Pass	Fail	Pass
74	31	Pass	Fail	Pass	Pass	Fail	Pass
75	13	Pass	Pass	Pass	Pass	Pass	Pass
75	14	Pass	Pass	Pass	Pass	Pass	Pass
75	15	Pass	Pass	Pass	Pass	Pass	Pass
75	30	Pass	Fail	Pass	Pass	Fail	Pass
75	31	Pass	Fail	Pass	Pass	Fail	Pass
76	13	Pass	Fail	Pass	Pass	Fail	Pass
76	14	Pass	Pass	Pass	Pass	Pass	Pass
76	15	Pass	Fail	Pass	Pass	Fail	Pass
76	16	Pass	Fail	Pass	Pass	Fail	Pass

76	17	Pass	Fail	Pass	Pass	Fail	Pass
76	30	Pass	Fail	Pass	Pass	Fail	Pass
76	31	Pass	Fail	Pass	Pass	Fail	Pass
76	33	Fail	Fail	Fail	Fail	Fail	Fail
77	13	Pass	Fail	Pass	Pass	Fail	Pass
77	14	Pass	Fail	Pass	Pass	Fail	Pass
77	15	Pass	Fail	Pass	Pass	Fail	Pass
77	16	Pass	Fail	Pass	Pass	Fail	Pass
77	17	Pass	Fail	Pass	Pass	Fail	Pass
77	30	Pass	Fail	Pass	Pass	Fail	Pass
77	31	Pass	Fail	Pass	Pass	Fail	Pass
78	13	Pass	Fail	Pass	Pass	Fail	Pass
78	14	Pass	Pass	Pass	Pass	Fail	Pass
78	15	Pass	Fail	Pass	Pass	Fail	Pass
78	16	Pass	Fail	Pass	Pass	Fail	Pass
78	17	Pass	Fail	Pass	Pass	Fail	Pass
78	30	Pass	Fail	Pass	Pass	Fail	Pass
78	31	Pass	Fail	Pass	Pass	Fail	Pass
79	13	Pass	Fail	Pass	Pass	Pass	Pass
79	14	Pass	Pass	Pass	Pass	Pass	Pass
79	15	Pass	Fail	Pass	Pass	Fail	Pass
79	30	Pass	Fail	Pass	Pass	Fail	Pass
79	31	Pass	Fail	Pass	Pass	Fail	Pass
80	13	Pass	Fail	Pass	Pass	Pass	Pass
80	14	Pass	Pass	Pass	Pass	Pass	Pass
80	15	Pass	Fail	Pass	Pass	Fail	Pass
80	30	Pass	Fail	Pass	Pass	Fail	Pass
80	31	Pass	Fail	Pass	Pass	Fail	Pass
81	13	Pass	Pass	Pass	Pass	Pass	Pass
81	14	Pass	Pass	Pass	Pass	Pass	Pass
81	15	Pass	Fail	Pass	Pass	Fail	Pass
81	30	Pass	Fail	Pass	Pass	Fail	Pass
81	31	Pass	Fail	Pass	Pass	Fail	Pass
82	13	Pass	Pass	Pass	Pass	Pass	Pass
82	14	Pass	Pass	Pass	Pass	Pass	Pass
82	15	Pass	Pass	Pass	Pass	Pass	Pass
82	16	Pass	Fail	Pass	Pass	Fail	Pass
82	17	Pass	Fail	Pass	Pass	Fail	Pass
82	18	Pass	Fail	Pass	Pass	Fail	Pass
82	19	Pass	Fail	Pass	Pass	Fail	Pass
82	20	Pass	Fail	Pass	Pass	Fail	Pass
82	21	Pass	Fail	Pass	Pass	Fail	Pass
82	29	Pass	Fail	Pass	Pass	Fail	Pass
82	30	Pass	Fail	Pass	Pass	Fail	Pass
82	31	Pass	Fail	Pass	Pass	Fail	Pass
83	13	Pass	Pass	Pass	Pass	Pass	Pass
83	14	Pass	Pass	Pass	Pass	Pass	Pass
83	15	Pass	Pass	Pass	Pass	Pass	Pass
83	21	Pass	Fail	Pass	Pass	Fail	Pass
83	30	Pass	Fail	Pass	Pass	Fail	Pass
83	31	Pass	Fail	Pass	Pass	Fail	Pass
84	13	Pass	Pass	Pass	Pass	Pass	Pass
84	14	Pass	Pass	Pass	Pass	Pass	Pass
84	15	Pass	Pass	Pass	Pass	Pass	Pass
84	21	Pass	Fail	Pass	Pass	Fail	Pass
84	30	Pass	Fail	Pass	Pass	Fail	Pass
84	31	Pass	Fail	Pass	Pass	Fail	Pass

85	13	Pass	Pass	Pass	Pass	Pass	Pass
85	14	Pass	Pass	Pass	Pass	Pass	Pass
85	15	Pass	Pass	Pass	Pass	Pass	Pass
85	21	Pass	Fail	Pass	Pass	Fail	Pass
85	30	Pass	Fail	Pass	Pass	Fail	Pass
86	13	Pass	Pass	Pass	Pass	Pass	Pass
86	14	Pass	Pass	Pass	Pass	Pass	Pass
86	15	Pass	Pass	Pass	Pass	Pass	Pass
86	17	Fail	Fail	Fail	Fail	Fail	Fail
86	21	Pass	Pass	Pass	Pass	Fail	Pass
86	30	Pass	Pass	Pass	Pass	Pass	Pass
87	13	Pass	Pass	Pass	Pass	Pass	Pass
87	14	Pass	Pass	Pass	Pass	Pass	Pass
87	15	Pass	Pass	Pass	Pass	Pass	Pass
87	30	Pass	Fail	Pass	Pass	Fail	Pass
87	32	Fail	Fail	Fail	Fail	Fail	Fail
88	13	Pass	Pass	Pass	Pass	Pass	Pass
88	14	Pass	Pass	Pass	Pass	Pass	Pass
88	15	Pass	Pass	Pass	Pass	Pass	Pass
88	30	Pass	Fail	Pass	Pass	Fail	Pass
89	13	Pass	Pass	Pass	Pass	Pass	Pass
89	14	Pass	Pass	Pass	Pass	Pass	Pass
89	15	Pass	Pass	Pass	Pass	Pass	Pass
89	30	Pass	Fail	Pass	Pass	Fail	Pass
90	13	Pass	Pass	Pass	Pass	Pass	Pass
90	14	Pass	Pass	Pass	Pass	Pass	Pass
90	15	Pass	Pass	Pass	Pass	Fail	Pass
90	30	Pass	Fail	Pass	Pass	Fail	Pass
91	13	Pass	Pass	Pass	Pass	Pass	Pass
91	14	Pass	Pass	Pass	Pass	Pass	Pass
91	15	Pass	Pass	Pass	Pass	Fail	Pass
91	16	Pass	Fail	Pass	Pass	Fail	Pass
91	30	Pass	Fail	Pass	Pass	Fail	Pass
92	13	Pass	Pass	Pass	Pass	Pass	Pass
92	14	Pass	Pass	Pass	Pass	Pass	Pass
92	15	Pass	Pass	Pass	Pass	Pass	Pass
92	16	Pass	Fail	Pass	Pass	Fail	Pass
92	30	Pass	Fail	Pass	Pass	Fail	Pass
92	32	Fail	Fail	Fail	Fail	Fail	Fail
93	13	Pass	Pass	Pass	Pass	Pass	Pass
93	14	Pass	Pass	Pass	Pass	Pass	Pass
93	15	Pass	Pass	Pass	Pass	Pass	Pass
93	16	Pass	Pass	Pass	Pass	Pass	Pass
93	30	Pass	Fail	Pass	Pass	Fail	Pass
94	13	Pass	Pass	Pass	Pass	Pass	Pass
94	14	Pass	Pass	Pass	Pass	Pass	Pass
94	15	Pass	Pass	Pass	Pass	Pass	Pass
94	16	Pass	Fail	Pass	Pass	Fail	Pass
94	26	Pass	Pass	Pass	Pass	Pass	Pass
94	30	Pass	Fail	Pass	Pass	Fail	Pass
95	13	Pass	Pass	Pass	Pass	Pass	Pass
95	14	Pass	Pass	Pass	Pass	Pass	Pass
95	15	Pass	Pass	Pass	Pass	Pass	Pass
95	16	Pass	Fail	Pass	Pass	Fail	Pass
95	26	Pass	Fail	Pass	Pass	Fail	Pass
95	28	Fail	Fail	Fail	Fail	Fail	Fail
95	30	Pass	Fail	Pass	Pass	Fail	Pass

96	11	Fail	Fail	Fail	Fail	Fail	Fail
96	13	Pass	Pass	Pass	Pass	Pass	Pass
96	14	Pass	Pass	Pass	Pass	Pass	Pass
96	15	Pass	Pass	Pass	Pass	Pass	Pass
96	26	Pass	Fail	Pass	Pass	Fail	Pass
96	30	Pass	Fail	Pass	Pass	Fail	Pass
97	13	Pass	Pass	Pass	Pass	Pass	Pass
97	14	Pass	Pass	Pass	Pass	Pass	Pass
97	15	Pass	Fail	Pass	Pass	Fail	Pass
97	26	Pass	Fail	Pass	Pass	Fail	Pass
97	30	Pass	Fail	Pass	Pass	Fail	Pass
98	13	Pass	Fail	Pass	Pass	Fail	Pass
98	14	Pass	Pass	Pass	Pass	Pass	Pass
98	15	Pass	Fail	Pass	Pass	Fail	Pass
98	26	Pass	Fail	Pass	Pass	Fail	Pass
98	27	Pass	Pass	Pass	Pass	Pass	Pass
98	28	Pass	Pass	Pass	Pass	Pass	Pass
98	29	Pass	Pass	Pass	Pass	Pass	Pass
98	30	Pass	Fail	Pass	Pass	Fail	Pass
99	13	Pass	Pass	Pass	Pass	Pass	Pass
99	14	Pass	Pass	Pass	Pass	Pass	Pass
99	15	Pass	Fail	Pass	Pass	Fail	Pass
99	16	Pass	Fail	Pass	Pass	Fail	Pass
99	17	Pass	Fail	Pass	Pass	Fail	Pass
99	18	Pass	Fail	Pass	Pass	Fail	Pass
99	19	Pass	Fail	Pass	Pass	Fail	Pass
99	20	Pass	Fail	Pass	Pass	Fail	Pass
99	21	Pass	Fail	Pass	Pass	Fail	Pass
99	22	Pass	Fail	Pass	Pass	Fail	Pass
99	23	Pass	Fail	Pass	Pass	Fail	Pass
99	26	Pass	Fail	Pass	Pass	Fail	Pass
99	30	Pass	Fail	Pass	Pass	Fail	Pass
100	13	Pass	Pass	Pass	Pass	Pass	Pass
100	14	Pass	Pass	Pass	Pass	Pass	Pass
100	15	Pass	Fail	Pass	Pass	Pass	Pass
100	23	Pass	Fail	Pass	Pass	Fail	Pass
100	24	Pass	Fail	Pass	Pass	Fail	Pass
100	25	Pass	Fail	Pass	Pass	Fail	Pass
100	26	Pass	Fail	Pass	Pass	Fail	Pass
100	30	Pass	Fail	Pass	Pass	Fail	Pass
101	13	Pass	Pass	Pass	Pass	Pass	Pass
101	14	Pass	Pass	Pass	Pass	Pass	Pass
101	15	Pass	Pass	Pass	Pass	Pass	Pass
101	16	Pass	Fail	Pass	Pass	Fail	Pass
101	17	Pass	Fail	Pass	Pass	Fail	Pass
101	18	Pass	Fail	Pass	Pass	Fail	Pass
101	19	Pass	Fail	Pass	Pass	Fail	Pass
101	20	Pass	Fail	Pass	Pass	Fail	Pass
101	21	Pass	Fail	Pass	Pass	Fail	Pass
101	22	Pass	Fail	Pass	Pass	Fail	Pass
101	23	Pass	Fail	Pass	Pass	Fail	Pass
101	26	Pass	Pass	Pass	Pass	Pass	Pass
101	30	Pass	Fail	Pass	Pass	Fail	Pass
102	13	Pass	Pass	Pass	Pass	Pass	Pass
102	14	Pass	Pass	Pass	Pass	Pass	Pass
102	15	Pass	Pass	Pass	Pass	Pass	Pass
102	26	Pass	Pass	Pass	Pass	Pass	Pass

102	30	Pass	Fail	Pass	Pass	Fail	Pass
103	13	Pass	Pass	Pass	Pass	Pass	Pass
103	14	Pass	Pass	Pass	Pass	Pass	Pass
103	15	Pass	Pass	Pass	Pass	Pass	Pass
103	26	Pass	Pass	Pass	Pass	Pass	Pass
103	30	Pass	Pass	Pass	Pass	Pass	Pass
104	11	Fail	Fail	Fail	Fail	Fail	Fail
104	13	Pass	Fail	Pass	Pass	Fail	Pass
104	14	Pass	Pass	Pass	Pass	Pass	Pass
104	15	Pass	Pass	Pass	Pass	Pass	Pass
104	26	Pass	Pass	Pass	Pass	Pass	Pass
104	30	Pass	Fail	Pass	Pass	Fail	Pass
105	13	Pass	Fail	Pass	Pass	Fail	Pass
105	14	Pass	Pass	Pass	Pass	Pass	Pass
105	15	Pass	Pass	Pass	Pass	Pass	Pass
105	26	Pass	Pass	Pass	Pass	Pass	Pass
105	30	Pass	Fail	Pass	Pass	Fail	Pass
106	13	Pass	Fail	Pass	Pass	Pass	Pass
106	14	Pass	Pass	Pass	Pass	Pass	Pass
106	15	Pass	Pass	Pass	Pass	Pass	Pass
106	26	Pass	Pass	Pass	Pass	Pass	Pass
106	27	Pass	Fail	Pass	Pass	Fail	Pass
106	30	Pass	Fail	Pass	Pass	Fail	Pass
106	39	Pass	Fail	Pass	Pass	Fail	Pass
107	13	Pass	Pass	Pass	Pass	Pass	Pass
107	14	Pass	Pass	Pass	Pass	Pass	Pass
107	15	Pass	Fail	Pass	Pass	Pass	Pass
107	22	Pass	Fail	Pass	Pass	Fail	Pass
107	26	Pass	Fail	Pass	Pass	Fail	Pass
107	30	Pass	Fail	Pass	Pass	Fail	Pass
107	39	Pass	Fail	Pass	Pass	Fail	Pass
108	13	Pass	Pass	Pass	Pass	Pass	Pass
108	14	Pass	Pass	Pass	Pass	Pass	Pass
108	15	Pass	Pass	Pass	Pass	Pass	Pass
108	22	Pass	Pass	Pass	Pass	Pass	Pass
108	24	Fail	Fail	Fail	Fail	Fail	Fail
108	26	Pass	Fail	Pass	Pass	Fail	Pass
108	30	Pass	Fail	Pass	Pass	Fail	Pass
108	39	Pass	Fail	Pass	Pass	Fail	Pass
109	13	Pass	Pass	Pass	Pass	Pass	Pass
109	14	Pass	Pass	Pass	Pass	Pass	Pass
109	15	Pass	Pass	Pass	Pass	Pass	Pass
109	22	Pass	Fail	Pass	Pass	Fail	Pass
109	26	Pass	Pass	Pass	Pass	Pass	Pass
109	30	Pass	Fail	Pass	Pass	Fail	Pass
109	39	Pass	Pass	Pass	Pass	Pass	Pass
110	13	Pass	Pass	Pass	Pass	Pass	Pass
110	14	Pass	Pass	Pass	Pass	Pass	Pass
110	15	Pass	Pass	Pass	Pass	Pass	Pass
110	22	Pass	Fail	Pass	Pass	Fail	Pass
110	26	Pass	Pass	Pass	Pass	Pass	Pass
110	28	Fail	Fail	Fail	Fail	Fail	Fail
110	39	Pass	Fail	Pass	Pass	Fail	Pass
111	13	Pass	Pass	Pass	Pass	Pass	Pass
111	14	Pass	Pass	Pass	Pass	Pass	Pass
111	15	Pass	Pass	Pass	Pass	Pass	Pass
111	22	Pass	Fail	Pass	Pass	Fail	Pass

111	26	Pass	Pass	Pass	Pass	Pass	Pass
111	39	Pass	Fail	Pass	Pass	Fail	Pass
112	13	Pass	Fail	Pass	Pass	Fail	Pass
112	14	Pass	Pass	Pass	Pass	Pass	Pass
112	15	Pass	Pass	Pass	Pass	Pass	Pass
112	22	Pass	Fail	Pass	Pass	Fail	Pass
112	26	Pass	Fail	Pass	Pass	Fail	Pass
112	39	Pass	Fail	Pass	Pass	Fail	Pass
113	13	Pass	Fail	Pass	Pass	Pass	Pass
113	14	Pass	Pass	Pass	Pass	Pass	Pass
113	15	Pass	Pass	Pass	Pass	Pass	Pass
113	26	Pass	Fail	Pass	Pass	Fail	Pass
113	27	Pass	Fail	Pass	Pass	Fail	Pass
113	39	Pass	Pass	Pass	Pass	Pass	Pass
113	41	Fail	Fail	Fail	Fail	Fail	Fail
114	13	Pass	Pass	Pass	Pass	Pass	Pass
114	14	Pass	Pass	Pass	Pass	Pass	Pass
114	15	Pass	Pass	Pass	Pass	Pass	Pass
114	26	Pass	Fail	Pass	Pass	Fail	Pass
114	39	Pass	Pass	Pass	Pass	Pass	Pass
115	13	Pass	Pass	Pass	Pass	Pass	Pass
115	14	Pass	Pass	Pass	Pass	Pass	Pass
115	15	Pass	Pass	Pass	Pass	Pass	Pass
115	26	Pass	Fail	Pass	Pass	Fail	Pass
115	39	Pass	Pass	Pass	Pass	Pass	Pass
116	13	Pass	Pass	Pass	Pass	Pass	Pass
116	14	Pass	Pass	Pass	Pass	Pass	Pass
116	15	Pass	Pass	Pass	Pass	Pass	Pass
116	26	Pass	Fail	Pass	Pass	Fail	Pass
116	28	Fail	Fail	Fail	Fail	Fail	Fail
116	39	Pass	Pass	Pass	Pass	Pass	Pass
117	13	Pass	Pass	Pass	Pass	Pass	Pass
117	14	Pass	Pass	Pass	Pass	Pass	Pass
117	15	Pass	Pass	Pass	Pass	Pass	Pass
117	26	Pass	Fail	Pass	Pass	Fail	Pass
117	39	Pass	Pass	Pass	Pass	Pass	Pass
118	13	Pass	Pass	Pass	Pass	Pass	Pass
118	14	Pass	Pass	Pass	Pass	Pass	Pass
118	15	Pass	Fail	Pass	Pass	Pass	Pass
118	20	Pass	Fail	Pass	Pass	Fail	Pass
118	26	Pass	Fail	Pass	Pass	Fail	Pass
118	39	Pass	Pass	Pass	Pass	Pass	Pass
119	13	Pass	Pass	Pass	Pass	Pass	Pass
119	14	Pass	Pass	Pass	Pass	Pass	Pass
119	15	Pass	Pass	Pass	Pass	Pass	Pass
119	20	Pass	Fail	Pass	Pass	Fail	Pass
119	26	Pass	Fail	Pass	Pass	Fail	Pass
119	39	Pass	Pass	Pass	Pass	Pass	Pass
120	13	Pass	Pass	Pass	Pass	Pass	Pass
120	14	Pass	Pass	Pass	Pass	Pass	Pass
120	15	Pass	Fail	Pass	Pass	Fail	Pass
120	16	Pass	Fail	Pass	Pass	Fail	Pass
120	26	Pass	Fail	Pass	Pass	Fail	Pass
120	39	Pass	Pass	Pass	Pass	Pass	Pass
121	13	Pass	Pass	Pass	Pass	Pass	Pass
121	14	Pass	Pass	Pass	Pass	Pass	Pass
121	26	Pass	Fail	Pass	Pass	Fail	Pass

121	39	Pass	Pass	Pass	Pass	Pass	Pass
122	13	Pass	Pass	Pass	Pass	Pass	Pass
122	14	Pass	Pass	Pass	Pass	Pass	Pass
122	26	Pass	Fail	Pass	Pass	Fail	Pass
122	39	Pass	Pass	Pass	Pass	Pass	Pass
122	41	Fail	Fail	Fail	Fail	Fail	Fail
123	13	Pass	Pass	Pass	Pass	Pass	Pass
123	14	Pass	Pass	Pass	Pass	Pass	Pass
123	15	Pass	Fail	Pass	Pass	Fail	Pass
123	16	Pass	Pass	Pass	Pass	Pass	Pass
123	17	Pass	Pass	Pass	Pass	Pass	Pass
123	18	Pass	Pass	Pass	Pass	Pass	Pass
123	19	Pass	Pass	Pass	Pass	Pass	Pass
123	20	Pass	Pass	Pass	Pass	Pass	Pass
123	21	Pass	Pass	Pass	Pass	Pass	Pass
123	22	Pass	Pass	Pass	Pass	Pass	Pass
123	23	Pass	Pass	Pass	Pass	Pass	Pass
123	24	Pass	Pass	Pass	Pass	Pass	Pass
123	25	Pass	Pass	Pass	Pass	Pass	Pass
123	26	Pass	Pass	Pass	Pass	Pass	Pass
123	27	Pass	Pass	Pass	Pass	Pass	Pass
123	28	Pass	Pass	Pass	Pass	Pass	Pass
123	29	Pass	Fail	Pass	Pass	Fail	Pass
123	30	Pass	Fail	Pass	Pass	Fail	Pass
123	31	Pass	Fail	Pass	Pass	Fail	Pass
123	32	Pass	Fail	Pass	Pass	Fail	Pass
123	33	Pass	Fail	Pass	Pass	Fail	Pass
123	34	Pass	Pass	Pass	Pass	Pass	Pass
123	35	Pass	Pass	Pass	Pass	Pass	Pass
123	36	Pass	Pass	Pass	Pass	Pass	Pass
123	37	Pass	Fail	Pass	Pass	Fail	Pass
123	38	Pass	Fail	Pass	Pass	Fail	Pass
123	39	Pass	Fail	Pass	Pass	Fail	Pass
124	13	Pass	Pass	Pass	Pass	Pass	Pass
124	14	Pass	Pass	Pass	Pass	Pass	Pass
124	23	Pass	Fail	Pass	Pass	Fail	Pass
125	13	Pass	Pass	Pass	Pass	Pass	Pass
125	14	Pass	Fail	Pass	Pass	Pass	Pass
125	23	Pass	Pass	Pass	Pass	Pass	Pass
125	28	Fail	Fail	Fail	Fail	Fail	Fail
125	33	Fail	Fail	Fail	Fail	Fail	Fail
126	13	Pass	Pass	Pass	Pass	Pass	Pass
126	14	Pass	Pass	Pass	Pass	Pass	Pass
126	23	Pass	Pass	Pass	Pass	Pass	Pass
127	13	Pass	Pass	Pass	Pass	Pass	Pass
127	14	Pass	Pass	Pass	Pass	Pass	Pass
127	23	Pass	Pass	Pass	Pass	Pass	Pass
128	13	Pass	Pass	Pass	Pass	Pass	Pass
128	14	Pass	Pass	Pass	Pass	Pass	Pass
128	23	Pass	Pass	Pass	Pass	Pass	Pass
129	13	Pass	Pass	Pass	Pass	Pass	Pass
129	14	Pass	Pass	Pass	Pass	Pass	Pass
129	23	Pass	Pass	Pass	Pass	Pass	Pass
130	8	Pass	Fail	Pass	Pass	Fail	Pass
130	9	Pass	Fail	Pass	Pass	Fail	Pass
130	10	Pass	Fail	Pass	Pass	Fail	Pass
130	11	Pass	Fail	Pass	Pass	Fail	Pass

130	12	Pass	Fail	Pass	Pass	Fail	Pass
130	13	Pass	Fail	Pass	Pass	Fail	Pass
130	14	Pass	Pass	Pass	Pass	Pass	Pass
130	23	Pass	Pass	Pass	Pass	Pass	Pass
131	14	Pass	Pass	Pass	Pass	Pass	Pass
131	23	Pass	Pass	Pass	Pass	Pass	Pass
132	14	Pass	Pass	Pass	Pass	Pass	Pass
132	23	Pass	Pass	Pass	Pass	Pass	Pass
133	14	Pass	Pass	Pass	Pass	Pass	Pass
133	23	Pass	Pass	Pass	Pass	Pass	Pass
134	14	Pass	Pass	Pass	Pass	Pass	Pass
134	23	Pass	Fail	Pass	Pass	Fail	Pass
135	14	Pass	Pass	Pass	Pass	Pass	Pass
136	14	Pass	Pass	Pass	Pass	Pass	Pass
137	14	Pass	Pass	Pass	Pass	Pass	Pass
138	14	Pass	Pass	Pass	Pass	Pass	Pass

2. Table D.7.2 Striped Bass eggs D.O. , Salinity, and Velocity criteria passing for existing and deepening (4 ft) scenarios within the analyzed period April 1 - April 30, 1997

HABITAT REQUIREMENTS:
RM 10-31; Depth Average
D.O. April (MG/L):10th %ile >=4.5
Salinity 50th %ile <= 9 ppt
Mean Velocity >= 30 cm/s

Savannah Harbor Estuary

Segments		Baseline Scenario			Project Scenario		
J	I	Salinity	Velocity	D.O.	Salinity	Velocity	D.O.
47	13	Fail	Pass	Pass	Fail	Pass	Pass
47	14	Fail	Pass	Pass	Fail	Pass	Pass
47	15	Fail	Pass	Pass	Fail	Pass	Pass
47	16	Fail	Pass	Pass	Fail	Pass	Pass
47	17	Fail	Fail	Pass	Fail	Fail	Pass
48	13	Fail	Pass	Pass	Fail	Pass	Pass
48	14	Fail	Pass	Pass	Fail	Pass	Pass
48	15	Fail	Pass	Pass	Fail	Pass	Pass
48	16	Fail	Pass	Pass	Fail	Pass	Pass
48	17	Fail	Pass	Pass	Fail	Pass	Pass
49	13	Fail	Pass	Pass	Fail	Pass	Pass
49	14	Fail	Pass	Pass	Fail	Pass	Pass
49	15	Pass	Pass	Pass	Fail	Pass	Pass
49	16	Fail	Pass	Pass	Fail	Pass	Pass
49	17	Fail	Pass	Pass	Fail	Pass	Pass
50	13	Pass	Pass	Pass	Fail	Pass	Pass
50	14	Fail	Pass	Pass	Fail	Pass	Pass
50	15	Fail	Fail	Pass	Fail	Fail	Pass
50	16	Fail	Fail	Pass	Fail	Fail	Pass
50	17	Fail	Fail	Pass	Fail	Fail	Pass
50	18	Pass	Fail	Pass	Pass	Fail	Pass
51	13	Pass	Pass	Pass	Fail	Pass	Pass
51	14	Fail	Pass	Pass	Fail	Pass	Pass
51	15	Pass	Pass	Pass	Fail	Pass	Pass
52	13	Pass	Pass	Pass	Fail	Pass	Pass
52	14	Fail	Pass	Pass	Fail	Pass	Pass
52	15	Pass	Pass	Pass	Fail	Pass	Pass
53	13	Pass	Pass	Pass	Fail	Pass	Pass
53	14	Fail	Pass	Pass	Fail	Pass	Pass
53	15	Pass	Pass	Pass	Pass	Pass	Pass
54	13	Pass	Pass	Pass	Fail	Pass	Pass
54	14	Fail	Pass	Pass	Fail	Pass	Pass
54	15	Pass	Pass	Pass	Pass	Pass	Pass
55	13	Pass	Pass	Pass	Pass	Pass	Pass
55	14	Fail	Pass	Pass	Fail	Pass	Pass
55	15	Pass	Pass	Pass	Pass	Pass	Pass
56	13	Pass	Pass	Pass	Pass	Pass	Pass
56	14	Fail	Pass	Pass	Fail	Pass	Pass

56	15	Pass	Pass	Pass	Pass	Pass	Pass
57	13	Pass	Pass	Pass	Pass	Pass	Pass
57	14	Fail	Pass	Pass	Fail	Pass	Pass
57	15	Pass	Pass	Pass	Pass	Pass	Pass
58	13	Pass	Pass	Pass	Pass	Pass	Pass
58	14	Fail	Pass	Pass	Fail	Pass	Pass
58	15	Pass	Pass	Pass	Pass	Pass	Pass
59	13	Pass	Pass	Pass	Pass	Pass	Pass
59	14	Pass	Pass	Pass	Fail	Pass	Pass
59	15	Pass	Pass	Pass	Pass	Pass	Pass
59	30	Pass	Fail	Pass	Fail	Fail	Pass
59	31	Fail	Fail	Pass	Fail	Fail	Pass
59	32	Pass	Fail	Pass	Pass	Fail	Pass
60	13	Pass	Pass	Pass	Pass	Pass	Pass
60	14	Pass	Pass	Pass	Fail	Pass	Pass
60	15	Pass	Pass	Pass	Pass	Pass	Pass
60	30	Pass	Fail	Pass	Fail	Fail	Pass
60	31	Fail	Fail	Pass	Fail	Fail	Pass
60	32	Pass	Fail	Pass	Fail	Fail	Pass
61	13	Pass	Pass	Pass	Pass	Pass	Pass
61	14	Pass	Pass	Pass	Fail	Pass	Pass
61	15	Pass	Pass	Pass	Pass	Pass	Pass
61	30	Pass	Fail	Pass	Fail	Fail	Pass
61	31	Fail	Fail	Pass	Fail	Fail	Pass
61	32	Pass	Fail	Pass	Fail	Fail	Pass
62	13	Pass	Pass	Pass	Pass	Pass	Pass
62	14	Pass	Pass	Pass	Fail	Pass	Pass
62	15	Pass	Pass	Pass	Pass	Pass	Pass
62	30	Pass	Fail	Pass	Fail	Fail	Pass
62	31	Fail	Fail	Pass	Fail	Fail	Pass
62	32	Pass	Fail	Pass	Fail	Fail	Pass
63	13	Pass	Pass	Pass	Pass	Pass	Pass
63	14	Pass	Pass	Pass	Fail	Pass	Pass
63	15	Pass	Pass	Pass	Pass	Pass	Pass
63	31	Pass	Pass	Pass	Fail	Pass	Pass
64	13	Pass	Pass	Pass	Pass	Pass	Pass
64	14	Pass	Pass	Pass	Fail	Pass	Pass
64	15	Pass	Pass	Pass	Pass	Pass	Pass
64	30	Pass	Fail	Pass	Pass	Fail	Pass
64	31	Pass	Pass	Pass	Fail	Pass	Pass
64	32	Pass	Fail	Pass	Fail	Fail	Pass
65	13	Pass	Pass	Pass	Pass	Pass	Pass
65	14	Pass	Pass	Pass	Fail	Pass	Pass
65	15	Pass	Pass	Pass	Pass	Pass	Pass
65	30	Pass	Fail	Pass	Pass	Fail	Pass
65	31	Pass	Pass	Pass	Pass	Pass	Pass
65	32	Pass	Fail	Pass	Fail	Fail	Pass
65	33	Pass	Fail	Pass	Fail	Fail	Pass
66	13	Pass	Pass	Pass	Pass	Pass	Pass
66	14	Pass	Pass	Pass	Fail	Pass	Pass
66	15	Pass	Fail	Pass	Pass	Fail	Pass
66	30	Pass	Fail	Pass	Pass	Fail	Pass
66	31	Pass	Pass	Pass	Pass	Pass	Pass
66	32	Pass	Fail	Pass	Pass	Fail	Pass
66	36	Pass	Fail	Pass	Fail	Fail	Pass
66	38	Fail	Fail	Fail	Fail	Fail	Fail
67	13	Pass	Pass	Pass	Pass	Pass	Pass

67	14	Pass	Pass	Pass	Pass	Pass	Pass
67	15	Pass	Fail	Pass	Pass	Fail	Pass
67	30	Pass	Fail	Pass	Pass	Fail	Pass
67	31	Pass	Pass	Pass	Pass	Pass	Pass
67	32	Pass	Fail	Pass	Pass	Fail	Pass
67	36	Pass	Fail	Pass	Fail	Fail	Pass
68	13	Pass	Pass	Pass	Pass	Pass	Pass
68	14	Pass	Pass	Pass	Pass	Pass	Pass
68	15	Pass	Fail	Pass	Pass	Fail	Pass
68	30	Pass	Fail	Pass	Pass	Fail	Pass
68	31	Pass	Pass	Pass	Pass	Pass	Pass
68	32	Pass	Fail	Pass	Pass	Fail	Pass
68	36	Pass	Fail	Pass	Pass	Fail	Pass
68	38	Fail	Fail	Fail	Fail	Fail	Fail
69	13	Pass	Pass	Pass	Pass	Pass	Pass
69	14	Pass	Pass	Pass	Pass	Pass	Pass
69	15	Pass	Fail	Pass	Pass	Fail	Pass
69	30	Pass	Pass	Pass	Pass	Pass	Pass
69	31	Pass	Pass	Pass	Pass	Pass	Pass
69	32	Pass	Fail	Pass	Pass	Fail	Pass
69	36	Pass	Fail	Pass	Pass	Fail	Pass
70	13	Pass	Pass	Pass	Pass	Pass	Pass
70	14	Pass	Pass	Pass	Pass	Pass	Pass
70	15	Pass	Fail	Pass	Pass	Fail	Pass
70	30	Pass	Fail	Pass	Pass	Fail	Pass
70	31	Pass	Fail	Pass	Pass	Fail	Pass
70	32	Pass	Fail	Pass	Pass	Fail	Pass
70	33	Pass	Fail	Pass	Pass	Fail	Pass
71	13	Pass	Pass	Pass	Pass	Pass	Pass
71	14	Pass	Pass	Pass	Pass	Pass	Pass
71	15	Pass	Pass	Pass	Pass	Pass	Pass
71	30	Pass	Fail	Pass	Pass	Fail	Pass
71	31	Pass	Fail	Pass	Pass	Fail	Pass
71	32	Pass	Fail	Pass	Pass	Fail	Pass
72	13	Pass	Pass	Pass	Pass	Pass	Pass
72	14	Pass	Pass	Pass	Pass	Pass	Pass
72	15	Pass	Pass	Pass	Pass	Pass	Pass
72	30	Pass	Fail	Pass	Pass	Fail	Pass
72	31	Pass	Fail	Pass	Pass	Fail	Pass
72	32	Pass	Fail	Pass	Pass	Fail	Pass
73	13	Pass	Pass	Pass	Pass	Pass	Pass
73	14	Pass	Pass	Pass	Pass	Pass	Pass
73	15	Pass	Pass	Pass	Pass	Pass	Pass
73	30	Pass	Fail	Pass	Pass	Fail	Pass
73	31	Pass	Fail	Pass	Pass	Fail	Pass
74	13	Pass	Pass	Pass	Pass	Pass	Pass
74	14	Pass	Pass	Pass	Pass	Pass	Pass
74	15	Pass	Pass	Pass	Pass	Pass	Pass
74	30	Pass	Fail	Pass	Pass	Fail	Pass
74	31	Pass	Fail	Pass	Pass	Fail	Pass
75	13	Pass	Pass	Pass	Pass	Pass	Pass
75	14	Pass	Pass	Pass	Pass	Pass	Pass
75	15	Pass	Pass	Pass	Pass	Pass	Pass
75	30	Pass	Fail	Pass	Pass	Fail	Pass
75	31	Pass	Fail	Pass	Pass	Fail	Pass
76	13	Pass	Fail	Pass	Pass	Fail	Pass
76	14	Pass	Pass	Pass	Pass	Pass	Pass

76	15	Pass	Fail	Pass	Pass	Fail	Pass
76	16	Pass	Fail	Pass	Pass	Fail	Pass
76	17	Pass	Fail	Pass	Pass	Fail	Pass
76	30	Pass	Fail	Pass	Pass	Fail	Pass
76	31	Pass	Fail	Pass	Pass	Fail	Pass
76	33	Fail	Fail	Fail	Fail	Fail	Fail
77	13	Pass	Fail	Pass	Pass	Fail	Pass
77	14	Pass	Fail	Pass	Pass	Fail	Pass
77	15	Pass	Fail	Pass	Pass	Fail	Pass
77	16	Pass	Fail	Pass	Pass	Fail	Pass
77	17	Pass	Fail	Pass	Pass	Fail	Pass
77	30	Pass	Fail	Pass	Pass	Fail	Pass
77	31	Pass	Fail	Pass	Pass	Fail	Pass
78	13	Pass	Fail	Pass	Pass	Fail	Pass
78	14	Pass	Pass	Pass	Pass	Fail	Pass
78	15	Pass	Fail	Pass	Pass	Fail	Pass
78	16	Pass	Fail	Pass	Pass	Fail	Pass
78	17	Pass	Fail	Pass	Pass	Fail	Pass
78	30	Pass	Fail	Pass	Pass	Fail	Pass
78	31	Pass	Fail	Pass	Pass	Fail	Pass
79	13	Pass	Fail	Pass	Pass	Fail	Pass
79	14	Pass	Pass	Pass	Pass	Pass	Pass
79	15	Pass	Fail	Pass	Pass	Fail	Pass
79	30	Pass	Fail	Pass	Pass	Fail	Pass
79	31	Pass	Fail	Pass	Pass	Fail	Pass
80	13	Pass	Fail	Pass	Pass	Fail	Pass
80	14	Pass	Pass	Pass	Pass	Pass	Pass
80	15	Pass	Fail	Pass	Pass	Fail	Pass
80	30	Pass	Fail	Pass	Pass	Fail	Pass
80	31	Pass	Fail	Pass	Pass	Fail	Pass
81	13	Pass	Pass	Pass	Pass	Pass	Pass
81	14	Pass	Pass	Pass	Pass	Pass	Pass
81	15	Pass	Fail	Pass	Pass	Fail	Pass
81	30	Pass	Fail	Pass	Pass	Fail	Pass
81	31	Pass	Fail	Pass	Pass	Fail	Pass
82	13	Pass	Pass	Pass	Pass	Pass	Pass
82	14	Pass	Pass	Pass	Pass	Pass	Pass
82	15	Pass	Pass	Pass	Pass	Pass	Pass
82	16	Pass	Fail	Pass	Pass	Fail	Pass
82	17	Pass	Fail	Pass	Pass	Fail	Pass
82	18	Pass	Fail	Pass	Pass	Fail	Pass
82	19	Pass	Fail	Pass	Pass	Fail	Pass
82	20	Pass	Fail	Pass	Pass	Fail	Pass
82	21	Pass	Fail	Pass	Pass	Fail	Pass
82	29	Pass	Fail	Pass	Pass	Fail	Pass
82	30	Pass	Fail	Pass	Pass	Fail	Pass
82	31	Pass	Fail	Pass	Pass	Fail	Pass
83	13	Pass	Pass	Pass	Pass	Pass	Pass
83	14	Pass	Pass	Pass	Pass	Pass	Pass
83	15	Pass	Pass	Pass	Pass	Pass	Pass
83	21	Pass	Fail	Pass	Pass	Fail	Pass
83	30	Pass	Fail	Pass	Pass	Fail	Pass
83	31	Pass	Fail	Pass	Pass	Fail	Pass
84	13	Pass	Pass	Pass	Pass	Pass	Pass
84	14	Pass	Pass	Pass	Pass	Pass	Pass
84	15	Pass	Pass	Pass	Pass	Pass	Pass
84	21	Pass	Fail	Pass	Pass	Fail	Pass

84	30	Pass	Fail	Pass	Pass	Fail	Pass
84	31	Pass	Fail	Pass	Pass	Fail	Pass
85	13	Pass	Pass	Pass	Pass	Pass	Pass
85	14	Pass	Pass	Pass	Pass	Pass	Pass
85	15	Pass	Pass	Pass	Pass	Pass	Pass
85	21	Pass	Fail	Pass	Pass	Fail	Pass
85	30	Pass	Fail	Pass	Pass	Fail	Pass
86	13	Pass	Pass	Pass	Pass	Pass	Pass
86	14	Pass	Pass	Pass	Pass	Pass	Pass
86	15	Pass	Pass	Pass	Pass	Pass	Pass
86	17	Fail	Fail	Fail	Fail	Fail	Fail
86	21	Pass	Pass	Pass	Pass	Fail	Pass
86	30	Pass	Pass	Pass	Pass	Pass	Pass
87	13	Pass	Pass	Pass	Pass	Pass	Pass
87	14	Pass	Pass	Pass	Pass	Pass	Pass
87	15	Pass	Pass	Pass	Pass	Pass	Pass
87	30	Pass	Fail	Pass	Pass	Fail	Pass
87	32	Fail	Fail	Fail	Fail	Fail	Fail
88	13	Pass	Pass	Pass	Pass	Pass	Pass
88	14	Pass	Pass	Pass	Pass	Pass	Pass
88	15	Pass	Pass	Pass	Pass	Pass	Pass
88	30	Pass	Fail	Pass	Pass	Fail	Pass
89	13	Pass	Pass	Pass	Pass	Pass	Pass
89	14	Pass	Pass	Pass	Pass	Pass	Pass
89	15	Pass	Pass	Pass	Pass	Pass	Pass
89	30	Pass	Fail	Pass	Pass	Fail	Pass
90	13	Pass	Pass	Pass	Pass	Pass	Pass
90	14	Pass	Pass	Pass	Pass	Pass	Pass
90	15	Pass	Pass	Pass	Pass	Fail	Pass
90	30	Pass	Fail	Pass	Pass	Fail	Pass
91	13	Pass	Pass	Pass	Pass	Pass	Pass
91	14	Pass	Pass	Pass	Pass	Pass	Pass
91	15	Pass	Pass	Pass	Pass	Fail	Pass
91	16	Pass	Fail	Pass	Pass	Fail	Pass
91	30	Pass	Fail	Pass	Pass	Fail	Pass
92	13	Pass	Pass	Pass	Pass	Pass	Pass
92	14	Pass	Pass	Pass	Pass	Pass	Pass
92	15	Pass	Pass	Pass	Pass	Pass	Pass
92	16	Pass	Fail	Pass	Pass	Fail	Pass
92	30	Pass	Fail	Pass	Pass	Fail	Pass
92	32	Fail	Fail	Fail	Fail	Fail	Fail
93	13	Pass	Pass	Pass	Pass	Pass	Pass
93	14	Pass	Pass	Pass	Pass	Pass	Pass
93	15	Pass	Pass	Pass	Pass	Pass	Pass
93	16	Pass	Pass	Pass	Pass	Pass	Pass
93	30	Pass	Fail	Pass	Pass	Fail	Pass
94	13	Pass	Pass	Pass	Pass	Pass	Pass
94	14	Pass	Pass	Pass	Pass	Pass	Pass
94	15	Pass	Pass	Pass	Pass	Pass	Pass
94	16	Pass	Fail	Pass	Pass	Fail	Pass
94	26	Pass	Pass	Pass	Pass	Pass	Pass
94	30	Pass	Fail	Pass	Pass	Fail	Pass
95	13	Pass	Pass	Pass	Pass	Pass	Pass
95	14	Pass	Pass	Pass	Pass	Pass	Pass
95	15	Pass	Pass	Pass	Pass	Pass	Pass
95	16	Pass	Fail	Pass	Pass	Fail	Pass
95	26	Pass	Fail	Pass	Pass	Fail	Pass

95	28	Fail	Fail	Fail	Fail	Fail	Fail
95	30	Pass	Fail	Pass	Pass	Fail	Pass
96	11	Fail	Fail	Fail	Fail	Fail	Fail
96	13	Pass	Pass	Pass	Pass	Pass	Pass
96	14	Pass	Pass	Pass	Pass	Pass	Pass
96	15	Pass	Pass	Pass	Pass	Pass	Pass
96	26	Pass	Fail	Pass	Pass	Fail	Pass
96	30	Pass	Fail	Pass	Pass	Fail	Pass
97	13	Pass	Pass	Pass	Pass	Pass	Pass
97	14	Pass	Pass	Pass	Pass	Pass	Pass
97	15	Pass	Fail	Pass	Pass	Fail	Pass
97	26	Pass	Fail	Pass	Pass	Fail	Pass
97	30	Pass	Fail	Pass	Pass	Fail	Pass
98	13	Pass	Fail	Pass	Pass	Fail	Pass
98	14	Pass	Pass	Pass	Pass	Pass	Pass
98	15	Pass	Fail	Pass	Pass	Fail	Pass
98	26	Pass	Fail	Pass	Pass	Fail	Pass
98	27	Pass	Pass	Pass	Pass	Pass	Pass
98	28	Pass	Pass	Pass	Pass	Pass	Pass
98	29	Pass	Pass	Pass	Pass	Pass	Pass
98	30	Pass	Fail	Pass	Pass	Fail	Pass
99	13	Pass	Pass	Pass	Pass	Pass	Pass
99	14	Pass	Pass	Pass	Pass	Pass	Pass
99	15	Pass	Fail	Pass	Pass	Fail	Pass
99	16	Pass	Fail	Pass	Pass	Fail	Pass
99	17	Pass	Fail	Pass	Pass	Fail	Pass
99	18	Pass	Fail	Pass	Pass	Fail	Pass
99	19	Pass	Fail	Pass	Pass	Fail	Pass
99	20	Pass	Fail	Pass	Pass	Fail	Pass
99	21	Pass	Fail	Pass	Pass	Fail	Pass
99	22	Pass	Fail	Pass	Pass	Fail	Pass
99	23	Pass	Fail	Pass	Pass	Fail	Pass
99	26	Pass	Fail	Pass	Pass	Fail	Pass
99	30	Pass	Fail	Pass	Pass	Fail	Pass
100	13	Pass	Pass	Pass	Pass	Pass	Pass
100	14	Pass	Pass	Pass	Pass	Pass	Pass
100	15	Pass	Fail	Pass	Pass	Pass	Pass
100	23	Pass	Fail	Pass	Pass	Fail	Pass
100	24	Pass	Fail	Pass	Pass	Fail	Pass
100	25	Pass	Fail	Pass	Pass	Fail	Pass
100	26	Pass	Fail	Pass	Pass	Fail	Pass
100	30	Pass	Fail	Pass	Pass	Fail	Pass
101	13	Pass	Pass	Pass	Pass	Pass	Pass
101	14	Pass	Pass	Pass	Pass	Pass	Pass
101	15	Pass	Pass	Pass	Pass	Pass	Pass
101	16	Pass	Fail	Pass	Pass	Fail	Pass
101	17	Pass	Fail	Pass	Pass	Fail	Pass
101	18	Pass	Fail	Pass	Pass	Fail	Pass
101	19	Pass	Fail	Pass	Pass	Fail	Pass
101	20	Pass	Fail	Pass	Pass	Fail	Pass
101	21	Pass	Fail	Pass	Pass	Fail	Pass
101	22	Pass	Fail	Pass	Pass	Fail	Pass
101	23	Pass	Fail	Pass	Pass	Fail	Pass
101	26	Pass	Pass	Pass	Pass	Pass	Pass
101	30	Pass	Fail	Pass	Pass	Fail	Pass
102	13	Pass	Pass	Pass	Pass	Pass	Pass
102	14	Pass	Pass	Pass	Pass	Pass	Pass

102	15	Pass	Pass	Pass	Pass	Pass	Pass
102	26	Pass	Pass	Pass	Pass	Pass	Pass
102	30	Pass	Fail	Pass	Pass	Fail	Pass
103	13	Pass	Pass	Pass	Pass	Pass	Pass
103	14	Pass	Pass	Pass	Pass	Pass	Pass
103	15	Pass	Pass	Pass	Pass	Pass	Pass
103	26	Pass	Pass	Pass	Pass	Pass	Pass
103	30	Pass	Pass	Pass	Pass	Pass	Pass
104	11	Fail	Fail	Fail	Fail	Fail	Fail
104	13	Pass	Fail	Pass	Pass	Fail	Pass
104	14	Pass	Pass	Pass	Pass	Pass	Pass
104	15	Pass	Pass	Pass	Pass	Pass	Pass
104	26	Pass	Pass	Pass	Pass	Pass	Pass
104	30	Pass	Fail	Pass	Pass	Fail	Pass
105	13	Pass	Fail	Pass	Pass	Fail	Pass
105	14	Pass	Pass	Pass	Pass	Pass	Pass
105	15	Pass	Pass	Pass	Pass	Pass	Pass
105	26	Pass	Pass	Pass	Pass	Pass	Pass
105	30	Pass	Fail	Pass	Pass	Fail	Pass
106	13	Pass	Fail	Pass	Pass	Pass	Pass
106	14	Pass	Pass	Pass	Pass	Pass	Pass
106	15	Pass	Pass	Pass	Pass	Pass	Pass
106	26	Pass	Pass	Pass	Pass	Pass	Pass
106	27	Pass	Fail	Pass	Pass	Fail	Pass
106	30	Pass	Fail	Pass	Pass	Fail	Pass
106	39	Pass	Fail	Pass	Pass	Fail	Pass
107	13	Pass	Pass	Pass	Pass	Pass	Pass
107	14	Pass	Pass	Pass	Pass	Pass	Pass
107	15	Pass	Fail	Pass	Pass	Pass	Pass
107	22	Pass	Fail	Pass	Pass	Fail	Pass
107	26	Pass	Fail	Pass	Pass	Fail	Pass
107	30	Pass	Fail	Pass	Pass	Fail	Pass
107	39	Pass	Fail	Pass	Pass	Fail	Pass
108	13	Pass	Pass	Pass	Pass	Pass	Pass
108	14	Pass	Pass	Pass	Pass	Pass	Pass
108	15	Pass	Pass	Pass	Pass	Pass	Pass
108	22	Pass	Pass	Pass	Pass	Pass	Pass
108	24	Fail	Fail	Fail	Fail	Fail	Fail
108	26	Pass	Fail	Pass	Pass	Fail	Pass
108	30	Pass	Fail	Pass	Pass	Fail	Pass
108	39	Pass	Fail	Pass	Pass	Fail	Pass
109	13	Pass	Pass	Pass	Pass	Pass	Pass
109	14	Pass	Pass	Pass	Pass	Pass	Pass
109	15	Pass	Pass	Pass	Pass	Pass	Pass
109	22	Pass	Fail	Pass	Pass	Fail	Pass
109	26	Pass	Pass	Pass	Pass	Pass	Pass
109	30	Pass	Fail	Pass	Pass	Fail	Pass
109	39	Pass	Pass	Pass	Pass	Pass	Pass
110	13	Pass	Pass	Pass	Pass	Pass	Pass
110	14	Pass	Pass	Pass	Pass	Pass	Pass
110	15	Pass	Pass	Pass	Pass	Pass	Pass
110	22	Pass	Fail	Pass	Pass	Fail	Pass
110	26	Pass	Pass	Pass	Pass	Pass	Pass
110	28	Fail	Fail	Fail	Fail	Fail	Fail
110	39	Pass	Fail	Pass	Pass	Fail	Pass
111	13	Pass	Pass	Pass	Pass	Pass	Pass
111	14	Pass	Pass	Pass	Pass	Pass	Pass

111	15	Pass	Pass	Pass	Pass	Pass	Pass
111	22	Pass	Fail	Pass	Pass	Fail	Pass
111	26	Pass	Pass	Pass	Pass	Pass	Pass
111	39	Pass	Fail	Pass	Pass	Fail	Pass
112	13	Pass	Fail	Pass	Pass	Fail	Pass
112	14	Pass	Pass	Pass	Pass	Pass	Pass
112	15	Pass	Pass	Pass	Pass	Pass	Pass
112	22	Pass	Fail	Pass	Pass	Fail	Pass
112	26	Pass	Fail	Pass	Pass	Fail	Pass
112	39	Pass	Fail	Pass	Pass	Fail	Pass
113	13	Pass	Fail	Pass	Pass	Pass	Pass
113	14	Pass	Pass	Pass	Pass	Pass	Pass
113	15	Pass	Pass	Pass	Pass	Pass	Pass
113	26	Pass	Fail	Pass	Pass	Fail	Pass
113	27	Pass	Fail	Pass	Pass	Fail	Pass
113	39	Pass	Pass	Pass	Pass	Pass	Pass
113	41	Fail	Fail	Fail	Fail	Fail	Fail
114	13	Pass	Pass	Pass	Pass	Pass	Pass
114	14	Pass	Pass	Pass	Pass	Pass	Pass
114	15	Pass	Pass	Pass	Pass	Pass	Pass
114	26	Pass	Fail	Pass	Pass	Fail	Pass
114	39	Pass	Pass	Pass	Pass	Pass	Pass
115	13	Pass	Pass	Pass	Pass	Pass	Pass
115	14	Pass	Pass	Pass	Pass	Pass	Pass
115	15	Pass	Pass	Pass	Pass	Pass	Pass
115	26	Pass	Fail	Pass	Pass	Fail	Pass
115	39	Pass	Pass	Pass	Pass	Pass	Pass
116	13	Pass	Pass	Pass	Pass	Pass	Pass
116	14	Pass	Pass	Pass	Pass	Pass	Pass
116	15	Pass	Pass	Pass	Pass	Pass	Pass
116	26	Pass	Fail	Pass	Pass	Fail	Pass
116	28	Fail	Fail	Fail	Fail	Fail	Fail
116	39	Pass	Pass	Pass	Pass	Pass	Pass
117	13	Pass	Pass	Pass	Pass	Pass	Pass
117	14	Pass	Pass	Pass	Pass	Pass	Pass
117	15	Pass	Pass	Pass	Pass	Pass	Pass
117	26	Pass	Fail	Pass	Pass	Fail	Pass
117	39	Pass	Pass	Pass	Pass	Pass	Pass
118	13	Pass	Pass	Pass	Pass	Pass	Pass
118	14	Pass	Pass	Pass	Pass	Pass	Pass
118	15	Pass	Fail	Pass	Pass	Pass	Pass
118	20	Pass	Fail	Pass	Pass	Fail	Pass
118	26	Pass	Fail	Pass	Pass	Fail	Pass
118	39	Pass	Pass	Pass	Pass	Pass	Pass
119	13	Pass	Pass	Pass	Pass	Pass	Pass
119	14	Pass	Pass	Pass	Pass	Pass	Pass
119	15	Pass	Pass	Pass	Pass	Pass	Pass
119	20	Pass	Fail	Pass	Pass	Fail	Pass
119	26	Pass	Fail	Pass	Pass	Fail	Pass
119	39	Pass	Pass	Pass	Pass	Pass	Pass
120	13	Pass	Pass	Pass	Pass	Pass	Pass
120	14	Pass	Pass	Pass	Pass	Pass	Pass
120	15	Pass	Fail	Pass	Pass	Fail	Pass
120	16	Pass	Fail	Pass	Pass	Fail	Pass
120	26	Pass	Fail	Pass	Pass	Fail	Pass
120	39	Pass	Pass	Pass	Pass	Pass	Pass
121	13	Pass	Pass	Pass	Pass	Pass	Pass

121	14	Pass	Pass	Pass	Pass	Pass	Pass
121	26	Pass	Fail	Pass	Pass	Fail	Pass
121	39	Pass	Pass	Pass	Pass	Pass	Pass
122	13	Pass	Pass	Pass	Pass	Pass	Pass
122	14	Pass	Pass	Pass	Pass	Pass	Pass
122	26	Pass	Fail	Pass	Pass	Fail	Pass
122	39	Pass	Pass	Pass	Pass	Pass	Pass
122	41	Fail	Fail	Fail	Fail	Fail	Fail
123	13	Pass	Pass	Pass	Pass	Pass	Pass
123	14	Pass	Pass	Pass	Pass	Pass	Pass
123	15	Pass	Fail	Pass	Pass	Fail	Pass
123	16	Pass	Pass	Pass	Pass	Pass	Pass
123	17	Pass	Pass	Pass	Pass	Pass	Pass
123	18	Pass	Pass	Pass	Pass	Pass	Pass
123	19	Pass	Pass	Pass	Pass	Pass	Pass
123	20	Pass	Pass	Pass	Pass	Pass	Pass
123	21	Pass	Pass	Pass	Pass	Pass	Pass
123	22	Pass	Pass	Pass	Pass	Pass	Pass
123	23	Pass	Pass	Pass	Pass	Pass	Pass
123	24	Pass	Pass	Pass	Pass	Pass	Pass
123	25	Pass	Pass	Pass	Pass	Pass	Pass
123	26	Pass	Pass	Pass	Pass	Pass	Pass
123	27	Pass	Pass	Pass	Pass	Pass	Pass
123	28	Pass	Pass	Pass	Pass	Pass	Pass
123	29	Pass	Fail	Pass	Pass	Fail	Pass
123	30	Pass	Fail	Pass	Pass	Fail	Pass
123	31	Pass	Fail	Pass	Pass	Fail	Pass
123	32	Pass	Fail	Pass	Pass	Fail	Pass
123	33	Pass	Fail	Pass	Pass	Fail	Pass
123	34	Pass	Pass	Pass	Pass	Pass	Pass
123	35	Pass	Pass	Pass	Pass	Pass	Pass
123	36	Pass	Pass	Pass	Pass	Pass	Pass
123	37	Pass	Fail	Pass	Pass	Fail	Pass
123	38	Pass	Fail	Pass	Pass	Fail	Pass
123	39	Pass	Fail	Pass	Pass	Fail	Pass
124	13	Pass	Pass	Pass	Pass	Pass	Pass
124	14	Pass	Pass	Pass	Pass	Pass	Pass
124	23	Pass	Fail	Pass	Pass	Fail	Pass
125	13	Pass	Pass	Pass	Pass	Pass	Pass
125	14	Pass	Fail	Pass	Pass	Pass	Pass
125	23	Pass	Pass	Pass	Pass	Pass	Pass
125	28	Fail	Fail	Fail	Fail	Fail	Fail
125	33	Fail	Fail	Fail	Fail	Fail	Fail
126	13	Pass	Pass	Pass	Pass	Pass	Pass
126	14	Pass	Pass	Pass	Pass	Pass	Pass
126	23	Pass	Pass	Pass	Pass	Pass	Pass
127	13	Pass	Pass	Pass	Pass	Pass	Pass
127	14	Pass	Pass	Pass	Pass	Pass	Pass
127	23	Pass	Pass	Pass	Pass	Pass	Pass
128	13	Pass	Pass	Pass	Pass	Pass	Pass
128	14	Pass	Pass	Pass	Pass	Pass	Pass
128	23	Pass	Pass	Pass	Pass	Pass	Pass
129	13	Pass	Pass	Pass	Pass	Pass	Pass
129	14	Pass	Pass	Pass	Pass	Pass	Pass
129	23	Pass	Pass	Pass	Pass	Pass	Pass
130	8	Pass	Fail	Pass	Pass	Fail	Pass
130	9	Pass	Fail	Pass	Pass	Fail	Pass

130	10	Pass	Fail	Pass	Pass	Fail	Pass
130	11	Pass	Fail	Pass	Pass	Fail	Pass
130	12	Pass	Fail	Pass	Pass	Fail	Pass
130	13	Pass	Fail	Pass	Pass	Fail	Pass
130	14	Pass	Pass	Pass	Pass	Pass	Pass
130	23	Pass	Pass	Pass	Pass	Pass	Pass
131	14	Pass	Pass	Pass	Pass	Pass	Pass
131	23	Pass	Pass	Pass	Pass	Pass	Pass
132	14	Pass	Pass	Pass	Pass	Pass	Pass
132	23	Pass	Pass	Pass	Pass	Pass	Pass
133	14	Pass	Pass	Pass	Pass	Pass	Pass
133	23	Pass	Pass	Pass	Pass	Pass	Pass
134	14	Pass	Pass	Pass	Pass	Pass	Pass
134	23	Pass	Fail	Pass	Pass	Fail	Pass
135	14	Pass	Pass	Pass	Pass	Pass	Pass
136	14	Pass	Pass	Pass	Pass	Pass	Pass
137	14	Pass	Pass	Pass	Pass	Pass	Pass
138	14	Pass	Pass	Pass	Pass	Pass	Pass

3. Table D.7.3 Striped Bass eggs D.O. , Salinity, and Velocity criteria passing for existing and deepening (3 ft) scenarios within the analyzed period April 1 - April 30, 1997

HABITAT REQUIREMENTS:
RM 10-31; Depth Average
D.O. April (MG/L):10th %ile >=4.5
Salinity 50th %ile <= 9 ppt
Mean Velocity >= 30 cm/s

Savannah Harbor Estuary

Segments		Baseline Scenario			Project Scenario		
J	I	Salinity	Velocity	D.O.	Salinity	Velocity	D.O.
47	13	Fail	Pass	Pass	Fail	Pass	Pass
47	14	Fail	Pass	Pass	Fail	Pass	Pass
47	15	Fail	Pass	Pass	Fail	Pass	Pass
47	16	Fail	Pass	Pass	Fail	Pass	Pass
47	17	Fail	Fail	Pass	Fail	Fail	Pass
48	13	Fail	Pass	Pass	Fail	Pass	Pass
48	14	Fail	Pass	Pass	Fail	Pass	Pass
48	15	Fail	Pass	Pass	Fail	Pass	Pass
48	16	Fail	Pass	Pass	Fail	Pass	Pass
48	17	Fail	Pass	Pass	Fail	Pass	Pass
49	13	Fail	Pass	Pass	Fail	Pass	Pass
49	14	Fail	Pass	Pass	Fail	Pass	Pass
49	15	Pass	Pass	Pass	Fail	Pass	Pass
49	16	Fail	Pass	Pass	Fail	Pass	Pass
49	17	Fail	Pass	Pass	Fail	Pass	Pass
50	13	Pass	Pass	Pass	Fail	Pass	Pass
50	14	Fail	Pass	Pass	Fail	Pass	Pass
50	15	Fail	Fail	Pass	Fail	Fail	Pass
50	16	Fail	Fail	Pass	Fail	Fail	Pass
50	17	Fail	Fail	Pass	Fail	Fail	Pass
50	18	Pass	Fail	Pass	Pass	Fail	Pass
51	13	Pass	Pass	Pass	Fail	Pass	Pass
51	14	Fail	Pass	Pass	Fail	Pass	Pass
51	15	Pass	Pass	Pass	Fail	Pass	Pass
52	13	Pass	Pass	Pass	Fail	Pass	Pass
52	14	Fail	Pass	Pass	Fail	Pass	Pass
52	15	Pass	Pass	Pass	Fail	Pass	Pass
53	13	Pass	Pass	Pass	Fail	Pass	Pass
53	14	Fail	Pass	Pass	Fail	Pass	Pass
53	15	Pass	Pass	Pass	Pass	Pass	Pass
54	13	Pass	Pass	Pass	Pass	Pass	Pass
54	14	Fail	Pass	Pass	Fail	Pass	Pass
54	15	Pass	Pass	Pass	Pass	Pass	Pass
55	13	Pass	Pass	Pass	Pass	Pass	Pass
55	14	Fail	Pass	Pass	Fail	Pass	Pass
55	15	Pass	Pass	Pass	Pass	Pass	Pass
56	13	Pass	Pass	Pass	Pass	Pass	Pass
56	14	Fail	Pass	Pass	Fail	Pass	Pass
56	15	Pass	Pass	Pass	Pass	Pass	Pass

57	13	Pass	Pass	Pass	Pass	Pass	Pass
57	14	Fail	Pass	Pass	Fail	Pass	Pass
57	15	Pass	Pass	Pass	Pass	Pass	Pass
58	13	Pass	Pass	Pass	Pass	Pass	Pass
58	14	Fail	Pass	Pass	Fail	Pass	Pass
58	15	Pass	Pass	Pass	Pass	Pass	Pass
59	13	Pass	Pass	Pass	Pass	Pass	Pass
59	14	Pass	Pass	Pass	Fail	Pass	Pass
59	15	Pass	Pass	Pass	Pass	Pass	Pass
59	30	Pass	Fail	Pass	Fail	Fail	Pass
59	31	Fail	Fail	Pass	Fail	Fail	Pass
59	32	Pass	Fail	Pass	Pass	Fail	Pass
60	13	Pass	Pass	Pass	Pass	Pass	Pass
60	14	Pass	Pass	Pass	Fail	Pass	Pass
60	15	Pass	Pass	Pass	Pass	Pass	Pass
60	30	Pass	Fail	Pass	Pass	Fail	Pass
60	31	Fail	Fail	Pass	Fail	Fail	Pass
60	32	Pass	Fail	Pass	Pass	Fail	Pass
61	13	Pass	Pass	Pass	Pass	Pass	Pass
61	14	Pass	Pass	Pass	Fail	Pass	Pass
61	15	Pass	Pass	Pass	Pass	Pass	Pass
61	30	Pass	Fail	Pass	Pass	Fail	Pass
61	31	Fail	Fail	Pass	Fail	Fail	Pass
61	32	Pass	Fail	Pass	Pass	Fail	Pass
62	13	Pass	Pass	Pass	Pass	Pass	Pass
62	14	Pass	Pass	Pass	Fail	Pass	Pass
62	15	Pass	Pass	Pass	Pass	Pass	Pass
62	30	Pass	Fail	Pass	Pass	Fail	Pass
62	31	Fail	Fail	Pass	Fail	Fail	Pass
62	32	Pass	Fail	Pass	Pass	Fail	Pass
63	13	Pass	Pass	Pass	Pass	Pass	Pass
63	14	Pass	Pass	Pass	Fail	Pass	Pass
63	15	Pass	Pass	Pass	Pass	Pass	Pass
63	31	Pass	Pass	Pass	Pass	Pass	Pass
64	13	Pass	Pass	Pass	Pass	Pass	Pass
64	14	Pass	Pass	Pass	Fail	Pass	Pass
64	15	Pass	Pass	Pass	Pass	Pass	Pass
64	30	Pass	Fail	Pass	Pass	Fail	Pass
64	31	Pass	Pass	Pass	Pass	Pass	Pass
64	32	Pass	Fail	Pass	Fail	Fail	Pass
65	13	Pass	Pass	Pass	Pass	Pass	Pass
65	14	Pass	Pass	Pass	Pass	Pass	Pass
65	15	Pass	Pass	Pass	Pass	Pass	Pass
65	30	Pass	Fail	Pass	Pass	Fail	Pass
65	31	Pass	Pass	Pass	Pass	Pass	Pass
65	32	Pass	Fail	Pass	Pass	Fail	Pass
65	33	Pass	Fail	Pass	Fail	Fail	Pass
66	13	Pass	Pass	Pass	Pass	Pass	Pass
66	14	Pass	Pass	Pass	Pass	Pass	Pass
66	15	Pass	Fail	Pass	Pass	Fail	Pass
66	30	Pass	Fail	Pass	Pass	Fail	Pass
66	31	Pass	Pass	Pass	Pass	Pass	Pass
66	32	Pass	Fail	Pass	Pass	Fail	Pass
66	36	Pass	Fail	Pass	Fail	Fail	Pass
66	38	Fail	Fail	Fail	Fail	Fail	Fail
67	13	Pass	Pass	Pass	Pass	Pass	Pass
67	14	Pass	Pass	Pass	Pass	Pass	Pass

67	15	Pass	Fail	Pass	Pass	Fail	Pass
67	30	Pass	Fail	Pass	Pass	Fail	Pass
67	31	Pass	Pass	Pass	Pass	Pass	Pass
67	32	Pass	Fail	Pass	Pass	Fail	Pass
67	36	Pass	Fail	Pass	Pass	Fail	Pass
68	13	Pass	Pass	Pass	Pass	Pass	Pass
68	14	Pass	Pass	Pass	Pass	Pass	Pass
68	15	Pass	Fail	Pass	Pass	Fail	Pass
68	30	Pass	Fail	Pass	Pass	Fail	Pass
68	31	Pass	Pass	Pass	Pass	Pass	Pass
68	32	Pass	Fail	Pass	Pass	Fail	Pass
68	36	Pass	Fail	Pass	Pass	Fail	Pass
68	38	Fail	Fail	Fail	Fail	Fail	Fail
69	13	Pass	Pass	Pass	Pass	Pass	Pass
69	14	Pass	Pass	Pass	Pass	Pass	Pass
69	15	Pass	Fail	Pass	Pass	Fail	Pass
69	30	Pass	Pass	Pass	Pass	Pass	Pass
69	31	Pass	Pass	Pass	Pass	Pass	Pass
69	32	Pass	Fail	Pass	Pass	Fail	Pass
69	36	Pass	Fail	Pass	Pass	Fail	Pass
70	13	Pass	Pass	Pass	Pass	Pass	Pass
70	14	Pass	Pass	Pass	Pass	Pass	Pass
70	15	Pass	Fail	Pass	Pass	Fail	Pass
70	30	Pass	Fail	Pass	Pass	Fail	Pass
70	31	Pass	Fail	Pass	Pass	Fail	Pass
70	32	Pass	Fail	Pass	Pass	Fail	Pass
70	33	Pass	Fail	Pass	Pass	Fail	Pass
71	13	Pass	Pass	Pass	Pass	Pass	Pass
71	14	Pass	Pass	Pass	Pass	Pass	Pass
71	15	Pass	Pass	Pass	Pass	Pass	Pass
71	30	Pass	Fail	Pass	Pass	Fail	Pass
71	31	Pass	Fail	Pass	Pass	Fail	Pass
71	32	Pass	Fail	Pass	Pass	Fail	Pass
72	13	Pass	Pass	Pass	Pass	Pass	Pass
72	14	Pass	Pass	Pass	Pass	Pass	Pass
72	15	Pass	Pass	Pass	Pass	Pass	Pass
72	30	Pass	Fail	Pass	Pass	Fail	Pass
72	31	Pass	Fail	Pass	Pass	Fail	Pass
72	32	Pass	Fail	Pass	Pass	Fail	Pass
73	13	Pass	Pass	Pass	Pass	Pass	Pass
73	14	Pass	Pass	Pass	Pass	Pass	Pass
73	15	Pass	Pass	Pass	Pass	Pass	Pass
73	30	Pass	Fail	Pass	Pass	Fail	Pass
73	31	Pass	Fail	Pass	Pass	Fail	Pass
74	13	Pass	Pass	Pass	Pass	Pass	Pass
74	14	Pass	Pass	Pass	Pass	Pass	Pass
74	15	Pass	Pass	Pass	Pass	Pass	Pass
74	30	Pass	Fail	Pass	Pass	Fail	Pass
74	31	Pass	Fail	Pass	Pass	Fail	Pass
75	13	Pass	Pass	Pass	Pass	Pass	Pass
75	14	Pass	Pass	Pass	Pass	Pass	Pass
75	15	Pass	Pass	Pass	Pass	Pass	Pass
75	30	Pass	Fail	Pass	Pass	Fail	Pass
75	31	Pass	Fail	Pass	Pass	Fail	Pass
76	13	Pass	Fail	Pass	Pass	Fail	Pass
76	14	Pass	Pass	Pass	Pass	Pass	Pass
76	15	Pass	Fail	Pass	Pass	Fail	Pass

76	16	Pass	Fail	Pass	Pass	Fail	Pass
76	17	Pass	Fail	Pass	Pass	Fail	Pass
76	30	Pass	Fail	Pass	Pass	Fail	Pass
76	31	Pass	Fail	Pass	Pass	Fail	Pass
76	33	Fail	Fail	Fail	Fail	Fail	Fail
77	13	Pass	Fail	Pass	Pass	Fail	Pass
77	14	Pass	Fail	Pass	Pass	Fail	Pass
77	15	Pass	Fail	Pass	Pass	Fail	Pass
77	16	Pass	Fail	Pass	Pass	Fail	Pass
77	17	Pass	Fail	Pass	Pass	Fail	Pass
77	30	Pass	Fail	Pass	Pass	Fail	Pass
77	31	Pass	Fail	Pass	Pass	Fail	Pass
78	13	Pass	Fail	Pass	Pass	Fail	Pass
78	14	Pass	Pass	Pass	Pass	Fail	Pass
78	15	Pass	Fail	Pass	Pass	Fail	Pass
78	16	Pass	Fail	Pass	Pass	Fail	Pass
78	17	Pass	Fail	Pass	Pass	Fail	Pass
78	30	Pass	Fail	Pass	Pass	Fail	Pass
78	31	Pass	Fail	Pass	Pass	Fail	Pass
79	13	Pass	Fail	Pass	Pass	Fail	Pass
79	14	Pass	Pass	Pass	Pass	Pass	Pass
79	15	Pass	Fail	Pass	Pass	Fail	Pass
79	30	Pass	Fail	Pass	Pass	Fail	Pass
79	31	Pass	Fail	Pass	Pass	Fail	Pass
80	13	Pass	Fail	Pass	Pass	Fail	Pass
80	14	Pass	Pass	Pass	Pass	Pass	Pass
80	15	Pass	Fail	Pass	Pass	Fail	Pass
80	30	Pass	Fail	Pass	Pass	Fail	Pass
80	31	Pass	Fail	Pass	Pass	Fail	Pass
81	13	Pass	Pass	Pass	Pass	Pass	Pass
81	14	Pass	Pass	Pass	Pass	Pass	Pass
81	15	Pass	Fail	Pass	Pass	Fail	Pass
81	30	Pass	Fail	Pass	Pass	Fail	Pass
81	31	Pass	Fail	Pass	Pass	Fail	Pass
82	13	Pass	Pass	Pass	Pass	Pass	Pass
82	14	Pass	Pass	Pass	Pass	Pass	Pass
82	15	Pass	Pass	Pass	Pass	Pass	Pass
82	16	Pass	Fail	Pass	Pass	Fail	Pass
82	17	Pass	Fail	Pass	Pass	Fail	Pass
82	18	Pass	Fail	Pass	Pass	Fail	Pass
82	19	Pass	Fail	Pass	Pass	Fail	Pass
82	20	Pass	Fail	Pass	Pass	Fail	Pass
82	21	Pass	Fail	Pass	Pass	Fail	Pass
82	29	Pass	Fail	Pass	Pass	Fail	Pass
82	30	Pass	Fail	Pass	Pass	Fail	Pass
82	31	Pass	Fail	Pass	Pass	Fail	Pass
83	13	Pass	Pass	Pass	Pass	Pass	Pass
83	14	Pass	Pass	Pass	Pass	Pass	Pass
83	15	Pass	Pass	Pass	Pass	Pass	Pass
83	21	Pass	Fail	Pass	Pass	Fail	Pass
83	30	Pass	Fail	Pass	Pass	Fail	Pass
83	31	Pass	Fail	Pass	Pass	Fail	Pass
84	13	Pass	Pass	Pass	Pass	Pass	Pass
84	14	Pass	Pass	Pass	Pass	Pass	Pass
84	15	Pass	Pass	Pass	Pass	Pass	Pass
84	21	Pass	Fail	Pass	Pass	Fail	Pass
84	30	Pass	Fail	Pass	Pass	Fail	Pass

84	31	Pass	Fail	Pass	Pass	Fail	Pass
85	13	Pass	Pass	Pass	Pass	Pass	Pass
85	14	Pass	Pass	Pass	Pass	Pass	Pass
85	15	Pass	Pass	Pass	Pass	Pass	Pass
85	21	Pass	Fail	Pass	Pass	Fail	Pass
85	30	Pass	Fail	Pass	Pass	Fail	Pass
86	13	Pass	Pass	Pass	Pass	Pass	Pass
86	14	Pass	Pass	Pass	Pass	Pass	Pass
86	15	Pass	Pass	Pass	Pass	Pass	Pass
86	17	Fail	Fail	Fail	Fail	Fail	Fail
86	21	Pass	Pass	Pass	Pass	Fail	Pass
86	30	Pass	Pass	Pass	Pass	Pass	Pass
87	13	Pass	Pass	Pass	Pass	Pass	Pass
87	14	Pass	Pass	Pass	Pass	Pass	Pass
87	15	Pass	Pass	Pass	Pass	Pass	Pass
87	30	Pass	Fail	Pass	Pass	Fail	Pass
87	32	Fail	Fail	Fail	Fail	Fail	Fail
88	13	Pass	Pass	Pass	Pass	Pass	Pass
88	14	Pass	Pass	Pass	Pass	Pass	Pass
88	15	Pass	Pass	Pass	Pass	Pass	Pass
88	30	Pass	Fail	Pass	Pass	Fail	Pass
89	13	Pass	Pass	Pass	Pass	Pass	Pass
89	14	Pass	Pass	Pass	Pass	Pass	Pass
89	15	Pass	Pass	Pass	Pass	Pass	Pass
89	30	Pass	Fail	Pass	Pass	Fail	Pass
90	13	Pass	Pass	Pass	Pass	Pass	Pass
90	14	Pass	Pass	Pass	Pass	Pass	Pass
90	15	Pass	Pass	Pass	Pass	Pass	Pass
90	30	Pass	Fail	Pass	Pass	Fail	Pass
91	13	Pass	Pass	Pass	Pass	Pass	Pass
91	14	Pass	Pass	Pass	Pass	Pass	Pass
91	15	Pass	Pass	Pass	Pass	Pass	Pass
91	16	Pass	Fail	Pass	Pass	Fail	Pass
91	30	Pass	Fail	Pass	Pass	Fail	Pass
92	13	Pass	Pass	Pass	Pass	Pass	Pass
92	14	Pass	Pass	Pass	Pass	Pass	Pass
92	15	Pass	Pass	Pass	Pass	Pass	Pass
92	16	Pass	Fail	Pass	Pass	Fail	Pass
92	30	Pass	Fail	Pass	Pass	Fail	Pass
92	32	Fail	Fail	Fail	Fail	Fail	Fail
93	13	Pass	Pass	Pass	Pass	Pass	Pass
93	14	Pass	Pass	Pass	Pass	Pass	Pass
93	15	Pass	Pass	Pass	Pass	Pass	Pass
93	16	Pass	Pass	Pass	Pass	Pass	Pass
93	30	Pass	Fail	Pass	Pass	Fail	Pass
94	13	Pass	Pass	Pass	Pass	Pass	Pass
94	14	Pass	Pass	Pass	Pass	Pass	Pass
94	15	Pass	Pass	Pass	Pass	Pass	Pass
94	16	Pass	Fail	Pass	Pass	Fail	Pass
94	26	Pass	Pass	Pass	Pass	Pass	Pass
94	30	Pass	Fail	Pass	Pass	Fail	Pass
95	13	Pass	Pass	Pass	Pass	Pass	Pass
95	14	Pass	Pass	Pass	Pass	Pass	Pass
95	15	Pass	Pass	Pass	Pass	Pass	Pass
95	16	Pass	Fail	Pass	Pass	Fail	Pass
95	26	Pass	Fail	Pass	Pass	Fail	Pass
95	28	Fail	Fail	Fail	Fail	Fail	Fail

95	30	Pass	Fail	Pass	Pass	Fail	Pass
96	11	Fail	Fail	Fail	Fail	Fail	Fail
96	13	Pass	Pass	Pass	Pass	Pass	Pass
96	14	Pass	Pass	Pass	Pass	Pass	Pass
96	15	Pass	Pass	Pass	Pass	Pass	Pass
96	26	Pass	Fail	Pass	Pass	Fail	Pass
96	30	Pass	Fail	Pass	Pass	Fail	Pass
97	13	Pass	Pass	Pass	Pass	Pass	Pass
97	14	Pass	Pass	Pass	Pass	Pass	Pass
97	15	Pass	Fail	Pass	Pass	Fail	Pass
97	26	Pass	Fail	Pass	Pass	Fail	Pass
97	30	Pass	Fail	Pass	Pass	Fail	Pass
98	13	Pass	Fail	Pass	Pass	Fail	Pass
98	14	Pass	Pass	Pass	Pass	Pass	Pass
98	15	Pass	Fail	Pass	Pass	Fail	Pass
98	26	Pass	Fail	Pass	Pass	Fail	Pass
98	27	Pass	Pass	Pass	Pass	Pass	Pass
98	28	Pass	Pass	Pass	Pass	Pass	Pass
98	29	Pass	Pass	Pass	Pass	Pass	Pass
98	30	Pass	Fail	Pass	Pass	Fail	Pass
99	13	Pass	Pass	Pass	Pass	Pass	Pass
99	14	Pass	Pass	Pass	Pass	Pass	Pass
99	15	Pass	Fail	Pass	Pass	Fail	Pass
99	16	Pass	Fail	Pass	Pass	Fail	Pass
99	17	Pass	Fail	Pass	Pass	Fail	Pass
99	18	Pass	Fail	Pass	Pass	Fail	Pass
99	19	Pass	Fail	Pass	Pass	Fail	Pass
99	20	Pass	Fail	Pass	Pass	Fail	Pass
99	21	Pass	Fail	Pass	Pass	Fail	Pass
99	22	Pass	Fail	Pass	Pass	Fail	Pass
99	23	Pass	Fail	Pass	Pass	Fail	Pass
99	26	Pass	Fail	Pass	Pass	Fail	Pass
99	30	Pass	Fail	Pass	Pass	Fail	Pass
100	13	Pass	Pass	Pass	Pass	Pass	Pass
100	14	Pass	Pass	Pass	Pass	Pass	Pass
100	15	Pass	Fail	Pass	Pass	Pass	Pass
100	23	Pass	Fail	Pass	Pass	Fail	Pass
100	24	Pass	Fail	Pass	Pass	Fail	Pass
100	25	Pass	Fail	Pass	Pass	Fail	Pass
100	26	Pass	Fail	Pass	Pass	Fail	Pass
100	30	Pass	Fail	Pass	Pass	Fail	Pass
101	13	Pass	Pass	Pass	Pass	Pass	Pass
101	14	Pass	Pass	Pass	Pass	Pass	Pass
101	15	Pass	Pass	Pass	Pass	Pass	Pass
101	16	Pass	Fail	Pass	Pass	Fail	Pass
101	17	Pass	Fail	Pass	Pass	Fail	Pass
101	18	Pass	Fail	Pass	Pass	Fail	Pass
101	19	Pass	Fail	Pass	Pass	Fail	Pass
101	20	Pass	Fail	Pass	Pass	Fail	Pass
101	21	Pass	Fail	Pass	Pass	Fail	Pass
101	22	Pass	Fail	Pass	Pass	Fail	Pass
101	23	Pass	Fail	Pass	Pass	Fail	Pass
101	26	Pass	Pass	Pass	Pass	Pass	Pass
101	30	Pass	Fail	Pass	Pass	Fail	Pass
102	13	Pass	Pass	Pass	Pass	Pass	Pass
102	14	Pass	Pass	Pass	Pass	Pass	Pass
102	15	Pass	Pass	Pass	Pass	Pass	Pass

102	26	Pass	Pass	Pass	Pass	Pass	Pass
102	30	Pass	Fail	Pass	Pass	Fail	Pass
103	13	Pass	Pass	Pass	Pass	Pass	Pass
103	14	Pass	Pass	Pass	Pass	Pass	Pass
103	15	Pass	Pass	Pass	Pass	Pass	Pass
103	26	Pass	Pass	Pass	Pass	Pass	Pass
103	30	Pass	Pass	Pass	Pass	Pass	Pass
104	11	Fail	Fail	Fail	Fail	Fail	Fail
104	13	Pass	Fail	Pass	Pass	Fail	Pass
104	14	Pass	Pass	Pass	Pass	Pass	Pass
104	15	Pass	Pass	Pass	Pass	Pass	Pass
104	26	Pass	Pass	Pass	Pass	Pass	Pass
104	30	Pass	Fail	Pass	Pass	Fail	Pass
105	13	Pass	Fail	Pass	Pass	Fail	Pass
105	14	Pass	Pass	Pass	Pass	Pass	Pass
105	15	Pass	Pass	Pass	Pass	Pass	Pass
105	26	Pass	Pass	Pass	Pass	Pass	Pass
105	30	Pass	Fail	Pass	Pass	Fail	Pass
106	13	Pass	Fail	Pass	Pass	Fail	Pass
106	14	Pass	Pass	Pass	Pass	Pass	Pass
106	15	Pass	Pass	Pass	Pass	Pass	Pass
106	26	Pass	Pass	Pass	Pass	Pass	Pass
106	27	Pass	Fail	Pass	Pass	Fail	Pass
106	30	Pass	Fail	Pass	Pass	Fail	Pass
106	39	Pass	Fail	Pass	Pass	Fail	Pass
107	13	Pass	Pass	Pass	Pass	Pass	Pass
107	14	Pass	Pass	Pass	Pass	Pass	Pass
107	15	Pass	Fail	Pass	Pass	Fail	Pass
107	22	Pass	Fail	Pass	Pass	Fail	Pass
107	26	Pass	Fail	Pass	Pass	Fail	Pass
107	30	Pass	Fail	Pass	Pass	Fail	Pass
107	39	Pass	Fail	Pass	Pass	Fail	Pass
108	13	Pass	Pass	Pass	Pass	Pass	Pass
108	14	Pass	Pass	Pass	Pass	Pass	Pass
108	15	Pass	Pass	Pass	Pass	Pass	Pass
108	22	Pass	Pass	Pass	Pass	Pass	Pass
108	24	Fail	Fail	Fail	Fail	Fail	Fail
108	26	Pass	Fail	Pass	Pass	Fail	Pass
108	30	Pass	Fail	Pass	Pass	Fail	Pass
108	39	Pass	Fail	Pass	Pass	Fail	Pass
109	13	Pass	Pass	Pass	Pass	Pass	Pass
109	14	Pass	Pass	Pass	Pass	Pass	Pass
109	15	Pass	Pass	Pass	Pass	Pass	Pass
109	22	Pass	Fail	Pass	Pass	Fail	Pass
109	26	Pass	Pass	Pass	Pass	Pass	Pass
109	30	Pass	Fail	Pass	Pass	Fail	Pass
109	39	Pass	Pass	Pass	Pass	Pass	Pass
110	13	Pass	Pass	Pass	Pass	Pass	Pass
110	14	Pass	Pass	Pass	Pass	Pass	Pass
110	15	Pass	Pass	Pass	Pass	Pass	Pass
110	22	Pass	Fail	Pass	Pass	Fail	Pass
110	26	Pass	Pass	Pass	Pass	Pass	Pass
110	28	Fail	Fail	Fail	Fail	Fail	Fail
110	39	Pass	Fail	Pass	Pass	Fail	Pass
111	13	Pass	Pass	Pass	Pass	Pass	Pass
111	14	Pass	Pass	Pass	Pass	Pass	Pass
111	15	Pass	Pass	Pass	Pass	Pass	Pass

111	22	Pass	Fail	Pass	Pass	Fail	Pass
111	26	Pass	Pass	Pass	Pass	Pass	Pass
111	39	Pass	Fail	Pass	Pass	Fail	Pass
112	13	Pass	Fail	Pass	Pass	Fail	Pass
112	14	Pass	Pass	Pass	Pass	Pass	Pass
112	15	Pass	Pass	Pass	Pass	Pass	Pass
112	22	Pass	Fail	Pass	Pass	Fail	Pass
112	26	Pass	Fail	Pass	Pass	Fail	Pass
112	39	Pass	Fail	Pass	Pass	Fail	Pass
113	13	Pass	Fail	Pass	Pass	Pass	Pass
113	14	Pass	Pass	Pass	Pass	Pass	Pass
113	15	Pass	Pass	Pass	Pass	Pass	Pass
113	26	Pass	Fail	Pass	Pass	Fail	Pass
113	27	Pass	Fail	Pass	Pass	Fail	Pass
113	39	Pass	Pass	Pass	Pass	Pass	Pass
113	41	Fail	Fail	Fail	Fail	Fail	Fail
114	13	Pass	Pass	Pass	Pass	Pass	Pass
114	14	Pass	Pass	Pass	Pass	Pass	Pass
114	15	Pass	Pass	Pass	Pass	Pass	Pass
114	26	Pass	Fail	Pass	Pass	Fail	Pass
114	39	Pass	Pass	Pass	Pass	Pass	Pass
115	13	Pass	Pass	Pass	Pass	Pass	Pass
115	14	Pass	Pass	Pass	Pass	Pass	Pass
115	15	Pass	Pass	Pass	Pass	Pass	Pass
115	26	Pass	Fail	Pass	Pass	Fail	Pass
115	39	Pass	Pass	Pass	Pass	Pass	Pass
116	13	Pass	Pass	Pass	Pass	Pass	Pass
116	14	Pass	Pass	Pass	Pass	Pass	Pass
116	15	Pass	Pass	Pass	Pass	Pass	Pass
116	26	Pass	Fail	Pass	Pass	Fail	Pass
116	28	Fail	Fail	Fail	Fail	Fail	Fail
116	39	Pass	Pass	Pass	Pass	Pass	Pass
117	13	Pass	Pass	Pass	Pass	Pass	Pass
117	14	Pass	Pass	Pass	Pass	Pass	Pass
117	15	Pass	Pass	Pass	Pass	Pass	Pass
117	26	Pass	Fail	Pass	Pass	Fail	Pass
117	39	Pass	Pass	Pass	Pass	Pass	Pass
118	13	Pass	Pass	Pass	Pass	Pass	Pass
118	14	Pass	Pass	Pass	Pass	Pass	Pass
118	15	Pass	Fail	Pass	Pass	Pass	Pass
118	20	Pass	Fail	Pass	Pass	Fail	Pass
118	26	Pass	Fail	Pass	Pass	Fail	Pass
118	39	Pass	Pass	Pass	Pass	Pass	Pass
119	13	Pass	Pass	Pass	Pass	Pass	Pass
119	14	Pass	Pass	Pass	Pass	Pass	Pass
119	15	Pass	Pass	Pass	Pass	Pass	Pass
119	20	Pass	Fail	Pass	Pass	Fail	Pass
119	26	Pass	Fail	Pass	Pass	Fail	Pass
119	39	Pass	Pass	Pass	Pass	Pass	Pass
120	13	Pass	Pass	Pass	Pass	Pass	Pass
120	14	Pass	Pass	Pass	Pass	Pass	Pass
120	15	Pass	Fail	Pass	Pass	Fail	Pass
120	16	Pass	Fail	Pass	Pass	Fail	Pass
120	26	Pass	Fail	Pass	Pass	Fail	Pass
120	39	Pass	Pass	Pass	Pass	Pass	Pass
121	13	Pass	Pass	Pass	Pass	Pass	Pass
121	14	Pass	Pass	Pass	Pass	Pass	Pass

121	26	Pass	Fail	Pass	Pass	Fail	Pass
121	39	Pass	Pass	Pass	Pass	Pass	Pass
122	13	Pass	Pass	Pass	Pass	Pass	Pass
122	14	Pass	Pass	Pass	Pass	Pass	Pass
122	26	Pass	Fail	Pass	Pass	Fail	Pass
122	39	Pass	Pass	Pass	Pass	Pass	Pass
122	41	Fail	Fail	Fail	Fail	Fail	Fail
123	13	Pass	Pass	Pass	Pass	Pass	Pass
123	14	Pass	Pass	Pass	Pass	Pass	Pass
123	15	Pass	Fail	Pass	Pass	Fail	Pass
123	16	Pass	Pass	Pass	Pass	Pass	Pass
123	17	Pass	Pass	Pass	Pass	Pass	Pass
123	18	Pass	Pass	Pass	Pass	Pass	Pass
123	19	Pass	Pass	Pass	Pass	Pass	Pass
123	20	Pass	Pass	Pass	Pass	Pass	Pass
123	21	Pass	Pass	Pass	Pass	Pass	Pass
123	22	Pass	Pass	Pass	Pass	Pass	Pass
123	23	Pass	Pass	Pass	Pass	Pass	Pass
123	24	Pass	Pass	Pass	Pass	Pass	Pass
123	25	Pass	Pass	Pass	Pass	Pass	Pass
123	26	Pass	Pass	Pass	Pass	Pass	Pass
123	27	Pass	Pass	Pass	Pass	Pass	Pass
123	28	Pass	Pass	Pass	Pass	Pass	Pass
123	29	Pass	Fail	Pass	Pass	Fail	Pass
123	30	Pass	Fail	Pass	Pass	Fail	Pass
123	31	Pass	Fail	Pass	Pass	Fail	Pass
123	32	Pass	Fail	Pass	Pass	Fail	Pass
123	33	Pass	Fail	Pass	Pass	Fail	Pass
123	34	Pass	Pass	Pass	Pass	Pass	Pass
123	35	Pass	Pass	Pass	Pass	Pass	Pass
123	36	Pass	Pass	Pass	Pass	Pass	Pass
123	37	Pass	Fail	Pass	Pass	Fail	Pass
123	38	Pass	Fail	Pass	Pass	Fail	Pass
123	39	Pass	Fail	Pass	Pass	Fail	Pass
124	13	Pass	Pass	Pass	Pass	Pass	Pass
124	14	Pass	Pass	Pass	Pass	Pass	Pass
124	23	Pass	Fail	Pass	Pass	Fail	Pass
125	13	Pass	Pass	Pass	Pass	Pass	Pass
125	14	Pass	Fail	Pass	Pass	Pass	Pass
125	23	Pass	Pass	Pass	Pass	Pass	Pass
125	28	Fail	Fail	Fail	Fail	Fail	Fail
125	33	Fail	Fail	Fail	Fail	Fail	Fail
126	13	Pass	Pass	Pass	Pass	Pass	Pass
126	14	Pass	Pass	Pass	Pass	Pass	Pass
126	23	Pass	Pass	Pass	Pass	Pass	Pass
127	13	Pass	Pass	Pass	Pass	Pass	Pass
127	14	Pass	Pass	Pass	Pass	Pass	Pass
127	23	Pass	Pass	Pass	Pass	Pass	Pass
128	13	Pass	Pass	Pass	Pass	Pass	Pass
128	14	Pass	Pass	Pass	Pass	Pass	Pass
128	23	Pass	Pass	Pass	Pass	Pass	Pass
129	13	Pass	Pass	Pass	Pass	Pass	Pass
129	14	Pass	Pass	Pass	Pass	Pass	Pass
129	23	Pass	Pass	Pass	Pass	Pass	Pass
130	8	Pass	Fail	Pass	Pass	Fail	Pass
130	9	Pass	Fail	Pass	Pass	Fail	Pass
130	10	Pass	Fail	Pass	Pass	Fail	Pass

130	11	Pass	Fail	Pass	Pass	Fail	Pass
130	12	Pass	Fail	Pass	Pass	Fail	Pass
130	13	Pass	Fail	Pass	Pass	Fail	Pass
130	14	Pass	Pass	Pass	Pass	Pass	Pass
130	23	Pass	Pass	Pass	Pass	Pass	Pass
131	14	Pass	Pass	Pass	Pass	Pass	Pass
131	23	Pass	Pass	Pass	Pass	Pass	Pass
132	14	Pass	Pass	Pass	Pass	Pass	Pass
132	23	Pass	Pass	Pass	Pass	Pass	Pass
133	14	Pass	Pass	Pass	Pass	Pass	Pass
133	23	Pass	Pass	Pass	Pass	Pass	Pass
134	14	Pass	Pass	Pass	Pass	Pass	Pass
134	23	Pass	Fail	Pass	Pass	Fail	Pass
135	14	Pass	Pass	Pass	Pass	Pass	Pass
136	14	Pass	Pass	Pass	Pass	Pass	Pass
137	14	Pass	Pass	Pass	Pass	Pass	Pass
138	14	Pass	Pass	Pass	Pass	Pass	Pass

4. Table D.7.4 Striped Bass eggs D.O. , Salinity, and Velocity criteria passing for existing and deepening (2 ft) scenarios within the analyzed period April 1 - April 30, 1997

HABITAT REQUIREMENTS:
RM 10-31; Depth Average
D.O. April (MG/L):10th %ile >=4.5
Salinity 50th %ile <= 9 ppt
Mean Velocity >= 30 cm/s

Savannah Harbor Estuary

Segments		Baseline Scenario			Project Scenario		
J	I	Salinity	Velocity	D.O.	Salinity	Velocity	D.O.
47	13	Fail	Pass	Pass	Fail	Pass	Pass
47	14	Fail	Pass	Pass	Fail	Pass	Pass
47	15	Fail	Pass	Pass	Fail	Pass	Pass
47	16	Fail	Pass	Pass	Fail	Pass	Pass
47	17	Fail	Fail	Pass	Fail	Fail	Pass
48	13	Fail	Pass	Pass	Fail	Pass	Pass
48	14	Fail	Pass	Pass	Fail	Pass	Pass
48	15	Fail	Pass	Pass	Fail	Pass	Pass
48	16	Fail	Pass	Pass	Fail	Pass	Pass
48	17	Fail	Pass	Pass	Fail	Pass	Pass
49	13	Fail	Pass	Pass	Fail	Pass	Pass
49	14	Fail	Pass	Pass	Fail	Pass	Pass
49	15	Pass	Pass	Pass	Fail	Pass	Pass
49	16	Fail	Pass	Pass	Fail	Pass	Pass
49	17	Fail	Pass	Pass	Fail	Pass	Pass
50	13	Pass	Pass	Pass	Fail	Pass	Pass
50	14	Fail	Pass	Pass	Fail	Pass	Pass
50	15	Fail	Fail	Pass	Fail	Fail	Pass
50	16	Fail	Fail	Pass	Fail	Fail	Pass
50	17	Fail	Fail	Pass	Fail	Fail	Pass
50	18	Pass	Fail	Pass	Pass	Fail	Pass
51	13	Pass	Pass	Pass	Fail	Pass	Pass
51	14	Fail	Pass	Pass	Fail	Pass	Pass
51	15	Pass	Pass	Pass	Fail	Pass	Pass
52	13	Pass	Pass	Pass	Fail	Pass	Pass
52	14	Fail	Pass	Pass	Fail	Pass	Pass
52	15	Pass	Pass	Pass	Pass	Pass	Pass
53	13	Pass	Pass	Pass	Fail	Pass	Pass
53	14	Fail	Pass	Pass	Fail	Pass	Pass
53	15	Pass	Pass	Pass	Pass	Pass	Pass
54	13	Pass	Pass	Pass	Pass	Pass	Pass
54	14	Fail	Pass	Pass	Fail	Pass	Pass
54	15	Pass	Pass	Pass	Pass	Pass	Pass
55	13	Pass	Pass	Pass	Pass	Pass	Pass
55	14	Fail	Pass	Pass	Fail	Pass	Pass
55	15	Pass	Pass	Pass	Pass	Pass	Pass
56	13	Pass	Pass	Pass	Pass	Pass	Pass
56	14	Fail	Pass	Pass	Fail	Pass	Pass
56	15	Pass	Pass	Pass	Pass	Pass	Pass

57	13	Pass	Pass	Pass	Pass	Pass	Pass
57	14	Fail	Pass	Pass	Fail	Pass	Pass
57	15	Pass	Pass	Pass	Pass	Pass	Pass
58	13	Pass	Pass	Pass	Pass	Pass	Pass
58	14	Fail	Pass	Pass	Fail	Pass	Pass
58	15	Pass	Pass	Pass	Pass	Pass	Pass
59	13	Pass	Pass	Pass	Pass	Pass	Pass
59	14	Pass	Pass	Pass	Fail	Pass	Pass
59	15	Pass	Pass	Pass	Pass	Pass	Pass
59	30	Pass	Fail	Pass	Pass	Fail	Pass
59	31	Fail	Fail	Pass	Fail	Fail	Pass
59	32	Pass	Fail	Pass	Pass	Fail	Pass
60	13	Pass	Pass	Pass	Pass	Pass	Pass
60	14	Pass	Pass	Pass	Fail	Pass	Pass
60	15	Pass	Pass	Pass	Pass	Pass	Pass
60	30	Pass	Fail	Pass	Pass	Fail	Pass
60	31	Fail	Fail	Pass	Fail	Fail	Pass
60	32	Pass	Fail	Pass	Pass	Fail	Pass
61	13	Pass	Pass	Pass	Pass	Pass	Pass
61	14	Pass	Pass	Pass	Fail	Pass	Pass
61	15	Pass	Pass	Pass	Pass	Pass	Pass
61	30	Pass	Fail	Pass	Pass	Fail	Pass
61	31	Fail	Fail	Pass	Fail	Fail	Pass
61	32	Pass	Fail	Pass	Pass	Fail	Pass
62	13	Pass	Pass	Pass	Pass	Pass	Pass
62	14	Pass	Pass	Pass	Fail	Pass	Pass
62	15	Pass	Pass	Pass	Pass	Pass	Pass
62	30	Pass	Fail	Pass	Pass	Fail	Pass
62	31	Fail	Fail	Pass	Fail	Fail	Pass
62	32	Pass	Fail	Pass	Pass	Fail	Pass
63	13	Pass	Pass	Pass	Pass	Pass	Pass
63	14	Pass	Pass	Pass	Pass	Pass	Pass
63	15	Pass	Pass	Pass	Pass	Pass	Pass
63	31	Pass	Pass	Pass	Pass	Pass	Pass
64	13	Pass	Pass	Pass	Pass	Pass	Pass
64	14	Pass	Pass	Pass	Pass	Pass	Pass
64	15	Pass	Pass	Pass	Pass	Pass	Pass
64	30	Pass	Fail	Pass	Pass	Fail	Pass
64	31	Pass	Pass	Pass	Pass	Pass	Pass
64	32	Pass	Fail	Pass	Pass	Fail	Pass
65	13	Pass	Pass	Pass	Pass	Pass	Pass
65	14	Pass	Pass	Pass	Pass	Pass	Pass
65	15	Pass	Pass	Pass	Pass	Pass	Pass
65	30	Pass	Fail	Pass	Pass	Fail	Pass
65	31	Pass	Pass	Pass	Pass	Pass	Pass
65	32	Pass	Fail	Pass	Pass	Fail	Pass
65	33	Pass	Fail	Pass	Pass	Fail	Pass
66	13	Pass	Pass	Pass	Pass	Pass	Pass
66	14	Pass	Pass	Pass	Pass	Pass	Pass
66	15	Pass	Fail	Pass	Pass	Fail	Pass
66	30	Pass	Fail	Pass	Pass	Fail	Pass
66	31	Pass	Pass	Pass	Pass	Pass	Pass
66	32	Pass	Fail	Pass	Pass	Fail	Pass
66	36	Pass	Fail	Pass	Pass	Fail	Pass
66	38	Fail	Fail	Fail	Fail	Fail	Fail
67	13	Pass	Pass	Pass	Pass	Pass	Pass
67	14	Pass	Pass	Pass	Pass	Pass	Pass

67	15	Pass	Fail	Pass	Pass	Fail	Pass
67	30	Pass	Fail	Pass	Pass	Fail	Pass
67	31	Pass	Pass	Pass	Pass	Pass	Pass
67	32	Pass	Fail	Pass	Pass	Fail	Pass
67	36	Pass	Fail	Pass	Pass	Fail	Pass
68	13	Pass	Pass	Pass	Pass	Pass	Pass
68	14	Pass	Pass	Pass	Pass	Pass	Pass
68	15	Pass	Fail	Pass	Pass	Fail	Pass
68	30	Pass	Fail	Pass	Pass	Fail	Pass
68	31	Pass	Pass	Pass	Pass	Pass	Pass
68	32	Pass	Fail	Pass	Pass	Fail	Pass
68	36	Pass	Fail	Pass	Pass	Fail	Pass
68	38	Fail	Fail	Fail	Fail	Fail	Fail
69	13	Pass	Pass	Pass	Pass	Pass	Pass
69	14	Pass	Pass	Pass	Pass	Pass	Pass
69	15	Pass	Fail	Pass	Pass	Fail	Pass
69	30	Pass	Pass	Pass	Pass	Pass	Pass
69	31	Pass	Pass	Pass	Pass	Pass	Pass
69	32	Pass	Fail	Pass	Pass	Fail	Pass
69	36	Pass	Fail	Pass	Pass	Fail	Pass
70	13	Pass	Pass	Pass	Pass	Pass	Pass
70	14	Pass	Pass	Pass	Pass	Pass	Pass
70	15	Pass	Fail	Pass	Pass	Fail	Pass
70	30	Pass	Fail	Pass	Pass	Fail	Pass
70	31	Pass	Fail	Pass	Pass	Fail	Pass
70	32	Pass	Fail	Pass	Pass	Fail	Pass
70	33	Pass	Fail	Pass	Pass	Fail	Pass
71	13	Pass	Pass	Pass	Pass	Pass	Pass
71	14	Pass	Pass	Pass	Pass	Pass	Pass
71	15	Pass	Pass	Pass	Pass	Pass	Pass
71	30	Pass	Fail	Pass	Pass	Fail	Pass
71	31	Pass	Fail	Pass	Pass	Fail	Pass
71	32	Pass	Fail	Pass	Pass	Fail	Pass
72	13	Pass	Pass	Pass	Pass	Pass	Pass
72	14	Pass	Pass	Pass	Pass	Pass	Pass
72	15	Pass	Pass	Pass	Pass	Pass	Pass
72	30	Pass	Fail	Pass	Pass	Fail	Pass
72	31	Pass	Fail	Pass	Pass	Fail	Pass
72	32	Pass	Fail	Pass	Pass	Fail	Pass
73	13	Pass	Pass	Pass	Pass	Pass	Pass
73	14	Pass	Pass	Pass	Pass	Pass	Pass
73	15	Pass	Pass	Pass	Pass	Pass	Pass
73	30	Pass	Fail	Pass	Pass	Fail	Pass
73	31	Pass	Fail	Pass	Pass	Fail	Pass
74	13	Pass	Pass	Pass	Pass	Pass	Pass
74	14	Pass	Pass	Pass	Pass	Pass	Pass
74	15	Pass	Pass	Pass	Pass	Pass	Pass
74	30	Pass	Fail	Pass	Pass	Fail	Pass
74	31	Pass	Fail	Pass	Pass	Fail	Pass
75	13	Pass	Pass	Pass	Pass	Pass	Pass
75	14	Pass	Pass	Pass	Pass	Pass	Pass
75	15	Pass	Pass	Pass	Pass	Pass	Pass
75	30	Pass	Fail	Pass	Pass	Fail	Pass
75	31	Pass	Fail	Pass	Pass	Fail	Pass
76	13	Pass	Fail	Pass	Pass	Fail	Pass
76	14	Pass	Pass	Pass	Pass	Pass	Pass
76	15	Pass	Fail	Pass	Pass	Fail	Pass

76	16	Pass	Fail	Pass	Pass	Fail	Pass
76	17	Pass	Fail	Pass	Pass	Fail	Pass
76	30	Pass	Fail	Pass	Pass	Fail	Pass
76	31	Pass	Fail	Pass	Pass	Fail	Pass
76	33	Fail	Fail	Fail	Fail	Fail	Fail
77	13	Pass	Fail	Pass	Pass	Fail	Pass
77	14	Pass	Fail	Pass	Pass	Fail	Pass
77	15	Pass	Fail	Pass	Pass	Fail	Pass
77	16	Pass	Fail	Pass	Pass	Fail	Pass
77	17	Pass	Fail	Pass	Pass	Fail	Pass
77	30	Pass	Fail	Pass	Pass	Fail	Pass
77	31	Pass	Fail	Pass	Pass	Fail	Pass
78	13	Pass	Fail	Pass	Pass	Fail	Pass
78	14	Pass	Pass	Pass	Pass	Pass	Pass
78	15	Pass	Fail	Pass	Pass	Fail	Pass
78	16	Pass	Fail	Pass	Pass	Fail	Pass
78	17	Pass	Fail	Pass	Pass	Fail	Pass
78	30	Pass	Fail	Pass	Pass	Fail	Pass
78	31	Pass	Fail	Pass	Pass	Fail	Pass
79	13	Pass	Fail	Pass	Pass	Fail	Pass
79	14	Pass	Pass	Pass	Pass	Pass	Pass
79	15	Pass	Fail	Pass	Pass	Fail	Pass
79	30	Pass	Fail	Pass	Pass	Fail	Pass
79	31	Pass	Fail	Pass	Pass	Fail	Pass
80	13	Pass	Fail	Pass	Pass	Fail	Pass
80	14	Pass	Pass	Pass	Pass	Pass	Pass
80	15	Pass	Fail	Pass	Pass	Fail	Pass
80	30	Pass	Fail	Pass	Pass	Fail	Pass
80	31	Pass	Fail	Pass	Pass	Fail	Pass
81	13	Pass	Pass	Pass	Pass	Pass	Pass
81	14	Pass	Pass	Pass	Pass	Pass	Pass
81	15	Pass	Fail	Pass	Pass	Fail	Pass
81	30	Pass	Fail	Pass	Pass	Fail	Pass
81	31	Pass	Fail	Pass	Pass	Fail	Pass
82	13	Pass	Pass	Pass	Pass	Pass	Pass
82	14	Pass	Pass	Pass	Pass	Pass	Pass
82	15	Pass	Pass	Pass	Pass	Pass	Pass
82	16	Pass	Fail	Pass	Pass	Fail	Pass
82	17	Pass	Fail	Pass	Pass	Fail	Pass
82	18	Pass	Fail	Pass	Pass	Fail	Pass
82	19	Pass	Fail	Pass	Pass	Fail	Pass
82	20	Pass	Fail	Pass	Pass	Fail	Pass
82	21	Pass	Fail	Pass	Pass	Fail	Pass
82	29	Pass	Fail	Pass	Pass	Fail	Pass
82	30	Pass	Fail	Pass	Pass	Fail	Pass
82	31	Pass	Fail	Pass	Pass	Fail	Pass
83	13	Pass	Pass	Pass	Pass	Pass	Pass
83	14	Pass	Pass	Pass	Pass	Pass	Pass
83	15	Pass	Pass	Pass	Pass	Pass	Pass
83	21	Pass	Fail	Pass	Pass	Fail	Pass
83	30	Pass	Fail	Pass	Pass	Fail	Pass
83	31	Pass	Fail	Pass	Pass	Fail	Pass
84	13	Pass	Pass	Pass	Pass	Pass	Pass
84	14	Pass	Pass	Pass	Pass	Pass	Pass
84	15	Pass	Pass	Pass	Pass	Pass	Pass
84	21	Pass	Fail	Pass	Pass	Fail	Pass
84	30	Pass	Fail	Pass	Pass	Fail	Pass

84	31	Pass	Fail	Pass	Pass	Fail	Pass
85	13	Pass	Pass	Pass	Pass	Pass	Pass
85	14	Pass	Pass	Pass	Pass	Pass	Pass
85	15	Pass	Pass	Pass	Pass	Pass	Pass
85	21	Pass	Fail	Pass	Pass	Fail	Pass
85	30	Pass	Fail	Pass	Pass	Fail	Pass
86	13	Pass	Pass	Pass	Pass	Pass	Pass
86	14	Pass	Pass	Pass	Pass	Pass	Pass
86	15	Pass	Pass	Pass	Pass	Pass	Pass
86	17	Fail	Fail	Fail	Fail	Fail	Fail
86	21	Pass	Pass	Pass	Pass	Fail	Pass
86	30	Pass	Pass	Pass	Pass	Pass	Pass
87	13	Pass	Pass	Pass	Pass	Pass	Pass
87	14	Pass	Pass	Pass	Pass	Pass	Pass
87	15	Pass	Pass	Pass	Pass	Pass	Pass
87	30	Pass	Fail	Pass	Pass	Fail	Pass
87	32	Fail	Fail	Fail	Fail	Fail	Fail
88	13	Pass	Pass	Pass	Pass	Pass	Pass
88	14	Pass	Pass	Pass	Pass	Pass	Pass
88	15	Pass	Pass	Pass	Pass	Pass	Pass
88	30	Pass	Fail	Pass	Pass	Fail	Pass
89	13	Pass	Pass	Pass	Pass	Pass	Pass
89	14	Pass	Pass	Pass	Pass	Pass	Pass
89	15	Pass	Pass	Pass	Pass	Pass	Pass
89	30	Pass	Fail	Pass	Pass	Fail	Pass
90	13	Pass	Pass	Pass	Pass	Pass	Pass
90	14	Pass	Pass	Pass	Pass	Pass	Pass
90	15	Pass	Pass	Pass	Pass	Pass	Pass
90	30	Pass	Fail	Pass	Pass	Fail	Pass
91	13	Pass	Pass	Pass	Pass	Pass	Pass
91	14	Pass	Pass	Pass	Pass	Pass	Pass
91	15	Pass	Pass	Pass	Pass	Pass	Pass
91	16	Pass	Fail	Pass	Pass	Fail	Pass
91	30	Pass	Fail	Pass	Pass	Fail	Pass
92	13	Pass	Pass	Pass	Pass	Pass	Pass
92	14	Pass	Pass	Pass	Pass	Pass	Pass
92	15	Pass	Pass	Pass	Pass	Pass	Pass
92	16	Pass	Fail	Pass	Pass	Fail	Pass
92	30	Pass	Fail	Pass	Pass	Fail	Pass
92	32	Fail	Fail	Fail	Fail	Fail	Fail
93	13	Pass	Pass	Pass	Pass	Pass	Pass
93	14	Pass	Pass	Pass	Pass	Pass	Pass
93	15	Pass	Pass	Pass	Pass	Pass	Pass
93	16	Pass	Pass	Pass	Pass	Pass	Pass
93	30	Pass	Fail	Pass	Pass	Fail	Pass
94	13	Pass	Pass	Pass	Pass	Pass	Pass
94	14	Pass	Pass	Pass	Pass	Pass	Pass
94	15	Pass	Pass	Pass	Pass	Pass	Pass
94	16	Pass	Fail	Pass	Pass	Fail	Pass
94	26	Pass	Pass	Pass	Pass	Pass	Pass
94	30	Pass	Fail	Pass	Pass	Fail	Pass
95	13	Pass	Pass	Pass	Pass	Pass	Pass
95	14	Pass	Pass	Pass	Pass	Pass	Pass
95	15	Pass	Pass	Pass	Pass	Pass	Pass
95	16	Pass	Fail	Pass	Pass	Fail	Pass
95	26	Pass	Fail	Pass	Pass	Fail	Pass
95	28	Fail	Fail	Fail	Fail	Fail	Fail

95	30	Pass	Fail	Pass	Pass	Fail	Pass
96	11	Fail	Fail	Fail	Fail	Fail	Fail
96	13	Pass	Pass	Pass	Pass	Pass	Pass
96	14	Pass	Pass	Pass	Pass	Pass	Pass
96	15	Pass	Pass	Pass	Pass	Pass	Pass
96	26	Pass	Fail	Pass	Pass	Fail	Pass
96	30	Pass	Fail	Pass	Pass	Fail	Pass
97	13	Pass	Pass	Pass	Pass	Pass	Pass
97	14	Pass	Pass	Pass	Pass	Pass	Pass
97	15	Pass	Fail	Pass	Pass	Fail	Pass
97	26	Pass	Fail	Pass	Pass	Fail	Pass
97	30	Pass	Fail	Pass	Pass	Fail	Pass
98	13	Pass	Fail	Pass	Pass	Fail	Pass
98	14	Pass	Pass	Pass	Pass	Pass	Pass
98	15	Pass	Fail	Pass	Pass	Fail	Pass
98	26	Pass	Fail	Pass	Pass	Fail	Pass
98	27	Pass	Pass	Pass	Pass	Pass	Pass
98	28	Pass	Pass	Pass	Pass	Pass	Pass
98	29	Pass	Pass	Pass	Pass	Pass	Pass
98	30	Pass	Fail	Pass	Pass	Fail	Pass
99	13	Pass	Pass	Pass	Pass	Pass	Pass
99	14	Pass	Pass	Pass	Pass	Pass	Pass
99	15	Pass	Fail	Pass	Pass	Fail	Pass
99	16	Pass	Fail	Pass	Pass	Fail	Pass
99	17	Pass	Fail	Pass	Pass	Fail	Pass
99	18	Pass	Fail	Pass	Pass	Fail	Pass
99	19	Pass	Fail	Pass	Pass	Fail	Pass
99	20	Pass	Fail	Pass	Pass	Fail	Pass
99	21	Pass	Fail	Pass	Pass	Fail	Pass
99	22	Pass	Fail	Pass	Pass	Fail	Pass
99	23	Pass	Fail	Pass	Pass	Fail	Pass
99	26	Pass	Fail	Pass	Pass	Fail	Pass
99	30	Pass	Fail	Pass	Pass	Fail	Pass
100	13	Pass	Pass	Pass	Pass	Pass	Pass
100	14	Pass	Pass	Pass	Pass	Pass	Pass
100	15	Pass	Fail	Pass	Pass	Pass	Pass
100	23	Pass	Fail	Pass	Pass	Fail	Pass
100	24	Pass	Fail	Pass	Pass	Fail	Pass
100	25	Pass	Fail	Pass	Pass	Fail	Pass
100	26	Pass	Fail	Pass	Pass	Fail	Pass
100	30	Pass	Fail	Pass	Pass	Fail	Pass
101	13	Pass	Pass	Pass	Pass	Pass	Pass
101	14	Pass	Pass	Pass	Pass	Pass	Pass
101	15	Pass	Pass	Pass	Pass	Pass	Pass
101	16	Pass	Fail	Pass	Pass	Fail	Pass
101	17	Pass	Fail	Pass	Pass	Fail	Pass
101	18	Pass	Fail	Pass	Pass	Fail	Pass
101	19	Pass	Fail	Pass	Pass	Fail	Pass
101	20	Pass	Fail	Pass	Pass	Fail	Pass
101	21	Pass	Fail	Pass	Pass	Fail	Pass
101	22	Pass	Fail	Pass	Pass	Fail	Pass
101	23	Pass	Fail	Pass	Pass	Fail	Pass
101	26	Pass	Pass	Pass	Pass	Pass	Pass
101	30	Pass	Fail	Pass	Pass	Fail	Pass
102	13	Pass	Pass	Pass	Pass	Pass	Pass
102	14	Pass	Pass	Pass	Pass	Pass	Pass
102	15	Pass	Pass	Pass	Pass	Pass	Pass

102	26	Pass	Pass	Pass	Pass	Pass	Pass
102	30	Pass	Fail	Pass	Pass	Fail	Pass
103	13	Pass	Pass	Pass	Pass	Pass	Pass
103	14	Pass	Pass	Pass	Pass	Pass	Pass
103	15	Pass	Pass	Pass	Pass	Pass	Pass
103	26	Pass	Pass	Pass	Pass	Pass	Pass
103	30	Pass	Pass	Pass	Pass	Pass	Pass
104	11	Fail	Fail	Fail	Fail	Fail	Fail
104	13	Pass	Fail	Pass	Pass	Fail	Pass
104	14	Pass	Pass	Pass	Pass	Pass	Pass
104	15	Pass	Pass	Pass	Pass	Pass	Pass
104	26	Pass	Pass	Pass	Pass	Pass	Pass
104	30	Pass	Fail	Pass	Pass	Fail	Pass
105	13	Pass	Fail	Pass	Pass	Fail	Pass
105	14	Pass	Pass	Pass	Pass	Pass	Pass
105	15	Pass	Pass	Pass	Pass	Pass	Pass
105	26	Pass	Pass	Pass	Pass	Pass	Pass
105	30	Pass	Fail	Pass	Pass	Fail	Pass
106	13	Pass	Fail	Pass	Pass	Fail	Pass
106	14	Pass	Pass	Pass	Pass	Pass	Pass
106	15	Pass	Pass	Pass	Pass	Pass	Pass
106	26	Pass	Pass	Pass	Pass	Pass	Pass
106	27	Pass	Fail	Pass	Pass	Fail	Pass
106	30	Pass	Fail	Pass	Pass	Fail	Pass
106	39	Pass	Fail	Pass	Pass	Fail	Pass
107	13	Pass	Pass	Pass	Pass	Pass	Pass
107	14	Pass	Pass	Pass	Pass	Pass	Pass
107	15	Pass	Fail	Pass	Pass	Fail	Pass
107	22	Pass	Fail	Pass	Pass	Fail	Pass
107	26	Pass	Fail	Pass	Pass	Fail	Pass
107	30	Pass	Fail	Pass	Pass	Fail	Pass
107	39	Pass	Fail	Pass	Pass	Fail	Pass
108	13	Pass	Pass	Pass	Pass	Pass	Pass
108	14	Pass	Pass	Pass	Pass	Pass	Pass
108	15	Pass	Pass	Pass	Pass	Pass	Pass
108	22	Pass	Pass	Pass	Pass	Pass	Pass
108	24	Fail	Fail	Fail	Fail	Fail	Fail
108	26	Pass	Fail	Pass	Pass	Fail	Pass
108	30	Pass	Fail	Pass	Pass	Fail	Pass
108	39	Pass	Fail	Pass	Pass	Fail	Pass
109	13	Pass	Pass	Pass	Pass	Pass	Pass
109	14	Pass	Pass	Pass	Pass	Pass	Pass
109	15	Pass	Pass	Pass	Pass	Pass	Pass
109	22	Pass	Fail	Pass	Pass	Fail	Pass
109	26	Pass	Pass	Pass	Pass	Pass	Pass
109	30	Pass	Fail	Pass	Pass	Fail	Pass
109	39	Pass	Pass	Pass	Pass	Pass	Pass
110	13	Pass	Pass	Pass	Pass	Pass	Pass
110	14	Pass	Pass	Pass	Pass	Pass	Pass
110	15	Pass	Pass	Pass	Pass	Pass	Pass
110	22	Pass	Fail	Pass	Pass	Fail	Pass
110	26	Pass	Pass	Pass	Pass	Pass	Pass
110	28	Fail	Fail	Fail	Fail	Fail	Fail
110	39	Pass	Fail	Pass	Pass	Fail	Pass
111	13	Pass	Pass	Pass	Pass	Pass	Pass
111	14	Pass	Pass	Pass	Pass	Pass	Pass
111	15	Pass	Pass	Pass	Pass	Pass	Pass

111	22	Pass	Fail	Pass	Pass	Fail	Pass
111	26	Pass	Pass	Pass	Pass	Pass	Pass
111	39	Pass	Fail	Pass	Pass	Fail	Pass
112	13	Pass	Fail	Pass	Pass	Fail	Pass
112	14	Pass	Pass	Pass	Pass	Pass	Pass
112	15	Pass	Pass	Pass	Pass	Pass	Pass
112	22	Pass	Fail	Pass	Pass	Fail	Pass
112	26	Pass	Fail	Pass	Pass	Fail	Pass
112	39	Pass	Fail	Pass	Pass	Fail	Pass
113	13	Pass	Fail	Pass	Pass	Fail	Pass
113	14	Pass	Pass	Pass	Pass	Pass	Pass
113	15	Pass	Pass	Pass	Pass	Pass	Pass
113	26	Pass	Fail	Pass	Pass	Fail	Pass
113	27	Pass	Fail	Pass	Pass	Fail	Pass
113	39	Pass	Pass	Pass	Pass	Pass	Pass
113	41	Fail	Fail	Fail	Fail	Fail	Fail
114	13	Pass	Pass	Pass	Pass	Pass	Pass
114	14	Pass	Pass	Pass	Pass	Pass	Pass
114	15	Pass	Pass	Pass	Pass	Pass	Pass
114	26	Pass	Fail	Pass	Pass	Fail	Pass
114	39	Pass	Pass	Pass	Pass	Pass	Pass
115	13	Pass	Pass	Pass	Pass	Pass	Pass
115	14	Pass	Pass	Pass	Pass	Pass	Pass
115	15	Pass	Pass	Pass	Pass	Pass	Pass
115	26	Pass	Fail	Pass	Pass	Fail	Pass
115	39	Pass	Pass	Pass	Pass	Pass	Pass
116	13	Pass	Pass	Pass	Pass	Pass	Pass
116	14	Pass	Pass	Pass	Pass	Pass	Pass
116	15	Pass	Pass	Pass	Pass	Pass	Pass
116	26	Pass	Fail	Pass	Pass	Fail	Pass
116	28	Fail	Fail	Fail	Fail	Fail	Fail
116	39	Pass	Pass	Pass	Pass	Pass	Pass
117	13	Pass	Pass	Pass	Pass	Pass	Pass
117	14	Pass	Pass	Pass	Pass	Pass	Pass
117	15	Pass	Pass	Pass	Pass	Pass	Pass
117	26	Pass	Fail	Pass	Pass	Fail	Pass
117	39	Pass	Pass	Pass	Pass	Pass	Pass
118	13	Pass	Pass	Pass	Pass	Pass	Pass
118	14	Pass	Pass	Pass	Pass	Pass	Pass
118	15	Pass	Fail	Pass	Pass	Fail	Pass
118	20	Pass	Fail	Pass	Pass	Fail	Pass
118	26	Pass	Fail	Pass	Pass	Fail	Pass
118	39	Pass	Pass	Pass	Pass	Pass	Pass
119	13	Pass	Pass	Pass	Pass	Pass	Pass
119	14	Pass	Pass	Pass	Pass	Pass	Pass
119	15	Pass	Pass	Pass	Pass	Pass	Pass
119	20	Pass	Fail	Pass	Pass	Fail	Pass
119	26	Pass	Fail	Pass	Pass	Fail	Pass
119	39	Pass	Pass	Pass	Pass	Pass	Pass
120	13	Pass	Pass	Pass	Pass	Pass	Pass
120	14	Pass	Pass	Pass	Pass	Pass	Pass
120	15	Pass	Fail	Pass	Pass	Fail	Pass
120	16	Pass	Fail	Pass	Pass	Fail	Pass
120	26	Pass	Fail	Pass	Pass	Fail	Pass
120	39	Pass	Pass	Pass	Pass	Pass	Pass
121	13	Pass	Pass	Pass	Pass	Pass	Pass
121	14	Pass	Pass	Pass	Pass	Pass	Pass

121	26	Pass	Fail	Pass	Pass	Fail	Pass
121	39	Pass	Pass	Pass	Pass	Pass	Pass
122	13	Pass	Pass	Pass	Pass	Pass	Pass
122	14	Pass	Pass	Pass	Pass	Pass	Pass
122	26	Pass	Fail	Pass	Pass	Fail	Pass
122	39	Pass	Pass	Pass	Pass	Pass	Pass
122	41	Fail	Fail	Fail	Fail	Fail	Fail
123	13	Pass	Pass	Pass	Pass	Pass	Pass
123	14	Pass	Pass	Pass	Pass	Pass	Pass
123	15	Pass	Fail	Pass	Pass	Fail	Pass
123	16	Pass	Pass	Pass	Pass	Pass	Pass
123	17	Pass	Pass	Pass	Pass	Pass	Pass
123	18	Pass	Pass	Pass	Pass	Pass	Pass
123	19	Pass	Pass	Pass	Pass	Pass	Pass
123	20	Pass	Pass	Pass	Pass	Pass	Pass
123	21	Pass	Pass	Pass	Pass	Pass	Pass
123	22	Pass	Pass	Pass	Pass	Pass	Pass
123	23	Pass	Pass	Pass	Pass	Pass	Pass
123	24	Pass	Pass	Pass	Pass	Pass	Pass
123	25	Pass	Pass	Pass	Pass	Pass	Pass
123	26	Pass	Pass	Pass	Pass	Pass	Pass
123	27	Pass	Pass	Pass	Pass	Pass	Pass
123	28	Pass	Pass	Pass	Pass	Pass	Pass
123	29	Pass	Fail	Pass	Pass	Fail	Pass
123	30	Pass	Fail	Pass	Pass	Fail	Pass
123	31	Pass	Fail	Pass	Pass	Fail	Pass
123	32	Pass	Fail	Pass	Pass	Fail	Pass
123	33	Pass	Fail	Pass	Pass	Fail	Pass
123	34	Pass	Pass	Pass	Pass	Pass	Pass
123	35	Pass	Pass	Pass	Pass	Pass	Pass
123	36	Pass	Pass	Pass	Pass	Pass	Pass
123	37	Pass	Fail	Pass	Pass	Fail	Pass
123	38	Pass	Fail	Pass	Pass	Fail	Pass
123	39	Pass	Fail	Pass	Pass	Fail	Pass
124	13	Pass	Pass	Pass	Pass	Pass	Pass
124	14	Pass	Pass	Pass	Pass	Pass	Pass
124	23	Pass	Fail	Pass	Pass	Fail	Pass
125	13	Pass	Pass	Pass	Pass	Pass	Pass
125	14	Pass	Fail	Pass	Pass	Fail	Pass
125	23	Pass	Pass	Pass	Pass	Pass	Pass
125	28	Fail	Fail	Fail	Fail	Fail	Fail
125	33	Fail	Fail	Fail	Fail	Fail	Fail
126	13	Pass	Pass	Pass	Pass	Pass	Pass
126	14	Pass	Pass	Pass	Pass	Pass	Pass
126	23	Pass	Pass	Pass	Pass	Pass	Pass
127	13	Pass	Pass	Pass	Pass	Pass	Pass
127	14	Pass	Pass	Pass	Pass	Pass	Pass
127	23	Pass	Pass	Pass	Pass	Pass	Pass
128	13	Pass	Pass	Pass	Pass	Pass	Pass
128	14	Pass	Pass	Pass	Pass	Pass	Pass
128	23	Pass	Pass	Pass	Pass	Pass	Pass
129	13	Pass	Pass	Pass	Pass	Pass	Pass
129	14	Pass	Pass	Pass	Pass	Pass	Pass
129	23	Pass	Pass	Pass	Pass	Pass	Pass
130	8	Pass	Fail	Pass	Pass	Fail	Pass
130	9	Pass	Fail	Pass	Pass	Fail	Pass
130	10	Pass	Fail	Pass	Pass	Fail	Pass

130	11	Pass	Fail	Pass	Pass	Fail	Pass
130	12	Pass	Fail	Pass	Pass	Fail	Pass
130	13	Pass	Fail	Pass	Pass	Fail	Pass
130	14	Pass	Pass	Pass	Pass	Pass	Pass
130	23	Pass	Pass	Pass	Pass	Pass	Pass
131	14	Pass	Pass	Pass	Pass	Pass	Pass
131	23	Pass	Pass	Pass	Pass	Pass	Pass
132	14	Pass	Pass	Pass	Pass	Pass	Pass
132	23	Pass	Pass	Pass	Pass	Pass	Pass
133	14	Pass	Pass	Pass	Pass	Pass	Pass
133	23	Pass	Pass	Pass	Pass	Pass	Pass
134	14	Pass	Pass	Pass	Pass	Pass	Pass
134	23	Pass	Fail	Pass	Pass	Fail	Pass
135	14	Pass	Pass	Pass	Pass	Pass	Pass
136	14	Pass	Pass	Pass	Pass	Pass	Pass
137	14	Pass	Pass	Pass	Pass	Pass	Pass
138	14	Pass	Pass	Pass	Pass	Pass	Pass

Appendix E

APRIL 1997

80th Percentile of Clyo Flow

Habitat Analysis Output

Fisheries Review Group

1. Table E.1. Comparisons of Bass Spawning and Bass Eggs habitat areas for existing and deepening (6 ft) scenarios and 80 %ile Clyo Flow within the analyzed period April 1 – April 30, 1997

	Baseline Scenario		Project Scenario		% Change
Bass Spawning	7.472033	km2	6.182209	km2	-17.3
Bass Eggs	9.148369	km2	8.486131	km2	-7.2

2. Table E.2. Comparisons of Bass Spawning and Bass Eggs habitat areas for existing and deepening (4 ft) scenarios and 80 %ile Clyo Flow within the analyzed period April 1 – April 30, 1997

	Baseline Scenario		Project Scenario		% Change
Bass Spawning	7.472033	km2	6.516577	km2	-12.8
Bass Eggs	9.148369	km2	8.711230	km2	-4.8

3. Table E.3. Comparisons of Bass Spawning and Bass Eggs habitat areas for existing and deepening (3 ft) scenarios and 80 %ile Clyo Flow within the analyzed period April 1 – April 30, 1997

	Baseline Scenario		Project Scenario		% Change
Bass Spawning	7.472033	km2	6.981884	km2	-6.6
Bass Eggs	9.148369	km2	8.697760	km2	-4.9

4. Table E.4. Comparisons of Bass Spawning and Bass Eggs habitat areas for existing and deepening (2 ft) scenarios and 80 %ile Clyo flow within the analyzed period April 1 – April 30, 1997

	Baseline Scenario		Project Scenario		% Change
Bass Spawning	7.472033	km2	7.011526	km2	-6.2
Bass Eggs	9.148369	km2	8.943928	km2	-2.2

5. Table E.6.1 Striped Bass spawning D.O. , Salinity, and Velocity criteria passing for existing and deepening (6 ft) scenarios within the analyzed period April 1 - April 30, 1997

(See Appendix E-1)

6. Table E.6.2 Striped Bass spawning D.O. , Salinity, and Velocity criteria passing for existing and deepening (4 ft) scenarios within the analyzed period April 1 - April 30, 1997

(See Appendix E-1)

7. Table E.6.3 Striped Bass spawning D.O. , Salinity, and Velocity criteria passing for existing and deepening (3 ft) scenarios within the analyzed period April 1 - April 30, 1997

(See Appendix E-1)

8. Table E.6.4 Striped Bass spawning D.O. , Salinity, and Velocity criteria passing for existing and deepening (2 ft) scenarios within the analyzed period April 1 - April 30, 1997

(See Appendix E-1)

9. Table E.7.1 Striped Bass eggs D.O. , Salinity, and Velocity criteria passing for existing and deepening (6 ft) scenarios within the analyzed period April 1 - April 30, 1997

(See Appendix E-2)

10. Table E.7.2 Striped Bass eggs D.O. , Salinity, and Velocity criteria passing for existing and deepening (4 ft) scenarios within the analyzed period April 1 - April 30, 1997

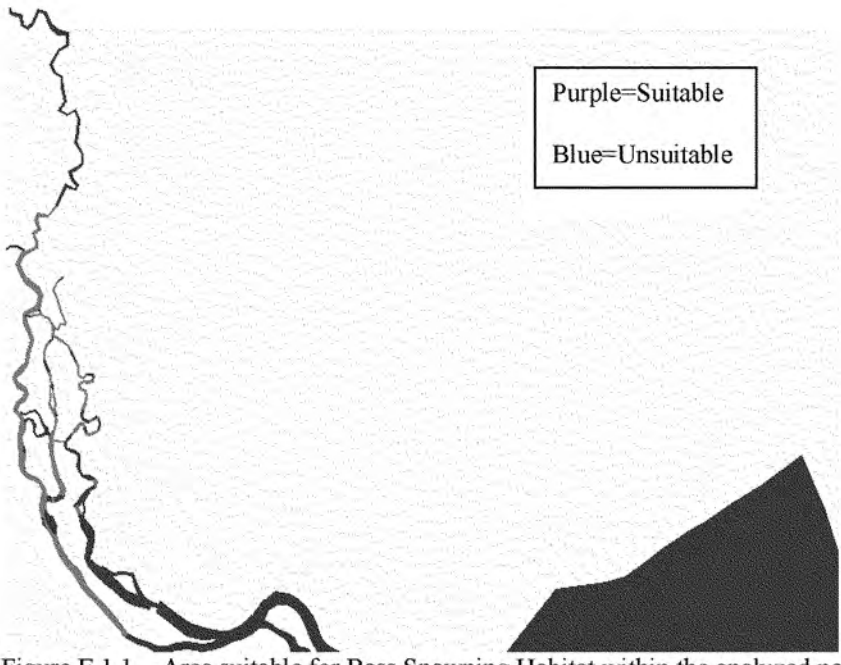
(See Appendix E-2)

11. Table E.7.3 Striped Bass eggs D.O. , Salinity, and Velocity criteria passing for existing and deepening (3 ft) scenarios within the analyzed period April 1 - April 30, 1997

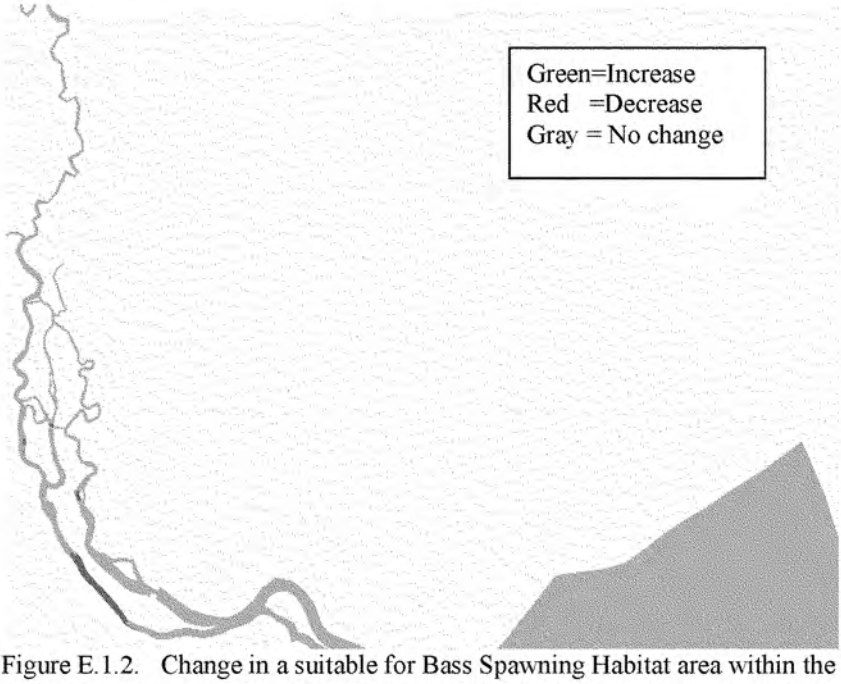
(See Appendix E-2)

12. Table E.7.4 Striped Bass eggs D.O. , Salinity, and Velocity criteria passing for existing and deepening (2 ft) scenarios within the analyzed period April 1 - April 30, 1997

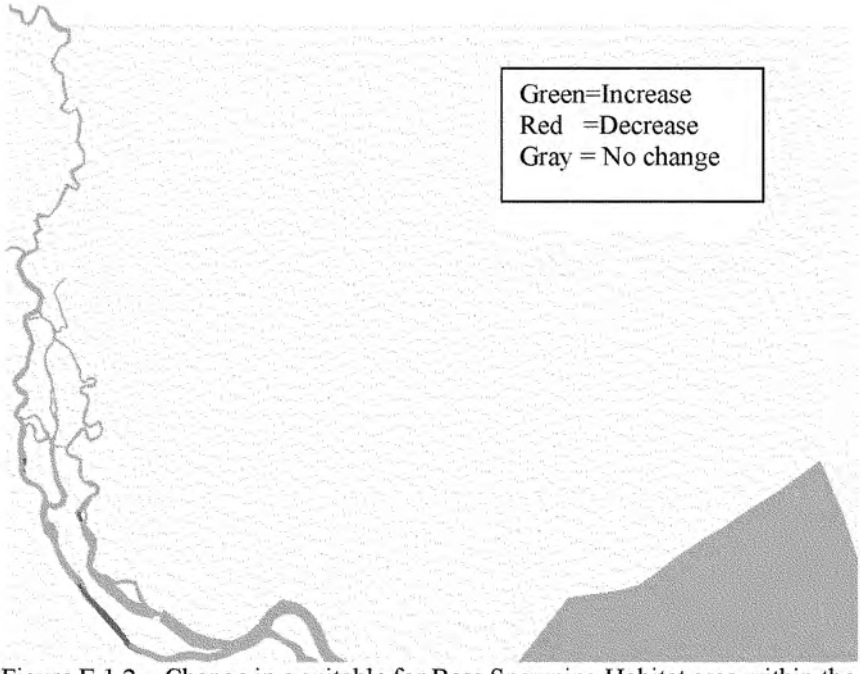
(See Appendix E-2)



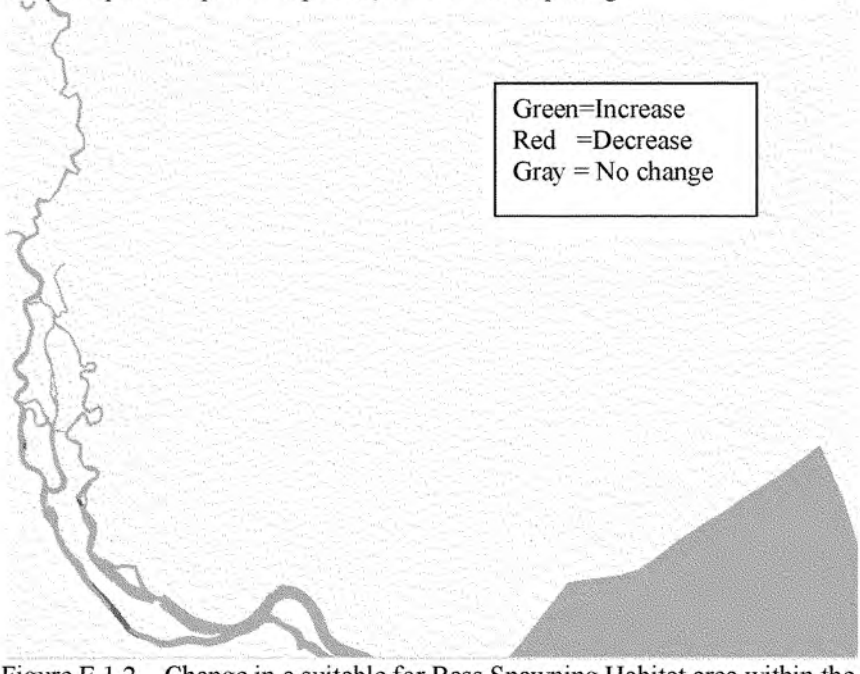
13. Figure E.1.1. Area suitable for Bass Spawning Habitat within the analyzed period April 1 – April 30, 1997: Existing bathymetry



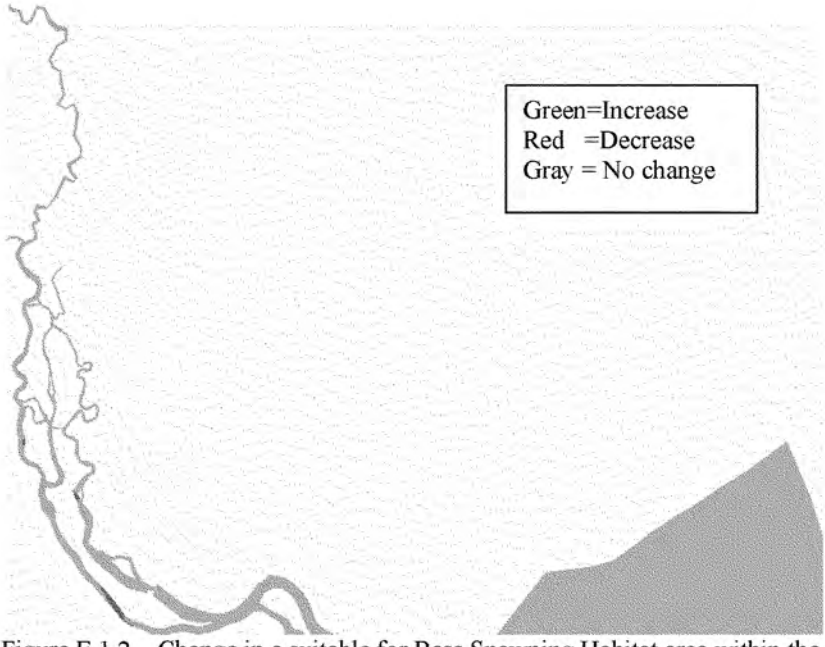
14. Figure E.1.2. Change in a suitable for Bass Spawning Habitat area within the analyzed period April 1 - April 30, 1999 : 6 ft deepening



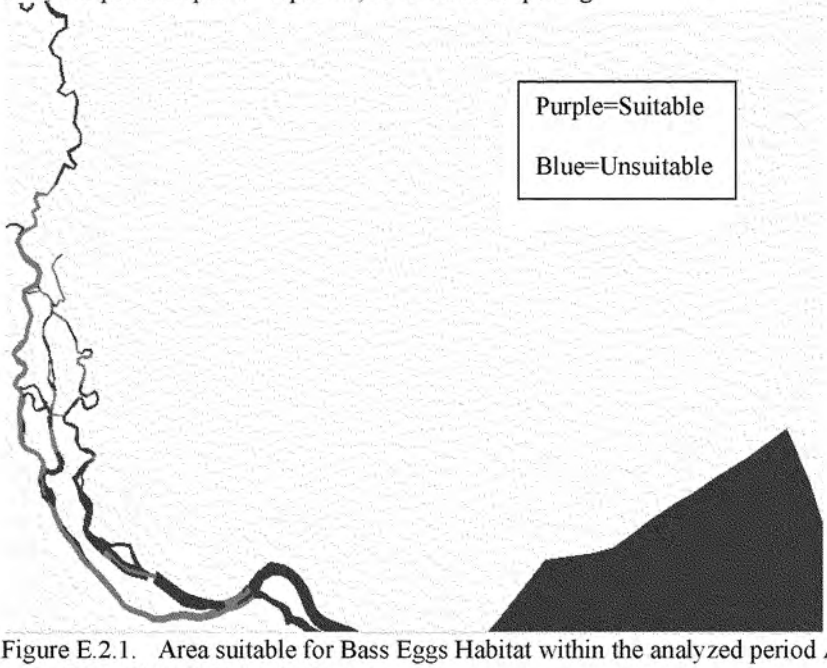
15. Figure E.1.2. Change in a suitable for Bass Spawning Habitat area within the analyzed period April 1 - April 30, 1999 : 4 ft deepening



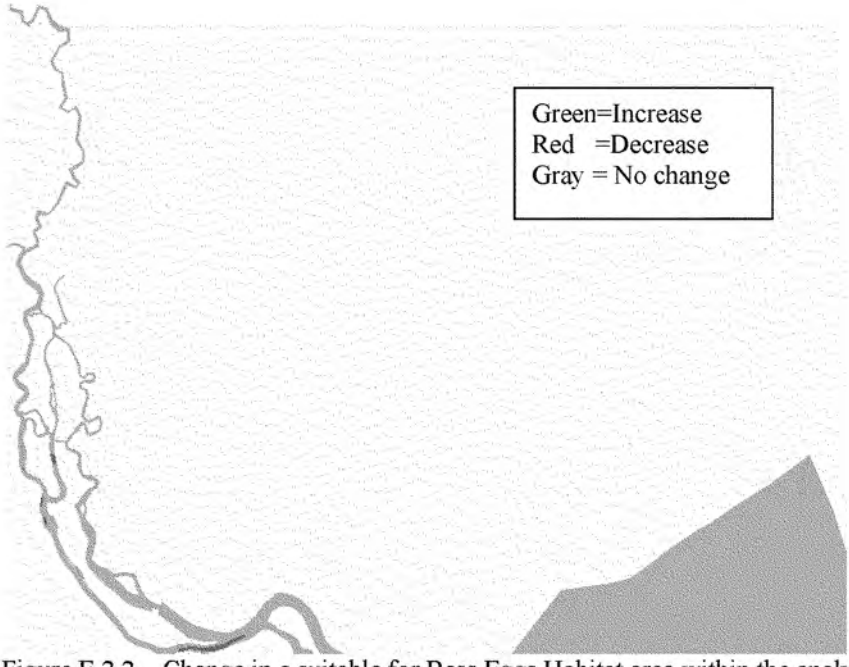
16. Figure E.1.2. Change in a suitable for Bass Spawning Habitat area within the analyzed period April 1 - April 30, 1999 : 3 ft deepening



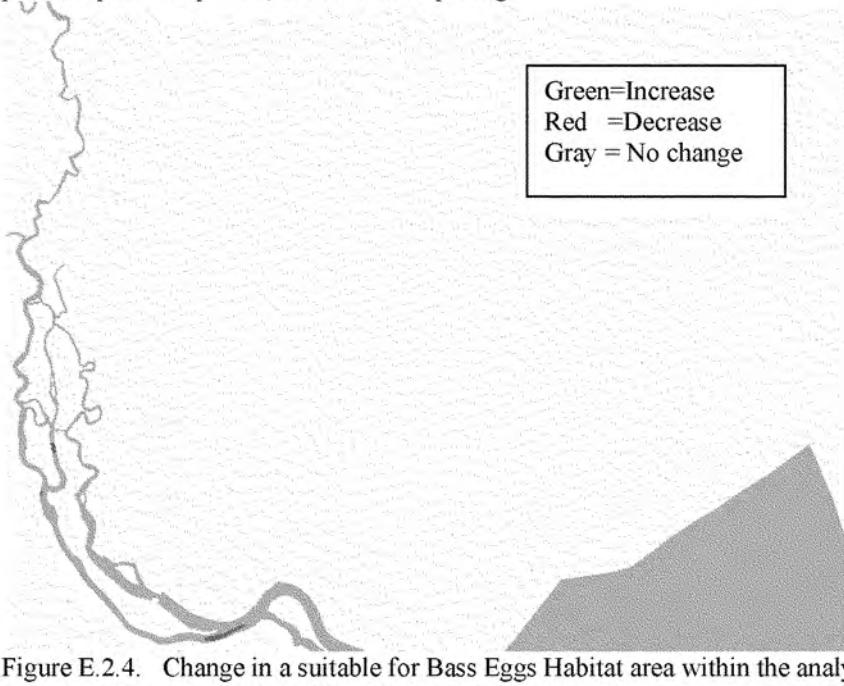
17. Figure E.1.2. Change in a suitable for Bass Spawning Habitat area within the analyzed period April 1 - April 30, 1999 : 2 ft deepening



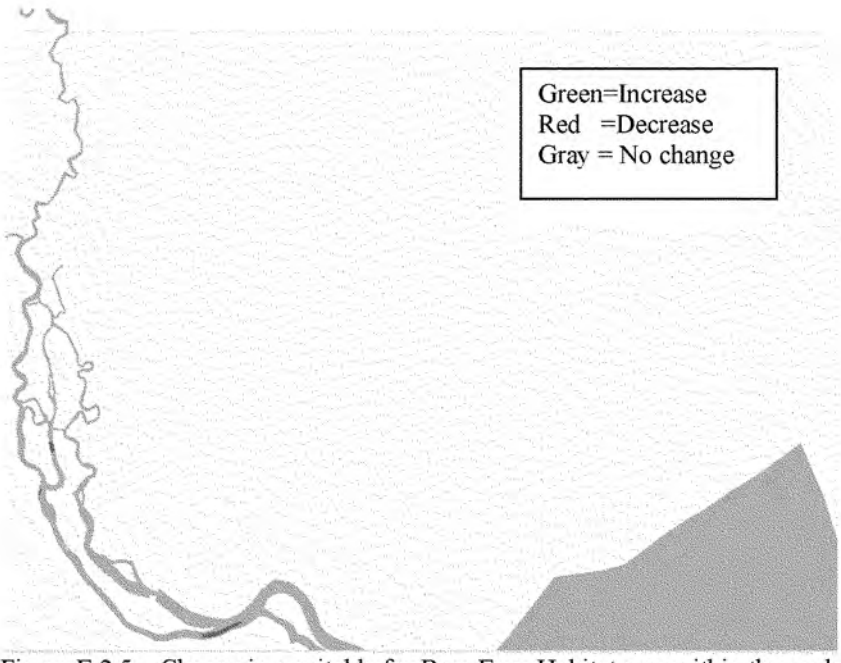
18. Figure E.2.1. Area suitable for Bass Eggs Habitat within the analyzed period April 1 – April 30, 1997: Existing bathymetry



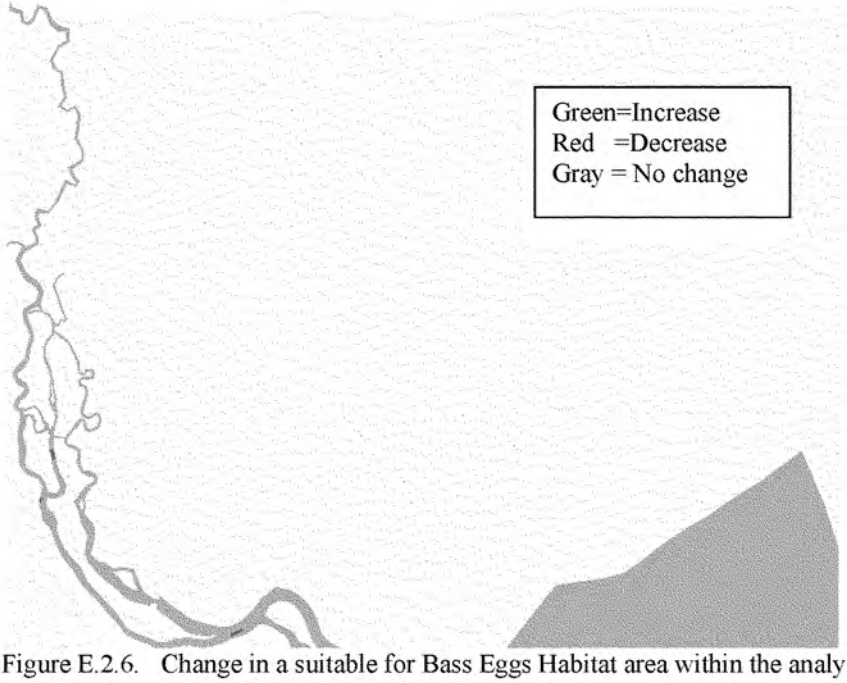
19. Figure E.2.2. Change in a suitable for Bass Eggs Habitat area within the analyzed period April 1 - April 30, 1999 : 6 ft deepening



20. Figure E.2.4. Change in a suitable for Bass Eggs Habitat area within the analyzed period April 1 - April 30, 1999 : 4 ft deepening



21. Figure E.2.5. Change in a suitable for Bass Eggs Habitat area within the analyzed period April 1 - April 30, 1999 : 3 ft deepening



22. Figure E.2.6. Change in a suitable for Bass Eggs Habitat area within the analyzed period April 1 - April 30, 1999 : 2 ft deepening

Appendix E-1

Tables of Criteria Passing for Striped Bass Spawning Habitat Suitability

April 1997

80th %ile of Clyo Flow

Fisheries Review Group

1. Table E.6.1 Striped Bass spawning D.O. , Salinity, and Velocity criteria passing for existing and deepening (6 ft) scenarios within the analyzed period April 1 - April 30, 1997

HABITAT REQUIREMENTS:
RM 10-31; Surface Layer
D.O. April (MG/L):n/a
Salinity 90th %ile <= 1 ppt
Mean Velocity >= 30 cm/s

Savannah Harbor Estuary

Segments J	Segments I	Baseline Scenario Salinity	Baseline Scenario Velocity	Project Scenario Salinity	Project Scenario Velocity
47	13	Fail	Pass	Fail	Pass
47	14	Fail	Pass	Fail	Pass
47	15	Fail	Pass	Fail	Pass
47	16	Fail	Pass	Fail	Pass
47	17	Fail	Fail	Fail	Fail
48	13	Fail	Pass	Fail	Pass
48	14	Fail	Pass	Fail	Pass
48	15	Fail	Pass	Fail	Pass
48	16	Fail	Pass	Fail	Pass
48	17	Fail	Pass	Fail	Pass
49	13	Fail	Pass	Fail	Pass
49	14	Fail	Pass	Fail	Pass
49	15	Fail	Pass	Fail	Pass
49	16	Fail	Pass	Fail	Pass
49	17	Fail	Pass	Fail	Pass
50	13	Fail	Pass	Fail	Pass
50	14	Fail	Pass	Fail	Pass
50	15	Fail	Pass	Fail	Pass
50	16	Fail	Pass	Fail	Pass
50	17	Fail	Pass	Fail	Pass
50	18	Fail	Fail	Fail	Fail
51	13	Fail	Pass	Fail	Pass
51	14	Fail	Pass	Fail	Pass
51	15	Fail	Pass	Fail	Pass
52	13	Fail	Pass	Fail	Pass
52	14	Fail	Pass	Fail	Pass
52	15	Fail	Pass	Fail	Pass
53	13	Fail	Pass	Fail	Pass
53	14	Fail	Pass	Fail	Pass
53	15	Fail	Pass	Fail	Pass
54	13	Fail	Pass	Fail	Pass
54	14	Fail	Pass	Fail	Pass
54	15	Fail	Pass	Fail	Pass
55	13	Fail	Pass	Fail	Pass
55	14	Fail	Pass	Fail	Pass
55	15	Fail	Pass	Fail	Pass
56	13	Fail	Pass	Fail	Pass
56	14	Fail	Pass	Fail	Pass
56	15	Fail	Pass	Fail	Pass
57	13	Fail	Pass	Fail	Pass

57	14	Fail	Pass	Fail	Pass
57	15	Fail	Pass	Fail	Pass
58	13	Fail	Pass	Fail	Pass
58	14	Fail	Pass	Fail	Pass
58	15	Fail	Pass	Fail	Pass
59	13	Pass	Pass	Fail	Pass
59	14	Fail	Pass	Fail	Pass
59	15	Fail	Pass	Fail	Pass
59	30	Fail	Pass	Fail	Pass
59	31	Fail	Pass	Fail	Pass
59	32	Fail	Fail	Fail	Fail
60	13	Pass	Pass	Fail	Pass
60	14	Pass	Pass	Fail	Pass
60	15	Pass	Pass	Fail	Pass
60	30	Fail	Fail	Fail	Fail
60	31	Fail	Fail	Fail	Fail
60	32	Fail	Fail	Fail	Fail
61	13	Pass	Pass	Fail	Pass
61	14	Pass	Pass	Fail	Pass
61	15	Pass	Pass	Fail	Pass
61	30	Fail	Fail	Fail	Fail
61	31	Fail	Fail	Fail	Pass
61	32	Fail	Fail	Fail	Fail
62	13	Pass	Pass	Fail	Pass
62	14	Pass	Pass	Fail	Pass
62	15	Pass	Pass	Fail	Pass
62	30	Fail	Fail	Fail	Fail
62	31	Fail	Pass	Fail	Pass
62	32	Fail	Fail	Fail	Fail
63	13	Pass	Pass	Fail	Pass
63	14	Pass	Pass	Fail	Pass
63	15	Pass	Pass	Fail	Pass
63	31	Fail	Pass	Fail	Pass
64	13	Pass	Pass	Fail	Pass
64	14	Pass	Pass	Fail	Pass
64	15	Pass	Pass	Fail	Pass
64	30	Fail	Fail	Fail	Fail
64	31	Fail	Pass	Fail	Pass
64	32	Fail	Fail	Fail	Fail
65	13	Pass	Pass	Fail	Pass
65	14	Pass	Pass	Fail	Pass
65	15	Pass	Pass	Fail	Pass
65	30	Fail	Pass	Fail	Pass
65	31	Fail	Pass	Fail	Pass
65	32	Fail	Pass	Fail	Pass
65	33	Fail	Fail	Fail	Fail
66	13	Pass	Pass	Fail	Pass
66	14	Pass	Pass	Fail	Pass
66	15	Pass	Pass	Fail	Pass
66	30	Fail	Pass	Fail	Pass
66	31	Fail	Pass	Fail	Pass
66	32	Fail	Pass	Fail	Pass
66	36	Fail	Pass	Fail	Pass
66	38	Fail	Fail	Fail	Fail
67	13	Pass	Pass	Fail	Pass
67	14	Pass	Pass	Fail	Pass
67	15	Pass	Pass	Fail	Pass

67	30	Fail	Pass	Fail	Pass
67	31	Fail	Pass	Fail	Pass
67	32	Fail	Pass	Fail	Pass
67	36	Fail	Fail	Fail	Fail
68	13	Pass	Pass	Pass	Pass
68	14	Pass	Pass	Fail	Pass
68	15	Pass	Pass	Fail	Pass
68	30	Fail	Pass	Fail	Pass
68	31	Fail	Pass	Fail	Pass
68	32	Fail	Pass	Fail	Pass
68	36	Fail	Fail	Fail	Fail
68	38	Fail	Fail	Fail	Fail
69	13	Pass	Pass	Pass	Pass
69	14	Pass	Pass	Fail	Pass
69	15	Pass	Pass	Fail	Pass
69	30	Fail	Pass	Fail	Pass
69	31	Fail	Pass	Fail	Pass
69	32	Fail	Fail	Fail	Fail
69	36	Fail	Fail	Fail	Fail
70	13	Pass	Pass	Pass	Pass
70	14	Pass	Pass	Fail	Pass
70	15	Pass	Pass	Pass	Pass
70	30	Fail	Pass	Fail	Pass
70	31	Fail	Pass	Fail	Pass
70	32	Fail	Fail	Fail	Fail
70	33	Fail	Fail	Fail	Fail
71	13	Pass	Pass	Pass	Pass
71	14	Pass	Pass	Pass	Pass
71	15	Pass	Pass	Pass	Pass
71	30	Fail	Pass	Fail	Pass
71	31	Fail	Pass	Fail	Pass
71	32	Fail	Fail	Fail	Fail
72	13	Pass	Pass	Pass	Pass
72	14	Pass	Pass	Pass	Pass
72	15	Pass	Pass	Pass	Pass
72	30	Fail	Fail	Fail	Pass
72	31	Fail	Pass	Fail	Pass
72	32	Fail	Fail	Fail	Fail
73	13	Pass	Pass	Pass	Pass
73	14	Pass	Pass	Pass	Pass
73	15	Pass	Pass	Pass	Pass
73	30	Fail	Fail	Fail	Fail
73	31	Fail	Pass	Fail	Pass
74	13	Pass	Pass	Pass	Pass
74	14	Pass	Pass	Pass	Pass
74	15	Pass	Pass	Pass	Pass
74	30	Fail	Fail	Fail	Fail
74	31	Fail	Pass	Fail	Pass
75	13	Pass	Pass	Pass	Pass
75	14	Pass	Pass	Pass	Pass
75	15	Pass	Pass	Pass	Pass
75	30	Fail	Fail	Fail	Fail
75	31	Fail	Fail	Fail	Pass
76	13	Pass	Pass	Pass	Pass
76	14	Pass	Pass	Pass	Pass
76	15	Pass	Fail	Pass	Fail
76	16	Pass	Fail	Pass	Fail

76	17	Pass	Fail	Pass	Fail
76	30	Fail	Fail	Fail	Fail
76	31	Fail	Pass	Fail	Pass
76	33	Fail	Fail	Fail	Fail
77	13	Pass	Fail	Pass	Fail
77	14	Pass	Pass	Pass	Pass
77	15	Pass	Fail	Pass	Fail
77	16	Pass	Fail	Pass	Fail
77	17	Pass	Fail	Pass	Fail
77	30	Fail	Fail	Fail	Fail
77	31	Fail	Fail	Fail	Fail
78	13	Pass	Fail	Pass	Fail
78	14	Pass	Pass	Pass	Pass
78	15	Pass	Fail	Pass	Fail
78	16	Pass	Fail	Pass	Fail
78	17	Pass	Fail	Pass	Fail
78	30	Fail	Fail	Fail	Fail
78	31	Fail	Fail	Fail	Fail
79	13	Pass	Pass	Pass	Pass
79	14	Pass	Pass	Pass	Pass
79	15	Pass	Fail	Pass	Pass
79	30	Fail	Pass	Fail	Pass
79	31	Fail	Fail	Fail	Fail
80	13	Pass	Pass	Pass	Pass
80	14	Pass	Pass	Pass	Pass
80	15	Pass	Pass	Pass	Pass
80	30	Pass	Pass	Fail	Pass
80	31	Fail	Fail	Fail	Fail
81	13	Pass	Pass	Pass	Pass
81	14	Pass	Pass	Pass	Pass
81	15	Pass	Pass	Pass	Pass
81	30	Pass	Pass	Fail	Pass
81	31	Fail	Fail	Fail	Fail
82	13	Pass	Pass	Pass	Pass
82	14	Pass	Pass	Pass	Pass
82	15	Pass	Pass	Pass	Pass
82	16	Pass	Fail	Pass	Fail
82	17	Pass	Fail	Pass	Fail
82	18	Pass	Pass	Pass	Pass
82	19	Pass	Fail	Pass	Fail
82	20	Pass	Fail	Pass	Fail
82	21	Pass	Fail	Pass	Fail
82	29	Pass	Fail	Pass	Fail
82	30	Pass	Pass	Fail	Pass
82	31	Pass	Fail	Fail	Fail
83	13	Pass	Pass	Pass	Pass
83	14	Pass	Pass	Pass	Pass
83	15	Pass	Pass	Pass	Pass
83	21	Pass	Pass	Pass	Pass
83	30	Pass	Fail	Fail	Fail
83	31	Pass	Fail	Fail	Fail
84	13	Pass	Pass	Pass	Pass
84	14	Pass	Pass	Pass	Pass
84	15	Pass	Pass	Pass	Pass
84	21	Pass	Pass	Pass	Pass
84	30	Pass	Fail	Pass	Fail
84	31	Pass	Fail	Pass	Fail

85	13	Pass	Pass	Pass	Pass
85	14	Pass	Pass	Pass	Pass
85	15	Pass	Pass	Pass	Pass
85	21	Pass	Pass	Pass	Pass
85	30	Pass	Fail	Pass	Fail
86	13	Pass	Pass	Pass	Pass
86	14	Pass	Pass	Pass	Pass
86	15	Pass	Pass	Pass	Pass
86	17	Fail	Fail	Fail	Fail
86	21	Pass	Pass	Pass	Pass
86	30	Pass	Pass	Pass	Pass
87	13	Pass	Pass	Pass	Pass
87	14	Pass	Pass	Pass	Pass
87	15	Pass	Pass	Pass	Pass
87	30	Pass	Pass	Pass	Pass
87	32	Fail	Fail	Fail	Fail
88	13	Pass	Pass	Pass	Pass
88	14	Pass	Pass	Pass	Pass
88	15	Pass	Pass	Pass	Pass
88	30	Pass	Fail	Pass	Fail
89	13	Pass	Pass	Pass	Pass
89	14	Pass	Pass	Pass	Pass
89	15	Pass	Pass	Pass	Pass
89	30	Pass	Fail	Pass	Fail
90	13	Pass	Pass	Pass	Pass
90	14	Pass	Pass	Pass	Pass
90	15	Pass	Pass	Pass	Pass
90	30	Pass	Fail	Pass	Fail
91	13	Pass	Pass	Pass	Pass
91	14	Pass	Pass	Pass	Pass
91	15	Pass	Pass	Pass	Pass
91	16	Pass	Fail	Pass	Fail
91	30	Pass	Fail	Pass	Fail
92	13	Pass	Pass	Pass	Pass
92	14	Pass	Pass	Pass	Pass
92	15	Pass	Pass	Pass	Pass
92	16	Pass	Pass	Pass	Fail
92	30	Pass	Fail	Pass	Fail
92	32	Fail	Fail	Fail	Fail
93	13	Pass	Pass	Pass	Pass
93	14	Pass	Pass	Pass	Pass
93	15	Pass	Pass	Pass	Pass
93	16	Pass	Pass	Pass	Pass
93	30	Pass	Fail	Pass	Fail
94	13	Pass	Pass	Pass	Pass
94	14	Pass	Pass	Pass	Pass
94	15	Pass	Pass	Pass	Pass
94	16	Pass	Pass	Pass	Fail
94	26	Pass	Pass	Pass	Pass
94	30	Pass	Fail	Pass	Fail
95	13	Pass	Pass	Pass	Pass
95	14	Pass	Pass	Pass	Pass
95	15	Pass	Pass	Pass	Pass
95	16	Pass	Fail	Pass	Fail
95	26	Pass	Pass	Pass	Pass
95	28	Fail	Fail	Fail	Fail
95	30	Pass	Fail	Pass	Fail

96	11	Fail	Fail	Fail	Fail
96	13	Pass	Pass	Pass	Pass
96	14	Pass	Pass	Pass	Pass
96	15	Pass	Pass	Pass	Pass
96	26	Pass	Pass	Pass	Pass
96	30	Pass	Fail	Pass	Fail
97	13	Pass	Pass	Pass	Pass
97	14	Pass	Pass	Pass	Pass
97	15	Pass	Pass	Pass	Pass
97	26	Pass	Pass	Pass	Pass
97	30	Pass	Fail	Pass	Fail
98	13	Pass	Pass	Pass	Pass
98	14	Pass	Pass	Pass	Pass
98	15	Pass	Pass	Pass	Pass
98	26	Pass	Pass	Pass	Pass
98	27	Pass	Pass	Pass	Pass
98	28	Pass	Pass	Pass	Pass
98	29	Pass	Pass	Pass	Pass
98	30	Pass	Fail	Pass	Fail
99	13	Pass	Pass	Pass	Pass
99	14	Pass	Pass	Pass	Pass
99	15	Pass	Pass	Pass	Pass
99	16	Pass	Fail	Pass	Fail
99	17	Pass	Fail	Pass	Fail
99	18	Pass	Fail	Pass	Fail
99	19	Pass	Fail	Pass	Fail
99	20	Pass	Fail	Pass	Fail
99	21	Pass	Fail	Pass	Fail
99	22	Pass	Fail	Pass	Fail
99	23	Pass	Fail	Pass	Fail
99	26	Pass	Pass	Pass	Fail
99	30	Pass	Fail	Pass	Fail
100	13	Pass	Pass	Pass	Pass
100	14	Pass	Pass	Pass	Pass
100	15	Pass	Pass	Pass	Pass
100	23	Pass	Fail	Pass	Fail
100	24	Pass	Fail	Pass	Fail
100	25	Pass	Fail	Pass	Fail
100	26	Pass	Pass	Pass	Pass
100	30	Pass	Fail	Pass	Fail
101	13	Pass	Pass	Pass	Pass
101	14	Pass	Pass	Pass	Pass
101	15	Pass	Pass	Pass	Pass
101	16	Pass	Fail	Pass	Fail
101	17	Pass	Fail	Pass	Fail
101	18	Pass	Fail	Pass	Fail
101	19	Pass	Fail	Pass	Fail
101	20	Pass	Fail	Pass	Fail
101	21	Pass	Fail	Pass	Fail
101	22	Pass	Fail	Pass	Fail
101	23	Pass	Fail	Pass	Fail
101	26	Pass	Pass	Pass	Pass
101	30	Pass	Pass	Pass	Pass
102	13	Pass	Pass	Pass	Pass
102	14	Pass	Pass	Pass	Pass
102	15	Pass	Pass	Pass	Pass
102	26	Pass	Pass	Pass	Pass

102	30	Pass	Pass	Pass	Pass
103	13	Pass	Pass	Pass	Pass
103	14	Pass	Pass	Pass	Pass
103	15	Pass	Pass	Pass	Pass
103	26	Pass	Pass	Pass	Pass
103	30	Pass	Pass	Pass	Pass
104	11	Fail	Fail	Fail	Fail
104	13	Pass	Pass	Pass	Pass
104	14	Pass	Pass	Pass	Pass
104	15	Pass	Pass	Pass	Pass
104	26	Pass	Pass	Pass	Pass
104	30	Pass	Pass	Pass	Pass
105	13	Pass	Pass	Pass	Pass
105	14	Pass	Pass	Pass	Pass
105	15	Pass	Pass	Pass	Pass
105	26	Pass	Pass	Pass	Pass
105	30	Pass	Fail	Pass	Fail
106	13	Pass	Pass	Pass	Pass
106	14	Pass	Pass	Pass	Pass
106	15	Pass	Pass	Pass	Pass
106	26	Pass	Pass	Pass	Pass
106	27	Pass	Fail	Pass	Fail
106	30	Pass	Pass	Pass	Pass
106	39	Pass	Fail	Pass	Fail
107	13	Pass	Pass	Pass	Pass
107	14	Pass	Pass	Pass	Pass
107	15	Pass	Pass	Pass	Pass
107	22	Pass	Pass	Pass	Pass
107	26	Pass	Pass	Pass	Pass
107	30	Pass	Pass	Pass	Pass
107	39	Pass	Pass	Pass	Pass
108	13	Pass	Pass	Pass	Pass
108	14	Pass	Pass	Pass	Pass
108	15	Pass	Pass	Pass	Pass
108	22	Pass	Pass	Pass	Pass
108	24	Fail	Fail	Fail	Fail
108	26	Pass	Pass	Pass	Pass
108	30	Pass	Pass	Pass	Pass
108	39	Pass	Fail	Pass	Fail
109	13	Pass	Pass	Pass	Pass
109	14	Pass	Pass	Pass	Pass
109	15	Pass	Pass	Pass	Pass
109	22	Pass	Pass	Pass	Pass
109	26	Pass	Pass	Pass	Pass
109	30	Pass	Fail	Pass	Fail
109	39	Pass	Pass	Pass	Pass
110	13	Pass	Pass	Pass	Pass
110	14	Pass	Pass	Pass	Pass
110	15	Pass	Pass	Pass	Pass
110	22	Pass	Pass	Pass	Pass
110	26	Pass	Pass	Pass	Pass
110	28	Fail	Fail	Fail	Fail
110	39	Pass	Fail	Pass	Fail
111	13	Pass	Pass	Pass	Pass
111	14	Pass	Pass	Pass	Pass
111	15	Pass	Pass	Pass	Pass
111	22	Pass	Pass	Pass	Pass

111	26	Pass	Pass	Pass	Pass
111	39	Pass	Fail	Pass	Fail
112	13	Pass	Pass	Pass	Pass
112	14	Pass	Pass	Pass	Pass
112	15	Pass	Pass	Pass	Pass
112	22	Pass	Fail	Pass	Fail
112	26	Pass	Pass	Pass	Pass
112	39	Pass	Fail	Pass	Fail
113	13	Pass	Pass	Pass	Pass
113	14	Pass	Pass	Pass	Pass
113	15	Pass	Pass	Pass	Pass
113	26	Pass	Pass	Pass	Pass
113	27	Pass	Fail	Pass	Fail
113	39	Pass	Pass	Pass	Pass
113	41	Fail	Fail	Fail	Fail
114	13	Pass	Pass	Pass	Pass
114	14	Pass	Pass	Pass	Pass
114	15	Pass	Pass	Pass	Pass
114	26	Pass	Pass	Pass	Pass
114	39	Pass	Pass	Pass	Pass
115	13	Pass	Pass	Pass	Pass
115	14	Pass	Pass	Pass	Pass
115	15	Pass	Pass	Pass	Pass
115	26	Pass	Pass	Pass	Pass
115	39	Pass	Pass	Pass	Pass
116	13	Pass	Pass	Pass	Pass
116	14	Pass	Pass	Pass	Pass
116	15	Pass	Pass	Pass	Pass
116	26	Pass	Fail	Pass	Fail
116	28	Fail	Fail	Fail	Fail
116	39	Pass	Pass	Pass	Pass
117	13	Pass	Pass	Pass	Pass
117	14	Pass	Pass	Pass	Pass
117	15	Pass	Pass	Pass	Pass
117	26	Pass	Fail	Pass	Fail
117	39	Pass	Pass	Pass	Pass
118	13	Pass	Pass	Pass	Pass
118	14	Pass	Pass	Pass	Pass
118	15	Pass	Pass	Pass	Pass
118	20	Pass	Pass	Pass	Pass
118	26	Pass	Pass	Pass	Pass
118	39	Pass	Pass	Pass	Pass
119	13	Pass	Pass	Pass	Pass
119	14	Pass	Pass	Pass	Pass
119	15	Pass	Pass	Pass	Pass
119	20	Pass	Pass	Pass	Pass
119	26	Pass	Pass	Pass	Pass
119	39	Pass	Pass	Pass	Pass
120	13	Pass	Pass	Pass	Pass
120	14	Pass	Pass	Pass	Pass
120	15	Pass	Fail	Pass	Fail
120	16	Pass	Fail	Pass	Fail
120	26	Pass	Pass	Pass	Pass
120	39	Pass	Pass	Pass	Pass
121	13	Pass	Pass	Pass	Pass
121	14	Pass	Pass	Pass	Pass
121	26	Pass	Fail	Pass	Fail

121	39	Pass	Pass	Pass	Pass
122	13	Pass	Pass	Pass	Pass
122	14	Pass	Pass	Pass	Pass
122	26	Pass	Fail	Pass	Fail
122	39	Pass	Pass	Pass	Pass
122	41	Fail	Fail	Fail	Fail
123	13	Pass	Pass	Pass	Pass
123	14	Pass	Pass	Pass	Pass
123	15	Pass	Fail	Pass	Fail
123	16	Pass	Pass	Pass	Pass
123	17	Pass	Pass	Pass	Pass
123	18	Pass	Pass	Pass	Pass
123	19	Pass	Pass	Pass	Pass
123	20	Pass	Pass	Pass	Pass
123	21	Pass	Pass	Pass	Pass
123	22	Pass	Pass	Pass	Pass
123	23	Pass	Pass	Pass	Pass
123	24	Pass	Pass	Pass	Pass
123	25	Pass	Pass	Pass	Pass
123	26	Pass	Pass	Pass	Pass
123	27	Pass	Pass	Pass	Pass
123	28	Pass	Pass	Pass	Pass
123	29	Pass	Pass	Pass	Pass
123	30	Pass	Pass	Pass	Pass
123	31	Pass	Fail	Pass	Fail
123	32	Pass	Fail	Pass	Fail
123	33	Pass	Pass	Pass	Pass
123	34	Pass	Pass	Pass	Pass
123	35	Pass	Pass	Pass	Pass
123	36	Pass	Pass	Pass	Pass
123	37	Pass	Pass	Pass	Pass
123	38	Pass	Fail	Pass	Fail
123	39	Pass	Fail	Pass	Fail
124	13	Pass	Pass	Pass	Pass
124	14	Pass	Pass	Pass	Pass
124	23	Pass	Pass	Pass	Pass
125	13	Pass	Pass	Pass	Pass
125	14	Pass	Pass	Pass	Pass
125	23	Pass	Pass	Pass	Pass
125	28	Fail	Fail	Fail	Fail
125	33	Fail	Fail	Fail	Fail
126	13	Pass	Pass	Pass	Pass
126	14	Pass	Pass	Pass	Pass
126	23	Pass	Pass	Pass	Pass
127	13	Pass	Pass	Pass	Pass
127	14	Pass	Pass	Pass	Pass
127	23	Pass	Pass	Pass	Pass
128	13	Pass	Pass	Pass	Pass
128	14	Pass	Pass	Pass	Pass
128	23	Pass	Pass	Pass	Pass
129	13	Pass	Pass	Pass	Pass
129	14	Pass	Pass	Pass	Pass
129	23	Pass	Pass	Pass	Pass
130	8	Pass	Fail	Pass	Fail
130	9	Pass	Fail	Pass	Fail
130	10	Pass	Fail	Pass	Fail
130	11	Pass	Fail	Pass	Fail

130	12	Pass	Fail	Pass	Fail
130	13	Pass	Pass	Pass	Pass
130	14	Pass	Pass	Pass	Pass
130	23	Pass	Pass	Pass	Pass
131	14	Pass	Pass	Pass	Pass
131	23	Pass	Pass	Pass	Pass
132	14	Pass	Pass	Pass	Pass
132	23	Pass	Pass	Pass	Pass
133	14	Pass	Pass	Pass	Pass
133	23	Pass	Pass	Pass	Pass
134	14	Pass	Pass	Pass	Pass
134	23	Pass	Fail	Pass	Fail
135	14	Pass	Pass	Pass	Pass
136	14	Pass	Pass	Pass	Pass
137	14	Pass	Pass	Pass	Pass
138	14	Pass	Pass	Pass	Pass

2. Table E.6.2 Striped Bass spawning D.O. , Salinity, and Velocity criteria passing for existing and deepening (4 ft) scenarios within the analyzed period April 1 - April 30, 1997

HABITAT REQUIREMENTS:
RM 10-31; Surface Layer
D.O. April (MG/L):n/a
Salinity 90th %ile <= 1 ppt
Mean Velocity >= 30 cm/s

Savannah Harbor Estuary

Segments J	Segments I	Baseline Scenario Salinity	Baseline Scenario Velocity	Project Scenario Salinity	Project Scenario Velocity
47	13	Fail	Pass	Fail	Pass
47	14	Fail	Pass	Fail	Pass
47	15	Fail	Pass	Fail	Pass
47	16	Fail	Pass	Fail	Pass
47	17	Fail	Fail	Fail	Fail
48	13	Fail	Pass	Fail	Pass
48	14	Fail	Pass	Fail	Pass
48	15	Fail	Pass	Fail	Pass
48	16	Fail	Pass	Fail	Pass
48	17	Fail	Pass	Fail	Pass
49	13	Fail	Pass	Fail	Pass
49	14	Fail	Pass	Fail	Pass
49	15	Fail	Pass	Fail	Pass
49	16	Fail	Pass	Fail	Pass
49	17	Fail	Pass	Fail	Pass
50	13	Fail	Pass	Fail	Pass
50	14	Fail	Pass	Fail	Pass
50	15	Fail	Pass	Fail	Pass
50	16	Fail	Pass	Fail	Pass
50	17	Fail	Pass	Fail	Pass
50	18	Fail	Fail	Fail	Fail
51	13	Fail	Pass	Fail	Pass
51	14	Fail	Pass	Fail	Pass
51	15	Fail	Pass	Fail	Pass
52	13	Fail	Pass	Fail	Pass
52	14	Fail	Pass	Fail	Pass
52	15	Fail	Pass	Fail	Pass
53	13	Fail	Pass	Fail	Pass
53	14	Fail	Pass	Fail	Pass
53	15	Fail	Pass	Fail	Pass
54	13	Fail	Pass	Fail	Pass
54	14	Fail	Pass	Fail	Pass
54	15	Fail	Pass	Fail	Pass
55	13	Fail	Pass	Fail	Pass
55	14	Fail	Pass	Fail	Pass
55	15	Fail	Pass	Fail	Pass
56	13	Fail	Pass	Fail	Pass
56	14	Fail	Pass	Fail	Pass
56	15	Fail	Pass	Fail	Pass

57	13	Fail	Pass	Fail	Pass
57	14	Fail	Pass	Fail	Pass
57	15	Fail	Pass	Fail	Pass
58	13	Fail	Pass	Fail	Pass
58	14	Fail	Pass	Fail	Pass
58	15	Fail	Pass	Fail	Pass
59	13	Pass	Pass	Fail	Pass
59	14	Fail	Pass	Fail	Pass
59	15	Fail	Pass	Fail	Pass
59	30	Fail	Pass	Fail	Pass
59	31	Fail	Pass	Fail	Pass
59	32	Fail	Fail	Fail	Fail
60	13	Pass	Pass	Fail	Pass
60	14	Pass	Pass	Fail	Pass
60	15	Pass	Pass	Fail	Pass
60	30	Fail	Fail	Fail	Fail
60	31	Fail	Fail	Fail	Pass
60	32	Fail	Fail	Fail	Fail
61	13	Pass	Pass	Fail	Pass
61	14	Pass	Pass	Fail	Pass
61	15	Pass	Pass	Fail	Pass
61	30	Fail	Fail	Fail	Fail
61	31	Fail	Fail	Fail	Pass
61	32	Fail	Fail	Fail	Fail
62	13	Pass	Pass	Fail	Pass
62	14	Pass	Pass	Fail	Pass
62	15	Pass	Pass	Fail	Pass
62	30	Fail	Fail	Fail	Fail
62	31	Fail	Pass	Fail	Pass
62	32	Fail	Fail	Fail	Fail
63	13	Pass	Pass	Fail	Pass
63	14	Pass	Pass	Fail	Pass
63	15	Pass	Pass	Fail	Pass
63	31	Fail	Pass	Fail	Pass
64	13	Pass	Pass	Fail	Pass
64	14	Pass	Pass	Fail	Pass
64	15	Pass	Pass	Fail	Pass
64	30	Fail	Fail	Fail	Fail
64	31	Fail	Pass	Fail	Pass
64	32	Fail	Fail	Fail	Fail
65	13	Pass	Pass	Pass	Pass
65	14	Pass	Pass	Fail	Pass
65	15	Pass	Pass	Fail	Pass
65	30	Fail	Pass	Fail	Pass
65	31	Fail	Pass	Fail	Pass
65	32	Fail	Pass	Fail	Pass
65	33	Fail	Fail	Fail	Fail
66	13	Pass	Pass	Pass	Pass
66	14	Pass	Pass	Fail	Pass
66	15	Pass	Pass	Pass	Pass
66	30	Fail	Pass	Fail	Pass
66	31	Fail	Pass	Fail	Pass
66	32	Fail	Pass	Fail	Pass
66	36	Fail	Pass	Fail	Pass
66	38	Fail	Fail	Fail	Fail
67	13	Pass	Pass	Pass	Pass
67	14	Pass	Pass	Fail	Pass

67	15	Pass	Pass	Pass	Pass
67	30	Fail	Pass	Fail	Pass
67	31	Fail	Pass	Fail	Pass
67	32	Fail	Pass	Fail	Pass
67	36	Fail	Fail	Fail	Fail
68	13	Pass	Pass	Pass	Pass
68	14	Pass	Pass	Fail	Pass
68	15	Pass	Pass	Pass	Pass
68	30	Fail	Pass	Fail	Pass
68	31	Fail	Pass	Fail	Pass
68	32	Fail	Pass	Fail	Pass
68	36	Fail	Fail	Fail	Fail
68	38	Fail	Fail	Fail	Fail
69	13	Pass	Pass	Pass	Pass
69	14	Pass	Pass	Pass	Pass
69	15	Pass	Pass	Pass	Pass
69	30	Fail	Pass	Fail	Pass
69	31	Fail	Pass	Fail	Pass
69	32	Fail	Fail	Fail	Fail
69	36	Fail	Fail	Fail	Fail
70	13	Pass	Pass	Pass	Pass
70	14	Pass	Pass	Pass	Pass
70	15	Pass	Pass	Pass	Pass
70	30	Fail	Pass	Fail	Pass
70	31	Fail	Pass	Fail	Pass
70	32	Fail	Fail	Fail	Fail
70	33	Fail	Fail	Fail	Fail
71	13	Pass	Pass	Pass	Pass
71	14	Pass	Pass	Pass	Pass
71	15	Pass	Pass	Pass	Pass
71	30	Fail	Pass	Fail	Pass
71	31	Fail	Pass	Fail	Pass
71	32	Fail	Fail	Fail	Fail
72	13	Pass	Pass	Pass	Pass
72	14	Pass	Pass	Pass	Pass
72	15	Pass	Pass	Pass	Pass
72	30	Fail	Fail	Fail	Fail
72	31	Fail	Pass	Fail	Pass
72	32	Fail	Fail	Fail	Fail
73	13	Pass	Pass	Pass	Pass
73	14	Pass	Pass	Pass	Pass
73	15	Pass	Pass	Pass	Pass
73	30	Fail	Fail	Fail	Fail
73	31	Fail	Pass	Fail	Pass
74	13	Pass	Pass	Pass	Pass
74	14	Pass	Pass	Pass	Pass
74	15	Pass	Pass	Pass	Pass
74	30	Fail	Fail	Fail	Fail
74	31	Fail	Pass	Fail	Pass
75	13	Pass	Pass	Pass	Pass
75	14	Pass	Pass	Pass	Pass
75	15	Pass	Pass	Pass	Pass
75	30	Fail	Fail	Fail	Fail
75	31	Fail	Fail	Fail	Pass
76	13	Pass	Pass	Pass	Pass
76	14	Pass	Pass	Pass	Pass
76	15	Pass	Fail	Pass	Fail

76	16	Pass	Fail	Pass	Fail
76	17	Pass	Fail	Pass	Fail
76	30	Fail	Fail	Fail	Fail
76	31	Fail	Pass	Fail	Pass
76	33	Fail	Fail	Fail	Fail
77	13	Pass	Fail	Pass	Fail
77	14	Pass	Pass	Pass	Pass
77	15	Pass	Fail	Pass	Fail
77	16	Pass	Fail	Pass	Fail
77	17	Pass	Fail	Pass	Fail
77	30	Fail	Fail	Fail	Fail
77	31	Fail	Fail	Fail	Fail
78	13	Pass	Fail	Pass	Fail
78	14	Pass	Pass	Pass	Pass
78	15	Pass	Fail	Pass	Fail
78	16	Pass	Fail	Pass	Fail
78	17	Pass	Fail	Pass	Fail
78	30	Fail	Fail	Fail	Fail
78	31	Fail	Fail	Fail	Fail
79	13	Pass	Pass	Pass	Pass
79	14	Pass	Pass	Pass	Pass
79	15	Pass	Fail	Pass	Pass
79	30	Fail	Pass	Fail	Pass
79	31	Fail	Fail	Fail	Fail
80	13	Pass	Pass	Pass	Pass
80	14	Pass	Pass	Pass	Pass
80	15	Pass	Pass	Pass	Pass
80	30	Pass	Pass	Fail	Pass
80	31	Fail	Fail	Fail	Fail
81	13	Pass	Pass	Pass	Pass
81	14	Pass	Pass	Pass	Pass
81	15	Pass	Pass	Pass	Pass
81	30	Pass	Pass	Fail	Pass
81	31	Fail	Fail	Fail	Fail
82	13	Pass	Pass	Pass	Pass
82	14	Pass	Pass	Pass	Pass
82	15	Pass	Pass	Pass	Pass
82	16	Pass	Fail	Pass	Fail
82	17	Pass	Fail	Pass	Fail
82	18	Pass	Pass	Pass	Pass
82	19	Pass	Fail	Pass	Fail
82	20	Pass	Fail	Pass	Fail
82	21	Pass	Fail	Pass	Fail
82	29	Pass	Fail	Pass	Fail
82	30	Pass	Pass	Fail	Pass
82	31	Pass	Fail	Fail	Fail
83	13	Pass	Pass	Pass	Pass
83	14	Pass	Pass	Pass	Pass
83	15	Pass	Pass	Pass	Pass
83	21	Pass	Pass	Pass	Pass
83	30	Pass	Fail	Pass	Fail
83	31	Pass	Fail	Fail	Fail
84	13	Pass	Pass	Pass	Pass
84	14	Pass	Pass	Pass	Pass
84	15	Pass	Pass	Pass	Pass
84	21	Pass	Pass	Pass	Pass
84	30	Pass	Fail	Pass	Fail

84	31	Pass	Fail	Pass	Fail
85	13	Pass	Pass	Pass	Pass
85	14	Pass	Pass	Pass	Pass
85	15	Pass	Pass	Pass	Pass
85	21	Pass	Pass	Pass	Pass
85	30	Pass	Fail	Pass	Fail
86	13	Pass	Pass	Pass	Pass
86	14	Pass	Pass	Pass	Pass
86	15	Pass	Pass	Pass	Pass
86	17	Fail	Fail	Fail	Fail
86	21	Pass	Pass	Pass	Pass
86	30	Pass	Pass	Pass	Pass
87	13	Pass	Pass	Pass	Pass
87	14	Pass	Pass	Pass	Pass
87	15	Pass	Pass	Pass	Pass
87	30	Pass	Pass	Pass	Pass
87	32	Fail	Fail	Fail	Fail
88	13	Pass	Pass	Pass	Pass
88	14	Pass	Pass	Pass	Pass
88	15	Pass	Pass	Pass	Pass
88	30	Pass	Fail	Pass	Fail
89	13	Pass	Pass	Pass	Pass
89	14	Pass	Pass	Pass	Pass
89	15	Pass	Pass	Pass	Pass
89	30	Pass	Fail	Pass	Fail
90	13	Pass	Pass	Pass	Pass
90	14	Pass	Pass	Pass	Pass
90	15	Pass	Pass	Pass	Pass
90	30	Pass	Fail	Pass	Fail
91	13	Pass	Pass	Pass	Pass
91	14	Pass	Pass	Pass	Pass
91	15	Pass	Pass	Pass	Pass
91	16	Pass	Fail	Pass	Fail
91	30	Pass	Fail	Pass	Fail
92	13	Pass	Pass	Pass	Pass
92	14	Pass	Pass	Pass	Pass
92	15	Pass	Pass	Pass	Pass
92	16	Pass	Pass	Pass	Fail
92	30	Pass	Fail	Pass	Fail
92	32	Fail	Fail	Fail	Fail
93	13	Pass	Pass	Pass	Pass
93	14	Pass	Pass	Pass	Pass
93	15	Pass	Pass	Pass	Pass
93	16	Pass	Pass	Pass	Pass
93	30	Pass	Fail	Pass	Fail
94	13	Pass	Pass	Pass	Pass
94	14	Pass	Pass	Pass	Pass
94	15	Pass	Pass	Pass	Pass
94	16	Pass	Pass	Pass	Fail
94	26	Pass	Pass	Pass	Pass
94	30	Pass	Fail	Pass	Fail
95	13	Pass	Pass	Pass	Pass
95	14	Pass	Pass	Pass	Pass
95	15	Pass	Pass	Pass	Pass
95	16	Pass	Fail	Pass	Fail
95	26	Pass	Pass	Pass	Pass
95	28	Fail	Fail	Fail	Fail

95	30	Pass	Fail	Pass	Fail
96	11	Fail	Fail	Fail	Fail
96	13	Pass	Pass	Pass	Pass
96	14	Pass	Pass	Pass	Pass
96	15	Pass	Pass	Pass	Pass
96	26	Pass	Pass	Pass	Pass
96	30	Pass	Fail	Pass	Fail
97	13	Pass	Pass	Pass	Pass
97	14	Pass	Pass	Pass	Pass
97	15	Pass	Pass	Pass	Pass
97	26	Pass	Pass	Pass	Pass
97	30	Pass	Fail	Pass	Fail
98	13	Pass	Pass	Pass	Pass
98	14	Pass	Pass	Pass	Pass
98	15	Pass	Pass	Pass	Pass
98	26	Pass	Pass	Pass	Pass
98	27	Pass	Pass	Pass	Pass
98	28	Pass	Pass	Pass	Pass
98	29	Pass	Pass	Pass	Pass
98	30	Pass	Fail	Pass	Fail
99	13	Pass	Pass	Pass	Pass
99	14	Pass	Pass	Pass	Pass
99	15	Pass	Pass	Pass	Pass
99	16	Pass	Fail	Pass	Fail
99	17	Pass	Fail	Pass	Fail
99	18	Pass	Fail	Pass	Fail
99	19	Pass	Fail	Pass	Fail
99	20	Pass	Fail	Pass	Fail
99	21	Pass	Fail	Pass	Fail
99	22	Pass	Fail	Pass	Fail
99	23	Pass	Fail	Pass	Fail
99	26	Pass	Pass	Pass	Pass
99	30	Pass	Fail	Pass	Fail
100	13	Pass	Pass	Pass	Pass
100	14	Pass	Pass	Pass	Pass
100	15	Pass	Pass	Pass	Pass
100	23	Pass	Fail	Pass	Fail
100	24	Pass	Fail	Pass	Fail
100	25	Pass	Fail	Pass	Fail
100	26	Pass	Pass	Pass	Pass
100	30	Pass	Fail	Pass	Fail
101	13	Pass	Pass	Pass	Pass
101	14	Pass	Pass	Pass	Pass
101	15	Pass	Pass	Pass	Pass
101	16	Pass	Fail	Pass	Fail
101	17	Pass	Fail	Pass	Fail
101	18	Pass	Fail	Pass	Fail
101	19	Pass	Fail	Pass	Fail
101	20	Pass	Fail	Pass	Fail
101	21	Pass	Fail	Pass	Fail
101	22	Pass	Fail	Pass	Fail
101	23	Pass	Fail	Pass	Fail
101	26	Pass	Pass	Pass	Pass
101	30	Pass	Pass	Pass	Pass
102	13	Pass	Pass	Pass	Pass
102	14	Pass	Pass	Pass	Pass
102	15	Pass	Pass	Pass	Pass

102	26	Pass	Pass	Pass	Pass
102	30	Pass	Pass	Pass	Pass
103	13	Pass	Pass	Pass	Pass
103	14	Pass	Pass	Pass	Pass
103	15	Pass	Pass	Pass	Pass
103	26	Pass	Pass	Pass	Pass
103	30	Pass	Pass	Pass	Pass
104	11	Fail	Fail	Fail	Fail
104	13	Pass	Pass	Pass	Pass
104	14	Pass	Pass	Pass	Pass
104	15	Pass	Pass	Pass	Pass
104	26	Pass	Pass	Pass	Pass
104	30	Pass	Pass	Pass	Pass
105	13	Pass	Pass	Pass	Pass
105	14	Pass	Pass	Pass	Pass
105	15	Pass	Pass	Pass	Pass
105	26	Pass	Pass	Pass	Pass
105	30	Pass	Fail	Pass	Fail
106	13	Pass	Pass	Pass	Pass
106	14	Pass	Pass	Pass	Pass
106	15	Pass	Pass	Pass	Pass
106	26	Pass	Pass	Pass	Pass
106	27	Pass	Fail	Pass	Fail
106	30	Pass	Pass	Pass	Pass
106	39	Pass	Fail	Pass	Fail
107	13	Pass	Pass	Pass	Pass
107	14	Pass	Pass	Pass	Pass
107	15	Pass	Pass	Pass	Pass
107	22	Pass	Pass	Pass	Pass
107	26	Pass	Pass	Pass	Pass
107	30	Pass	Pass	Pass	Pass
107	39	Pass	Pass	Pass	Pass
108	13	Pass	Pass	Pass	Pass
108	14	Pass	Pass	Pass	Pass
108	15	Pass	Pass	Pass	Pass
108	22	Pass	Pass	Pass	Pass
108	24	Fail	Fail	Fail	Fail
108	26	Pass	Pass	Pass	Pass
108	30	Pass	Pass	Pass	Pass
108	39	Pass	Fail	Pass	Fail
109	13	Pass	Pass	Pass	Pass
109	14	Pass	Pass	Pass	Pass
109	15	Pass	Pass	Pass	Pass
109	22	Pass	Pass	Pass	Pass
109	26	Pass	Pass	Pass	Pass
109	30	Pass	Fail	Pass	Fail
109	39	Pass	Pass	Pass	Pass
110	13	Pass	Pass	Pass	Pass
110	14	Pass	Pass	Pass	Pass
110	15	Pass	Pass	Pass	Pass
110	22	Pass	Pass	Pass	Pass
110	26	Pass	Pass	Pass	Pass
110	28	Fail	Fail	Fail	Fail
110	39	Pass	Fail	Pass	Fail
111	13	Pass	Pass	Pass	Pass
111	14	Pass	Pass	Pass	Pass
111	15	Pass	Pass	Pass	Pass

111	22	Pass	Pass	Pass	Pass
111	26	Pass	Pass	Pass	Pass
111	39	Pass	Fail	Pass	Fail
112	13	Pass	Pass	Pass	Pass
112	14	Pass	Pass	Pass	Pass
112	15	Pass	Pass	Pass	Pass
112	22	Pass	Fail	Pass	Fail
112	26	Pass	Pass	Pass	Pass
112	39	Pass	Fail	Pass	Fail
113	13	Pass	Pass	Pass	Pass
113	14	Pass	Pass	Pass	Pass
113	15	Pass	Pass	Pass	Pass
113	26	Pass	Pass	Pass	Pass
113	27	Pass	Fail	Pass	Fail
113	39	Pass	Pass	Pass	Pass
113	41	Fail	Fail	Fail	Fail
114	13	Pass	Pass	Pass	Pass
114	14	Pass	Pass	Pass	Pass
114	15	Pass	Pass	Pass	Pass
114	26	Pass	Pass	Pass	Pass
114	39	Pass	Pass	Pass	Pass
115	13	Pass	Pass	Pass	Pass
115	14	Pass	Pass	Pass	Pass
115	15	Pass	Pass	Pass	Pass
115	26	Pass	Pass	Pass	Pass
115	39	Pass	Pass	Pass	Pass
116	13	Pass	Pass	Pass	Pass
116	14	Pass	Pass	Pass	Pass
116	15	Pass	Pass	Pass	Pass
116	26	Pass	Fail	Pass	Fail
116	28	Fail	Fail	Fail	Fail
116	39	Pass	Pass	Pass	Pass
117	13	Pass	Pass	Pass	Pass
117	14	Pass	Pass	Pass	Pass
117	15	Pass	Pass	Pass	Pass
117	26	Pass	Fail	Pass	Fail
117	39	Pass	Pass	Pass	Pass
118	13	Pass	Pass	Pass	Pass
118	14	Pass	Pass	Pass	Pass
118	15	Pass	Pass	Pass	Pass
118	20	Pass	Pass	Pass	Pass
118	26	Pass	Pass	Pass	Pass
118	39	Pass	Pass	Pass	Pass
119	13	Pass	Pass	Pass	Pass
119	14	Pass	Pass	Pass	Pass
119	15	Pass	Pass	Pass	Pass
119	20	Pass	Pass	Pass	Pass
119	26	Pass	Pass	Pass	Pass
119	39	Pass	Pass	Pass	Pass
120	13	Pass	Pass	Pass	Pass
120	14	Pass	Pass	Pass	Pass
120	15	Pass	Fail	Pass	Fail
120	16	Pass	Fail	Pass	Fail
120	26	Pass	Pass	Pass	Pass
120	39	Pass	Pass	Pass	Pass
121	13	Pass	Pass	Pass	Pass
121	14	Pass	Pass	Pass	Pass

121	26	Pass	Fail	Pass	Fail
121	39	Pass	Pass	Pass	Pass
122	13	Pass	Pass	Pass	Pass
122	14	Pass	Pass	Pass	Pass
122	26	Pass	Fail	Pass	Fail
122	39	Pass	Pass	Pass	Pass
122	41	Fail	Fail	Fail	Fail
123	13	Pass	Pass	Pass	Pass
123	14	Pass	Pass	Pass	Pass
123	15	Pass	Fail	Pass	Fail
123	16	Pass	Pass	Pass	Pass
123	17	Pass	Pass	Pass	Pass
123	18	Pass	Pass	Pass	Pass
123	19	Pass	Pass	Pass	Pass
123	20	Pass	Pass	Pass	Pass
123	21	Pass	Pass	Pass	Pass
123	22	Pass	Pass	Pass	Pass
123	23	Pass	Pass	Pass	Pass
123	24	Pass	Pass	Pass	Pass
123	25	Pass	Pass	Pass	Pass
123	26	Pass	Pass	Pass	Pass
123	27	Pass	Pass	Pass	Pass
123	28	Pass	Pass	Pass	Pass
123	29	Pass	Pass	Pass	Pass
123	30	Pass	Pass	Pass	Pass
123	31	Pass	Fail	Pass	Fail
123	32	Pass	Fail	Pass	Fail
123	33	Pass	Pass	Pass	Pass
123	34	Pass	Pass	Pass	Pass
123	35	Pass	Pass	Pass	Pass
123	36	Pass	Pass	Pass	Pass
123	37	Pass	Pass	Pass	Pass
123	38	Pass	Fail	Pass	Fail
123	39	Pass	Fail	Pass	Fail
124	13	Pass	Pass	Pass	Pass
124	14	Pass	Pass	Pass	Pass
124	23	Pass	Pass	Pass	Pass
125	13	Pass	Pass	Pass	Pass
125	14	Pass	Pass	Pass	Pass
125	23	Pass	Pass	Pass	Pass
125	28	Fail	Fail	Fail	Fail
125	33	Fail	Fail	Fail	Fail
126	13	Pass	Pass	Pass	Pass
126	14	Pass	Pass	Pass	Pass
126	23	Pass	Pass	Pass	Pass
127	13	Pass	Pass	Pass	Pass
127	14	Pass	Pass	Pass	Pass
127	23	Pass	Pass	Pass	Pass
128	13	Pass	Pass	Pass	Pass
128	14	Pass	Pass	Pass	Pass
128	23	Pass	Pass	Pass	Pass
129	13	Pass	Pass	Pass	Pass
129	14	Pass	Pass	Pass	Pass
129	23	Pass	Pass	Pass	Pass
130	8	Pass	Fail	Pass	Fail
130	9	Pass	Fail	Pass	Fail
130	10	Pass	Fail	Pass	Fail

130	11	Pass	Fail	Pass	Fail
130	12	Pass	Fail	Pass	Fail
130	13	Pass	Pass	Pass	Pass
130	14	Pass	Pass	Pass	Pass
130	23	Pass	Pass	Pass	Pass
131	14	Pass	Pass	Pass	Pass
131	23	Pass	Pass	Pass	Pass
132	14	Pass	Pass	Pass	Pass
132	23	Pass	Pass	Pass	Pass
133	14	Pass	Pass	Pass	Pass
133	23	Pass	Pass	Pass	Pass
134	14	Pass	Pass	Pass	Pass
134	23	Pass	Fail	Pass	Fail
135	14	Pass	Pass	Pass	Pass
136	14	Pass	Pass	Pass	Pass
137	14	Pass	Pass	Pass	Pass
138	14	Pass	Pass	Pass	Pass

3. Table E.6.3 Striped Bass spawning D.O. , Salinity, and Velocity criteria passing for existing and deepening (3 ft) scenarios within the analyzed period April 1 - April 30, 1997

HABITAT REQUIREMENTS:
RM 10-31; Surface Layer
D.O. April (MG/L):n/a
Salinity 90th %ile <= 1 ppt
Mean Velocity >= 30 cm/s

Savannah Harbor Estuary

Segments		Baseline Scenario		Project Scenario	
J	I	Salinity	Velocity	Salinity	Velocity
47	13	Fail	Pass	Fail	Pass
47	14	Fail	Pass	Fail	Pass
47	15	Fail	Pass	Fail	Pass
47	16	Fail	Pass	Fail	Pass
47	17	Fail	Fail	Fail	Fail
48	13	Fail	Pass	Fail	Pass
48	14	Fail	Pass	Fail	Pass
48	15	Fail	Pass	Fail	Pass
48	16	Fail	Pass	Fail	Pass
48	17	Fail	Pass	Fail	Pass
49	13	Fail	Pass	Fail	Pass
49	14	Fail	Pass	Fail	Pass
49	15	Fail	Pass	Fail	Pass
49	16	Fail	Pass	Fail	Pass
49	17	Fail	Pass	Fail	Pass
50	13	Fail	Pass	Fail	Pass
50	14	Fail	Pass	Fail	Pass
50	15	Fail	Pass	Fail	Pass
50	16	Fail	Pass	Fail	Pass
50	17	Fail	Pass	Fail	Pass
50	18	Fail	Fail	Fail	Fail
51	13	Fail	Pass	Fail	Pass
51	14	Fail	Pass	Fail	Pass
51	15	Fail	Pass	Fail	Pass
52	13	Fail	Pass	Fail	Pass
52	14	Fail	Pass	Fail	Pass
52	15	Fail	Pass	Fail	Pass
53	13	Fail	Pass	Fail	Pass
53	14	Fail	Pass	Fail	Pass
53	15	Fail	Pass	Fail	Pass
54	13	Fail	Pass	Fail	Pass
54	14	Fail	Pass	Fail	Pass
54	15	Fail	Pass	Fail	Pass
55	13	Fail	Pass	Fail	Pass
55	14	Fail	Pass	Fail	Pass
55	15	Fail	Pass	Fail	Pass
56	13	Fail	Pass	Fail	Pass
56	14	Fail	Pass	Fail	Pass
56	15	Fail	Pass	Fail	Pass

57	13	Fail	Pass	Fail	Pass
57	14	Fail	Pass	Fail	Pass
57	15	Fail	Pass	Fail	Pass
58	13	Fail	Pass	Fail	Pass
58	14	Fail	Pass	Fail	Pass
58	15	Fail	Pass	Fail	Pass
59	13	Pass	Pass	Fail	Pass
59	14	Fail	Pass	Fail	Pass
59	15	Fail	Pass	Fail	Pass
59	30	Fail	Pass	Fail	Pass
59	31	Fail	Pass	Fail	Pass
59	32	Fail	Fail	Fail	Fail
60	13	Pass	Pass	Fail	Pass
60	14	Pass	Pass	Fail	Pass
60	15	Pass	Pass	Fail	Pass
60	30	Fail	Fail	Fail	Fail
60	31	Fail	Fail	Fail	Fail
60	32	Fail	Fail	Fail	Fail
61	13	Pass	Pass	Fail	Pass
61	14	Pass	Pass	Fail	Pass
61	15	Pass	Pass	Fail	Pass
61	30	Fail	Fail	Fail	Fail
61	31	Fail	Fail	Fail	Pass
61	32	Fail	Fail	Fail	Fail
62	13	Pass	Pass	Pass	Pass
62	14	Pass	Pass	Fail	Pass
62	15	Pass	Pass	Fail	Pass
62	30	Fail	Fail	Fail	Fail
62	31	Fail	Pass	Fail	Pass
62	32	Fail	Fail	Fail	Fail
63	13	Pass	Pass	Pass	Pass
63	14	Pass	Pass	Pass	Pass
63	15	Pass	Pass	Fail	Pass
63	31	Fail	Pass	Fail	Pass
64	13	Pass	Pass	Pass	Pass
64	14	Pass	Pass	Pass	Pass
64	15	Pass	Pass	Fail	Pass
64	30	Fail	Fail	Fail	Fail
64	31	Fail	Pass	Fail	Pass
64	32	Fail	Fail	Fail	Fail
65	13	Pass	Pass	Pass	Pass
65	14	Pass	Pass	Pass	Pass
65	15	Pass	Pass	Fail	Pass
65	30	Fail	Pass	Fail	Pass
65	31	Fail	Pass	Fail	Pass
65	32	Fail	Pass	Fail	Pass
65	33	Fail	Fail	Fail	Fail
66	13	Pass	Pass	Pass	Pass
66	14	Pass	Pass	Pass	Pass
66	15	Pass	Pass	Pass	Pass
66	30	Fail	Pass	Fail	Pass
66	31	Fail	Pass	Fail	Pass
66	32	Fail	Pass	Fail	Pass
66	36	Fail	Pass	Fail	Pass
66	38	Fail	Fail	Fail	Fail
67	13	Pass	Pass	Pass	Pass
67	14	Pass	Pass	Pass	Pass

67	15	Pass	Pass	Pass	Pass
67	30	Fail	Pass	Fail	Pass
67	31	Fail	Pass	Fail	Pass
67	32	Fail	Pass	Fail	Pass
67	36	Fail	Fail	Fail	Fail
68	13	Pass	Pass	Pass	Pass
68	14	Pass	Pass	Pass	Pass
68	15	Pass	Pass	Pass	Pass
68	30	Fail	Pass	Fail	Pass
68	31	Fail	Pass	Fail	Pass
68	32	Fail	Pass	Fail	Pass
68	36	Fail	Fail	Fail	Fail
68	38	Fail	Fail	Fail	Fail
69	13	Pass	Pass	Pass	Pass
69	14	Pass	Pass	Pass	Pass
69	15	Pass	Pass	Pass	Pass
69	30	Fail	Pass	Fail	Pass
69	31	Fail	Pass	Fail	Pass
69	32	Fail	Fail	Fail	Fail
69	36	Fail	Fail	Fail	Fail
70	13	Pass	Pass	Pass	Pass
70	14	Pass	Pass	Pass	Pass
70	15	Pass	Pass	Pass	Pass
70	30	Fail	Pass	Fail	Pass
70	31	Fail	Pass	Fail	Pass
70	32	Fail	Fail	Fail	Fail
70	33	Fail	Fail	Fail	Fail
71	13	Pass	Pass	Pass	Pass
71	14	Pass	Pass	Pass	Pass
71	15	Pass	Pass	Pass	Pass
71	30	Fail	Pass	Fail	Pass
71	31	Fail	Pass	Fail	Pass
71	32	Fail	Fail	Fail	Fail
72	13	Pass	Pass	Pass	Pass
72	14	Pass	Pass	Pass	Pass
72	15	Pass	Pass	Pass	Pass
72	30	Fail	Fail	Fail	Fail
72	31	Fail	Pass	Fail	Pass
72	32	Fail	Fail	Fail	Fail
73	13	Pass	Pass	Pass	Pass
73	14	Pass	Pass	Pass	Pass
73	15	Pass	Pass	Pass	Pass
73	30	Fail	Fail	Fail	Fail
73	31	Fail	Pass	Fail	Pass
74	13	Pass	Pass	Pass	Pass
74	14	Pass	Pass	Pass	Pass
74	15	Pass	Pass	Pass	Pass
74	30	Fail	Fail	Fail	Fail
74	31	Fail	Pass	Fail	Pass
75	13	Pass	Pass	Pass	Pass
75	14	Pass	Pass	Pass	Pass
75	15	Pass	Pass	Pass	Pass
75	30	Fail	Fail	Fail	Fail
75	31	Fail	Fail	Fail	Pass
76	13	Pass	Pass	Pass	Pass
76	14	Pass	Pass	Pass	Pass
76	15	Pass	Fail	Pass	Fail

76	16	Pass	Fail	Pass	Fail
76	17	Pass	Fail	Pass	Fail
76	30	Fail	Fail	Fail	Fail
76	31	Fail	Pass	Fail	Pass
76	33	Fail	Fail	Fail	Fail
77	13	Pass	Fail	Pass	Fail
77	14	Pass	Pass	Pass	Pass
77	15	Pass	Fail	Pass	Fail
77	16	Pass	Fail	Pass	Fail
77	17	Pass	Fail	Pass	Fail
77	30	Fail	Fail	Fail	Fail
77	31	Fail	Fail	Fail	Fail
78	13	Pass	Fail	Pass	Fail
78	14	Pass	Pass	Pass	Pass
78	15	Pass	Fail	Pass	Fail
78	16	Pass	Fail	Pass	Fail
78	17	Pass	Fail	Pass	Fail
78	30	Fail	Fail	Fail	Fail
78	31	Fail	Fail	Fail	Fail
79	13	Pass	Pass	Pass	Pass
79	14	Pass	Pass	Pass	Pass
79	15	Pass	Fail	Pass	Pass
79	30	Fail	Pass	Fail	Pass
79	31	Fail	Fail	Fail	Fail
80	13	Pass	Pass	Pass	Pass
80	14	Pass	Pass	Pass	Pass
80	15	Pass	Pass	Pass	Pass
80	30	Pass	Pass	Fail	Pass
80	31	Fail	Fail	Fail	Fail
81	13	Pass	Pass	Pass	Pass
81	14	Pass	Pass	Pass	Pass
81	15	Pass	Pass	Pass	Pass
81	30	Pass	Pass	Fail	Pass
81	31	Fail	Fail	Fail	Fail
82	13	Pass	Pass	Pass	Pass
82	14	Pass	Pass	Pass	Pass
82	15	Pass	Pass	Pass	Pass
82	16	Pass	Fail	Pass	Fail
82	17	Pass	Fail	Pass	Fail
82	18	Pass	Pass	Pass	Pass
82	19	Pass	Fail	Pass	Fail
82	20	Pass	Fail	Pass	Fail
82	21	Pass	Fail	Pass	Fail
82	29	Pass	Fail	Pass	Fail
82	30	Pass	Pass	Pass	Pass
82	31	Pass	Fail	Fail	Fail
83	13	Pass	Pass	Pass	Pass
83	14	Pass	Pass	Pass	Pass
83	15	Pass	Pass	Pass	Pass
83	21	Pass	Pass	Pass	Pass
83	30	Pass	Fail	Pass	Fail
83	31	Pass	Fail	Fail	Fail
84	13	Pass	Pass	Pass	Pass
84	14	Pass	Pass	Pass	Pass
84	15	Pass	Pass	Pass	Pass
84	21	Pass	Pass	Pass	Pass
84	30	Pass	Fail	Pass	Fail

84	31	Pass	Fail	Pass	Fail
85	13	Pass	Pass	Pass	Pass
85	14	Pass	Pass	Pass	Pass
85	15	Pass	Pass	Pass	Pass
85	21	Pass	Pass	Pass	Pass
85	30	Pass	Fail	Pass	Fail
86	13	Pass	Pass	Pass	Pass
86	14	Pass	Pass	Pass	Pass
86	15	Pass	Pass	Pass	Pass
86	17	Fail	Fail	Fail	Fail
86	21	Pass	Pass	Pass	Pass
86	30	Pass	Pass	Pass	Pass
87	13	Pass	Pass	Pass	Pass
87	14	Pass	Pass	Pass	Pass
87	15	Pass	Pass	Pass	Pass
87	30	Pass	Pass	Pass	Pass
87	32	Fail	Fail	Fail	Fail
88	13	Pass	Pass	Pass	Pass
88	14	Pass	Pass	Pass	Pass
88	15	Pass	Pass	Pass	Pass
88	30	Pass	Fail	Pass	Fail
89	13	Pass	Pass	Pass	Pass
89	14	Pass	Pass	Pass	Pass
89	15	Pass	Pass	Pass	Pass
89	30	Pass	Fail	Pass	Fail
90	13	Pass	Pass	Pass	Pass
90	14	Pass	Pass	Pass	Pass
90	15	Pass	Pass	Pass	Pass
90	30	Pass	Fail	Pass	Fail
91	13	Pass	Pass	Pass	Pass
91	14	Pass	Pass	Pass	Pass
91	15	Pass	Pass	Pass	Pass
91	16	Pass	Fail	Pass	Fail
91	30	Pass	Fail	Pass	Fail
92	13	Pass	Pass	Pass	Pass
92	14	Pass	Pass	Pass	Pass
92	15	Pass	Pass	Pass	Pass
92	16	Pass	Pass	Pass	Pass
92	30	Pass	Fail	Pass	Fail
92	32	Fail	Fail	Fail	Fail
93	13	Pass	Pass	Pass	Pass
93	14	Pass	Pass	Pass	Pass
93	15	Pass	Pass	Pass	Pass
93	16	Pass	Pass	Pass	Pass
93	30	Pass	Fail	Pass	Fail
94	13	Pass	Pass	Pass	Pass
94	14	Pass	Pass	Pass	Pass
94	15	Pass	Pass	Pass	Pass
94	16	Pass	Pass	Pass	Fail
94	26	Pass	Pass	Pass	Pass
94	30	Pass	Fail	Pass	Fail
95	13	Pass	Pass	Pass	Pass
95	14	Pass	Pass	Pass	Pass
95	15	Pass	Pass	Pass	Pass
95	16	Pass	Fail	Pass	Fail
95	26	Pass	Pass	Pass	Pass
95	28	Fail	Fail	Fail	Fail

95	30	Pass	Fail	Pass	Fail
96	11	Fail	Fail	Fail	Fail
96	13	Pass	Pass	Pass	Pass
96	14	Pass	Pass	Pass	Pass
96	15	Pass	Pass	Pass	Pass
96	26	Pass	Pass	Pass	Pass
96	30	Pass	Fail	Pass	Fail
97	13	Pass	Pass	Pass	Pass
97	14	Pass	Pass	Pass	Pass
97	15	Pass	Pass	Pass	Pass
97	26	Pass	Pass	Pass	Pass
97	30	Pass	Fail	Pass	Fail
98	13	Pass	Pass	Pass	Pass
98	14	Pass	Pass	Pass	Pass
98	15	Pass	Pass	Pass	Pass
98	26	Pass	Pass	Pass	Pass
98	27	Pass	Pass	Pass	Pass
98	28	Pass	Pass	Pass	Pass
98	29	Pass	Pass	Pass	Pass
98	30	Pass	Fail	Pass	Fail
99	13	Pass	Pass	Pass	Pass
99	14	Pass	Pass	Pass	Pass
99	15	Pass	Pass	Pass	Pass
99	16	Pass	Fail	Pass	Fail
99	17	Pass	Fail	Pass	Fail
99	18	Pass	Fail	Pass	Fail
99	19	Pass	Fail	Pass	Fail
99	20	Pass	Fail	Pass	Fail
99	21	Pass	Fail	Pass	Fail
99	22	Pass	Fail	Pass	Fail
99	23	Pass	Fail	Pass	Fail
99	26	Pass	Pass	Pass	Pass
99	30	Pass	Fail	Pass	Fail
100	13	Pass	Pass	Pass	Pass
100	14	Pass	Pass	Pass	Pass
100	15	Pass	Pass	Pass	Pass
100	23	Pass	Fail	Pass	Fail
100	24	Pass	Fail	Pass	Fail
100	25	Pass	Fail	Pass	Fail
100	26	Pass	Pass	Pass	Pass
100	30	Pass	Fail	Pass	Fail
101	13	Pass	Pass	Pass	Pass
101	14	Pass	Pass	Pass	Pass
101	15	Pass	Pass	Pass	Pass
101	16	Pass	Fail	Pass	Fail
101	17	Pass	Fail	Pass	Fail
101	18	Pass	Fail	Pass	Fail
101	19	Pass	Fail	Pass	Fail
101	20	Pass	Fail	Pass	Fail
101	21	Pass	Fail	Pass	Fail
101	22	Pass	Fail	Pass	Fail
101	23	Pass	Fail	Pass	Fail
101	26	Pass	Pass	Pass	Pass
101	30	Pass	Pass	Pass	Pass
102	13	Pass	Pass	Pass	Pass
102	14	Pass	Pass	Pass	Pass
102	15	Pass	Pass	Pass	Pass

102	26	Pass	Pass	Pass	Pass
102	30	Pass	Pass	Pass	Pass
103	13	Pass	Pass	Pass	Pass
103	14	Pass	Pass	Pass	Pass
103	15	Pass	Pass	Pass	Pass
103	26	Pass	Pass	Pass	Pass
103	30	Pass	Pass	Pass	Pass
104	11	Fail	Fail	Fail	Fail
104	13	Pass	Pass	Pass	Pass
104	14	Pass	Pass	Pass	Pass
104	15	Pass	Pass	Pass	Pass
104	26	Pass	Pass	Pass	Pass
104	30	Pass	Pass	Pass	Pass
105	13	Pass	Pass	Pass	Pass
105	14	Pass	Pass	Pass	Pass
105	15	Pass	Pass	Pass	Pass
105	26	Pass	Pass	Pass	Pass
105	30	Pass	Fail	Pass	Fail
106	13	Pass	Pass	Pass	Pass
106	14	Pass	Pass	Pass	Pass
106	15	Pass	Pass	Pass	Pass
106	26	Pass	Pass	Pass	Pass
106	27	Pass	Fail	Pass	Fail
106	30	Pass	Pass	Pass	Pass
106	39	Pass	Fail	Pass	Fail
107	13	Pass	Pass	Pass	Pass
107	14	Pass	Pass	Pass	Pass
107	15	Pass	Pass	Pass	Pass
107	22	Pass	Pass	Pass	Pass
107	26	Pass	Pass	Pass	Pass
107	30	Pass	Pass	Pass	Pass
107	39	Pass	Pass	Pass	Pass
108	13	Pass	Pass	Pass	Pass
108	14	Pass	Pass	Pass	Pass
108	15	Pass	Pass	Pass	Pass
108	22	Pass	Pass	Pass	Pass
108	24	Fail	Fail	Fail	Fail
108	26	Pass	Pass	Pass	Pass
108	30	Pass	Pass	Pass	Pass
108	39	Pass	Fail	Pass	Fail
109	13	Pass	Pass	Pass	Pass
109	14	Pass	Pass	Pass	Pass
109	15	Pass	Pass	Pass	Pass
109	22	Pass	Pass	Pass	Pass
109	26	Pass	Pass	Pass	Pass
109	30	Pass	Fail	Pass	Fail
109	39	Pass	Pass	Pass	Pass
110	13	Pass	Pass	Pass	Pass
110	14	Pass	Pass	Pass	Pass
110	15	Pass	Pass	Pass	Pass
110	22	Pass	Pass	Pass	Pass
110	26	Pass	Pass	Pass	Pass
110	28	Fail	Fail	Fail	Fail
110	39	Pass	Fail	Pass	Fail
111	13	Pass	Pass	Pass	Pass
111	14	Pass	Pass	Pass	Pass
111	15	Pass	Pass	Pass	Pass

111	22	Pass	Pass	Pass	Pass
111	26	Pass	Pass	Pass	Pass
111	39	Pass	Fail	Pass	Fail
112	13	Pass	Pass	Pass	Pass
112	14	Pass	Pass	Pass	Pass
112	15	Pass	Pass	Pass	Pass
112	22	Pass	Fail	Pass	Fail
112	26	Pass	Pass	Pass	Pass
112	39	Pass	Fail	Pass	Fail
113	13	Pass	Pass	Pass	Pass
113	14	Pass	Pass	Pass	Pass
113	15	Pass	Pass	Pass	Pass
113	26	Pass	Pass	Pass	Pass
113	27	Pass	Fail	Pass	Fail
113	39	Pass	Pass	Pass	Pass
113	41	Fail	Fail	Fail	Fail
114	13	Pass	Pass	Pass	Pass
114	14	Pass	Pass	Pass	Pass
114	15	Pass	Pass	Pass	Pass
114	26	Pass	Pass	Pass	Pass
114	39	Pass	Pass	Pass	Pass
115	13	Pass	Pass	Pass	Pass
115	14	Pass	Pass	Pass	Pass
115	15	Pass	Pass	Pass	Pass
115	26	Pass	Pass	Pass	Pass
115	39	Pass	Pass	Pass	Pass
116	13	Pass	Pass	Pass	Pass
116	14	Pass	Pass	Pass	Pass
116	15	Pass	Pass	Pass	Pass
116	26	Pass	Fail	Pass	Fail
116	28	Fail	Fail	Fail	Fail
116	39	Pass	Pass	Pass	Pass
117	13	Pass	Pass	Pass	Pass
117	14	Pass	Pass	Pass	Pass
117	15	Pass	Pass	Pass	Pass
117	26	Pass	Fail	Pass	Fail
117	39	Pass	Pass	Pass	Pass
118	13	Pass	Pass	Pass	Pass
118	14	Pass	Pass	Pass	Pass
118	15	Pass	Pass	Pass	Pass
118	20	Pass	Pass	Pass	Pass
118	26	Pass	Pass	Pass	Pass
118	39	Pass	Pass	Pass	Pass
119	13	Pass	Pass	Pass	Pass
119	14	Pass	Pass	Pass	Pass
119	15	Pass	Pass	Pass	Pass
119	20	Pass	Pass	Pass	Pass
119	26	Pass	Pass	Pass	Pass
119	39	Pass	Pass	Pass	Pass
120	13	Pass	Pass	Pass	Pass
120	14	Pass	Pass	Pass	Pass
120	15	Pass	Fail	Pass	Fail
120	16	Pass	Fail	Pass	Fail
120	26	Pass	Pass	Pass	Pass
120	39	Pass	Pass	Pass	Pass
121	13	Pass	Pass	Pass	Pass
121	14	Pass	Pass	Pass	Pass

121	26	Pass	Fail	Pass	Fail
121	39	Pass	Pass	Pass	Pass
122	13	Pass	Pass	Pass	Pass
122	14	Pass	Pass	Pass	Pass
122	26	Pass	Fail	Pass	Fail
122	39	Pass	Pass	Pass	Pass
122	41	Fail	Fail	Fail	Fail
123	13	Pass	Pass	Pass	Pass
123	14	Pass	Pass	Pass	Pass
123	15	Pass	Fail	Pass	Fail
123	16	Pass	Pass	Pass	Pass
123	17	Pass	Pass	Pass	Pass
123	18	Pass	Pass	Pass	Pass
123	19	Pass	Pass	Pass	Pass
123	20	Pass	Pass	Pass	Pass
123	21	Pass	Pass	Pass	Pass
123	22	Pass	Pass	Pass	Pass
123	23	Pass	Pass	Pass	Pass
123	24	Pass	Pass	Pass	Pass
123	25	Pass	Pass	Pass	Pass
123	26	Pass	Pass	Pass	Pass
123	27	Pass	Pass	Pass	Pass
123	28	Pass	Pass	Pass	Pass
123	29	Pass	Pass	Pass	Pass
123	30	Pass	Pass	Pass	Pass
123	31	Pass	Fail	Pass	Fail
123	32	Pass	Fail	Pass	Fail
123	33	Pass	Pass	Pass	Pass
123	34	Pass	Pass	Pass	Pass
123	35	Pass	Pass	Pass	Pass
123	36	Pass	Pass	Pass	Pass
123	37	Pass	Pass	Pass	Pass
123	38	Pass	Fail	Pass	Fail
123	39	Pass	Fail	Pass	Fail
124	13	Pass	Pass	Pass	Pass
124	14	Pass	Pass	Pass	Pass
124	23	Pass	Pass	Pass	Pass
125	13	Pass	Pass	Pass	Pass
125	14	Pass	Pass	Pass	Pass
125	23	Pass	Pass	Pass	Pass
125	28	Fail	Fail	Fail	Fail
125	33	Fail	Fail	Fail	Fail
126	13	Pass	Pass	Pass	Pass
126	14	Pass	Pass	Pass	Pass
126	23	Pass	Pass	Pass	Pass
127	13	Pass	Pass	Pass	Pass
127	14	Pass	Pass	Pass	Pass
127	23	Pass	Pass	Pass	Pass
128	13	Pass	Pass	Pass	Pass
128	14	Pass	Pass	Pass	Pass
128	23	Pass	Pass	Pass	Pass
129	13	Pass	Pass	Pass	Pass
129	14	Pass	Pass	Pass	Pass
129	23	Pass	Pass	Pass	Pass
130	8	Pass	Fail	Pass	Fail
130	9	Pass	Fail	Pass	Fail
130	10	Pass	Fail	Pass	Fail

130	11	Pass	Fail	Pass	Fail
130	12	Pass	Fail	Pass	Fail
130	13	Pass	Pass	Pass	Pass
130	14	Pass	Pass	Pass	Pass
130	23	Pass	Pass	Pass	Pass
131	14	Pass	Pass	Pass	Pass
131	23	Pass	Pass	Pass	Pass
132	14	Pass	Pass	Pass	Pass
132	23	Pass	Pass	Pass	Pass
133	14	Pass	Pass	Pass	Pass
133	23	Pass	Pass	Pass	Pass
134	14	Pass	Pass	Pass	Pass
134	23	Pass	Fail	Pass	Fail
135	14	Pass	Pass	Pass	Pass
136	14	Pass	Pass	Pass	Pass
137	14	Pass	Pass	Pass	Pass
138	14	Pass	Pass	Pass	Pass

4. Table E.6.4 Striped Bass spawning D.O. , Salinity, and Velocity criteria passing for existing and deepening (2 ft) scenarios within the analyzed period April 1 - April 30, 1997

HABITAT REQUIREMENTS:
RM 10-31; Surface Layer
D.O. April (MG/L):n/a
Salinity 90th %ile <= 1 ppt
Mean Velocity >= 30 cm/s

Savannah Harbor Estuary

Segments		Baseline Scenario		Project Scenario	
J	I	Salinity	Velocity	Salinity	Velocity
47	13	Fail	Pass	Fail	Pass
47	14	Fail	Pass	Fail	Pass
47	15	Fail	Pass	Fail	Pass
47	16	Fail	Pass	Fail	Pass
47	17	Fail	Fail	Fail	Fail
48	13	Fail	Pass	Fail	Pass
48	14	Fail	Pass	Fail	Pass
48	15	Fail	Pass	Fail	Pass
48	16	Fail	Pass	Fail	Pass
48	17	Fail	Pass	Fail	Pass
49	13	Fail	Pass	Fail	Pass
49	14	Fail	Pass	Fail	Pass
49	15	Fail	Pass	Fail	Pass
49	16	Fail	Pass	Fail	Pass
49	17	Fail	Pass	Fail	Pass
50	13	Fail	Pass	Fail	Pass
50	14	Fail	Pass	Fail	Pass
50	15	Fail	Pass	Fail	Pass
50	16	Fail	Pass	Fail	Pass
50	17	Fail	Pass	Fail	Pass
50	18	Fail	Fail	Fail	Fail
51	13	Fail	Pass	Fail	Pass
51	14	Fail	Pass	Fail	Pass
51	15	Fail	Pass	Fail	Pass
52	13	Fail	Pass	Fail	Pass
52	14	Fail	Pass	Fail	Pass
52	15	Fail	Pass	Fail	Pass
53	13	Fail	Pass	Fail	Pass
53	14	Fail	Pass	Fail	Pass
53	15	Fail	Pass	Fail	Pass
54	13	Fail	Pass	Fail	Pass
54	14	Fail	Pass	Fail	Pass
54	15	Fail	Pass	Fail	Pass
55	13	Fail	Pass	Fail	Pass
55	14	Fail	Pass	Fail	Pass
55	15	Fail	Pass	Fail	Pass
56	13	Fail	Pass	Fail	Pass
56	14	Fail	Pass	Fail	Pass
56	15	Fail	Pass	Fail	Pass

57	13	Fail	Pass	Fail	Pass
57	14	Fail	Pass	Fail	Pass
57	15	Fail	Pass	Fail	Pass
58	13	Fail	Pass	Fail	Pass
58	14	Fail	Pass	Fail	Pass
58	15	Fail	Pass	Fail	Pass
59	13	Pass	Pass	Fail	Pass
59	14	Fail	Pass	Fail	Pass
59	15	Fail	Pass	Fail	Pass
59	30	Fail	Pass	Fail	Pass
59	31	Fail	Pass	Fail	Pass
59	32	Fail	Fail	Fail	Fail
60	13	Pass	Pass	Fail	Pass
60	14	Pass	Pass	Fail	Pass
60	15	Pass	Pass	Fail	Pass
60	30	Fail	Fail	Fail	Fail
60	31	Fail	Fail	Fail	Pass
60	32	Fail	Fail	Fail	Fail
61	13	Pass	Pass	Pass	Pass
61	14	Pass	Pass	Fail	Pass
61	15	Pass	Pass	Fail	Pass
61	30	Fail	Fail	Fail	Fail
61	31	Fail	Fail	Fail	Pass
61	32	Fail	Fail	Fail	Fail
62	13	Pass	Pass	Pass	Pass
62	14	Pass	Pass	Fail	Pass
62	15	Pass	Pass	Fail	Pass
62	30	Fail	Fail	Fail	Fail
62	31	Fail	Pass	Fail	Pass
62	32	Fail	Fail	Fail	Fail
63	13	Pass	Pass	Pass	Pass
63	14	Pass	Pass	Pass	Pass
63	15	Pass	Pass	Fail	Pass
63	31	Fail	Pass	Fail	Pass
64	13	Pass	Pass	Pass	Pass
64	14	Pass	Pass	Pass	Pass
64	15	Pass	Pass	Pass	Pass
64	30	Fail	Fail	Fail	Fail
64	31	Fail	Pass	Fail	Pass
64	32	Fail	Fail	Fail	Fail
65	13	Pass	Pass	Pass	Pass
65	14	Pass	Pass	Pass	Pass
65	15	Pass	Pass	Pass	Pass
65	30	Fail	Pass	Fail	Pass
65	31	Fail	Pass	Fail	Pass
65	32	Fail	Pass	Fail	Pass
65	33	Fail	Fail	Fail	Fail
66	13	Pass	Pass	Pass	Pass
66	14	Pass	Pass	Pass	Pass
66	15	Pass	Pass	Pass	Pass
66	30	Fail	Pass	Fail	Pass
66	31	Fail	Pass	Fail	Pass
66	32	Fail	Pass	Fail	Pass
66	36	Fail	Pass	Fail	Pass
66	38	Fail	Fail	Fail	Fail
67	13	Pass	Pass	Pass	Pass
67	14	Pass	Pass	Pass	Pass

67	15	Pass	Pass	Pass	Pass
67	30	Fail	Pass	Fail	Pass
67	31	Fail	Pass	Fail	Pass
67	32	Fail	Pass	Fail	Pass
67	36	Fail	Fail	Fail	Fail
68	13	Pass	Pass	Pass	Pass
68	14	Pass	Pass	Pass	Pass
68	15	Pass	Pass	Pass	Pass
68	30	Fail	Pass	Fail	Pass
68	31	Fail	Pass	Fail	Pass
68	32	Fail	Pass	Fail	Pass
68	36	Fail	Fail	Fail	Fail
68	38	Fail	Fail	Fail	Fail
69	13	Pass	Pass	Pass	Pass
69	14	Pass	Pass	Pass	Pass
69	15	Pass	Pass	Pass	Pass
69	30	Fail	Pass	Fail	Pass
69	31	Fail	Pass	Fail	Pass
69	32	Fail	Fail	Fail	Fail
69	36	Fail	Fail	Fail	Fail
70	13	Pass	Pass	Pass	Pass
70	14	Pass	Pass	Pass	Pass
70	15	Pass	Pass	Pass	Pass
70	30	Fail	Pass	Fail	Pass
70	31	Fail	Pass	Fail	Pass
70	32	Fail	Fail	Fail	Fail
70	33	Fail	Fail	Fail	Fail
71	13	Pass	Pass	Pass	Pass
71	14	Pass	Pass	Pass	Pass
71	15	Pass	Pass	Pass	Pass
71	30	Fail	Pass	Fail	Pass
71	31	Fail	Pass	Fail	Pass
71	32	Fail	Fail	Fail	Fail
72	13	Pass	Pass	Pass	Pass
72	14	Pass	Pass	Pass	Pass
72	15	Pass	Pass	Pass	Pass
72	30	Fail	Fail	Fail	Fail
72	31	Fail	Pass	Fail	Pass
72	32	Fail	Fail	Fail	Fail
73	13	Pass	Pass	Pass	Pass
73	14	Pass	Pass	Pass	Pass
73	15	Pass	Pass	Pass	Pass
73	30	Fail	Fail	Fail	Fail
73	31	Fail	Pass	Fail	Pass
74	13	Pass	Pass	Pass	Pass
74	14	Pass	Pass	Pass	Pass
74	15	Pass	Pass	Pass	Pass
74	30	Fail	Fail	Fail	Fail
74	31	Fail	Pass	Fail	Pass
75	13	Pass	Pass	Pass	Pass
75	14	Pass	Pass	Pass	Pass
75	15	Pass	Pass	Pass	Pass
75	30	Fail	Fail	Fail	Fail
75	31	Fail	Fail	Fail	Pass
76	13	Pass	Pass	Pass	Pass
76	14	Pass	Pass	Pass	Pass
76	15	Pass	Fail	Pass	Fail

76	16	Pass	Fail	Pass	Fail
76	17	Pass	Fail	Pass	Fail
76	30	Fail	Fail	Fail	Fail
76	31	Fail	Pass	Fail	Pass
76	33	Fail	Fail	Fail	Fail
77	13	Pass	Fail	Pass	Fail
77	14	Pass	Pass	Pass	Pass
77	15	Pass	Fail	Pass	Fail
77	16	Pass	Fail	Pass	Fail
77	17	Pass	Fail	Pass	Fail
77	30	Fail	Fail	Fail	Fail
77	31	Fail	Fail	Fail	Fail
78	13	Pass	Fail	Pass	Fail
78	14	Pass	Pass	Pass	Pass
78	15	Pass	Fail	Pass	Fail
78	16	Pass	Fail	Pass	Fail
78	17	Pass	Fail	Pass	Fail
78	30	Fail	Fail	Fail	Fail
78	31	Fail	Fail	Fail	Fail
79	13	Pass	Pass	Pass	Pass
79	14	Pass	Pass	Pass	Pass
79	15	Pass	Fail	Pass	Fail
79	30	Fail	Pass	Fail	Pass
79	31	Fail	Fail	Fail	Fail
80	13	Pass	Pass	Pass	Pass
80	14	Pass	Pass	Pass	Pass
80	15	Pass	Pass	Pass	Pass
80	30	Pass	Pass	Fail	Pass
80	31	Fail	Fail	Fail	Fail
81	13	Pass	Pass	Pass	Pass
81	14	Pass	Pass	Pass	Pass
81	15	Pass	Pass	Pass	Pass
81	30	Pass	Pass	Fail	Pass
81	31	Fail	Fail	Fail	Fail
82	13	Pass	Pass	Pass	Pass
82	14	Pass	Pass	Pass	Pass
82	15	Pass	Pass	Pass	Pass
82	16	Pass	Fail	Pass	Fail
82	17	Pass	Fail	Pass	Fail
82	18	Pass	Pass	Pass	Pass
82	19	Pass	Fail	Pass	Fail
82	20	Pass	Fail	Pass	Fail
82	21	Pass	Fail	Pass	Fail
82	29	Pass	Fail	Pass	Fail
82	30	Pass	Pass	Pass	Pass
82	31	Pass	Fail	Fail	Fail
83	13	Pass	Pass	Pass	Pass
83	14	Pass	Pass	Pass	Pass
83	15	Pass	Pass	Pass	Pass
83	21	Pass	Pass	Pass	Pass
83	30	Pass	Fail	Pass	Fail
83	31	Pass	Fail	Fail	Fail
84	13	Pass	Pass	Pass	Pass
84	14	Pass	Pass	Pass	Pass
84	15	Pass	Pass	Pass	Pass
84	21	Pass	Pass	Pass	Pass
84	30	Pass	Fail	Pass	Fail

84	31	Pass	Fail	Pass	Fail
85	13	Pass	Pass	Pass	Pass
85	14	Pass	Pass	Pass	Pass
85	15	Pass	Pass	Pass	Pass
85	21	Pass	Pass	Pass	Pass
85	30	Pass	Fail	Pass	Fail
86	13	Pass	Pass	Pass	Pass
86	14	Pass	Pass	Pass	Pass
86	15	Pass	Pass	Pass	Pass
86	17	Fail	Fail	Fail	Fail
86	21	Pass	Pass	Pass	Pass
86	30	Pass	Pass	Pass	Pass
87	13	Pass	Pass	Pass	Pass
87	14	Pass	Pass	Pass	Pass
87	15	Pass	Pass	Pass	Pass
87	30	Pass	Pass	Pass	Pass
87	32	Fail	Fail	Fail	Fail
88	13	Pass	Pass	Pass	Pass
88	14	Pass	Pass	Pass	Pass
88	15	Pass	Pass	Pass	Pass
88	30	Pass	Fail	Pass	Fail
89	13	Pass	Pass	Pass	Pass
89	14	Pass	Pass	Pass	Pass
89	15	Pass	Pass	Pass	Pass
89	30	Pass	Fail	Pass	Fail
90	13	Pass	Pass	Pass	Pass
90	14	Pass	Pass	Pass	Pass
90	15	Pass	Pass	Pass	Pass
90	30	Pass	Fail	Pass	Fail
91	13	Pass	Pass	Pass	Pass
91	14	Pass	Pass	Pass	Pass
91	15	Pass	Pass	Pass	Pass
91	16	Pass	Fail	Pass	Fail
91	30	Pass	Fail	Pass	Fail
92	13	Pass	Pass	Pass	Pass
92	14	Pass	Pass	Pass	Pass
92	15	Pass	Pass	Pass	Pass
92	16	Pass	Pass	Pass	Pass
92	30	Pass	Fail	Pass	Fail
92	32	Fail	Fail	Fail	Fail
93	13	Pass	Pass	Pass	Pass
93	14	Pass	Pass	Pass	Pass
93	15	Pass	Pass	Pass	Pass
93	16	Pass	Pass	Pass	Pass
93	30	Pass	Fail	Pass	Fail
94	13	Pass	Pass	Pass	Pass
94	14	Pass	Pass	Pass	Pass
94	15	Pass	Pass	Pass	Pass
94	16	Pass	Pass	Pass	Fail
94	26	Pass	Pass	Pass	Pass
94	30	Pass	Fail	Pass	Fail
95	13	Pass	Pass	Pass	Pass
95	14	Pass	Pass	Pass	Pass
95	15	Pass	Pass	Pass	Pass
95	16	Pass	Fail	Pass	Fail
95	26	Pass	Pass	Pass	Pass
95	28	Fail	Fail	Fail	Fail

95	30	Pass	Fail	Pass	Fail
96	11	Fail	Fail	Fail	Fail
96	13	Pass	Pass	Pass	Pass
96	14	Pass	Pass	Pass	Pass
96	15	Pass	Pass	Pass	Pass
96	26	Pass	Pass	Pass	Pass
96	30	Pass	Fail	Pass	Fail
97	13	Pass	Pass	Pass	Pass
97	14	Pass	Pass	Pass	Pass
97	15	Pass	Pass	Pass	Pass
97	26	Pass	Pass	Pass	Pass
97	30	Pass	Fail	Pass	Fail
98	13	Pass	Pass	Pass	Pass
98	14	Pass	Pass	Pass	Pass
98	15	Pass	Pass	Pass	Pass
98	26	Pass	Pass	Pass	Pass
98	27	Pass	Pass	Pass	Pass
98	28	Pass	Pass	Pass	Pass
98	29	Pass	Pass	Pass	Pass
98	30	Pass	Fail	Pass	Fail
99	13	Pass	Pass	Pass	Pass
99	14	Pass	Pass	Pass	Pass
99	15	Pass	Pass	Pass	Pass
99	16	Pass	Fail	Pass	Fail
99	17	Pass	Fail	Pass	Fail
99	18	Pass	Fail	Pass	Fail
99	19	Pass	Fail	Pass	Fail
99	20	Pass	Fail	Pass	Fail
99	21	Pass	Fail	Pass	Fail
99	22	Pass	Fail	Pass	Fail
99	23	Pass	Fail	Pass	Fail
99	26	Pass	Pass	Pass	Pass
99	30	Pass	Fail	Pass	Fail
100	13	Pass	Pass	Pass	Pass
100	14	Pass	Pass	Pass	Pass
100	15	Pass	Pass	Pass	Pass
100	23	Pass	Fail	Pass	Fail
100	24	Pass	Fail	Pass	Fail
100	25	Pass	Fail	Pass	Fail
100	26	Pass	Pass	Pass	Pass
100	30	Pass	Fail	Pass	Fail
101	13	Pass	Pass	Pass	Pass
101	14	Pass	Pass	Pass	Pass
101	15	Pass	Pass	Pass	Pass
101	16	Pass	Fail	Pass	Fail
101	17	Pass	Fail	Pass	Fail
101	18	Pass	Fail	Pass	Fail
101	19	Pass	Fail	Pass	Fail
101	20	Pass	Fail	Pass	Fail
101	21	Pass	Fail	Pass	Fail
101	22	Pass	Fail	Pass	Fail
101	23	Pass	Fail	Pass	Fail
101	26	Pass	Pass	Pass	Pass
101	30	Pass	Pass	Pass	Pass
102	13	Pass	Pass	Pass	Pass
102	14	Pass	Pass	Pass	Pass
102	15	Pass	Pass	Pass	Pass

102	26	Pass	Pass	Pass	Pass
102	30	Pass	Pass	Pass	Pass
103	13	Pass	Pass	Pass	Pass
103	14	Pass	Pass	Pass	Pass
103	15	Pass	Pass	Pass	Pass
103	26	Pass	Pass	Pass	Pass
103	30	Pass	Pass	Pass	Pass
104	11	Fail	Fail	Fail	Fail
104	13	Pass	Pass	Pass	Pass
104	14	Pass	Pass	Pass	Pass
104	15	Pass	Pass	Pass	Pass
104	26	Pass	Pass	Pass	Pass
104	30	Pass	Pass	Pass	Pass
105	13	Pass	Pass	Pass	Pass
105	14	Pass	Pass	Pass	Pass
105	15	Pass	Pass	Pass	Pass
105	26	Pass	Pass	Pass	Pass
105	30	Pass	Fail	Pass	Fail
106	13	Pass	Pass	Pass	Pass
106	14	Pass	Pass	Pass	Pass
106	15	Pass	Pass	Pass	Pass
106	26	Pass	Pass	Pass	Pass
106	27	Pass	Fail	Pass	Fail
106	30	Pass	Pass	Pass	Pass
106	39	Pass	Fail	Pass	Fail
107	13	Pass	Pass	Pass	Pass
107	14	Pass	Pass	Pass	Pass
107	15	Pass	Pass	Pass	Pass
107	22	Pass	Pass	Pass	Pass
107	26	Pass	Pass	Pass	Pass
107	30	Pass	Pass	Pass	Pass
107	39	Pass	Pass	Pass	Pass
108	13	Pass	Pass	Pass	Pass
108	14	Pass	Pass	Pass	Pass
108	15	Pass	Pass	Pass	Pass
108	22	Pass	Pass	Pass	Pass
108	24	Fail	Fail	Fail	Fail
108	26	Pass	Pass	Pass	Pass
108	30	Pass	Pass	Pass	Pass
108	39	Pass	Fail	Pass	Fail
109	13	Pass	Pass	Pass	Pass
109	14	Pass	Pass	Pass	Pass
109	15	Pass	Pass	Pass	Pass
109	22	Pass	Pass	Pass	Pass
109	26	Pass	Pass	Pass	Pass
109	30	Pass	Fail	Pass	Fail
109	39	Pass	Pass	Pass	Pass
110	13	Pass	Pass	Pass	Pass
110	14	Pass	Pass	Pass	Pass
110	15	Pass	Pass	Pass	Pass
110	22	Pass	Pass	Pass	Pass
110	26	Pass	Pass	Pass	Pass
110	28	Fail	Fail	Fail	Fail
110	39	Pass	Fail	Pass	Fail
111	13	Pass	Pass	Pass	Pass
111	14	Pass	Pass	Pass	Pass
111	15	Pass	Pass	Pass	Pass

111	22	Pass	Pass	Pass	Pass
111	26	Pass	Pass	Pass	Pass
111	39	Pass	Fail	Pass	Fail
112	13	Pass	Pass	Pass	Pass
112	14	Pass	Pass	Pass	Pass
112	15	Pass	Pass	Pass	Pass
112	22	Pass	Fail	Pass	Fail
112	26	Pass	Pass	Pass	Pass
112	39	Pass	Fail	Pass	Fail
113	13	Pass	Pass	Pass	Pass
113	14	Pass	Pass	Pass	Pass
113	15	Pass	Pass	Pass	Pass
113	26	Pass	Pass	Pass	Pass
113	27	Pass	Fail	Pass	Fail
113	39	Pass	Pass	Pass	Pass
113	41	Fail	Fail	Fail	Fail
114	13	Pass	Pass	Pass	Pass
114	14	Pass	Pass	Pass	Pass
114	15	Pass	Pass	Pass	Pass
114	26	Pass	Pass	Pass	Pass
114	39	Pass	Pass	Pass	Pass
115	13	Pass	Pass	Pass	Pass
115	14	Pass	Pass	Pass	Pass
115	15	Pass	Pass	Pass	Pass
115	26	Pass	Pass	Pass	Pass
115	39	Pass	Pass	Pass	Pass
116	13	Pass	Pass	Pass	Pass
116	14	Pass	Pass	Pass	Pass
116	15	Pass	Pass	Pass	Pass
116	26	Pass	Fail	Pass	Fail
116	28	Fail	Fail	Fail	Fail
116	39	Pass	Pass	Pass	Pass
117	13	Pass	Pass	Pass	Pass
117	14	Pass	Pass	Pass	Pass
117	15	Pass	Pass	Pass	Pass
117	26	Pass	Fail	Pass	Fail
117	39	Pass	Pass	Pass	Pass
118	13	Pass	Pass	Pass	Pass
118	14	Pass	Pass	Pass	Pass
118	15	Pass	Pass	Pass	Pass
118	20	Pass	Pass	Pass	Pass
118	26	Pass	Pass	Pass	Pass
118	39	Pass	Pass	Pass	Pass
119	13	Pass	Pass	Pass	Pass
119	14	Pass	Pass	Pass	Pass
119	15	Pass	Pass	Pass	Pass
119	20	Pass	Pass	Pass	Pass
119	26	Pass	Pass	Pass	Pass
119	39	Pass	Pass	Pass	Pass
120	13	Pass	Pass	Pass	Pass
120	14	Pass	Pass	Pass	Pass
120	15	Pass	Fail	Pass	Fail
120	16	Pass	Fail	Pass	Fail
120	26	Pass	Pass	Pass	Pass
120	39	Pass	Pass	Pass	Pass
121	13	Pass	Pass	Pass	Pass
121	14	Pass	Pass	Pass	Pass

121	26	Pass	Fail	Pass	Fail
121	39	Pass	Pass	Pass	Pass
122	13	Pass	Pass	Pass	Pass
122	14	Pass	Pass	Pass	Pass
122	26	Pass	Fail	Pass	Fail
122	39	Pass	Pass	Pass	Pass
122	41	Fail	Fail	Fail	Fail
123	13	Pass	Pass	Pass	Pass
123	14	Pass	Pass	Pass	Pass
123	15	Pass	Fail	Pass	Fail
123	16	Pass	Pass	Pass	Pass
123	17	Pass	Pass	Pass	Pass
123	18	Pass	Pass	Pass	Pass
123	19	Pass	Pass	Pass	Pass
123	20	Pass	Pass	Pass	Pass
123	21	Pass	Pass	Pass	Pass
123	22	Pass	Pass	Pass	Pass
123	23	Pass	Pass	Pass	Pass
123	24	Pass	Pass	Pass	Pass
123	25	Pass	Pass	Pass	Pass
123	26	Pass	Pass	Pass	Pass
123	27	Pass	Pass	Pass	Pass
123	28	Pass	Pass	Pass	Pass
123	29	Pass	Pass	Pass	Pass
123	30	Pass	Pass	Pass	Pass
123	31	Pass	Fail	Pass	Fail
123	32	Pass	Fail	Pass	Fail
123	33	Pass	Pass	Pass	Pass
123	34	Pass	Pass	Pass	Pass
123	35	Pass	Pass	Pass	Pass
123	36	Pass	Pass	Pass	Pass
123	37	Pass	Pass	Pass	Pass
123	38	Pass	Fail	Pass	Fail
123	39	Pass	Fail	Pass	Fail
124	13	Pass	Pass	Pass	Pass
124	14	Pass	Pass	Pass	Pass
124	23	Pass	Pass	Pass	Pass
125	13	Pass	Pass	Pass	Pass
125	14	Pass	Pass	Pass	Pass
125	23	Pass	Pass	Pass	Pass
125	28	Fail	Fail	Fail	Fail
125	33	Fail	Fail	Fail	Fail
126	13	Pass	Pass	Pass	Pass
126	14	Pass	Pass	Pass	Pass
126	23	Pass	Pass	Pass	Pass
127	13	Pass	Pass	Pass	Pass
127	14	Pass	Pass	Pass	Pass
127	23	Pass	Pass	Pass	Pass
128	13	Pass	Pass	Pass	Pass
128	14	Pass	Pass	Pass	Pass
128	23	Pass	Pass	Pass	Pass
129	13	Pass	Pass	Pass	Pass
129	14	Pass	Pass	Pass	Pass
129	23	Pass	Pass	Pass	Pass
130	8	Pass	Fail	Pass	Fail
130	9	Pass	Fail	Pass	Fail
130	10	Pass	Fail	Pass	Fail

130	11	Pass	Fail	Pass	Fail
130	12	Pass	Fail	Pass	Fail
130	13	Pass	Pass	Pass	Pass
130	14	Pass	Pass	Pass	Pass
130	23	Pass	Pass	Pass	Pass
131	14	Pass	Pass	Pass	Pass
131	23	Pass	Pass	Pass	Pass
132	14	Pass	Pass	Pass	Pass
132	23	Pass	Pass	Pass	Pass
133	14	Pass	Pass	Pass	Pass
133	23	Pass	Pass	Pass	Pass
134	14	Pass	Pass	Pass	Pass
134	23	Pass	Fail	Pass	Fail
135	14	Pass	Pass	Pass	Pass
136	14	Pass	Pass	Pass	Pass
137	14	Pass	Pass	Pass	Pass
138	14	Pass	Pass	Pass	Pass

Appendix E-2

Tables of Criteria Passing for Striped Bass Eggs Habitat Suitability

April 1997

80th %ile of Clyo Flow

Fisheries Review Group

1. Table E.7.1 Striped Bass eggs D.O. , Salinity, and Velocity criteria passing for existing and deepening (6 ft) scenarios within the analyzed period April 1 - April 30, 1997

HABITAT REQUIREMENTS:
RM 10-31; Depth Average
D.O. April (MG/L):10th %ile >=4.5
Salinity 50th %ile <= 9 ppt
Mean Velocity >= 30 cm/s

Savannah Harbor Estuary

Segments		Baseline Scenario			Project Scenario		
J	I	Salinity	Velocity	D.O.	Salinity	Velocity	D.O.
47	13	Pass	Pass	Pass	Pass	Pass	Pass
47	14	Fail	Pass	Pass	Fail	Pass	Pass
47	15	Pass	Pass	Pass	Pass	Pass	Pass
47	16	Pass	Pass	Pass	Pass	Pass	Pass
47	17	Pass	Fail	Pass	Pass	Fail	Pass
48	13	Pass	Pass	Pass	Pass	Pass	Pass
48	14	Fail	Pass	Pass	Fail	Pass	Pass
48	15	Pass	Pass	Pass	Pass	Pass	Pass
48	16	Pass	Pass	Pass	Pass	Pass	Pass
48	17	Pass	Pass	Pass	Pass	Pass	Pass
49	13	Pass	Pass	Pass	Pass	Pass	Pass
49	14	Pass	Pass	Pass	Fail	Pass	Pass
49	15	Pass	Pass	Pass	Pass	Pass	Pass
49	16	Pass	Pass	Pass	Pass	Pass	Pass
49	17	Pass	Pass	Pass	Pass	Pass	Pass
50	13	Pass	Pass	Pass	Pass	Pass	Pass
50	14	Pass	Pass	Pass	Fail	Pass	Pass
50	15	Pass	Fail	Pass	Fail	Fail	Pass
50	16	Pass	Fail	Pass	Pass	Fail	Pass
50	17	Pass	Fail	Pass	Pass	Fail	Pass
50	18	Pass	Fail	Pass	Pass	Fail	Pass
51	13	Pass	Pass	Pass	Pass	Pass	Pass
51	14	Pass	Pass	Pass	Fail	Pass	Pass
51	15	Pass	Pass	Pass	Pass	Pass	Pass
52	13	Pass	Pass	Pass	Pass	Pass	Pass
52	14	Pass	Pass	Pass	Fail	Pass	Pass
52	15	Pass	Pass	Pass	Pass	Pass	Pass
53	13	Pass	Pass	Pass	Pass	Pass	Pass
53	14	Pass	Pass	Pass	Fail	Pass	Pass
53	15	Pass	Pass	Pass	Pass	Pass	Pass
54	13	Pass	Pass	Pass	Pass	Pass	Pass
54	14	Pass	Pass	Pass	Fail	Pass	Pass
54	15	Pass	Pass	Pass	Pass	Pass	Pass
55	13	Pass	Pass	Pass	Pass	Pass	Pass
55	14	Pass	Pass	Pass	Pass	Pass	Pass
55	15	Pass	Pass	Pass	Pass	Pass	Pass
56	13	Pass	Pass	Pass	Pass	Pass	Pass
56	14	Pass	Pass	Pass	Pass	Pass	Pass
56	15	Pass	Pass	Pass	Pass	Pass	Pass
57	13	Pass	Pass	Pass	Pass	Pass	Pass

57	14	Pass	Pass	Pass	Pass	Pass	Pass
57	15	Pass	Pass	Pass	Pass	Pass	Pass
58	13	Pass	Pass	Pass	Pass	Pass	Pass
58	14	Pass	Pass	Pass	Pass	Pass	Pass
58	15	Pass	Pass	Pass	Pass	Pass	Pass
59	13	Pass	Pass	Pass	Pass	Pass	Pass
59	14	Pass	Pass	Pass	Pass	Pass	Pass
59	15	Pass	Pass	Pass	Pass	Pass	Pass
59	30	Pass	Fail	Pass	Pass	Fail	Pass
59	31	Pass	Fail	Pass	Pass	Fail	Pass
59	32	Pass	Fail	Pass	Pass	Fail	Pass
60	13	Pass	Pass	Pass	Pass	Pass	Pass
60	14	Pass	Pass	Pass	Pass	Pass	Pass
60	15	Pass	Pass	Pass	Pass	Pass	Pass
60	30	Pass	Fail	Pass	Pass	Fail	Pass
60	31	Pass	Fail	Pass	Pass	Fail	Pass
60	32	Pass	Fail	Pass	Pass	Fail	Pass
61	13	Pass	Pass	Pass	Pass	Pass	Pass
61	14	Pass	Pass	Pass	Pass	Pass	Pass
61	15	Pass	Pass	Pass	Pass	Pass	Pass
61	30	Pass	Fail	Pass	Pass	Fail	Pass
61	31	Pass	Fail	Pass	Pass	Fail	Pass
61	32	Pass	Fail	Pass	Pass	Fail	Pass
62	13	Pass	Pass	Pass	Pass	Pass	Pass
62	14	Pass	Pass	Pass	Pass	Pass	Pass
62	15	Pass	Pass	Pass	Pass	Pass	Pass
62	30	Pass	Fail	Pass	Pass	Fail	Pass
62	31	Pass	Fail	Pass	Pass	Fail	Pass
62	32	Pass	Fail	Pass	Pass	Fail	Pass
63	13	Pass	Pass	Pass	Pass	Pass	Pass
63	14	Pass	Pass	Pass	Pass	Pass	Pass
63	15	Pass	Pass	Pass	Pass	Pass	Pass
63	31	Pass	Pass	Pass	Pass	Pass	Pass
64	13	Pass	Pass	Pass	Pass	Pass	Pass
64	14	Pass	Pass	Pass	Pass	Pass	Pass
64	15	Pass	Pass	Pass	Pass	Pass	Pass
64	30	Pass	Fail	Pass	Pass	Fail	Pass
64	31	Pass	Pass	Pass	Pass	Pass	Pass
64	32	Pass	Fail	Pass	Pass	Fail	Pass
65	13	Pass	Pass	Pass	Pass	Pass	Pass
65	14	Pass	Pass	Pass	Pass	Pass	Pass
65	15	Pass	Pass	Pass	Pass	Pass	Pass
65	30	Pass	Fail	Pass	Pass	Fail	Pass
65	31	Pass	Pass	Pass	Pass	Pass	Pass
65	32	Pass	Fail	Pass	Pass	Fail	Pass
65	33	Pass	Fail	Pass	Pass	Fail	Pass
66	13	Pass	Pass	Pass	Pass	Pass	Pass
66	14	Pass	Pass	Pass	Pass	Pass	Pass
66	15	Pass	Fail	Pass	Pass	Pass	Pass
66	30	Pass	Fail	Pass	Pass	Fail	Pass
66	31	Pass	Pass	Pass	Pass	Pass	Pass
66	32	Pass	Fail	Pass	Pass	Fail	Pass
66	36	Pass	Fail	Pass	Pass	Fail	Pass
66	38	Fail	Fail	Fail	Fail	Fail	Fail
67	13	Pass	Pass	Pass	Pass	Pass	Pass
67	14	Pass	Pass	Pass	Pass	Pass	Pass
67	15	Pass	Fail	Pass	Pass	Pass	Pass

67	30	Pass	Fail	Pass	Pass	Fail	Pass
67	31	Pass	Pass	Pass	Pass	Pass	Pass
67	32	Pass	Fail	Pass	Pass	Fail	Pass
67	36	Pass	Fail	Pass	Pass	Fail	Pass
68	13	Pass	Pass	Pass	Pass	Pass	Pass
68	14	Pass	Pass	Pass	Pass	Pass	Pass
68	15	Pass	Fail	Pass	Pass	Fail	Pass
68	30	Pass	Fail	Pass	Pass	Fail	Pass
68	31	Pass	Pass	Pass	Pass	Pass	Pass
68	32	Pass	Fail	Pass	Pass	Fail	Pass
68	36	Pass	Fail	Pass	Pass	Fail	Pass
68	38	Fail	Fail	Fail	Fail	Fail	Fail
69	13	Pass	Pass	Pass	Pass	Pass	Pass
69	14	Pass	Pass	Pass	Pass	Pass	Pass
69	15	Pass	Fail	Pass	Pass	Fail	Pass
69	30	Pass	Pass	Pass	Pass	Pass	Pass
69	31	Pass	Pass	Pass	Pass	Pass	Pass
69	32	Pass	Fail	Pass	Pass	Fail	Pass
69	36	Pass	Fail	Pass	Pass	Fail	Pass
70	13	Pass	Pass	Pass	Pass	Pass	Pass
70	14	Pass	Pass	Pass	Pass	Pass	Pass
70	15	Pass	Fail	Pass	Pass	Fail	Pass
70	30	Pass	Fail	Pass	Pass	Fail	Pass
70	31	Pass	Fail	Pass	Pass	Fail	Pass
70	32	Pass	Fail	Pass	Pass	Fail	Pass
70	33	Pass	Fail	Pass	Pass	Fail	Pass
71	13	Pass	Fail	Pass	Pass	Fail	Pass
71	14	Pass	Pass	Pass	Pass	Pass	Pass
71	15	Pass	Fail	Pass	Pass	Pass	Pass
71	30	Pass	Fail	Pass	Pass	Fail	Pass
71	31	Pass	Fail	Pass	Pass	Fail	Pass
71	32	Pass	Fail	Pass	Pass	Fail	Pass
72	13	Pass	Pass	Pass	Pass	Pass	Pass
72	14	Pass	Pass	Pass	Pass	Pass	Pass
72	15	Pass	Fail	Pass	Pass	Pass	Pass
72	30	Pass	Fail	Pass	Pass	Fail	Pass
72	31	Pass	Fail	Pass	Pass	Fail	Pass
72	32	Pass	Fail	Pass	Pass	Fail	Pass
73	13	Pass	Pass	Pass	Pass	Pass	Pass
73	14	Pass	Pass	Pass	Pass	Pass	Pass
73	15	Pass	Pass	Pass	Pass	Pass	Pass
73	30	Pass	Fail	Pass	Pass	Fail	Pass
73	31	Pass	Fail	Pass	Pass	Fail	Pass
74	13	Pass	Pass	Pass	Pass	Pass	Pass
74	14	Pass	Pass	Pass	Pass	Pass	Pass
74	15	Pass	Pass	Pass	Pass	Pass	Pass
74	30	Pass	Fail	Pass	Pass	Fail	Pass
74	31	Pass	Fail	Pass	Pass	Fail	Pass
75	13	Pass	Pass	Pass	Pass	Pass	Pass
75	14	Pass	Pass	Pass	Pass	Pass	Pass
75	15	Pass	Pass	Pass	Pass	Pass	Pass
75	30	Pass	Fail	Pass	Pass	Fail	Pass
75	31	Pass	Fail	Pass	Pass	Fail	Pass
76	13	Pass	Fail	Pass	Pass	Fail	Pass
76	14	Pass	Pass	Pass	Pass	Pass	Pass
76	15	Pass	Fail	Pass	Pass	Fail	Pass
76	16	Pass	Fail	Pass	Pass	Fail	Pass

76	17	Pass	Fail	Pass	Pass	Fail	Pass
76	30	Pass	Fail	Pass	Pass	Fail	Pass
76	31	Pass	Fail	Pass	Pass	Fail	Pass
76	33	Fail	Fail	Fail	Fail	Fail	Fail
77	13	Pass	Fail	Pass	Pass	Fail	Pass
77	14	Pass	Fail	Pass	Pass	Fail	Pass
77	15	Pass	Fail	Pass	Pass	Fail	Pass
77	16	Pass	Fail	Pass	Pass	Fail	Pass
77	17	Pass	Fail	Pass	Pass	Fail	Pass
77	30	Pass	Fail	Pass	Pass	Fail	Pass
77	31	Pass	Fail	Pass	Pass	Fail	Pass
78	13	Pass	Fail	Pass	Pass	Fail	Pass
78	14	Pass	Pass	Pass	Pass	Fail	Pass
78	15	Pass	Fail	Pass	Pass	Fail	Pass
78	16	Pass	Fail	Pass	Pass	Fail	Pass
78	17	Pass	Fail	Pass	Pass	Fail	Pass
78	30	Pass	Fail	Pass	Pass	Fail	Pass
78	31	Pass	Fail	Pass	Pass	Fail	Pass
79	13	Pass	Fail	Pass	Pass	Fail	Pass
79	14	Pass	Pass	Pass	Pass	Pass	Pass
79	15	Pass	Fail	Pass	Pass	Fail	Pass
79	30	Pass	Fail	Pass	Pass	Fail	Pass
79	31	Pass	Fail	Pass	Pass	Fail	Pass
80	13	Pass	Fail	Pass	Pass	Fail	Pass
80	14	Pass	Pass	Pass	Pass	Pass	Pass
80	15	Pass	Fail	Pass	Pass	Fail	Pass
80	30	Pass	Fail	Pass	Pass	Fail	Pass
80	31	Pass	Fail	Pass	Pass	Fail	Pass
81	13	Pass	Pass	Pass	Pass	Fail	Pass
81	14	Pass	Pass	Pass	Pass	Pass	Pass
81	15	Pass	Fail	Pass	Pass	Fail	Pass
81	30	Pass	Fail	Pass	Pass	Fail	Pass
81	31	Pass	Fail	Pass	Pass	Fail	Pass
82	13	Pass	Pass	Pass	Pass	Fail	Pass
82	14	Pass	Pass	Pass	Pass	Pass	Pass
82	15	Pass	Pass	Pass	Pass	Pass	Pass
82	16	Pass	Fail	Pass	Pass	Fail	Pass
82	17	Pass	Fail	Pass	Pass	Fail	Pass
82	18	Pass	Fail	Pass	Pass	Fail	Pass
82	19	Pass	Fail	Pass	Pass	Fail	Pass
82	20	Pass	Fail	Pass	Pass	Fail	Pass
82	21	Pass	Fail	Pass	Pass	Fail	Pass
82	29	Pass	Fail	Pass	Pass	Fail	Pass
82	30	Pass	Fail	Pass	Pass	Fail	Pass
82	31	Pass	Fail	Pass	Pass	Fail	Pass
83	13	Pass	Pass	Pass	Pass	Pass	Pass
83	14	Pass	Pass	Pass	Pass	Pass	Pass
83	15	Pass	Pass	Pass	Pass	Pass	Pass
83	21	Pass	Fail	Pass	Pass	Fail	Pass
83	30	Pass	Fail	Pass	Pass	Fail	Pass
83	31	Pass	Fail	Pass	Pass	Fail	Pass
84	13	Pass	Pass	Pass	Pass	Pass	Pass
84	14	Pass	Pass	Pass	Pass	Pass	Pass
84	15	Pass	Pass	Pass	Pass	Pass	Pass
84	21	Pass	Fail	Pass	Pass	Fail	Pass
84	30	Pass	Fail	Pass	Pass	Fail	Pass
84	31	Pass	Fail	Pass	Pass	Fail	Pass

85	13	Pass	Pass	Pass	Pass	Pass	Pass
85	14	Pass	Pass	Pass	Pass	Pass	Pass
85	15	Pass	Pass	Pass	Pass	Pass	Pass
85	21	Pass	Fail	Pass	Pass	Fail	Pass
85	30	Pass	Fail	Pass	Pass	Fail	Pass
86	13	Pass	Pass	Pass	Pass	Pass	Pass
86	14	Pass	Pass	Pass	Pass	Pass	Pass
86	15	Pass	Pass	Pass	Pass	Pass	Pass
86	17	Fail	Fail	Fail	Fail	Fail	Fail
86	21	Pass	Pass	Pass	Pass	Pass	Pass
86	30	Pass	Pass	Pass	Pass	Pass	Pass
87	13	Pass	Pass	Pass	Pass	Pass	Pass
87	14	Pass	Pass	Pass	Pass	Pass	Pass
87	15	Pass	Pass	Pass	Pass	Pass	Pass
87	30	Pass	Fail	Pass	Pass	Fail	Pass
87	32	Fail	Fail	Fail	Fail	Fail	Fail
88	13	Pass	Pass	Pass	Pass	Pass	Pass
88	14	Pass	Pass	Pass	Pass	Pass	Pass
88	15	Pass	Pass	Pass	Pass	Pass	Pass
88	30	Pass	Fail	Pass	Pass	Fail	Pass
89	13	Pass	Pass	Pass	Pass	Pass	Pass
89	14	Pass	Pass	Pass	Pass	Pass	Pass
89	15	Pass	Pass	Pass	Pass	Pass	Pass
89	30	Pass	Fail	Pass	Pass	Fail	Pass
90	13	Pass	Pass	Pass	Pass	Pass	Pass
90	14	Pass	Pass	Pass	Pass	Pass	Pass
90	15	Pass	Pass	Pass	Pass	Pass	Pass
90	30	Pass	Fail	Pass	Pass	Fail	Pass
91	13	Pass	Pass	Pass	Pass	Pass	Pass
91	14	Pass	Pass	Pass	Pass	Pass	Pass
91	15	Pass	Pass	Pass	Pass	Fail	Pass
91	16	Pass	Fail	Pass	Pass	Fail	Pass
91	30	Pass	Fail	Pass	Pass	Fail	Pass
92	13	Pass	Pass	Pass	Pass	Pass	Pass
92	14	Pass	Pass	Pass	Pass	Pass	Pass
92	15	Pass	Pass	Pass	Pass	Pass	Pass
92	16	Pass	Fail	Pass	Pass	Fail	Pass
92	30	Pass	Fail	Pass	Pass	Fail	Pass
92	32	Fail	Fail	Fail	Fail	Fail	Fail
93	13	Pass	Pass	Pass	Pass	Pass	Pass
93	14	Pass	Pass	Pass	Pass	Pass	Pass
93	15	Pass	Pass	Pass	Pass	Pass	Pass
93	16	Pass	Pass	Pass	Pass	Pass	Pass
93	30	Pass	Fail	Pass	Pass	Fail	Pass
94	13	Pass	Pass	Pass	Pass	Pass	Pass
94	14	Pass	Pass	Pass	Pass	Pass	Pass
94	15	Pass	Pass	Pass	Pass	Pass	Pass
94	16	Pass	Fail	Pass	Pass	Fail	Pass
94	26	Pass	Pass	Pass	Pass	Pass	Pass
94	30	Pass	Fail	Pass	Pass	Fail	Pass
95	13	Pass	Pass	Pass	Pass	Pass	Pass
95	14	Pass	Pass	Pass	Pass	Pass	Pass
95	15	Pass	Pass	Pass	Pass	Pass	Pass
95	16	Pass	Fail	Pass	Pass	Fail	Pass
95	26	Pass	Pass	Pass	Pass	Fail	Pass
95	28	Fail	Fail	Fail	Fail	Fail	Fail
95	30	Pass	Fail	Pass	Pass	Fail	Pass

96	11	Fail	Fail	Fail	Fail	Fail	Fail
96	13	Pass	Pass	Pass	Pass	Pass	Pass
96	14	Pass	Pass	Pass	Pass	Pass	Pass
96	15	Pass	Pass	Pass	Pass	Pass	Pass
96	26	Pass	Fail	Pass	Pass	Fail	Pass
96	30	Pass	Fail	Pass	Pass	Fail	Pass
97	13	Pass	Pass	Pass	Pass	Pass	Pass
97	14	Pass	Pass	Pass	Pass	Pass	Pass
97	15	Pass	Pass	Pass	Pass	Pass	Pass
97	26	Pass	Fail	Pass	Pass	Fail	Pass
97	30	Pass	Fail	Pass	Pass	Fail	Pass
98	13	Pass	Pass	Pass	Pass	Pass	Pass
98	14	Pass	Pass	Pass	Pass	Pass	Pass
98	15	Pass	Pass	Pass	Pass	Pass	Pass
98	26	Pass	Pass	Pass	Pass	Pass	Pass
98	27	Pass	Pass	Pass	Pass	Pass	Pass
98	28	Pass	Pass	Pass	Pass	Pass	Pass
98	29	Pass	Pass	Pass	Pass	Pass	Pass
98	30	Pass	Fail	Pass	Pass	Fail	Pass
99	13	Pass	Pass	Pass	Pass	Pass	Pass
99	14	Pass	Pass	Pass	Pass	Pass	Pass
99	15	Pass	Fail	Pass	Pass	Fail	Pass
99	16	Pass	Fail	Pass	Pass	Fail	Pass
99	17	Pass	Fail	Pass	Pass	Fail	Pass
99	18	Pass	Fail	Pass	Pass	Fail	Pass
99	19	Pass	Fail	Pass	Pass	Fail	Pass
99	20	Pass	Fail	Pass	Pass	Fail	Pass
99	21	Pass	Fail	Pass	Pass	Fail	Pass
99	22	Pass	Fail	Pass	Pass	Fail	Pass
99	23	Pass	Fail	Pass	Pass	Fail	Pass
99	26	Pass	Fail	Pass	Pass	Fail	Pass
99	30	Pass	Fail	Pass	Pass	Fail	Pass
100	13	Pass	Pass	Pass	Pass	Pass	Pass
100	14	Pass	Pass	Pass	Pass	Pass	Pass
100	15	Pass	Pass	Pass	Pass	Pass	Pass
100	23	Pass	Fail	Pass	Pass	Fail	Pass
100	24	Pass	Fail	Pass	Pass	Fail	Pass
100	25	Pass	Fail	Pass	Pass	Fail	Pass
100	26	Pass	Fail	Pass	Pass	Fail	Pass
100	30	Pass	Fail	Pass	Pass	Fail	Pass
101	13	Pass	Pass	Pass	Pass	Pass	Pass
101	14	Pass	Pass	Pass	Pass	Pass	Pass
101	15	Pass	Pass	Pass	Pass	Pass	Pass
101	16	Pass	Fail	Pass	Pass	Fail	Pass
101	17	Pass	Fail	Pass	Pass	Fail	Pass
101	18	Pass	Fail	Pass	Pass	Fail	Pass
101	19	Pass	Fail	Pass	Pass	Fail	Pass
101	20	Pass	Fail	Pass	Pass	Fail	Pass
101	21	Pass	Fail	Pass	Pass	Fail	Pass
101	22	Pass	Fail	Pass	Pass	Fail	Pass
101	23	Pass	Fail	Pass	Pass	Fail	Pass
101	26	Pass	Pass	Pass	Pass	Pass	Pass
101	30	Pass	Fail	Pass	Pass	Fail	Pass
102	13	Pass	Pass	Pass	Pass	Pass	Pass
102	14	Pass	Pass	Pass	Pass	Pass	Pass
102	15	Pass	Pass	Pass	Pass	Pass	Pass
102	26	Pass	Pass	Pass	Pass	Pass	Pass

102	30	Pass	Fail	Pass	Pass	Fail	Pass
103	13	Pass	Pass	Pass	Pass	Pass	Pass
103	14	Pass	Pass	Pass	Pass	Pass	Pass
103	15	Pass	Pass	Pass	Pass	Pass	Pass
103	26	Pass	Pass	Pass	Pass	Pass	Pass
103	30	Pass	Pass	Pass	Pass	Pass	Pass
104	11	Fail	Fail	Fail	Fail	Fail	Fail
104	13	Pass	Pass	Pass	Pass	Pass	Pass
104	14	Pass	Pass	Pass	Pass	Pass	Pass
104	15	Pass	Pass	Pass	Pass	Pass	Pass
104	26	Pass	Pass	Pass	Pass	Pass	Pass
104	30	Pass	Fail	Pass	Pass	Fail	Pass
105	13	Pass	Pass	Pass	Pass	Pass	Pass
105	14	Pass	Pass	Pass	Pass	Pass	Pass
105	15	Pass	Pass	Pass	Pass	Pass	Pass
105	26	Pass	Pass	Pass	Pass	Pass	Pass
105	30	Pass	Fail	Pass	Pass	Fail	Pass
106	13	Pass	Pass	Pass	Pass	Pass	Pass
106	14	Pass	Pass	Pass	Pass	Pass	Pass
106	15	Pass	Pass	Pass	Pass	Pass	Pass
106	26	Pass	Pass	Pass	Pass	Pass	Pass
106	27	Pass	Fail	Pass	Pass	Fail	Pass
106	30	Pass	Fail	Pass	Pass	Fail	Pass
106	39	Pass	Fail	Pass	Pass	Fail	Pass
107	13	Pass	Pass	Pass	Pass	Pass	Pass
107	14	Pass	Pass	Pass	Pass	Pass	Pass
107	15	Pass	Pass	Pass	Pass	Pass	Pass
107	22	Pass	Fail	Pass	Pass	Fail	Pass
107	26	Pass	Fail	Pass	Pass	Fail	Pass
107	30	Pass	Fail	Pass	Pass	Fail	Pass
107	39	Pass	Fail	Pass	Pass	Fail	Pass
108	13	Pass	Pass	Pass	Pass	Pass	Pass
108	14	Pass	Pass	Pass	Pass	Pass	Pass
108	15	Pass	Pass	Pass	Pass	Pass	Pass
108	22	Pass	Pass	Pass	Pass	Pass	Pass
108	24	Fail	Fail	Fail	Fail	Fail	Fail
108	26	Pass	Fail	Pass	Pass	Fail	Pass
108	30	Pass	Fail	Pass	Pass	Fail	Pass
108	39	Pass	Fail	Pass	Pass	Fail	Pass
109	13	Pass	Pass	Pass	Pass	Pass	Pass
109	14	Pass	Pass	Pass	Pass	Pass	Pass
109	15	Pass	Pass	Pass	Pass	Pass	Pass
109	22	Pass	Fail	Pass	Pass	Fail	Pass
109	26	Pass	Pass	Pass	Pass	Pass	Pass
109	30	Pass	Fail	Pass	Pass	Fail	Pass
109	39	Pass	Pass	Pass	Pass	Pass	Pass
110	13	Pass	Pass	Pass	Pass	Pass	Pass
110	14	Pass	Pass	Pass	Pass	Pass	Pass
110	15	Pass	Pass	Pass	Pass	Pass	Pass
110	22	Pass	Fail	Pass	Pass	Pass	Pass
110	26	Pass	Pass	Pass	Pass	Pass	Pass
110	28	Fail	Fail	Fail	Fail	Fail	Fail
110	39	Pass	Fail	Pass	Pass	Fail	Pass
111	13	Pass	Pass	Pass	Pass	Pass	Pass
111	14	Pass	Pass	Pass	Pass	Pass	Pass
111	15	Pass	Pass	Pass	Pass	Pass	Pass
111	22	Pass	Fail	Pass	Pass	Fail	Pass

111	26	Pass	Pass	Pass	Pass	Pass	Pass
111	39	Pass	Fail	Pass	Pass	Fail	Pass
112	13	Pass	Pass	Pass	Pass	Pass	Pass
112	14	Pass	Pass	Pass	Pass	Pass	Pass
112	15	Pass	Pass	Pass	Pass	Pass	Pass
112	22	Pass	Fail	Pass	Pass	Fail	Pass
112	26	Pass	Fail	Pass	Pass	Fail	Pass
112	39	Pass	Fail	Pass	Pass	Fail	Pass
113	13	Pass	Pass	Pass	Pass	Pass	Pass
113	14	Pass	Pass	Pass	Pass	Pass	Pass
113	15	Pass	Pass	Pass	Pass	Pass	Pass
113	26	Pass	Fail	Pass	Pass	Fail	Pass
113	27	Pass	Fail	Pass	Pass	Fail	Pass
113	39	Pass	Pass	Pass	Pass	Pass	Pass
113	41	Fail	Fail	Fail	Fail	Fail	Fail
114	13	Pass	Pass	Pass	Pass	Pass	Pass
114	14	Pass	Pass	Pass	Pass	Pass	Pass
114	15	Pass	Pass	Pass	Pass	Pass	Pass
114	26	Pass	Fail	Pass	Pass	Fail	Pass
114	39	Pass	Pass	Pass	Pass	Pass	Pass
115	13	Pass	Pass	Pass	Pass	Pass	Pass
115	14	Pass	Pass	Pass	Pass	Pass	Pass
115	15	Pass	Pass	Pass	Pass	Pass	Pass
115	26	Pass	Fail	Pass	Pass	Fail	Pass
115	39	Pass	Pass	Pass	Pass	Pass	Pass
116	13	Pass	Pass	Pass	Pass	Pass	Pass
116	14	Pass	Pass	Pass	Pass	Pass	Pass
116	15	Pass	Pass	Pass	Pass	Pass	Pass
116	26	Pass	Fail	Pass	Pass	Fail	Pass
116	28	Fail	Fail	Fail	Fail	Fail	Fail
116	39	Pass	Pass	Pass	Pass	Pass	Pass
117	13	Pass	Pass	Pass	Pass	Pass	Pass
117	14	Pass	Pass	Pass	Pass	Pass	Pass
117	15	Pass	Pass	Pass	Pass	Pass	Pass
117	26	Pass	Fail	Pass	Pass	Fail	Pass
117	39	Pass	Pass	Pass	Pass	Pass	Pass
118	13	Pass	Pass	Pass	Pass	Pass	Pass
118	14	Pass	Pass	Pass	Pass	Pass	Pass
118	15	Pass	Pass	Pass	Pass	Pass	Pass
118	20	Pass	Pass	Pass	Pass	Pass	Pass
118	26	Pass	Pass	Pass	Pass	Pass	Pass
118	39	Pass	Pass	Pass	Pass	Pass	Pass
119	13	Pass	Pass	Pass	Pass	Pass	Pass
119	14	Pass	Pass	Pass	Pass	Pass	Pass
119	15	Pass	Pass	Pass	Pass	Pass	Pass
119	20	Pass	Pass	Pass	Pass	Pass	Pass
119	26	Pass	Fail	Pass	Pass	Fail	Pass
119	39	Pass	Pass	Pass	Pass	Pass	Pass
120	13	Pass	Pass	Pass	Pass	Pass	Pass
120	14	Pass	Pass	Pass	Pass	Pass	Pass
120	15	Pass	Fail	Pass	Pass	Fail	Pass
120	16	Pass	Fail	Pass	Pass	Fail	Pass
120	26	Pass	Fail	Pass	Pass	Fail	Pass
120	39	Pass	Pass	Pass	Pass	Pass	Pass
121	13	Pass	Pass	Pass	Pass	Pass	Pass
121	14	Pass	Pass	Pass	Pass	Pass	Pass
121	26	Pass	Fail	Pass	Pass	Fail	Pass

121	39	Pass	Pass	Pass	Pass	Pass	Pass
122	13	Pass	Pass	Pass	Pass	Pass	Pass
122	14	Pass	Pass	Pass	Pass	Pass	Pass
122	26	Pass	Fail	Pass	Pass	Fail	Pass
122	39	Pass	Pass	Pass	Pass	Pass	Pass
122	41	Fail	Fail	Fail	Fail	Fail	Fail
123	13	Pass	Pass	Pass	Pass	Pass	Pass
123	14	Pass	Pass	Pass	Pass	Pass	Pass
123	15	Pass	Fail	Pass	Pass	Fail	Pass
123	16	Pass	Pass	Pass	Pass	Pass	Pass
123	17	Pass	Pass	Pass	Pass	Pass	Pass
123	18	Pass	Pass	Pass	Pass	Pass	Pass
123	19	Pass	Pass	Pass	Pass	Pass	Pass
123	20	Pass	Pass	Pass	Pass	Pass	Pass
123	21	Pass	Pass	Pass	Pass	Pass	Pass
123	22	Pass	Pass	Pass	Pass	Pass	Pass
123	23	Pass	Pass	Pass	Pass	Pass	Pass
123	24	Pass	Pass	Pass	Pass	Pass	Pass
123	25	Pass	Pass	Pass	Pass	Pass	Pass
123	26	Pass	Pass	Pass	Pass	Pass	Pass
123	27	Pass	Pass	Pass	Pass	Pass	Pass
123	28	Pass	Pass	Pass	Pass	Pass	Pass
123	29	Pass	Pass	Pass	Pass	Pass	Pass
123	30	Pass	Fail	Pass	Pass	Fail	Pass
123	31	Pass	Fail	Pass	Pass	Fail	Pass
123	32	Pass	Fail	Pass	Pass	Fail	Pass
123	33	Pass	Fail	Pass	Pass	Fail	Pass
123	34	Pass	Pass	Pass	Pass	Pass	Pass
123	35	Pass	Pass	Pass	Pass	Pass	Pass
123	36	Pass	Pass	Pass	Pass	Pass	Pass
123	37	Pass	Fail	Pass	Pass	Fail	Pass
123	38	Pass	Fail	Pass	Pass	Fail	Pass
123	39	Pass	Fail	Pass	Pass	Fail	Pass
124	13	Pass	Pass	Pass	Pass	Pass	Pass
124	14	Pass	Pass	Pass	Pass	Pass	Pass
124	23	Pass	Fail	Pass	Pass	Fail	Pass
125	13	Pass	Pass	Pass	Pass	Pass	Pass
125	14	Pass	Pass	Pass	Pass	Pass	Pass
125	23	Pass	Pass	Pass	Pass	Pass	Pass
125	28	Fail	Fail	Fail	Fail	Fail	Fail
125	33	Fail	Fail	Fail	Fail	Fail	Fail
126	13	Pass	Pass	Pass	Pass	Pass	Pass
126	14	Pass	Pass	Pass	Pass	Pass	Pass
126	23	Pass	Pass	Pass	Pass	Pass	Pass
127	13	Pass	Pass	Pass	Pass	Pass	Pass
127	14	Pass	Pass	Pass	Pass	Pass	Pass
127	23	Pass	Pass	Pass	Pass	Pass	Pass
128	13	Pass	Pass	Pass	Pass	Pass	Pass
128	14	Pass	Pass	Pass	Pass	Pass	Pass
128	23	Pass	Pass	Pass	Pass	Pass	Pass
129	13	Pass	Pass	Pass	Pass	Pass	Pass
129	14	Pass	Pass	Pass	Pass	Pass	Pass
129	23	Pass	Pass	Pass	Pass	Pass	Pass
130	8	Pass	Fail	Pass	Pass	Fail	Pass
130	9	Pass	Fail	Pass	Pass	Fail	Pass
130	10	Pass	Fail	Pass	Pass	Fail	Pass
130	11	Pass	Fail	Pass	Pass	Fail	Pass

130	12	Pass	Fail	Pass	Pass	Fail	Pass
130	13	Pass	Fail	Pass	Pass	Fail	Pass
130	14	Pass	Pass	Pass	Pass	Pass	Pass
130	23	Pass	Pass	Pass	Pass	Pass	Pass
131	14	Pass	Pass	Pass	Pass	Pass	Pass
131	23	Pass	Pass	Pass	Pass	Pass	Pass
132	14	Pass	Pass	Pass	Pass	Pass	Pass
132	23	Pass	Pass	Pass	Pass	Pass	Pass
133	14	Pass	Pass	Pass	Pass	Pass	Pass
133	23	Pass	Pass	Pass	Pass	Pass	Pass
134	14	Pass	Pass	Pass	Pass	Pass	Pass
134	23	Pass	Fail	Pass	Pass	Fail	Pass
135	14	Pass	Pass	Pass	Pass	Pass	Pass
136	14	Pass	Pass	Pass	Pass	Pass	Pass
137	14	Pass	Pass	Pass	Pass	Pass	Pass
138	14	Pass	Pass	Pass	Pass	Pass	Pass

2. Table E.7.2 Striped Bass eggs D.O. , Salinity, and Velocity criteria passing for existing and deepening (4 ft) scenarios within the analyzed period April 1 - April 30, 1997

HABITAT REQUIREMENTS:
RM 10-31; Depth Average
D.O. April (MG/L):10th %ile >=4.5
Salinity 50th %ile <= 9 ppt
Mean Velocity >= 30 cm/s

Savannah Harbor Estuary

Segments		Baseline Scenario			Project Scenario		
J	I	Salinity	Velocity	D.O.	Salinity	Velocity	D.O.
47	13	Pass	Pass	Pass	Pass	Pass	Pass
47	14	Fail	Pass	Pass	Fail	Pass	Pass
47	15	Pass	Pass	Pass	Pass	Pass	Pass
47	16	Pass	Pass	Pass	Pass	Pass	Pass
47	17	Pass	Fail	Pass	Pass	Fail	Pass
48	13	Pass	Pass	Pass	Pass	Pass	Pass
48	14	Fail	Pass	Pass	Fail	Pass	Pass
48	15	Pass	Pass	Pass	Pass	Pass	Pass
48	16	Pass	Pass	Pass	Pass	Pass	Pass
48	17	Pass	Pass	Pass	Pass	Pass	Pass
49	13	Pass	Pass	Pass	Pass	Pass	Pass
49	14	Pass	Pass	Pass	Fail	Pass	Pass
49	15	Pass	Pass	Pass	Pass	Pass	Pass
49	16	Pass	Pass	Pass	Pass	Pass	Pass
49	17	Pass	Pass	Pass	Pass	Pass	Pass
50	13	Pass	Pass	Pass	Pass	Pass	Pass
50	14	Pass	Pass	Pass	Fail	Pass	Pass
50	15	Pass	Fail	Pass	Pass	Fail	Pass
50	16	Pass	Fail	Pass	Pass	Fail	Pass
50	17	Pass	Fail	Pass	Pass	Fail	Pass
50	18	Pass	Fail	Pass	Pass	Fail	Pass
51	13	Pass	Pass	Pass	Pass	Pass	Pass
51	14	Pass	Pass	Pass	Fail	Pass	Pass
51	15	Pass	Pass	Pass	Pass	Pass	Pass
52	13	Pass	Pass	Pass	Pass	Pass	Pass
52	14	Pass	Pass	Pass	Fail	Pass	Pass
52	15	Pass	Pass	Pass	Pass	Pass	Pass
53	13	Pass	Pass	Pass	Pass	Pass	Pass
53	14	Pass	Pass	Pass	Pass	Pass	Pass
53	15	Pass	Pass	Pass	Pass	Pass	Pass
54	13	Pass	Pass	Pass	Pass	Pass	Pass
54	14	Pass	Pass	Pass	Pass	Pass	Pass
54	15	Pass	Pass	Pass	Pass	Pass	Pass
55	13	Pass	Pass	Pass	Pass	Pass	Pass
55	14	Pass	Pass	Pass	Pass	Pass	Pass
55	15	Pass	Pass	Pass	Pass	Pass	Pass
56	13	Pass	Pass	Pass	Pass	Pass	Pass
56	14	Pass	Pass	Pass	Pass	Pass	Pass
56	15	Pass	Pass	Pass	Pass	Pass	Pass

57	13	Pass	Pass	Pass	Pass	Pass	Pass
57	14	Pass	Pass	Pass	Pass	Pass	Pass
57	15	Pass	Pass	Pass	Pass	Pass	Pass
58	13	Pass	Pass	Pass	Pass	Pass	Pass
58	14	Pass	Pass	Pass	Pass	Pass	Pass
58	15	Pass	Pass	Pass	Pass	Pass	Pass
59	13	Pass	Pass	Pass	Pass	Pass	Pass
59	14	Pass	Pass	Pass	Pass	Pass	Pass
59	15	Pass	Pass	Pass	Pass	Pass	Pass
59	30	Pass	Fail	Pass	Pass	Fail	Pass
59	31	Pass	Fail	Pass	Pass	Fail	Pass
59	32	Pass	Fail	Pass	Pass	Fail	Pass
60	13	Pass	Pass	Pass	Pass	Pass	Pass
60	14	Pass	Pass	Pass	Pass	Pass	Pass
60	15	Pass	Pass	Pass	Pass	Pass	Pass
60	30	Pass	Fail	Pass	Pass	Fail	Pass
60	31	Pass	Fail	Pass	Pass	Fail	Pass
60	32	Pass	Fail	Pass	Pass	Fail	Pass
61	13	Pass	Pass	Pass	Pass	Pass	Pass
61	14	Pass	Pass	Pass	Pass	Pass	Pass
61	15	Pass	Pass	Pass	Pass	Pass	Pass
61	30	Pass	Fail	Pass	Pass	Fail	Pass
61	31	Pass	Fail	Pass	Pass	Fail	Pass
61	32	Pass	Fail	Pass	Pass	Fail	Pass
62	13	Pass	Pass	Pass	Pass	Pass	Pass
62	14	Pass	Pass	Pass	Pass	Pass	Pass
62	15	Pass	Pass	Pass	Pass	Pass	Pass
62	30	Pass	Fail	Pass	Pass	Fail	Pass
62	31	Pass	Fail	Pass	Pass	Fail	Pass
62	32	Pass	Fail	Pass	Pass	Fail	Pass
63	13	Pass	Pass	Pass	Pass	Pass	Pass
63	14	Pass	Pass	Pass	Pass	Pass	Pass
63	15	Pass	Pass	Pass	Pass	Pass	Pass
63	31	Pass	Pass	Pass	Pass	Pass	Pass
64	13	Pass	Pass	Pass	Pass	Pass	Pass
64	14	Pass	Pass	Pass	Pass	Pass	Pass
64	15	Pass	Pass	Pass	Pass	Pass	Pass
64	30	Pass	Fail	Pass	Pass	Fail	Pass
64	31	Pass	Pass	Pass	Pass	Pass	Pass
64	32	Pass	Fail	Pass	Pass	Fail	Pass
65	13	Pass	Pass	Pass	Pass	Pass	Pass
65	14	Pass	Pass	Pass	Pass	Pass	Pass
65	15	Pass	Pass	Pass	Pass	Pass	Pass
65	30	Pass	Fail	Pass	Pass	Fail	Pass
65	31	Pass	Pass	Pass	Pass	Pass	Pass
65	32	Pass	Fail	Pass	Pass	Fail	Pass
65	33	Pass	Fail	Pass	Pass	Fail	Pass
66	13	Pass	Pass	Pass	Pass	Pass	Pass
66	14	Pass	Pass	Pass	Pass	Pass	Pass
66	15	Pass	Fail	Pass	Pass	Fail	Pass
66	30	Pass	Fail	Pass	Pass	Fail	Pass
66	31	Pass	Pass	Pass	Pass	Pass	Pass
66	32	Pass	Fail	Pass	Pass	Fail	Pass
66	36	Pass	Fail	Pass	Pass	Fail	Pass
66	38	Fail	Fail	Fail	Fail	Fail	Fail
67	13	Pass	Pass	Pass	Pass	Pass	Pass
67	14	Pass	Pass	Pass	Pass	Pass	Pass

67	15	Pass	Fail	Pass	Pass	Fail	Pass
67	30	Pass	Fail	Pass	Pass	Fail	Pass
67	31	Pass	Pass	Pass	Pass	Pass	Pass
67	32	Pass	Fail	Pass	Pass	Fail	Pass
67	36	Pass	Fail	Pass	Pass	Fail	Pass
68	13	Pass	Pass	Pass	Pass	Pass	Pass
68	14	Pass	Pass	Pass	Pass	Pass	Pass
68	15	Pass	Fail	Pass	Pass	Fail	Pass
68	30	Pass	Fail	Pass	Pass	Fail	Pass
68	31	Pass	Pass	Pass	Pass	Pass	Pass
68	32	Pass	Fail	Pass	Pass	Fail	Pass
68	36	Pass	Fail	Pass	Pass	Fail	Pass
68	38	Fail	Fail	Fail	Fail	Fail	Fail
69	13	Pass	Pass	Pass	Pass	Pass	Pass
69	14	Pass	Pass	Pass	Pass	Pass	Pass
69	15	Pass	Fail	Pass	Pass	Fail	Pass
69	30	Pass	Pass	Pass	Pass	Pass	Pass
69	31	Pass	Pass	Pass	Pass	Pass	Pass
69	32	Pass	Fail	Pass	Pass	Fail	Pass
69	36	Pass	Fail	Pass	Pass	Fail	Pass
70	13	Pass	Pass	Pass	Pass	Pass	Pass
70	14	Pass	Pass	Pass	Pass	Pass	Pass
70	15	Pass	Fail	Pass	Pass	Fail	Pass
70	30	Pass	Fail	Pass	Pass	Fail	Pass
70	31	Pass	Fail	Pass	Pass	Fail	Pass
70	32	Pass	Fail	Pass	Pass	Fail	Pass
70	33	Pass	Fail	Pass	Pass	Fail	Pass
71	13	Pass	Fail	Pass	Pass	Fail	Pass
71	14	Pass	Pass	Pass	Pass	Pass	Pass
71	15	Pass	Fail	Pass	Pass	Pass	Pass
71	30	Pass	Fail	Pass	Pass	Fail	Pass
71	31	Pass	Fail	Pass	Pass	Fail	Pass
71	32	Pass	Fail	Pass	Pass	Fail	Pass
72	13	Pass	Pass	Pass	Pass	Pass	Pass
72	14	Pass	Pass	Pass	Pass	Pass	Pass
72	15	Pass	Fail	Pass	Pass	Pass	Pass
72	30	Pass	Fail	Pass	Pass	Fail	Pass
72	31	Pass	Fail	Pass	Pass	Fail	Pass
72	32	Pass	Fail	Pass	Pass	Fail	Pass
73	13	Pass	Pass	Pass	Pass	Pass	Pass
73	14	Pass	Pass	Pass	Pass	Pass	Pass
73	15	Pass	Pass	Pass	Pass	Pass	Pass
73	30	Pass	Fail	Pass	Pass	Fail	Pass
73	31	Pass	Fail	Pass	Pass	Fail	Pass
74	13	Pass	Pass	Pass	Pass	Pass	Pass
74	14	Pass	Pass	Pass	Pass	Pass	Pass
74	15	Pass	Pass	Pass	Pass	Pass	Pass
74	30	Pass	Fail	Pass	Pass	Fail	Pass
74	31	Pass	Fail	Pass	Pass	Fail	Pass
75	13	Pass	Pass	Pass	Pass	Pass	Pass
75	14	Pass	Pass	Pass	Pass	Pass	Pass
75	15	Pass	Pass	Pass	Pass	Pass	Pass
75	30	Pass	Fail	Pass	Pass	Fail	Pass
75	31	Pass	Fail	Pass	Pass	Fail	Pass
76	13	Pass	Fail	Pass	Pass	Fail	Pass
76	14	Pass	Pass	Pass	Pass	Pass	Pass
76	15	Pass	Fail	Pass	Pass	Fail	Pass

76	16	Pass	Fail	Pass	Pass	Fail	Pass
76	17	Pass	Fail	Pass	Pass	Fail	Pass
76	30	Pass	Fail	Pass	Pass	Fail	Pass
76	31	Pass	Fail	Pass	Pass	Fail	Pass
76	33	Fail	Fail	Fail	Fail	Fail	Fail
77	13	Pass	Fail	Pass	Pass	Fail	Pass
77	14	Pass	Fail	Pass	Pass	Fail	Pass
77	15	Pass	Fail	Pass	Pass	Fail	Pass
77	16	Pass	Fail	Pass	Pass	Fail	Pass
77	17	Pass	Fail	Pass	Pass	Fail	Pass
77	30	Pass	Fail	Pass	Pass	Fail	Pass
77	31	Pass	Fail	Pass	Pass	Fail	Pass
78	13	Pass	Fail	Pass	Pass	Fail	Pass
78	14	Pass	Pass	Pass	Pass	Pass	Pass
78	15	Pass	Fail	Pass	Pass	Fail	Pass
78	16	Pass	Fail	Pass	Pass	Fail	Pass
78	17	Pass	Fail	Pass	Pass	Fail	Pass
78	30	Pass	Fail	Pass	Pass	Fail	Pass
78	31	Pass	Fail	Pass	Pass	Fail	Pass
79	13	Pass	Fail	Pass	Pass	Fail	Pass
79	14	Pass	Pass	Pass	Pass	Pass	Pass
79	15	Pass	Fail	Pass	Pass	Fail	Pass
79	30	Pass	Fail	Pass	Pass	Fail	Pass
79	31	Pass	Fail	Pass	Pass	Fail	Pass
80	13	Pass	Fail	Pass	Pass	Fail	Pass
80	14	Pass	Pass	Pass	Pass	Pass	Pass
80	15	Pass	Fail	Pass	Pass	Fail	Pass
80	30	Pass	Fail	Pass	Pass	Fail	Pass
80	31	Pass	Fail	Pass	Pass	Fail	Pass
81	13	Pass	Pass	Pass	Pass	Fail	Pass
81	14	Pass	Pass	Pass	Pass	Pass	Pass
81	15	Pass	Fail	Pass	Pass	Fail	Pass
81	30	Pass	Fail	Pass	Pass	Fail	Pass
81	31	Pass	Fail	Pass	Pass	Fail	Pass
82	13	Pass	Pass	Pass	Pass	Pass	Pass
82	14	Pass	Pass	Pass	Pass	Pass	Pass
82	15	Pass	Pass	Pass	Pass	Pass	Pass
82	16	Pass	Fail	Pass	Pass	Fail	Pass
82	17	Pass	Fail	Pass	Pass	Fail	Pass
82	18	Pass	Fail	Pass	Pass	Fail	Pass
82	19	Pass	Fail	Pass	Pass	Fail	Pass
82	20	Pass	Fail	Pass	Pass	Fail	Pass
82	21	Pass	Fail	Pass	Pass	Fail	Pass
82	29	Pass	Fail	Pass	Pass	Fail	Pass
82	30	Pass	Fail	Pass	Pass	Fail	Pass
82	31	Pass	Fail	Pass	Pass	Fail	Pass
83	13	Pass	Pass	Pass	Pass	Pass	Pass
83	14	Pass	Pass	Pass	Pass	Pass	Pass
83	15	Pass	Pass	Pass	Pass	Pass	Pass
83	21	Pass	Fail	Pass	Pass	Fail	Pass
83	30	Pass	Fail	Pass	Pass	Fail	Pass
83	31	Pass	Fail	Pass	Pass	Fail	Pass
84	13	Pass	Pass	Pass	Pass	Pass	Pass
84	14	Pass	Pass	Pass	Pass	Pass	Pass
84	15	Pass	Pass	Pass	Pass	Pass	Pass
84	21	Pass	Fail	Pass	Pass	Fail	Pass
84	30	Pass	Fail	Pass	Pass	Fail	Pass

84	31	Pass	Fail	Pass	Pass	Fail	Pass
85	13	Pass	Pass	Pass	Pass	Pass	Pass
85	14	Pass	Pass	Pass	Pass	Pass	Pass
85	15	Pass	Pass	Pass	Pass	Pass	Pass
85	21	Pass	Fail	Pass	Pass	Fail	Pass
85	30	Pass	Fail	Pass	Pass	Fail	Pass
86	13	Pass	Pass	Pass	Pass	Pass	Pass
86	14	Pass	Pass	Pass	Pass	Pass	Pass
86	15	Pass	Pass	Pass	Pass	Pass	Pass
86	17	Fail	Fail	Fail	Fail	Fail	Fail
86	21	Pass	Pass	Pass	Pass	Pass	Pass
86	30	Pass	Pass	Pass	Pass	Pass	Pass
87	13	Pass	Pass	Pass	Pass	Pass	Pass
87	14	Pass	Pass	Pass	Pass	Pass	Pass
87	15	Pass	Pass	Pass	Pass	Pass	Pass
87	30	Pass	Fail	Pass	Pass	Fail	Pass
87	32	Fail	Fail	Fail	Fail	Fail	Fail
88	13	Pass	Pass	Pass	Pass	Pass	Pass
88	14	Pass	Pass	Pass	Pass	Pass	Pass
88	15	Pass	Pass	Pass	Pass	Pass	Pass
88	30	Pass	Fail	Pass	Pass	Fail	Pass
89	13	Pass	Pass	Pass	Pass	Pass	Pass
89	14	Pass	Pass	Pass	Pass	Pass	Pass
89	15	Pass	Pass	Pass	Pass	Pass	Pass
89	30	Pass	Fail	Pass	Pass	Fail	Pass
90	13	Pass	Pass	Pass	Pass	Pass	Pass
90	14	Pass	Pass	Pass	Pass	Pass	Pass
90	15	Pass	Pass	Pass	Pass	Pass	Pass
90	30	Pass	Fail	Pass	Pass	Fail	Pass
91	13	Pass	Pass	Pass	Pass	Pass	Pass
91	14	Pass	Pass	Pass	Pass	Pass	Pass
91	15	Pass	Pass	Pass	Pass	Pass	Pass
91	16	Pass	Fail	Pass	Pass	Fail	Pass
91	30	Pass	Fail	Pass	Pass	Fail	Pass
92	13	Pass	Pass	Pass	Pass	Pass	Pass
92	14	Pass	Pass	Pass	Pass	Pass	Pass
92	15	Pass	Pass	Pass	Pass	Pass	Pass
92	16	Pass	Fail	Pass	Pass	Fail	Pass
92	30	Pass	Fail	Pass	Pass	Fail	Pass
92	32	Fail	Fail	Fail	Fail	Fail	Fail
93	13	Pass	Pass	Pass	Pass	Pass	Pass
93	14	Pass	Pass	Pass	Pass	Pass	Pass
93	15	Pass	Pass	Pass	Pass	Pass	Pass
93	16	Pass	Pass	Pass	Pass	Pass	Pass
93	30	Pass	Fail	Pass	Pass	Fail	Pass
94	13	Pass	Pass	Pass	Pass	Pass	Pass
94	14	Pass	Pass	Pass	Pass	Pass	Pass
94	15	Pass	Pass	Pass	Pass	Pass	Pass
94	16	Pass	Fail	Pass	Pass	Fail	Pass
94	26	Pass	Pass	Pass	Pass	Pass	Pass
94	30	Pass	Fail	Pass	Pass	Fail	Pass
95	13	Pass	Pass	Pass	Pass	Pass	Pass
95	14	Pass	Pass	Pass	Pass	Pass	Pass
95	15	Pass	Pass	Pass	Pass	Pass	Pass
95	16	Pass	Fail	Pass	Pass	Fail	Pass
95	26	Pass	Pass	Pass	Pass	Fail	Pass
95	28	Fail	Fail	Fail	Fail	Fail	Fail

95	30	Pass	Fail	Pass	Pass	Fail	Pass
96	11	Fail	Fail	Fail	Fail	Fail	Fail
96	13	Pass	Pass	Pass	Pass	Pass	Pass
96	14	Pass	Pass	Pass	Pass	Pass	Pass
96	15	Pass	Pass	Pass	Pass	Pass	Pass
96	26	Pass	Fail	Pass	Pass	Fail	Pass
96	30	Pass	Fail	Pass	Pass	Fail	Pass
97	13	Pass	Pass	Pass	Pass	Pass	Pass
97	14	Pass	Pass	Pass	Pass	Pass	Pass
97	15	Pass	Pass	Pass	Pass	Pass	Pass
97	26	Pass	Fail	Pass	Pass	Fail	Pass
97	30	Pass	Fail	Pass	Pass	Fail	Pass
98	13	Pass	Pass	Pass	Pass	Pass	Pass
98	14	Pass	Pass	Pass	Pass	Pass	Pass
98	15	Pass	Pass	Pass	Pass	Pass	Pass
98	26	Pass	Pass	Pass	Pass	Pass	Pass
98	27	Pass	Pass	Pass	Pass	Pass	Pass
98	28	Pass	Pass	Pass	Pass	Pass	Pass
98	29	Pass	Pass	Pass	Pass	Pass	Pass
98	30	Pass	Fail	Pass	Pass	Fail	Pass
99	13	Pass	Pass	Pass	Pass	Pass	Pass
99	14	Pass	Pass	Pass	Pass	Pass	Pass
99	15	Pass	Fail	Pass	Pass	Fail	Pass
99	16	Pass	Fail	Pass	Pass	Fail	Pass
99	17	Pass	Fail	Pass	Pass	Fail	Pass
99	18	Pass	Fail	Pass	Pass	Fail	Pass
99	19	Pass	Fail	Pass	Pass	Fail	Pass
99	20	Pass	Fail	Pass	Pass	Fail	Pass
99	21	Pass	Fail	Pass	Pass	Fail	Pass
99	22	Pass	Fail	Pass	Pass	Fail	Pass
99	23	Pass	Fail	Pass	Pass	Fail	Pass
99	26	Pass	Fail	Pass	Pass	Fail	Pass
99	30	Pass	Fail	Pass	Pass	Fail	Pass
100	13	Pass	Pass	Pass	Pass	Pass	Pass
100	14	Pass	Pass	Pass	Pass	Pass	Pass
100	15	Pass	Pass	Pass	Pass	Pass	Pass
100	23	Pass	Fail	Pass	Pass	Fail	Pass
100	24	Pass	Fail	Pass	Pass	Fail	Pass
100	25	Pass	Fail	Pass	Pass	Fail	Pass
100	26	Pass	Fail	Pass	Pass	Fail	Pass
100	30	Pass	Fail	Pass	Pass	Fail	Pass
101	13	Pass	Pass	Pass	Pass	Pass	Pass
101	14	Pass	Pass	Pass	Pass	Pass	Pass
101	15	Pass	Pass	Pass	Pass	Pass	Pass
101	16	Pass	Fail	Pass	Pass	Fail	Pass
101	17	Pass	Fail	Pass	Pass	Fail	Pass
101	18	Pass	Fail	Pass	Pass	Fail	Pass
101	19	Pass	Fail	Pass	Pass	Fail	Pass
101	20	Pass	Fail	Pass	Pass	Fail	Pass
101	21	Pass	Fail	Pass	Pass	Fail	Pass
101	22	Pass	Fail	Pass	Pass	Fail	Pass
101	23	Pass	Fail	Pass	Pass	Fail	Pass
101	26	Pass	Pass	Pass	Pass	Pass	Pass
101	30	Pass	Fail	Pass	Pass	Fail	Pass
102	13	Pass	Pass	Pass	Pass	Pass	Pass
102	14	Pass	Pass	Pass	Pass	Pass	Pass
102	15	Pass	Pass	Pass	Pass	Pass	Pass

102	26	Pass	Pass	Pass	Pass	Pass	Pass
102	30	Pass	Fail	Pass	Pass	Fail	Pass
103	13	Pass	Pass	Pass	Pass	Pass	Pass
103	14	Pass	Pass	Pass	Pass	Pass	Pass
103	15	Pass	Pass	Pass	Pass	Pass	Pass
103	26	Pass	Pass	Pass	Pass	Pass	Pass
103	30	Pass	Pass	Pass	Pass	Pass	Pass
104	11	Fail	Fail	Fail	Fail	Fail	Fail
104	13	Pass	Pass	Pass	Pass	Pass	Pass
104	14	Pass	Pass	Pass	Pass	Pass	Pass
104	15	Pass	Pass	Pass	Pass	Pass	Pass
104	26	Pass	Pass	Pass	Pass	Pass	Pass
104	30	Pass	Fail	Pass	Pass	Fail	Pass
105	13	Pass	Pass	Pass	Pass	Pass	Pass
105	14	Pass	Pass	Pass	Pass	Pass	Pass
105	15	Pass	Pass	Pass	Pass	Pass	Pass
105	26	Pass	Pass	Pass	Pass	Pass	Pass
105	30	Pass	Fail	Pass	Pass	Fail	Pass
106	13	Pass	Pass	Pass	Pass	Pass	Pass
106	14	Pass	Pass	Pass	Pass	Pass	Pass
106	15	Pass	Pass	Pass	Pass	Pass	Pass
106	26	Pass	Pass	Pass	Pass	Pass	Pass
106	27	Pass	Fail	Pass	Pass	Fail	Pass
106	30	Pass	Fail	Pass	Pass	Fail	Pass
106	39	Pass	Fail	Pass	Pass	Fail	Pass
107	13	Pass	Pass	Pass	Pass	Pass	Pass
107	14	Pass	Pass	Pass	Pass	Pass	Pass
107	15	Pass	Pass	Pass	Pass	Pass	Pass
107	22	Pass	Fail	Pass	Pass	Fail	Pass
107	26	Pass	Fail	Pass	Pass	Fail	Pass
107	30	Pass	Fail	Pass	Pass	Fail	Pass
107	39	Pass	Fail	Pass	Pass	Fail	Pass
108	13	Pass	Pass	Pass	Pass	Pass	Pass
108	14	Pass	Pass	Pass	Pass	Pass	Pass
108	15	Pass	Pass	Pass	Pass	Pass	Pass
108	22	Pass	Pass	Pass	Pass	Pass	Pass
108	24	Fail	Fail	Fail	Fail	Fail	Fail
108	26	Pass	Fail	Pass	Pass	Fail	Pass
108	30	Pass	Fail	Pass	Pass	Fail	Pass
108	39	Pass	Fail	Pass	Pass	Fail	Pass
109	13	Pass	Pass	Pass	Pass	Pass	Pass
109	14	Pass	Pass	Pass	Pass	Pass	Pass
109	15	Pass	Pass	Pass	Pass	Pass	Pass
109	22	Pass	Fail	Pass	Pass	Fail	Pass
109	26	Pass	Pass	Pass	Pass	Pass	Pass
109	30	Pass	Fail	Pass	Pass	Fail	Pass
109	39	Pass	Pass	Pass	Pass	Pass	Pass
110	13	Pass	Pass	Pass	Pass	Pass	Pass
110	14	Pass	Pass	Pass	Pass	Pass	Pass
110	15	Pass	Pass	Pass	Pass	Pass	Pass
110	22	Pass	Fail	Pass	Pass	Fail	Pass
110	26	Pass	Pass	Pass	Pass	Pass	Pass
110	28	Fail	Fail	Fail	Fail	Fail	Fail
110	39	Pass	Fail	Pass	Pass	Fail	Pass
111	13	Pass	Pass	Pass	Pass	Pass	Pass
111	14	Pass	Pass	Pass	Pass	Pass	Pass
111	15	Pass	Pass	Pass	Pass	Pass	Pass

111	22	Pass	Fail	Pass	Pass	Fail	Pass
111	26	Pass	Pass	Pass	Pass	Pass	Pass
111	39	Pass	Fail	Pass	Pass	Fail	Pass
112	13	Pass	Pass	Pass	Pass	Pass	Pass
112	14	Pass	Pass	Pass	Pass	Pass	Pass
112	15	Pass	Pass	Pass	Pass	Pass	Pass
112	22	Pass	Fail	Pass	Pass	Fail	Pass
112	26	Pass	Fail	Pass	Pass	Fail	Pass
112	39	Pass	Fail	Pass	Pass	Fail	Pass
113	13	Pass	Pass	Pass	Pass	Pass	Pass
113	14	Pass	Pass	Pass	Pass	Pass	Pass
113	15	Pass	Pass	Pass	Pass	Pass	Pass
113	26	Pass	Fail	Pass	Pass	Pass	Pass
113	27	Pass	Fail	Pass	Pass	Fail	Pass
113	39	Pass	Pass	Pass	Pass	Pass	Pass
113	41	Fail	Fail	Fail	Fail	Fail	Fail
114	13	Pass	Pass	Pass	Pass	Pass	Pass
114	14	Pass	Pass	Pass	Pass	Pass	Pass
114	15	Pass	Pass	Pass	Pass	Pass	Pass
114	26	Pass	Fail	Pass	Pass	Fail	Pass
114	39	Pass	Pass	Pass	Pass	Pass	Pass
115	13	Pass	Pass	Pass	Pass	Pass	Pass
115	14	Pass	Pass	Pass	Pass	Pass	Pass
115	15	Pass	Pass	Pass	Pass	Pass	Pass
115	26	Pass	Fail	Pass	Pass	Fail	Pass
115	39	Pass	Pass	Pass	Pass	Pass	Pass
116	13	Pass	Pass	Pass	Pass	Pass	Pass
116	14	Pass	Pass	Pass	Pass	Pass	Pass
116	15	Pass	Pass	Pass	Pass	Pass	Pass
116	26	Pass	Fail	Pass	Pass	Fail	Pass
116	28	Fail	Fail	Fail	Fail	Fail	Fail
116	39	Pass	Pass	Pass	Pass	Pass	Pass
117	13	Pass	Pass	Pass	Pass	Pass	Pass
117	14	Pass	Pass	Pass	Pass	Pass	Pass
117	15	Pass	Pass	Pass	Pass	Pass	Pass
117	26	Pass	Fail	Pass	Pass	Fail	Pass
117	39	Pass	Pass	Pass	Pass	Pass	Pass
118	13	Pass	Pass	Pass	Pass	Pass	Pass
118	14	Pass	Pass	Pass	Pass	Pass	Pass
118	15	Pass	Pass	Pass	Pass	Pass	Pass
118	20	Pass	Pass	Pass	Pass	Pass	Pass
118	26	Pass	Pass	Pass	Pass	Pass	Pass
118	39	Pass	Pass	Pass	Pass	Pass	Pass
119	13	Pass	Pass	Pass	Pass	Pass	Pass
119	14	Pass	Pass	Pass	Pass	Pass	Pass
119	15	Pass	Pass	Pass	Pass	Pass	Pass
119	20	Pass	Pass	Pass	Pass	Pass	Pass
119	26	Pass	Fail	Pass	Pass	Fail	Pass
119	39	Pass	Pass	Pass	Pass	Pass	Pass
120	13	Pass	Pass	Pass	Pass	Pass	Pass
120	14	Pass	Pass	Pass	Pass	Pass	Pass
120	15	Pass	Fail	Pass	Pass	Fail	Pass
120	16	Pass	Fail	Pass	Pass	Fail	Pass
120	26	Pass	Fail	Pass	Pass	Fail	Pass
120	39	Pass	Pass	Pass	Pass	Pass	Pass
121	13	Pass	Pass	Pass	Pass	Pass	Pass
121	14	Pass	Pass	Pass	Pass	Pass	Pass

121	26	Pass	Fail	Pass	Pass	Fail	Pass
121	39	Pass	Pass	Pass	Pass	Pass	Pass
122	13	Pass	Pass	Pass	Pass	Pass	Pass
122	14	Pass	Pass	Pass	Pass	Pass	Pass
122	26	Pass	Fail	Pass	Pass	Fail	Pass
122	39	Pass	Pass	Pass	Pass	Pass	Pass
122	41	Fail	Fail	Fail	Fail	Fail	Fail
123	13	Pass	Pass	Pass	Pass	Pass	Pass
123	14	Pass	Pass	Pass	Pass	Pass	Pass
123	15	Pass	Fail	Pass	Pass	Fail	Pass
123	16	Pass	Pass	Pass	Pass	Pass	Pass
123	17	Pass	Pass	Pass	Pass	Pass	Pass
123	18	Pass	Pass	Pass	Pass	Pass	Pass
123	19	Pass	Pass	Pass	Pass	Pass	Pass
123	20	Pass	Pass	Pass	Pass	Pass	Pass
123	21	Pass	Pass	Pass	Pass	Pass	Pass
123	22	Pass	Pass	Pass	Pass	Pass	Pass
123	23	Pass	Pass	Pass	Pass	Pass	Pass
123	24	Pass	Pass	Pass	Pass	Pass	Pass
123	25	Pass	Pass	Pass	Pass	Pass	Pass
123	26	Pass	Pass	Pass	Pass	Pass	Pass
123	27	Pass	Pass	Pass	Pass	Pass	Pass
123	28	Pass	Pass	Pass	Pass	Pass	Pass
123	29	Pass	Pass	Pass	Pass	Pass	Pass
123	30	Pass	Fail	Pass	Pass	Fail	Pass
123	31	Pass	Fail	Pass	Pass	Fail	Pass
123	32	Pass	Fail	Pass	Pass	Fail	Pass
123	33	Pass	Fail	Pass	Pass	Fail	Pass
123	34	Pass	Pass	Pass	Pass	Pass	Pass
123	35	Pass	Pass	Pass	Pass	Pass	Pass
123	36	Pass	Pass	Pass	Pass	Pass	Pass
123	37	Pass	Fail	Pass	Pass	Fail	Pass
123	38	Pass	Fail	Pass	Pass	Fail	Pass
123	39	Pass	Fail	Pass	Pass	Fail	Pass
124	13	Pass	Pass	Pass	Pass	Pass	Pass
124	14	Pass	Pass	Pass	Pass	Pass	Pass
124	23	Pass	Fail	Pass	Pass	Fail	Pass
125	13	Pass	Pass	Pass	Pass	Pass	Pass
125	14	Pass	Pass	Pass	Pass	Pass	Pass
125	23	Pass	Pass	Pass	Pass	Pass	Pass
125	28	Fail	Fail	Fail	Fail	Fail	Fail
125	33	Fail	Fail	Fail	Fail	Fail	Fail
126	13	Pass	Pass	Pass	Pass	Pass	Pass
126	14	Pass	Pass	Pass	Pass	Pass	Pass
126	23	Pass	Pass	Pass	Pass	Pass	Pass
127	13	Pass	Pass	Pass	Pass	Pass	Pass
127	14	Pass	Pass	Pass	Pass	Pass	Pass
127	23	Pass	Pass	Pass	Pass	Pass	Pass
128	13	Pass	Pass	Pass	Pass	Pass	Pass
128	14	Pass	Pass	Pass	Pass	Pass	Pass
128	23	Pass	Pass	Pass	Pass	Pass	Pass
129	13	Pass	Pass	Pass	Pass	Pass	Pass
129	14	Pass	Pass	Pass	Pass	Pass	Pass
129	23	Pass	Pass	Pass	Pass	Pass	Pass
130	8	Pass	Fail	Pass	Pass	Fail	Pass
130	9	Pass	Fail	Pass	Pass	Fail	Pass
130	10	Pass	Fail	Pass	Pass	Fail	Pass

130	11	Pass	Fail	Pass	Pass	Fail	Pass
130	12	Pass	Fail	Pass	Pass	Fail	Pass
130	13	Pass	Fail	Pass	Pass	Fail	Pass
130	14	Pass	Pass	Pass	Pass	Pass	Pass
130	23	Pass	Pass	Pass	Pass	Pass	Pass
131	14	Pass	Pass	Pass	Pass	Pass	Pass
131	23	Pass	Pass	Pass	Pass	Pass	Pass
132	14	Pass	Pass	Pass	Pass	Pass	Pass
132	23	Pass	Pass	Pass	Pass	Pass	Pass
133	14	Pass	Pass	Pass	Pass	Pass	Pass
133	23	Pass	Pass	Pass	Pass	Pass	Pass
134	14	Pass	Pass	Pass	Pass	Pass	Pass
134	23	Pass	Fail	Pass	Pass	Fail	Pass
135	14	Pass	Pass	Pass	Pass	Pass	Pass
136	14	Pass	Pass	Pass	Pass	Pass	Pass
137	14	Pass	Pass	Pass	Pass	Pass	Pass
138	14	Pass	Pass	Pass	Pass	Pass	Pass

3. Table E.7.3 Striped Bass eggs D.O. , Salinity, and Velocity criteria passing for existing and deepening (3 ft) scenarios within the analyzed period April 1 - April 30, 1997

HABITAT REQUIREMENTS:
RM 10-31; Depth Average
D.O. April (MG/L):10th %ile >=4.5
Salinity 50th %ile <= 9 ppt
Mean Velocity >= 30 cm/s

Savannah Harbor Estuary

Segments		Baseline Scenario			Project Scenario		
J	I	Salinity	Velocity	D.O.	Salinity	Velocity	D.O.
47	13	Pass	Pass	Pass	Pass	Pass	Pass
47	14	Fail	Pass	Pass	Fail	Pass	Pass
47	15	Pass	Pass	Pass	Pass	Pass	Pass
47	16	Pass	Pass	Pass	Pass	Pass	Pass
47	17	Pass	Fail	Pass	Pass	Fail	Pass
48	13	Pass	Pass	Pass	Pass	Pass	Pass
48	14	Fail	Pass	Pass	Fail	Pass	Pass
48	15	Pass	Pass	Pass	Pass	Pass	Pass
48	16	Pass	Pass	Pass	Pass	Pass	Pass
48	17	Pass	Pass	Pass	Pass	Pass	Pass
49	13	Pass	Pass	Pass	Pass	Pass	Pass
49	14	Pass	Pass	Pass	Fail	Pass	Pass
49	15	Pass	Pass	Pass	Pass	Pass	Pass
49	16	Pass	Pass	Pass	Pass	Pass	Pass
49	17	Pass	Pass	Pass	Pass	Pass	Pass
50	13	Pass	Pass	Pass	Pass	Pass	Pass
50	14	Pass	Pass	Pass	Fail	Pass	Pass
50	15	Pass	Fail	Pass	Pass	Fail	Pass
50	16	Pass	Fail	Pass	Pass	Fail	Pass
50	17	Pass	Fail	Pass	Pass	Fail	Pass
50	18	Pass	Fail	Pass	Pass	Fail	Pass
51	13	Pass	Pass	Pass	Pass	Pass	Pass
51	14	Pass	Pass	Pass	Fail	Pass	Pass
51	15	Pass	Pass	Pass	Pass	Pass	Pass
52	13	Pass	Pass	Pass	Pass	Pass	Pass
52	14	Pass	Pass	Pass	Fail	Pass	Pass
52	15	Pass	Pass	Pass	Pass	Pass	Pass
53	13	Pass	Pass	Pass	Pass	Pass	Pass
53	14	Pass	Pass	Pass	Pass	Pass	Pass
53	15	Pass	Pass	Pass	Pass	Pass	Pass
54	13	Pass	Pass	Pass	Pass	Pass	Pass
54	14	Pass	Pass	Pass	Pass	Pass	Pass
54	15	Pass	Pass	Pass	Pass	Pass	Pass
55	13	Pass	Pass	Pass	Pass	Pass	Pass
55	14	Pass	Pass	Pass	Pass	Pass	Pass
55	15	Pass	Pass	Pass	Pass	Pass	Pass
56	13	Pass	Pass	Pass	Pass	Pass	Pass
56	14	Pass	Pass	Pass	Pass	Pass	Pass
56	15	Pass	Pass	Pass	Pass	Pass	Pass

57	13	Pass	Pass	Pass	Pass	Pass	Pass
57	14	Pass	Pass	Pass	Pass	Pass	Pass
57	15	Pass	Pass	Pass	Pass	Pass	Pass
58	13	Pass	Pass	Pass	Pass	Pass	Pass
58	14	Pass	Pass	Pass	Pass	Pass	Pass
58	15	Pass	Pass	Pass	Pass	Pass	Pass
59	13	Pass	Pass	Pass	Pass	Pass	Pass
59	14	Pass	Pass	Pass	Pass	Pass	Pass
59	15	Pass	Pass	Pass	Pass	Pass	Pass
59	30	Pass	Fail	Pass	Pass	Fail	Pass
59	31	Pass	Fail	Pass	Pass	Fail	Pass
59	32	Pass	Fail	Pass	Pass	Fail	Pass
60	13	Pass	Pass	Pass	Pass	Pass	Pass
60	14	Pass	Pass	Pass	Pass	Pass	Pass
60	15	Pass	Pass	Pass	Pass	Pass	Pass
60	30	Pass	Fail	Pass	Pass	Fail	Pass
60	31	Pass	Fail	Pass	Pass	Fail	Pass
60	32	Pass	Fail	Pass	Pass	Fail	Pass
61	13	Pass	Pass	Pass	Pass	Pass	Pass
61	14	Pass	Pass	Pass	Pass	Pass	Pass
61	15	Pass	Pass	Pass	Pass	Pass	Pass
61	30	Pass	Fail	Pass	Pass	Fail	Pass
61	31	Pass	Fail	Pass	Pass	Fail	Pass
61	32	Pass	Fail	Pass	Pass	Fail	Pass
62	13	Pass	Pass	Pass	Pass	Pass	Pass
62	14	Pass	Pass	Pass	Pass	Pass	Pass
62	15	Pass	Pass	Pass	Pass	Pass	Pass
62	30	Pass	Fail	Pass	Pass	Fail	Pass
62	31	Pass	Fail	Pass	Pass	Fail	Pass
62	32	Pass	Fail	Pass	Pass	Fail	Pass
63	13	Pass	Pass	Pass	Pass	Pass	Pass
63	14	Pass	Pass	Pass	Pass	Pass	Pass
63	15	Pass	Pass	Pass	Pass	Pass	Pass
63	31	Pass	Pass	Pass	Pass	Pass	Pass
64	13	Pass	Pass	Pass	Pass	Pass	Pass
64	14	Pass	Pass	Pass	Pass	Pass	Pass
64	15	Pass	Pass	Pass	Pass	Pass	Pass
64	30	Pass	Fail	Pass	Pass	Fail	Pass
64	31	Pass	Pass	Pass	Pass	Pass	Pass
64	32	Pass	Fail	Pass	Pass	Fail	Pass
65	13	Pass	Pass	Pass	Pass	Pass	Pass
65	14	Pass	Pass	Pass	Pass	Pass	Pass
65	15	Pass	Pass	Pass	Pass	Pass	Pass
65	30	Pass	Fail	Pass	Pass	Fail	Pass
65	31	Pass	Pass	Pass	Pass	Pass	Pass
65	32	Pass	Fail	Pass	Pass	Fail	Pass
65	33	Pass	Fail	Pass	Pass	Fail	Pass
66	13	Pass	Pass	Pass	Pass	Pass	Pass
66	14	Pass	Pass	Pass	Pass	Pass	Pass
66	15	Pass	Fail	Pass	Pass	Fail	Pass
66	30	Pass	Fail	Pass	Pass	Fail	Pass
66	31	Pass	Pass	Pass	Pass	Pass	Pass
66	32	Pass	Fail	Pass	Pass	Fail	Pass
66	36	Pass	Fail	Pass	Pass	Fail	Pass
66	38	Fail	Fail	Fail	Fail	Fail	Fail
67	13	Pass	Pass	Pass	Pass	Pass	Pass
67	14	Pass	Pass	Pass	Pass	Pass	Pass

67	15	Pass	Fail	Pass	Pass	Fail	Pass
67	30	Pass	Fail	Pass	Pass	Fail	Pass
67	31	Pass	Pass	Pass	Pass	Pass	Pass
67	32	Pass	Fail	Pass	Pass	Fail	Pass
67	36	Pass	Fail	Pass	Pass	Fail	Pass
68	13	Pass	Pass	Pass	Pass	Pass	Pass
68	14	Pass	Pass	Pass	Pass	Pass	Pass
68	15	Pass	Fail	Pass	Pass	Fail	Pass
68	30	Pass	Fail	Pass	Pass	Fail	Pass
68	31	Pass	Pass	Pass	Pass	Pass	Pass
68	32	Pass	Fail	Pass	Pass	Fail	Pass
68	36	Pass	Fail	Pass	Pass	Fail	Pass
68	38	Fail	Fail	Fail	Fail	Fail	Fail
69	13	Pass	Pass	Pass	Pass	Pass	Pass
69	14	Pass	Pass	Pass	Pass	Pass	Pass
69	15	Pass	Fail	Pass	Pass	Fail	Pass
69	30	Pass	Pass	Pass	Pass	Pass	Pass
69	31	Pass	Pass	Pass	Pass	Pass	Pass
69	32	Pass	Fail	Pass	Pass	Fail	Pass
69	36	Pass	Fail	Pass	Pass	Fail	Pass
70	13	Pass	Pass	Pass	Pass	Pass	Pass
70	14	Pass	Pass	Pass	Pass	Pass	Pass
70	15	Pass	Fail	Pass	Pass	Fail	Pass
70	30	Pass	Fail	Pass	Pass	Fail	Pass
70	31	Pass	Fail	Pass	Pass	Fail	Pass
70	32	Pass	Fail	Pass	Pass	Fail	Pass
70	33	Pass	Fail	Pass	Pass	Fail	Pass
71	13	Pass	Fail	Pass	Pass	Fail	Pass
71	14	Pass	Pass	Pass	Pass	Pass	Pass
71	15	Pass	Fail	Pass	Pass	Fail	Pass
71	30	Pass	Fail	Pass	Pass	Fail	Pass
71	31	Pass	Fail	Pass	Pass	Fail	Pass
71	32	Pass	Fail	Pass	Pass	Fail	Pass
72	13	Pass	Pass	Pass	Pass	Pass	Pass
72	14	Pass	Pass	Pass	Pass	Pass	Pass
72	15	Pass	Fail	Pass	Pass	Pass	Pass
72	30	Pass	Fail	Pass	Pass	Fail	Pass
72	31	Pass	Fail	Pass	Pass	Fail	Pass
72	32	Pass	Fail	Pass	Pass	Fail	Pass
73	13	Pass	Pass	Pass	Pass	Pass	Pass
73	14	Pass	Pass	Pass	Pass	Pass	Pass
73	15	Pass	Pass	Pass	Pass	Pass	Pass
73	30	Pass	Fail	Pass	Pass	Fail	Pass
73	31	Pass	Fail	Pass	Pass	Fail	Pass
74	13	Pass	Pass	Pass	Pass	Pass	Pass
74	14	Pass	Pass	Pass	Pass	Pass	Pass
74	15	Pass	Pass	Pass	Pass	Pass	Pass
74	30	Pass	Fail	Pass	Pass	Fail	Pass
74	31	Pass	Fail	Pass	Pass	Fail	Pass
75	13	Pass	Pass	Pass	Pass	Pass	Pass
75	14	Pass	Pass	Pass	Pass	Pass	Pass
75	15	Pass	Pass	Pass	Pass	Pass	Pass
75	30	Pass	Fail	Pass	Pass	Fail	Pass
75	31	Pass	Fail	Pass	Pass	Fail	Pass
76	13	Pass	Fail	Pass	Pass	Fail	Pass
76	14	Pass	Pass	Pass	Pass	Pass	Pass
76	15	Pass	Fail	Pass	Pass	Fail	Pass

76	16	Pass	Fail	Pass	Pass	Fail	Pass
76	17	Pass	Fail	Pass	Pass	Fail	Pass
76	30	Pass	Fail	Pass	Pass	Fail	Pass
76	31	Pass	Fail	Pass	Pass	Fail	Pass
76	33	Fail	Fail	Fail	Fail	Fail	Fail
77	13	Pass	Fail	Pass	Pass	Fail	Pass
77	14	Pass	Fail	Pass	Pass	Fail	Pass
77	15	Pass	Fail	Pass	Pass	Fail	Pass
77	16	Pass	Fail	Pass	Pass	Fail	Pass
77	17	Pass	Fail	Pass	Pass	Fail	Pass
77	30	Pass	Fail	Pass	Pass	Fail	Pass
77	31	Pass	Fail	Pass	Pass	Fail	Pass
78	13	Pass	Fail	Pass	Pass	Fail	Pass
78	14	Pass	Pass	Pass	Pass	Pass	Pass
78	15	Pass	Fail	Pass	Pass	Fail	Pass
78	16	Pass	Fail	Pass	Pass	Fail	Pass
78	17	Pass	Fail	Pass	Pass	Fail	Pass
78	30	Pass	Fail	Pass	Pass	Fail	Pass
78	31	Pass	Fail	Pass	Pass	Fail	Pass
79	13	Pass	Fail	Pass	Pass	Fail	Pass
79	14	Pass	Pass	Pass	Pass	Pass	Pass
79	15	Pass	Fail	Pass	Pass	Fail	Pass
79	30	Pass	Fail	Pass	Pass	Fail	Pass
79	31	Pass	Fail	Pass	Pass	Fail	Pass
80	13	Pass	Fail	Pass	Pass	Fail	Pass
80	14	Pass	Pass	Pass	Pass	Pass	Pass
80	15	Pass	Fail	Pass	Pass	Fail	Pass
80	30	Pass	Fail	Pass	Pass	Fail	Pass
80	31	Pass	Fail	Pass	Pass	Fail	Pass
81	13	Pass	Pass	Pass	Pass	Fail	Pass
81	14	Pass	Pass	Pass	Pass	Pass	Pass
81	15	Pass	Fail	Pass	Pass	Fail	Pass
81	30	Pass	Fail	Pass	Pass	Fail	Pass
81	31	Pass	Fail	Pass	Pass	Fail	Pass
82	13	Pass	Pass	Pass	Pass	Pass	Pass
82	14	Pass	Pass	Pass	Pass	Pass	Pass
82	15	Pass	Pass	Pass	Pass	Pass	Pass
82	16	Pass	Fail	Pass	Pass	Fail	Pass
82	17	Pass	Fail	Pass	Pass	Fail	Pass
82	18	Pass	Fail	Pass	Pass	Fail	Pass
82	19	Pass	Fail	Pass	Pass	Fail	Pass
82	20	Pass	Fail	Pass	Pass	Fail	Pass
82	21	Pass	Fail	Pass	Pass	Fail	Pass
82	29	Pass	Fail	Pass	Pass	Fail	Pass
82	30	Pass	Fail	Pass	Pass	Fail	Pass
82	31	Pass	Fail	Pass	Pass	Fail	Pass
83	13	Pass	Pass	Pass	Pass	Pass	Pass
83	14	Pass	Pass	Pass	Pass	Pass	Pass
83	15	Pass	Pass	Pass	Pass	Pass	Pass
83	21	Pass	Fail	Pass	Pass	Fail	Pass
83	30	Pass	Fail	Pass	Pass	Fail	Pass
83	31	Pass	Fail	Pass	Pass	Fail	Pass
84	13	Pass	Pass	Pass	Pass	Pass	Pass
84	14	Pass	Pass	Pass	Pass	Pass	Pass
84	15	Pass	Pass	Pass	Pass	Pass	Pass
84	21	Pass	Fail	Pass	Pass	Fail	Pass
84	30	Pass	Fail	Pass	Pass	Fail	Pass

84	31	Pass	Fail	Pass	Pass	Fail	Pass
85	13	Pass	Pass	Pass	Pass	Pass	Pass
85	14	Pass	Pass	Pass	Pass	Pass	Pass
85	15	Pass	Pass	Pass	Pass	Pass	Pass
85	21	Pass	Fail	Pass	Pass	Fail	Pass
85	30	Pass	Fail	Pass	Pass	Fail	Pass
86	13	Pass	Pass	Pass	Pass	Pass	Pass
86	14	Pass	Pass	Pass	Pass	Pass	Pass
86	15	Pass	Pass	Pass	Pass	Pass	Pass
86	17	Fail	Fail	Fail	Fail	Fail	Fail
86	21	Pass	Pass	Pass	Pass	Pass	Pass
86	30	Pass	Pass	Pass	Pass	Pass	Pass
87	13	Pass	Pass	Pass	Pass	Pass	Pass
87	14	Pass	Pass	Pass	Pass	Pass	Pass
87	15	Pass	Pass	Pass	Pass	Pass	Pass
87	30	Pass	Fail	Pass	Pass	Fail	Pass
87	32	Fail	Fail	Fail	Fail	Fail	Fail
88	13	Pass	Pass	Pass	Pass	Pass	Pass
88	14	Pass	Pass	Pass	Pass	Pass	Pass
88	15	Pass	Pass	Pass	Pass	Pass	Pass
88	30	Pass	Fail	Pass	Pass	Fail	Pass
89	13	Pass	Pass	Pass	Pass	Pass	Pass
89	14	Pass	Pass	Pass	Pass	Pass	Pass
89	15	Pass	Pass	Pass	Pass	Pass	Pass
89	30	Pass	Fail	Pass	Pass	Fail	Pass
90	13	Pass	Pass	Pass	Pass	Pass	Pass
90	14	Pass	Pass	Pass	Pass	Pass	Pass
90	15	Pass	Pass	Pass	Pass	Pass	Pass
90	30	Pass	Fail	Pass	Pass	Fail	Pass
91	13	Pass	Pass	Pass	Pass	Pass	Pass
91	14	Pass	Pass	Pass	Pass	Pass	Pass
91	15	Pass	Pass	Pass	Pass	Pass	Pass
91	16	Pass	Fail	Pass	Pass	Fail	Pass
91	30	Pass	Fail	Pass	Pass	Fail	Pass
92	13	Pass	Pass	Pass	Pass	Pass	Pass
92	14	Pass	Pass	Pass	Pass	Pass	Pass
92	15	Pass	Pass	Pass	Pass	Pass	Pass
92	16	Pass	Fail	Pass	Pass	Fail	Pass
92	30	Pass	Fail	Pass	Pass	Fail	Pass
92	32	Fail	Fail	Fail	Fail	Fail	Fail
93	13	Pass	Pass	Pass	Pass	Pass	Pass
93	14	Pass	Pass	Pass	Pass	Pass	Pass
93	15	Pass	Pass	Pass	Pass	Pass	Pass
93	16	Pass	Pass	Pass	Pass	Pass	Pass
93	30	Pass	Fail	Pass	Pass	Fail	Pass
94	13	Pass	Pass	Pass	Pass	Pass	Pass
94	14	Pass	Pass	Pass	Pass	Pass	Pass
94	15	Pass	Pass	Pass	Pass	Pass	Pass
94	16	Pass	Fail	Pass	Pass	Fail	Pass
94	26	Pass	Pass	Pass	Pass	Pass	Pass
94	30	Pass	Fail	Pass	Pass	Fail	Pass
95	13	Pass	Pass	Pass	Pass	Pass	Pass
95	14	Pass	Pass	Pass	Pass	Pass	Pass
95	15	Pass	Pass	Pass	Pass	Pass	Pass
95	16	Pass	Fail	Pass	Pass	Fail	Pass
95	26	Pass	Pass	Pass	Pass	Fail	Pass
95	28	Fail	Fail	Fail	Fail	Fail	Fail

95	30	Pass	Fail	Pass	Pass	Fail	Pass
96	11	Fail	Fail	Fail	Fail	Fail	Fail
96	13	Pass	Pass	Pass	Pass	Pass	Pass
96	14	Pass	Pass	Pass	Pass	Pass	Pass
96	15	Pass	Pass	Pass	Pass	Pass	Pass
96	26	Pass	Fail	Pass	Pass	Fail	Pass
96	30	Pass	Fail	Pass	Pass	Fail	Pass
97	13	Pass	Pass	Pass	Pass	Pass	Pass
97	14	Pass	Pass	Pass	Pass	Pass	Pass
97	15	Pass	Pass	Pass	Pass	Pass	Pass
97	26	Pass	Fail	Pass	Pass	Fail	Pass
97	30	Pass	Fail	Pass	Pass	Fail	Pass
98	13	Pass	Pass	Pass	Pass	Pass	Pass
98	14	Pass	Pass	Pass	Pass	Pass	Pass
98	15	Pass	Pass	Pass	Pass	Pass	Pass
98	26	Pass	Pass	Pass	Pass	Pass	Pass
98	27	Pass	Pass	Pass	Pass	Pass	Pass
98	28	Pass	Pass	Pass	Pass	Pass	Pass
98	29	Pass	Pass	Pass	Pass	Pass	Pass
98	30	Pass	Fail	Pass	Pass	Fail	Pass
99	13	Pass	Pass	Pass	Pass	Pass	Pass
99	14	Pass	Pass	Pass	Pass	Pass	Pass
99	15	Pass	Fail	Pass	Pass	Fail	Pass
99	16	Pass	Fail	Pass	Pass	Fail	Pass
99	17	Pass	Fail	Pass	Pass	Fail	Pass
99	18	Pass	Fail	Pass	Pass	Fail	Pass
99	19	Pass	Fail	Pass	Pass	Fail	Pass
99	20	Pass	Fail	Pass	Pass	Fail	Pass
99	21	Pass	Fail	Pass	Pass	Fail	Pass
99	22	Pass	Fail	Pass	Pass	Fail	Pass
99	23	Pass	Fail	Pass	Pass	Fail	Pass
99	26	Pass	Fail	Pass	Pass	Fail	Pass
99	30	Pass	Fail	Pass	Pass	Fail	Pass
100	13	Pass	Pass	Pass	Pass	Pass	Pass
100	14	Pass	Pass	Pass	Pass	Pass	Pass
100	15	Pass	Pass	Pass	Pass	Pass	Pass
100	23	Pass	Fail	Pass	Pass	Fail	Pass
100	24	Pass	Fail	Pass	Pass	Fail	Pass
100	25	Pass	Fail	Pass	Pass	Fail	Pass
100	26	Pass	Fail	Pass	Pass	Fail	Pass
100	30	Pass	Fail	Pass	Pass	Fail	Pass
101	13	Pass	Pass	Pass	Pass	Pass	Pass
101	14	Pass	Pass	Pass	Pass	Pass	Pass
101	15	Pass	Pass	Pass	Pass	Pass	Pass
101	16	Pass	Fail	Pass	Pass	Fail	Pass
101	17	Pass	Fail	Pass	Pass	Fail	Pass
101	18	Pass	Fail	Pass	Pass	Fail	Pass
101	19	Pass	Fail	Pass	Pass	Fail	Pass
101	20	Pass	Fail	Pass	Pass	Fail	Pass
101	21	Pass	Fail	Pass	Pass	Fail	Pass
101	22	Pass	Fail	Pass	Pass	Fail	Pass
101	23	Pass	Fail	Pass	Pass	Fail	Pass
101	26	Pass	Pass	Pass	Pass	Pass	Pass
101	30	Pass	Fail	Pass	Pass	Fail	Pass
102	13	Pass	Pass	Pass	Pass	Pass	Pass
102	14	Pass	Pass	Pass	Pass	Pass	Pass
102	15	Pass	Pass	Pass	Pass	Pass	Pass

102	26	Pass	Pass	Pass	Pass	Pass	Pass
102	30	Pass	Fail	Pass	Pass	Fail	Pass
103	13	Pass	Pass	Pass	Pass	Pass	Pass
103	14	Pass	Pass	Pass	Pass	Pass	Pass
103	15	Pass	Pass	Pass	Pass	Pass	Pass
103	26	Pass	Pass	Pass	Pass	Pass	Pass
103	30	Pass	Pass	Pass	Pass	Pass	Pass
104	11	Fail	Fail	Fail	Fail	Fail	Fail
104	13	Pass	Pass	Pass	Pass	Pass	Pass
104	14	Pass	Pass	Pass	Pass	Pass	Pass
104	15	Pass	Pass	Pass	Pass	Pass	Pass
104	26	Pass	Pass	Pass	Pass	Pass	Pass
104	30	Pass	Fail	Pass	Pass	Fail	Pass
105	13	Pass	Pass	Pass	Pass	Pass	Pass
105	14	Pass	Pass	Pass	Pass	Pass	Pass
105	15	Pass	Pass	Pass	Pass	Pass	Pass
105	26	Pass	Pass	Pass	Pass	Pass	Pass
105	30	Pass	Fail	Pass	Pass	Fail	Pass
106	13	Pass	Pass	Pass	Pass	Pass	Pass
106	14	Pass	Pass	Pass	Pass	Pass	Pass
106	15	Pass	Pass	Pass	Pass	Pass	Pass
106	26	Pass	Pass	Pass	Pass	Pass	Pass
106	27	Pass	Fail	Pass	Pass	Fail	Pass
106	30	Pass	Fail	Pass	Pass	Fail	Pass
106	39	Pass	Fail	Pass	Pass	Fail	Pass
107	13	Pass	Pass	Pass	Pass	Pass	Pass
107	14	Pass	Pass	Pass	Pass	Pass	Pass
107	15	Pass	Pass	Pass	Pass	Pass	Pass
107	22	Pass	Fail	Pass	Pass	Fail	Pass
107	26	Pass	Fail	Pass	Pass	Fail	Pass
107	30	Pass	Fail	Pass	Pass	Fail	Pass
107	39	Pass	Fail	Pass	Pass	Fail	Pass
108	13	Pass	Pass	Pass	Pass	Pass	Pass
108	14	Pass	Pass	Pass	Pass	Pass	Pass
108	15	Pass	Pass	Pass	Pass	Pass	Pass
108	22	Pass	Pass	Pass	Pass	Pass	Pass
108	24	Fail	Fail	Fail	Fail	Fail	Fail
108	26	Pass	Fail	Pass	Pass	Fail	Pass
108	30	Pass	Fail	Pass	Pass	Fail	Pass
108	39	Pass	Fail	Pass	Pass	Fail	Pass
109	13	Pass	Pass	Pass	Pass	Pass	Pass
109	14	Pass	Pass	Pass	Pass	Pass	Pass
109	15	Pass	Pass	Pass	Pass	Pass	Pass
109	22	Pass	Fail	Pass	Pass	Fail	Pass
109	26	Pass	Pass	Pass	Pass	Pass	Pass
109	30	Pass	Fail	Pass	Pass	Fail	Pass
109	39	Pass	Pass	Pass	Pass	Pass	Pass
110	13	Pass	Pass	Pass	Pass	Pass	Pass
110	14	Pass	Pass	Pass	Pass	Pass	Pass
110	15	Pass	Pass	Pass	Pass	Pass	Pass
110	22	Pass	Fail	Pass	Pass	Fail	Pass
110	26	Pass	Pass	Pass	Pass	Pass	Pass
110	28	Fail	Fail	Fail	Fail	Fail	Fail
110	39	Pass	Fail	Pass	Pass	Fail	Pass
111	13	Pass	Pass	Pass	Pass	Pass	Pass
111	14	Pass	Pass	Pass	Pass	Pass	Pass
111	15	Pass	Pass	Pass	Pass	Pass	Pass

111	22	Pass	Fail	Pass	Pass	Fail	Pass
111	26	Pass	Pass	Pass	Pass	Pass	Pass
111	39	Pass	Fail	Pass	Pass	Fail	Pass
112	13	Pass	Pass	Pass	Pass	Pass	Pass
112	14	Pass	Pass	Pass	Pass	Pass	Pass
112	15	Pass	Pass	Pass	Pass	Pass	Pass
112	22	Pass	Fail	Pass	Pass	Fail	Pass
112	26	Pass	Fail	Pass	Pass	Fail	Pass
112	39	Pass	Fail	Pass	Pass	Fail	Pass
113	13	Pass	Pass	Pass	Pass	Pass	Pass
113	14	Pass	Pass	Pass	Pass	Pass	Pass
113	15	Pass	Pass	Pass	Pass	Pass	Pass
113	26	Pass	Fail	Pass	Pass	Pass	Pass
113	27	Pass	Fail	Pass	Pass	Fail	Pass
113	39	Pass	Pass	Pass	Pass	Pass	Pass
113	41	Fail	Fail	Fail	Fail	Fail	Fail
114	13	Pass	Pass	Pass	Pass	Pass	Pass
114	14	Pass	Pass	Pass	Pass	Pass	Pass
114	15	Pass	Pass	Pass	Pass	Pass	Pass
114	26	Pass	Fail	Pass	Pass	Fail	Pass
114	39	Pass	Pass	Pass	Pass	Pass	Pass
115	13	Pass	Pass	Pass	Pass	Pass	Pass
115	14	Pass	Pass	Pass	Pass	Pass	Pass
115	15	Pass	Pass	Pass	Pass	Pass	Pass
115	26	Pass	Fail	Pass	Pass	Fail	Pass
115	39	Pass	Pass	Pass	Pass	Pass	Pass
116	13	Pass	Pass	Pass	Pass	Pass	Pass
116	14	Pass	Pass	Pass	Pass	Pass	Pass
116	15	Pass	Pass	Pass	Pass	Pass	Pass
116	26	Pass	Fail	Pass	Pass	Fail	Pass
116	28	Fail	Fail	Fail	Fail	Fail	Fail
116	39	Pass	Pass	Pass	Pass	Pass	Pass
117	13	Pass	Pass	Pass	Pass	Pass	Pass
117	14	Pass	Pass	Pass	Pass	Pass	Pass
117	15	Pass	Pass	Pass	Pass	Pass	Pass
117	26	Pass	Fail	Pass	Pass	Fail	Pass
117	39	Pass	Pass	Pass	Pass	Pass	Pass
118	13	Pass	Pass	Pass	Pass	Pass	Pass
118	14	Pass	Pass	Pass	Pass	Pass	Pass
118	15	Pass	Pass	Pass	Pass	Pass	Pass
118	20	Pass	Pass	Pass	Pass	Pass	Pass
118	26	Pass	Pass	Pass	Pass	Pass	Pass
118	39	Pass	Pass	Pass	Pass	Pass	Pass
119	13	Pass	Pass	Pass	Pass	Pass	Pass
119	14	Pass	Pass	Pass	Pass	Pass	Pass
119	15	Pass	Pass	Pass	Pass	Pass	Pass
119	20	Pass	Pass	Pass	Pass	Pass	Pass
119	26	Pass	Fail	Pass	Pass	Fail	Pass
119	39	Pass	Pass	Pass	Pass	Pass	Pass
120	13	Pass	Pass	Pass	Pass	Pass	Pass
120	14	Pass	Pass	Pass	Pass	Pass	Pass
120	15	Pass	Fail	Pass	Pass	Fail	Pass
120	16	Pass	Fail	Pass	Pass	Fail	Pass
120	26	Pass	Fail	Pass	Pass	Fail	Pass
120	39	Pass	Pass	Pass	Pass	Pass	Pass
121	13	Pass	Pass	Pass	Pass	Pass	Pass
121	14	Pass	Pass	Pass	Pass	Pass	Pass

121	26	Pass	Fail	Pass	Pass	Fail	Pass
121	39	Pass	Pass	Pass	Pass	Pass	Pass
122	13	Pass	Pass	Pass	Pass	Pass	Pass
122	14	Pass	Pass	Pass	Pass	Pass	Pass
122	26	Pass	Fail	Pass	Pass	Fail	Pass
122	39	Pass	Pass	Pass	Pass	Pass	Pass
122	41	Fail	Fail	Fail	Fail	Fail	Fail
123	13	Pass	Pass	Pass	Pass	Pass	Pass
123	14	Pass	Pass	Pass	Pass	Pass	Pass
123	15	Pass	Fail	Pass	Pass	Fail	Pass
123	16	Pass	Pass	Pass	Pass	Pass	Pass
123	17	Pass	Pass	Pass	Pass	Pass	Pass
123	18	Pass	Pass	Pass	Pass	Pass	Pass
123	19	Pass	Pass	Pass	Pass	Pass	Pass
123	20	Pass	Pass	Pass	Pass	Pass	Pass
123	21	Pass	Pass	Pass	Pass	Pass	Pass
123	22	Pass	Pass	Pass	Pass	Pass	Pass
123	23	Pass	Pass	Pass	Pass	Pass	Pass
123	24	Pass	Pass	Pass	Pass	Pass	Pass
123	25	Pass	Pass	Pass	Pass	Pass	Pass
123	26	Pass	Pass	Pass	Pass	Pass	Pass
123	27	Pass	Pass	Pass	Pass	Pass	Pass
123	28	Pass	Pass	Pass	Pass	Pass	Pass
123	29	Pass	Pass	Pass	Pass	Pass	Pass
123	30	Pass	Fail	Pass	Pass	Fail	Pass
123	31	Pass	Fail	Pass	Pass	Fail	Pass
123	32	Pass	Fail	Pass	Pass	Fail	Pass
123	33	Pass	Fail	Pass	Pass	Fail	Pass
123	34	Pass	Pass	Pass	Pass	Pass	Pass
123	35	Pass	Pass	Pass	Pass	Pass	Pass
123	36	Pass	Pass	Pass	Pass	Pass	Pass
123	37	Pass	Fail	Pass	Pass	Fail	Pass
123	38	Pass	Fail	Pass	Pass	Fail	Pass
123	39	Pass	Fail	Pass	Pass	Fail	Pass
124	13	Pass	Pass	Pass	Pass	Pass	Pass
124	14	Pass	Pass	Pass	Pass	Pass	Pass
124	23	Pass	Fail	Pass	Pass	Fail	Pass
125	13	Pass	Pass	Pass	Pass	Pass	Pass
125	14	Pass	Pass	Pass	Pass	Pass	Pass
125	23	Pass	Pass	Pass	Pass	Pass	Pass
125	28	Fail	Fail	Fail	Fail	Fail	Fail
125	33	Fail	Fail	Fail	Fail	Fail	Fail
126	13	Pass	Pass	Pass	Pass	Pass	Pass
126	14	Pass	Pass	Pass	Pass	Pass	Pass
126	23	Pass	Pass	Pass	Pass	Pass	Pass
127	13	Pass	Pass	Pass	Pass	Pass	Pass
127	14	Pass	Pass	Pass	Pass	Pass	Pass
127	23	Pass	Pass	Pass	Pass	Pass	Pass
128	13	Pass	Pass	Pass	Pass	Pass	Pass
128	14	Pass	Pass	Pass	Pass	Pass	Pass
128	23	Pass	Pass	Pass	Pass	Pass	Pass
129	13	Pass	Pass	Pass	Pass	Pass	Pass
129	14	Pass	Pass	Pass	Pass	Pass	Pass
129	23	Pass	Pass	Pass	Pass	Pass	Pass
130	8	Pass	Fail	Pass	Pass	Fail	Pass
130	9	Pass	Fail	Pass	Pass	Fail	Pass
130	10	Pass	Fail	Pass	Pass	Fail	Pass

130	11	Pass	Fail	Pass	Pass	Fail	Pass
130	12	Pass	Fail	Pass	Pass	Fail	Pass
130	13	Pass	Fail	Pass	Pass	Fail	Pass
130	14	Pass	Pass	Pass	Pass	Pass	Pass
130	23	Pass	Pass	Pass	Pass	Pass	Pass
131	14	Pass	Pass	Pass	Pass	Pass	Pass
131	23	Pass	Pass	Pass	Pass	Pass	Pass
132	14	Pass	Pass	Pass	Pass	Pass	Pass
132	23	Pass	Pass	Pass	Pass	Pass	Pass
133	14	Pass	Pass	Pass	Pass	Pass	Pass
133	23	Pass	Pass	Pass	Pass	Pass	Pass
134	14	Pass	Pass	Pass	Pass	Pass	Pass
134	23	Pass	Fail	Pass	Pass	Fail	Pass
135	14	Pass	Pass	Pass	Pass	Pass	Pass
136	14	Pass	Pass	Pass	Pass	Pass	Pass
137	14	Pass	Pass	Pass	Pass	Pass	Pass
138	14	Pass	Pass	Pass	Pass	Pass	Pass

4. Table E.7.4 Striped Bass eggs D.O. , Salinity, and Velocity criteria passing for existing and deepening (2 ft) scenarios within the analyzed period April 1 - April 30, 1997

HABITAT REQUIREMENTS:
RM 10-31; Depth Average
D.O. April (MG/L):10th %ile >=4.5
Salinity 50th %ile <= 9 ppt
Mean Velocity >= 30 cm/s

Savannah Harbor Estuary

Segments		Baseline Scenario			Project Scenario		
J	I	Salinity	Velocity	D.O.	Salinity	Velocity	D.O.
47	13	Pass	Pass	Pass	Pass	Pass	Pass
47	14	Fail	Pass	Pass	Fail	Pass	Pass
47	15	Pass	Pass	Pass	Pass	Pass	Pass
47	16	Pass	Pass	Pass	Pass	Pass	Pass
47	17	Pass	Fail	Pass	Pass	Fail	Pass
48	13	Pass	Pass	Pass	Pass	Pass	Pass
48	14	Fail	Pass	Pass	Fail	Pass	Pass
48	15	Pass	Pass	Pass	Pass	Pass	Pass
48	16	Pass	Pass	Pass	Pass	Pass	Pass
48	17	Pass	Pass	Pass	Pass	Pass	Pass
49	13	Pass	Pass	Pass	Pass	Pass	Pass
49	14	Pass	Pass	Pass	Fail	Pass	Pass
49	15	Pass	Pass	Pass	Pass	Pass	Pass
49	16	Pass	Pass	Pass	Pass	Pass	Pass
49	17	Pass	Pass	Pass	Pass	Pass	Pass
50	13	Pass	Pass	Pass	Pass	Pass	Pass
50	14	Pass	Pass	Pass	Pass	Pass	Pass
50	15	Pass	Fail	Pass	Pass	Fail	Pass
50	16	Pass	Fail	Pass	Pass	Fail	Pass
50	17	Pass	Fail	Pass	Pass	Fail	Pass
50	18	Pass	Fail	Pass	Pass	Fail	Pass
51	13	Pass	Pass	Pass	Pass	Pass	Pass
51	14	Pass	Pass	Pass	Pass	Pass	Pass
51	15	Pass	Pass	Pass	Pass	Pass	Pass
52	13	Pass	Pass	Pass	Pass	Pass	Pass
52	14	Pass	Pass	Pass	Pass	Pass	Pass
52	15	Pass	Pass	Pass	Pass	Pass	Pass
53	13	Pass	Pass	Pass	Pass	Pass	Pass
53	14	Pass	Pass	Pass	Pass	Pass	Pass
53	15	Pass	Pass	Pass	Pass	Pass	Pass
54	13	Pass	Pass	Pass	Pass	Pass	Pass
54	14	Pass	Pass	Pass	Pass	Pass	Pass
54	15	Pass	Pass	Pass	Pass	Pass	Pass
55	13	Pass	Pass	Pass	Pass	Pass	Pass
55	14	Pass	Pass	Pass	Pass	Pass	Pass
55	15	Pass	Pass	Pass	Pass	Pass	Pass
56	13	Pass	Pass	Pass	Pass	Pass	Pass
56	14	Pass	Pass	Pass	Pass	Pass	Pass
56	15	Pass	Pass	Pass	Pass	Pass	Pass

57	13	Pass	Pass	Pass	Pass	Pass	Pass
57	14	Pass	Pass	Pass	Pass	Pass	Pass
57	15	Pass	Pass	Pass	Pass	Pass	Pass
58	13	Pass	Pass	Pass	Pass	Pass	Pass
58	14	Pass	Pass	Pass	Pass	Pass	Pass
58	15	Pass	Pass	Pass	Pass	Pass	Pass
59	13	Pass	Pass	Pass	Pass	Pass	Pass
59	14	Pass	Pass	Pass	Pass	Pass	Pass
59	15	Pass	Pass	Pass	Pass	Pass	Pass
59	30	Pass	Fail	Pass	Pass	Fail	Pass
59	31	Pass	Fail	Pass	Pass	Fail	Pass
59	32	Pass	Fail	Pass	Pass	Fail	Pass
60	13	Pass	Pass	Pass	Pass	Pass	Pass
60	14	Pass	Pass	Pass	Pass	Pass	Pass
60	15	Pass	Pass	Pass	Pass	Pass	Pass
60	30	Pass	Fail	Pass	Pass	Fail	Pass
60	31	Pass	Fail	Pass	Pass	Fail	Pass
60	32	Pass	Fail	Pass	Pass	Fail	Pass
61	13	Pass	Pass	Pass	Pass	Pass	Pass
61	14	Pass	Pass	Pass	Pass	Pass	Pass
61	15	Pass	Pass	Pass	Pass	Pass	Pass
61	30	Pass	Fail	Pass	Pass	Fail	Pass
61	31	Pass	Fail	Pass	Pass	Fail	Pass
61	32	Pass	Fail	Pass	Pass	Fail	Pass
62	13	Pass	Pass	Pass	Pass	Pass	Pass
62	14	Pass	Pass	Pass	Pass	Pass	Pass
62	15	Pass	Pass	Pass	Pass	Pass	Pass
62	30	Pass	Fail	Pass	Pass	Fail	Pass
62	31	Pass	Fail	Pass	Pass	Fail	Pass
62	32	Pass	Fail	Pass	Pass	Fail	Pass
63	13	Pass	Pass	Pass	Pass	Pass	Pass
63	14	Pass	Pass	Pass	Pass	Pass	Pass
63	15	Pass	Pass	Pass	Pass	Pass	Pass
63	31	Pass	Pass	Pass	Pass	Pass	Pass
64	13	Pass	Pass	Pass	Pass	Pass	Pass
64	14	Pass	Pass	Pass	Pass	Pass	Pass
64	15	Pass	Pass	Pass	Pass	Pass	Pass
64	30	Pass	Fail	Pass	Pass	Fail	Pass
64	31	Pass	Pass	Pass	Pass	Pass	Pass
64	32	Pass	Fail	Pass	Pass	Fail	Pass
65	13	Pass	Pass	Pass	Pass	Pass	Pass
65	14	Pass	Pass	Pass	Pass	Pass	Pass
65	15	Pass	Pass	Pass	Pass	Pass	Pass
65	30	Pass	Fail	Pass	Pass	Fail	Pass
65	31	Pass	Pass	Pass	Pass	Pass	Pass
65	32	Pass	Fail	Pass	Pass	Fail	Pass
65	33	Pass	Fail	Pass	Pass	Fail	Pass
66	13	Pass	Pass	Pass	Pass	Pass	Pass
66	14	Pass	Pass	Pass	Pass	Pass	Pass
66	15	Pass	Fail	Pass	Pass	Fail	Pass
66	30	Pass	Fail	Pass	Pass	Fail	Pass
66	31	Pass	Pass	Pass	Pass	Pass	Pass
66	32	Pass	Fail	Pass	Pass	Fail	Pass
66	36	Pass	Fail	Pass	Pass	Fail	Pass
66	38	Fail	Fail	Fail	Fail	Fail	Fail
67	13	Pass	Pass	Pass	Pass	Pass	Pass
67	14	Pass	Pass	Pass	Pass	Pass	Pass

67	15	Pass	Fail	Pass	Pass	Fail	Pass
67	30	Pass	Fail	Pass	Pass	Fail	Pass
67	31	Pass	Pass	Pass	Pass	Pass	Pass
67	32	Pass	Fail	Pass	Pass	Fail	Pass
67	36	Pass	Fail	Pass	Pass	Fail	Pass
68	13	Pass	Pass	Pass	Pass	Pass	Pass
68	14	Pass	Pass	Pass	Pass	Pass	Pass
68	15	Pass	Fail	Pass	Pass	Fail	Pass
68	30	Pass	Fail	Pass	Pass	Fail	Pass
68	31	Pass	Pass	Pass	Pass	Pass	Pass
68	32	Pass	Fail	Pass	Pass	Fail	Pass
68	36	Pass	Fail	Pass	Pass	Fail	Pass
68	38	Fail	Fail	Fail	Fail	Fail	Fail
69	13	Pass	Pass	Pass	Pass	Pass	Pass
69	14	Pass	Pass	Pass	Pass	Pass	Pass
69	15	Pass	Fail	Pass	Pass	Fail	Pass
69	30	Pass	Pass	Pass	Pass	Pass	Pass
69	31	Pass	Pass	Pass	Pass	Pass	Pass
69	32	Pass	Fail	Pass	Pass	Fail	Pass
69	36	Pass	Fail	Pass	Pass	Fail	Pass
70	13	Pass	Pass	Pass	Pass	Pass	Pass
70	14	Pass	Pass	Pass	Pass	Pass	Pass
70	15	Pass	Fail	Pass	Pass	Fail	Pass
70	30	Pass	Fail	Pass	Pass	Fail	Pass
70	31	Pass	Fail	Pass	Pass	Fail	Pass
70	32	Pass	Fail	Pass	Pass	Fail	Pass
70	33	Pass	Fail	Pass	Pass	Fail	Pass
71	13	Pass	Fail	Pass	Pass	Fail	Pass
71	14	Pass	Pass	Pass	Pass	Pass	Pass
71	15	Pass	Fail	Pass	Pass	Fail	Pass
71	30	Pass	Fail	Pass	Pass	Fail	Pass
71	31	Pass	Fail	Pass	Pass	Fail	Pass
71	32	Pass	Fail	Pass	Pass	Fail	Pass
72	13	Pass	Pass	Pass	Pass	Pass	Pass
72	14	Pass	Pass	Pass	Pass	Pass	Pass
72	15	Pass	Fail	Pass	Pass	Fail	Pass
72	30	Pass	Fail	Pass	Pass	Fail	Pass
72	31	Pass	Fail	Pass	Pass	Fail	Pass
72	32	Pass	Fail	Pass	Pass	Fail	Pass
73	13	Pass	Pass	Pass	Pass	Pass	Pass
73	14	Pass	Pass	Pass	Pass	Pass	Pass
73	15	Pass	Pass	Pass	Pass	Pass	Pass
73	30	Pass	Fail	Pass	Pass	Fail	Pass
73	31	Pass	Fail	Pass	Pass	Fail	Pass
74	13	Pass	Pass	Pass	Pass	Pass	Pass
74	14	Pass	Pass	Pass	Pass	Pass	Pass
74	15	Pass	Pass	Pass	Pass	Pass	Pass
74	30	Pass	Fail	Pass	Pass	Fail	Pass
74	31	Pass	Fail	Pass	Pass	Fail	Pass
75	13	Pass	Pass	Pass	Pass	Pass	Pass
75	14	Pass	Pass	Pass	Pass	Pass	Pass
75	15	Pass	Pass	Pass	Pass	Pass	Pass
75	30	Pass	Fail	Pass	Pass	Fail	Pass
75	31	Pass	Fail	Pass	Pass	Fail	Pass
76	13	Pass	Fail	Pass	Pass	Fail	Pass
76	14	Pass	Pass	Pass	Pass	Pass	Pass
76	15	Pass	Fail	Pass	Pass	Fail	Pass

76	16	Pass	Fail	Pass	Pass	Fail	Pass
76	17	Pass	Fail	Pass	Pass	Fail	Pass
76	30	Pass	Fail	Pass	Pass	Fail	Pass
76	31	Pass	Fail	Pass	Pass	Fail	Pass
76	33	Fail	Fail	Fail	Fail	Fail	Fail
77	13	Pass	Fail	Pass	Pass	Fail	Pass
77	14	Pass	Fail	Pass	Pass	Fail	Pass
77	15	Pass	Fail	Pass	Pass	Fail	Pass
77	16	Pass	Fail	Pass	Pass	Fail	Pass
77	17	Pass	Fail	Pass	Pass	Fail	Pass
77	30	Pass	Fail	Pass	Pass	Fail	Pass
77	31	Pass	Fail	Pass	Pass	Fail	Pass
78	13	Pass	Fail	Pass	Pass	Fail	Pass
78	14	Pass	Pass	Pass	Pass	Pass	Pass
78	15	Pass	Fail	Pass	Pass	Fail	Pass
78	16	Pass	Fail	Pass	Pass	Fail	Pass
78	17	Pass	Fail	Pass	Pass	Fail	Pass
78	30	Pass	Fail	Pass	Pass	Fail	Pass
78	31	Pass	Fail	Pass	Pass	Fail	Pass
79	13	Pass	Fail	Pass	Pass	Fail	Pass
79	14	Pass	Pass	Pass	Pass	Pass	Pass
79	15	Pass	Fail	Pass	Pass	Fail	Pass
79	30	Pass	Fail	Pass	Pass	Fail	Pass
79	31	Pass	Fail	Pass	Pass	Fail	Pass
80	13	Pass	Fail	Pass	Pass	Fail	Pass
80	14	Pass	Pass	Pass	Pass	Pass	Pass
80	15	Pass	Fail	Pass	Pass	Fail	Pass
80	30	Pass	Fail	Pass	Pass	Fail	Pass
80	31	Pass	Fail	Pass	Pass	Fail	Pass
81	13	Pass	Pass	Pass	Pass	Fail	Pass
81	14	Pass	Pass	Pass	Pass	Pass	Pass
81	15	Pass	Fail	Pass	Pass	Fail	Pass
81	30	Pass	Fail	Pass	Pass	Fail	Pass
81	31	Pass	Fail	Pass	Pass	Fail	Pass
82	13	Pass	Pass	Pass	Pass	Pass	Pass
82	14	Pass	Pass	Pass	Pass	Pass	Pass
82	15	Pass	Pass	Pass	Pass	Pass	Pass
82	16	Pass	Fail	Pass	Pass	Fail	Pass
82	17	Pass	Fail	Pass	Pass	Fail	Pass
82	18	Pass	Fail	Pass	Pass	Fail	Pass
82	19	Pass	Fail	Pass	Pass	Fail	Pass
82	20	Pass	Fail	Pass	Pass	Fail	Pass
82	21	Pass	Fail	Pass	Pass	Fail	Pass
82	29	Pass	Fail	Pass	Pass	Fail	Pass
82	30	Pass	Fail	Pass	Pass	Fail	Pass
82	31	Pass	Fail	Pass	Pass	Fail	Pass
83	13	Pass	Pass	Pass	Pass	Pass	Pass
83	14	Pass	Pass	Pass	Pass	Pass	Pass
83	15	Pass	Pass	Pass	Pass	Pass	Pass
83	21	Pass	Fail	Pass	Pass	Fail	Pass
83	30	Pass	Fail	Pass	Pass	Fail	Pass
83	31	Pass	Fail	Pass	Pass	Fail	Pass
84	13	Pass	Pass	Pass	Pass	Pass	Pass
84	14	Pass	Pass	Pass	Pass	Pass	Pass
84	15	Pass	Pass	Pass	Pass	Pass	Pass
84	21	Pass	Fail	Pass	Pass	Fail	Pass
84	30	Pass	Fail	Pass	Pass	Fail	Pass

84	31	Pass	Fail	Pass	Pass	Fail	Pass
85	13	Pass	Pass	Pass	Pass	Pass	Pass
85	14	Pass	Pass	Pass	Pass	Pass	Pass
85	15	Pass	Pass	Pass	Pass	Pass	Pass
85	21	Pass	Fail	Pass	Pass	Fail	Pass
85	30	Pass	Fail	Pass	Pass	Fail	Pass
86	13	Pass	Pass	Pass	Pass	Pass	Pass
86	14	Pass	Pass	Pass	Pass	Pass	Pass
86	15	Pass	Pass	Pass	Pass	Pass	Pass
86	17	Fail	Fail	Fail	Fail	Fail	Fail
86	21	Pass	Pass	Pass	Pass	Pass	Pass
86	30	Pass	Pass	Pass	Pass	Pass	Pass
87	13	Pass	Pass	Pass	Pass	Pass	Pass
87	14	Pass	Pass	Pass	Pass	Pass	Pass
87	15	Pass	Pass	Pass	Pass	Pass	Pass
87	30	Pass	Fail	Pass	Pass	Fail	Pass
87	32	Fail	Fail	Fail	Fail	Fail	Fail
88	13	Pass	Pass	Pass	Pass	Pass	Pass
88	14	Pass	Pass	Pass	Pass	Pass	Pass
88	15	Pass	Pass	Pass	Pass	Pass	Pass
88	30	Pass	Fail	Pass	Pass	Fail	Pass
89	13	Pass	Pass	Pass	Pass	Pass	Pass
89	14	Pass	Pass	Pass	Pass	Pass	Pass
89	15	Pass	Pass	Pass	Pass	Pass	Pass
89	30	Pass	Fail	Pass	Pass	Fail	Pass
90	13	Pass	Pass	Pass	Pass	Pass	Pass
90	14	Pass	Pass	Pass	Pass	Pass	Pass
90	15	Pass	Pass	Pass	Pass	Pass	Pass
90	30	Pass	Fail	Pass	Pass	Fail	Pass
91	13	Pass	Pass	Pass	Pass	Pass	Pass
91	14	Pass	Pass	Pass	Pass	Pass	Pass
91	15	Pass	Pass	Pass	Pass	Pass	Pass
91	16	Pass	Fail	Pass	Pass	Fail	Pass
91	30	Pass	Fail	Pass	Pass	Fail	Pass
92	13	Pass	Pass	Pass	Pass	Pass	Pass
92	14	Pass	Pass	Pass	Pass	Pass	Pass
92	15	Pass	Pass	Pass	Pass	Pass	Pass
92	16	Pass	Fail	Pass	Pass	Fail	Pass
92	30	Pass	Fail	Pass	Pass	Fail	Pass
92	32	Fail	Fail	Fail	Fail	Fail	Fail
93	13	Pass	Pass	Pass	Pass	Pass	Pass
93	14	Pass	Pass	Pass	Pass	Pass	Pass
93	15	Pass	Pass	Pass	Pass	Pass	Pass
93	16	Pass	Pass	Pass	Pass	Pass	Pass
93	30	Pass	Fail	Pass	Pass	Fail	Pass
94	13	Pass	Pass	Pass	Pass	Pass	Pass
94	14	Pass	Pass	Pass	Pass	Pass	Pass
94	15	Pass	Pass	Pass	Pass	Pass	Pass
94	16	Pass	Fail	Pass	Pass	Fail	Pass
94	26	Pass	Pass	Pass	Pass	Pass	Pass
94	30	Pass	Fail	Pass	Pass	Fail	Pass
95	13	Pass	Pass	Pass	Pass	Pass	Pass
95	14	Pass	Pass	Pass	Pass	Pass	Pass
95	15	Pass	Pass	Pass	Pass	Pass	Pass
95	16	Pass	Fail	Pass	Pass	Fail	Pass
95	26	Pass	Pass	Pass	Pass	Fail	Pass
95	28	Fail	Fail	Fail	Fail	Fail	Fail

95	30	Pass	Fail	Pass	Pass	Fail	Pass
96	11	Fail	Fail	Fail	Fail	Fail	Fail
96	13	Pass	Pass	Pass	Pass	Pass	Pass
96	14	Pass	Pass	Pass	Pass	Pass	Pass
96	15	Pass	Pass	Pass	Pass	Pass	Pass
96	26	Pass	Fail	Pass	Pass	Fail	Pass
96	30	Pass	Fail	Pass	Pass	Fail	Pass
97	13	Pass	Pass	Pass	Pass	Pass	Pass
97	14	Pass	Pass	Pass	Pass	Pass	Pass
97	15	Pass	Pass	Pass	Pass	Pass	Pass
97	26	Pass	Fail	Pass	Pass	Fail	Pass
97	30	Pass	Fail	Pass	Pass	Fail	Pass
98	13	Pass	Pass	Pass	Pass	Pass	Pass
98	14	Pass	Pass	Pass	Pass	Pass	Pass
98	15	Pass	Pass	Pass	Pass	Pass	Pass
98	26	Pass	Pass	Pass	Pass	Pass	Pass
98	27	Pass	Pass	Pass	Pass	Pass	Pass
98	28	Pass	Pass	Pass	Pass	Pass	Pass
98	29	Pass	Pass	Pass	Pass	Pass	Pass
98	30	Pass	Fail	Pass	Pass	Fail	Pass
99	13	Pass	Pass	Pass	Pass	Pass	Pass
99	14	Pass	Pass	Pass	Pass	Pass	Pass
99	15	Pass	Fail	Pass	Pass	Fail	Pass
99	16	Pass	Fail	Pass	Pass	Fail	Pass
99	17	Pass	Fail	Pass	Pass	Fail	Pass
99	18	Pass	Fail	Pass	Pass	Fail	Pass
99	19	Pass	Fail	Pass	Pass	Fail	Pass
99	20	Pass	Fail	Pass	Pass	Fail	Pass
99	21	Pass	Fail	Pass	Pass	Fail	Pass
99	22	Pass	Fail	Pass	Pass	Fail	Pass
99	23	Pass	Fail	Pass	Pass	Fail	Pass
99	26	Pass	Fail	Pass	Pass	Fail	Pass
99	30	Pass	Fail	Pass	Pass	Fail	Pass
100	13	Pass	Pass	Pass	Pass	Pass	Pass
100	14	Pass	Pass	Pass	Pass	Pass	Pass
100	15	Pass	Pass	Pass	Pass	Pass	Pass
100	23	Pass	Fail	Pass	Pass	Fail	Pass
100	24	Pass	Fail	Pass	Pass	Fail	Pass
100	25	Pass	Fail	Pass	Pass	Fail	Pass
100	26	Pass	Fail	Pass	Pass	Fail	Pass
100	30	Pass	Fail	Pass	Pass	Fail	Pass
101	13	Pass	Pass	Pass	Pass	Pass	Pass
101	14	Pass	Pass	Pass	Pass	Pass	Pass
101	15	Pass	Pass	Pass	Pass	Pass	Pass
101	16	Pass	Fail	Pass	Pass	Fail	Pass
101	17	Pass	Fail	Pass	Pass	Fail	Pass
101	18	Pass	Fail	Pass	Pass	Fail	Pass
101	19	Pass	Fail	Pass	Pass	Fail	Pass
101	20	Pass	Fail	Pass	Pass	Fail	Pass
101	21	Pass	Fail	Pass	Pass	Fail	Pass
101	22	Pass	Fail	Pass	Pass	Fail	Pass
101	23	Pass	Fail	Pass	Pass	Fail	Pass
101	26	Pass	Pass	Pass	Pass	Pass	Pass
101	30	Pass	Fail	Pass	Pass	Fail	Pass
102	13	Pass	Pass	Pass	Pass	Pass	Pass
102	14	Pass	Pass	Pass	Pass	Pass	Pass
102	15	Pass	Pass	Pass	Pass	Pass	Pass

102	26	Pass	Pass	Pass	Pass	Pass	Pass
102	30	Pass	Fail	Pass	Pass	Fail	Pass
103	13	Pass	Pass	Pass	Pass	Pass	Pass
103	14	Pass	Pass	Pass	Pass	Pass	Pass
103	15	Pass	Pass	Pass	Pass	Pass	Pass
103	26	Pass	Pass	Pass	Pass	Pass	Pass
103	30	Pass	Pass	Pass	Pass	Pass	Pass
104	11	Fail	Fail	Fail	Fail	Fail	Fail
104	13	Pass	Pass	Pass	Pass	Pass	Pass
104	14	Pass	Pass	Pass	Pass	Pass	Pass
104	15	Pass	Pass	Pass	Pass	Pass	Pass
104	26	Pass	Pass	Pass	Pass	Pass	Pass
104	30	Pass	Fail	Pass	Pass	Fail	Pass
105	13	Pass	Pass	Pass	Pass	Pass	Pass
105	14	Pass	Pass	Pass	Pass	Pass	Pass
105	15	Pass	Pass	Pass	Pass	Pass	Pass
105	26	Pass	Pass	Pass	Pass	Pass	Pass
105	30	Pass	Fail	Pass	Pass	Fail	Pass
106	13	Pass	Pass	Pass	Pass	Pass	Pass
106	14	Pass	Pass	Pass	Pass	Pass	Pass
106	15	Pass	Pass	Pass	Pass	Pass	Pass
106	26	Pass	Pass	Pass	Pass	Pass	Pass
106	27	Pass	Fail	Pass	Pass	Fail	Pass
106	30	Pass	Fail	Pass	Pass	Fail	Pass
106	39	Pass	Fail	Pass	Pass	Fail	Pass
107	13	Pass	Pass	Pass	Pass	Pass	Pass
107	14	Pass	Pass	Pass	Pass	Pass	Pass
107	15	Pass	Pass	Pass	Pass	Pass	Pass
107	22	Pass	Fail	Pass	Pass	Fail	Pass
107	26	Pass	Fail	Pass	Pass	Fail	Pass
107	30	Pass	Fail	Pass	Pass	Fail	Pass
107	39	Pass	Fail	Pass	Pass	Fail	Pass
108	13	Pass	Pass	Pass	Pass	Pass	Pass
108	14	Pass	Pass	Pass	Pass	Pass	Pass
108	15	Pass	Pass	Pass	Pass	Pass	Pass
108	22	Pass	Pass	Pass	Pass	Pass	Pass
108	24	Fail	Fail	Fail	Fail	Fail	Fail
108	26	Pass	Fail	Pass	Pass	Fail	Pass
108	30	Pass	Fail	Pass	Pass	Fail	Pass
108	39	Pass	Fail	Pass	Pass	Fail	Pass
109	13	Pass	Pass	Pass	Pass	Pass	Pass
109	14	Pass	Pass	Pass	Pass	Pass	Pass
109	15	Pass	Pass	Pass	Pass	Pass	Pass
109	22	Pass	Fail	Pass	Pass	Fail	Pass
109	26	Pass	Pass	Pass	Pass	Pass	Pass
109	30	Pass	Fail	Pass	Pass	Fail	Pass
109	39	Pass	Pass	Pass	Pass	Pass	Pass
110	13	Pass	Pass	Pass	Pass	Pass	Pass
110	14	Pass	Pass	Pass	Pass	Pass	Pass
110	15	Pass	Pass	Pass	Pass	Pass	Pass
110	22	Pass	Fail	Pass	Pass	Fail	Pass
110	26	Pass	Pass	Pass	Pass	Pass	Pass
110	28	Fail	Fail	Fail	Fail	Fail	Fail
110	39	Pass	Fail	Pass	Pass	Fail	Pass
111	13	Pass	Pass	Pass	Pass	Pass	Pass
111	14	Pass	Pass	Pass	Pass	Pass	Pass
111	15	Pass	Pass	Pass	Pass	Pass	Pass

111	22	Pass	Fail	Pass	Pass	Fail	Pass
111	26	Pass	Pass	Pass	Pass	Pass	Pass
111	39	Pass	Fail	Pass	Pass	Fail	Pass
112	13	Pass	Pass	Pass	Pass	Pass	Pass
112	14	Pass	Pass	Pass	Pass	Pass	Pass
112	15	Pass	Pass	Pass	Pass	Pass	Pass
112	22	Pass	Fail	Pass	Pass	Fail	Pass
112	26	Pass	Fail	Pass	Pass	Fail	Pass
112	39	Pass	Fail	Pass	Pass	Fail	Pass
113	13	Pass	Pass	Pass	Pass	Pass	Pass
113	14	Pass	Pass	Pass	Pass	Pass	Pass
113	15	Pass	Pass	Pass	Pass	Pass	Pass
113	26	Pass	Fail	Pass	Pass	Pass	Pass
113	27	Pass	Fail	Pass	Pass	Fail	Pass
113	39	Pass	Pass	Pass	Pass	Pass	Pass
113	41	Fail	Fail	Fail	Fail	Fail	Fail
114	13	Pass	Pass	Pass	Pass	Pass	Pass
114	14	Pass	Pass	Pass	Pass	Pass	Pass
114	15	Pass	Pass	Pass	Pass	Pass	Pass
114	26	Pass	Fail	Pass	Pass	Fail	Pass
114	39	Pass	Pass	Pass	Pass	Pass	Pass
115	13	Pass	Pass	Pass	Pass	Pass	Pass
115	14	Pass	Pass	Pass	Pass	Pass	Pass
115	15	Pass	Pass	Pass	Pass	Pass	Pass
115	26	Pass	Fail	Pass	Pass	Fail	Pass
115	39	Pass	Pass	Pass	Pass	Pass	Pass
116	13	Pass	Pass	Pass	Pass	Pass	Pass
116	14	Pass	Pass	Pass	Pass	Pass	Pass
116	15	Pass	Pass	Pass	Pass	Pass	Pass
116	26	Pass	Fail	Pass	Pass	Fail	Pass
116	28	Fail	Fail	Fail	Fail	Fail	Fail
116	39	Pass	Pass	Pass	Pass	Pass	Pass
117	13	Pass	Pass	Pass	Pass	Pass	Pass
117	14	Pass	Pass	Pass	Pass	Pass	Pass
117	15	Pass	Pass	Pass	Pass	Pass	Pass
117	26	Pass	Fail	Pass	Pass	Fail	Pass
117	39	Pass	Pass	Pass	Pass	Pass	Pass
118	13	Pass	Pass	Pass	Pass	Pass	Pass
118	14	Pass	Pass	Pass	Pass	Pass	Pass
118	15	Pass	Pass	Pass	Pass	Pass	Pass
118	20	Pass	Pass	Pass	Pass	Pass	Pass
118	26	Pass	Pass	Pass	Pass	Pass	Pass
118	39	Pass	Pass	Pass	Pass	Pass	Pass
119	13	Pass	Pass	Pass	Pass	Pass	Pass
119	14	Pass	Pass	Pass	Pass	Pass	Pass
119	15	Pass	Pass	Pass	Pass	Pass	Pass
119	20	Pass	Pass	Pass	Pass	Pass	Pass
119	26	Pass	Fail	Pass	Pass	Fail	Pass
119	39	Pass	Pass	Pass	Pass	Pass	Pass
120	13	Pass	Pass	Pass	Pass	Pass	Pass
120	14	Pass	Pass	Pass	Pass	Pass	Pass
120	15	Pass	Fail	Pass	Pass	Fail	Pass
120	16	Pass	Fail	Pass	Pass	Fail	Pass
120	26	Pass	Fail	Pass	Pass	Fail	Pass
120	39	Pass	Pass	Pass	Pass	Pass	Pass
121	13	Pass	Pass	Pass	Pass	Pass	Pass
121	14	Pass	Pass	Pass	Pass	Pass	Pass

121	26	Pass	Fail	Pass	Pass	Fail	Pass
121	39	Pass	Pass	Pass	Pass	Pass	Pass
122	13	Pass	Pass	Pass	Pass	Pass	Pass
122	14	Pass	Pass	Pass	Pass	Pass	Pass
122	26	Pass	Fail	Pass	Pass	Fail	Pass
122	39	Pass	Pass	Pass	Pass	Pass	Pass
122	41	Fail	Fail	Fail	Fail	Fail	Fail
123	13	Pass	Pass	Pass	Pass	Pass	Pass
123	14	Pass	Pass	Pass	Pass	Pass	Pass
123	15	Pass	Fail	Pass	Pass	Fail	Pass
123	16	Pass	Pass	Pass	Pass	Pass	Pass
123	17	Pass	Pass	Pass	Pass	Pass	Pass
123	18	Pass	Pass	Pass	Pass	Pass	Pass
123	19	Pass	Pass	Pass	Pass	Pass	Pass
123	20	Pass	Pass	Pass	Pass	Pass	Pass
123	21	Pass	Pass	Pass	Pass	Pass	Pass
123	22	Pass	Pass	Pass	Pass	Pass	Pass
123	23	Pass	Pass	Pass	Pass	Pass	Pass
123	24	Pass	Pass	Pass	Pass	Pass	Pass
123	25	Pass	Pass	Pass	Pass	Pass	Pass
123	26	Pass	Pass	Pass	Pass	Pass	Pass
123	27	Pass	Pass	Pass	Pass	Pass	Pass
123	28	Pass	Pass	Pass	Pass	Pass	Pass
123	29	Pass	Pass	Pass	Pass	Pass	Pass
123	30	Pass	Fail	Pass	Pass	Fail	Pass
123	31	Pass	Fail	Pass	Pass	Fail	Pass
123	32	Pass	Fail	Pass	Pass	Fail	Pass
123	33	Pass	Fail	Pass	Pass	Fail	Pass
123	34	Pass	Pass	Pass	Pass	Pass	Pass
123	35	Pass	Pass	Pass	Pass	Pass	Pass
123	36	Pass	Pass	Pass	Pass	Pass	Pass
123	37	Pass	Fail	Pass	Pass	Fail	Pass
123	38	Pass	Fail	Pass	Pass	Fail	Pass
123	39	Pass	Fail	Pass	Pass	Fail	Pass
124	13	Pass	Pass	Pass	Pass	Pass	Pass
124	14	Pass	Pass	Pass	Pass	Pass	Pass
124	23	Pass	Fail	Pass	Pass	Fail	Pass
125	13	Pass	Pass	Pass	Pass	Pass	Pass
125	14	Pass	Pass	Pass	Pass	Pass	Pass
125	23	Pass	Pass	Pass	Pass	Pass	Pass
125	28	Fail	Fail	Fail	Fail	Fail	Fail
125	33	Fail	Fail	Fail	Fail	Fail	Fail
126	13	Pass	Pass	Pass	Pass	Pass	Pass
126	14	Pass	Pass	Pass	Pass	Pass	Pass
126	23	Pass	Pass	Pass	Pass	Pass	Pass
127	13	Pass	Pass	Pass	Pass	Pass	Pass
127	14	Pass	Pass	Pass	Pass	Pass	Pass
127	23	Pass	Pass	Pass	Pass	Pass	Pass
128	13	Pass	Pass	Pass	Pass	Pass	Pass
128	14	Pass	Pass	Pass	Pass	Pass	Pass
128	23	Pass	Pass	Pass	Pass	Pass	Pass
129	13	Pass	Pass	Pass	Pass	Pass	Pass
129	14	Pass	Pass	Pass	Pass	Pass	Pass
129	23	Pass	Pass	Pass	Pass	Pass	Pass
130	8	Pass	Fail	Pass	Pass	Fail	Pass
130	9	Pass	Fail	Pass	Pass	Fail	Pass
130	10	Pass	Fail	Pass	Pass	Fail	Pass

130	11	Pass	Fail	Pass	Pass	Fail	Pass
130	12	Pass	Fail	Pass	Pass	Fail	Pass
130	13	Pass	Fail	Pass	Pass	Fail	Pass
130	14	Pass	Pass	Pass	Pass	Pass	Pass
130	23	Pass	Pass	Pass	Pass	Pass	Pass
131	14	Pass	Pass	Pass	Pass	Pass	Pass
131	23	Pass	Pass	Pass	Pass	Pass	Pass
132	14	Pass	Pass	Pass	Pass	Pass	Pass
132	23	Pass	Pass	Pass	Pass	Pass	Pass
133	14	Pass	Pass	Pass	Pass	Pass	Pass
133	23	Pass	Pass	Pass	Pass	Pass	Pass
134	14	Pass	Pass	Pass	Pass	Pass	Pass
134	23	Pass	Fail	Pass	Pass	Fail	Pass
135	14	Pass	Pass	Pass	Pass	Pass	Pass
136	14	Pass	Pass	Pass	Pass	Pass	Pass
137	14	Pass	Pass	Pass	Pass	Pass	Pass
138	14	Pass	Pass	Pass	Pass	Pass	Pass

Appendix F

MAY 1997

20th %ile of Clyo Flow

Habitat Analysis Output

Fisheries Review Group

1. Table F.1. Comparisons of American Shad and Striped Bass Larvae habitat areas for existing and deepening (6 ft) scenarios and 20 %ile Clyo Flow within the analyzed period May 1 – May 31, 1997

	Baseline Scenario		Project Scenario		% Change
American Shad	19.962807	km2	19.962807	km2	0.0
Bass Larvae	0.818275	km2	1.674018	km2	104.6

2. Table F.2. Comparisons of American Shad and Striped Bass Larvae habitat areas for existing and deepening (4 ft) scenarios and 20 %ile Clyo Flow within the analyzed period May 1 – May 31, 1997

	Baseline Scenario		Project Scenario		% Change
American Shad	19.962807	km2	19.962807	km2	0.0
Bass Larvae	0.818275	km2	1.632263	km2	99.5

3. Table F.3. Comparisons of American Shad and Striped Bass Larvae habitat areas for existing and deepening (3 ft) scenarios and 20 %ile Clyo Flow within the analyzed period May 1 – May 31, 1997

	Baseline Scenario		Project Scenario		% Change
American Shad	19.962807	km2	19.962807	km2	0.0
Bass Larvae	0.818275	km2	1.279611	km2	56.4

4. Table F.4. Comparisons of American Shad and Striped Bass Larvae habitat areas for existing and deepening (2 ft) scenarios and 20 %ile Clyo flow within the analyzed period May 1 – May 31, 1997

	Baseline Scenario		Project Scenario		% Change
American Shad	19.962807	km2	19.962807	km2	0.0
Bass Larvae	0.818275	km2	1.129014	km2	38.0

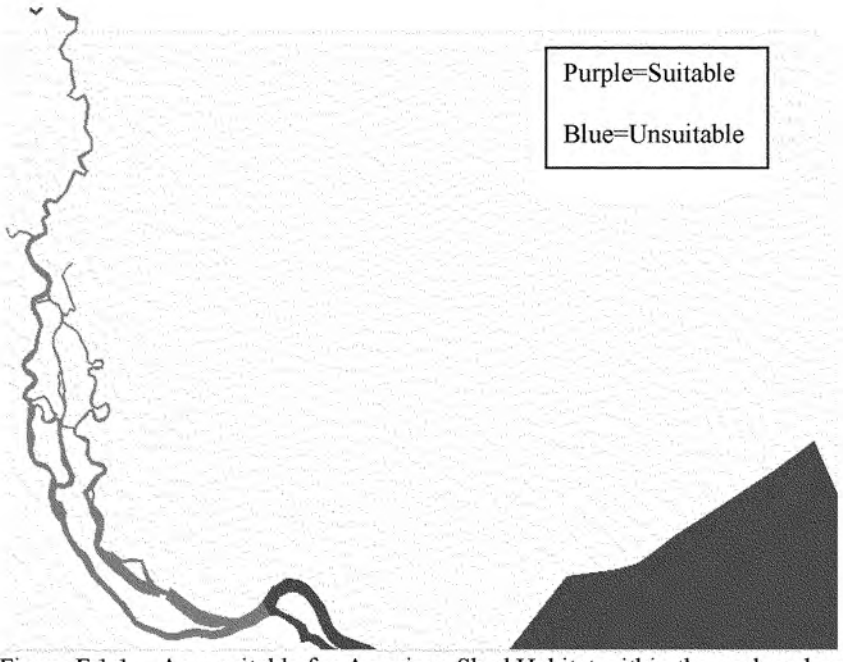
5. Table F.6.1 American Shad D.O. criteria passing for existing and deepening (6 ft, 4 ft, 3 ft, and 2 ft) scenarios within the analyzed period May 1 - May 31, 1997
(See Appendix F-1)

6. Table F.7.1 Striped Bass Larvae salinity and D.O. criteria passing for existing and deepening (6 ft) scenarios within the analyzed period May 1 - May 31, 1997
(See Appendix F-2)

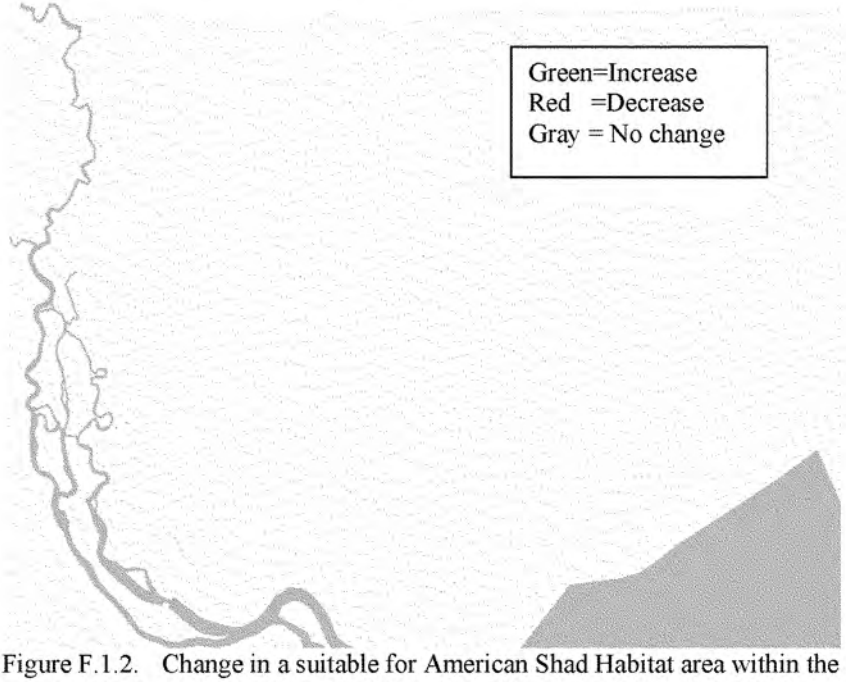
7. Table F.7.2 Striped Bass Larvae salinity and D.O. criteria passing for existing and deepening (4 ft) scenarios within the analyzed period May 1 - May 31, 1997
(See Appendix F-2)

8. Table F.7.3 Striped Bass Larvae salinity and D.O. criteria passing for existing and deepening (3 ft) scenarios within the analyzed period May 1 - May 31, 1997
(See Appendix F-2)

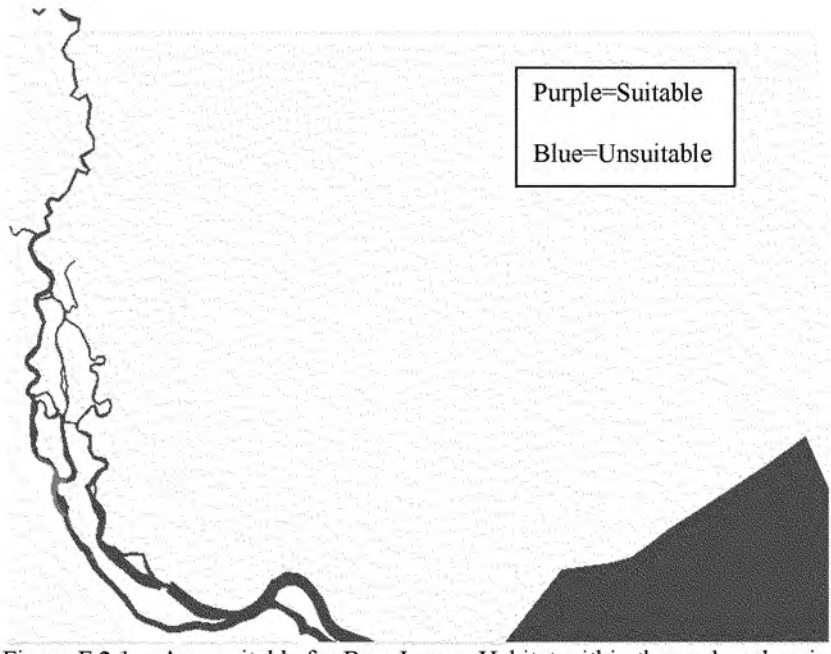
9. Table F.7.4 Striped Bass Larvae salinity and D.O. criteria passing for existing and deepening (2 ft) scenarios within the analyzed period May 1 - May 31, 1997
(See Appendix F-2)



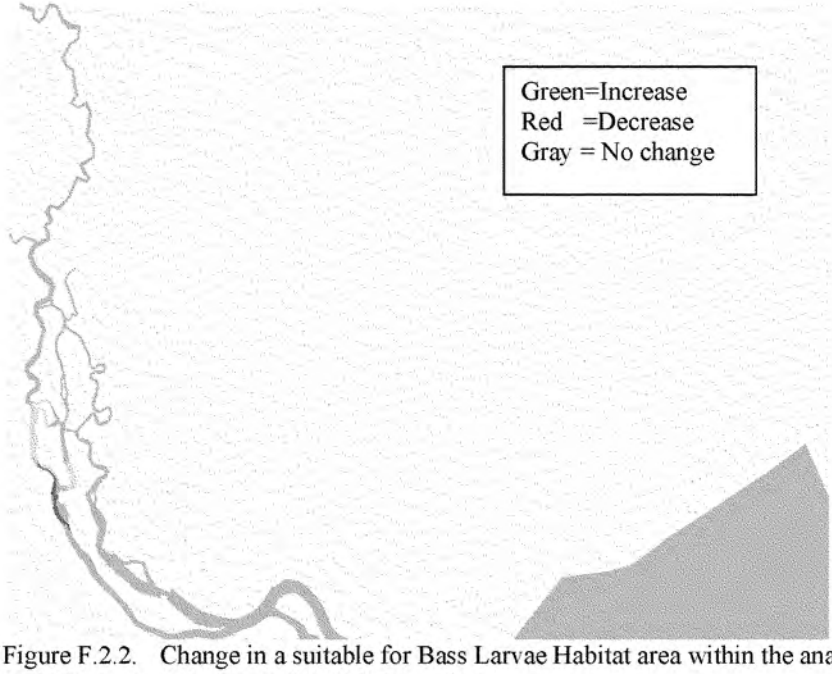
10. Figure F.1.1. Area suitable for American Shad Habitat within the analyzed period May 1 – May 31, 1997: Existing bathymetry



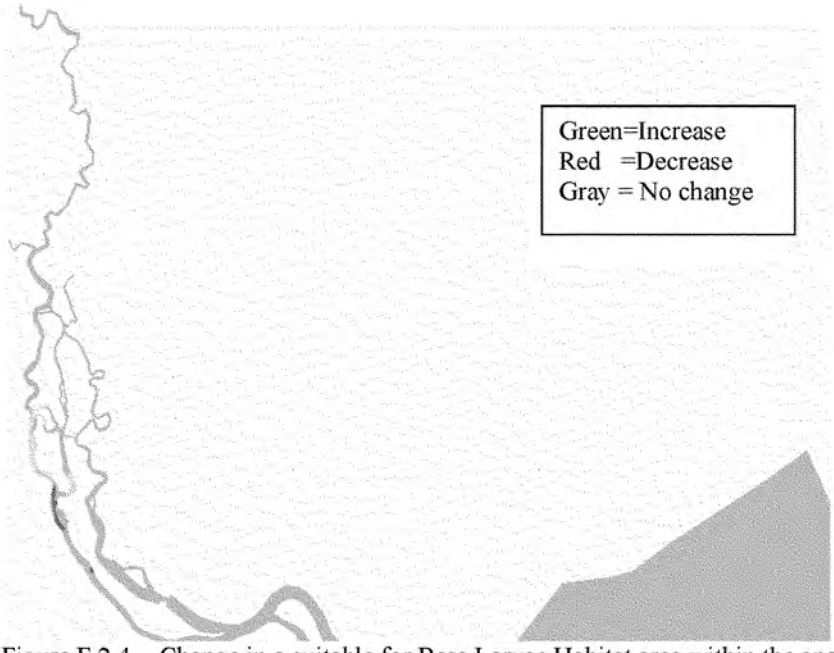
11. Figure F.1.2. Change in a suitable for American Shad Habitat area within the analyzed period May 1 - May 31, 1999 : 6 ft, 4 ft, 3 ft, and 2 ft deepening



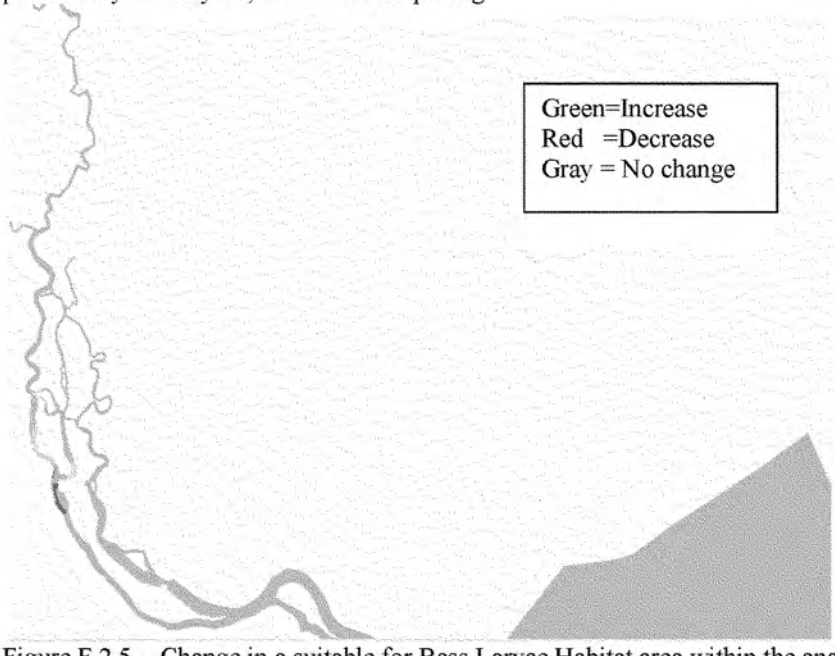
12. Figure F.2.1. Area suitable for Bass Larvae Habitat within the analyzed period May 1 – May 31, 1997: Existing bathymetry



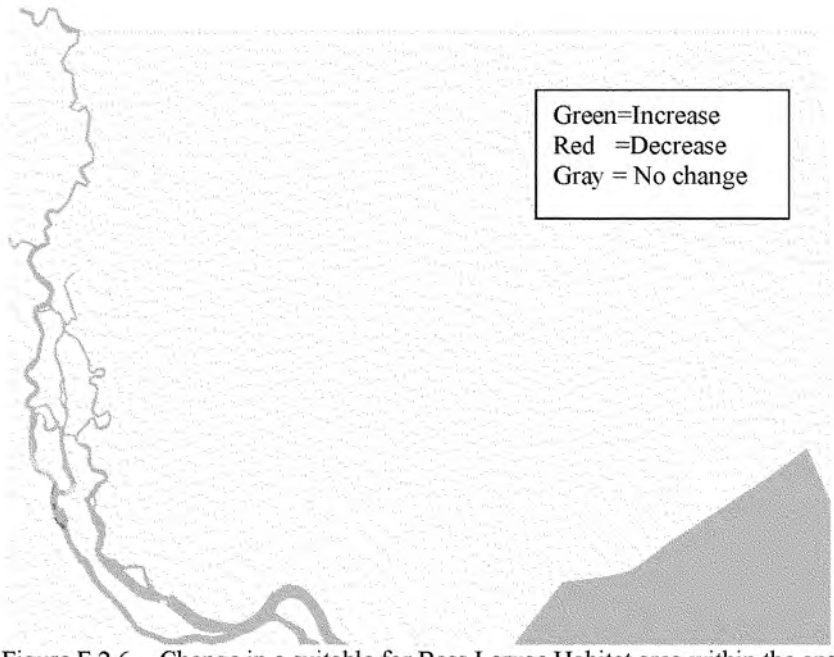
13. Figure F.2.2. Change in a suitable for Bass Larvae Habitat area within the analyzed period May 1 - May 31, 1999 : 6 ft deepening



14. Figure F.2.4. Change in a suitable for Bass Larvae Habitat area within the analyzed period May 1 - May 31, 1999 : 4 ft deepening



15. Figure F.2.5. Change in a suitable for Bass Larvae Habitat area within the analyzed period May 1 - May 31, 1999 : 3 ft deepening



16. Figure F.2.6. Change in a suitable for Bass Larvae Habitat area within the analyzed period May 1 - May 31, 1999 : 2 ft deepening

Appendix F-1

Tables of Criteria Passing for American Shad Habitat Suitability

May 1997

20th %ile of Clyo Flow

Fisheries Review Group

1. Table F.6.1 American Shad D.O. criteria passing for existing and deepening (6 ft, 4 ft, 3 ft, and 2 ft) scenarios within the analyzed period May 1 - May 31, 1997

HABITAT REQUIREMENTS:
RM 10-40; Top half of water column
D.O. January, May, and August (MG/L):10th %ile >=4.0

Savannah Harbor Estuary

Segments J	Segments I	Baseline Scenario D.O.	Project Scenario D.O.
47	13	Pass	Pass
47	14	Pass	Pass
47	15	Pass	Pass
47	16	Pass	Pass
47	17	Pass	Pass
48	13	Pass	Pass
48	14	Pass	Pass
48	15	Pass	Pass
48	16	Pass	Pass
48	17	Pass	Pass
49	13	Pass	Pass
49	14	Pass	Pass
49	15	Pass	Pass
49	16	Pass	Pass
49	17	Pass	Pass
50	13	Pass	Pass
50	14	Pass	Pass
50	15	Pass	Pass
50	16	Pass	Pass
50	17	Pass	Pass
50	18	Pass	Pass
51	13	Pass	Pass
51	14	Pass	Pass
51	15	Pass	Pass
52	13	Pass	Pass
52	14	Pass	Pass
52	15	Pass	Pass
53	13	Pass	Pass
53	14	Pass	Pass
53	15	Pass	Pass
54	13	Pass	Pass
54	14	Pass	Pass
54	15	Pass	Pass
55	13	Pass	Pass
55	14	Pass	Pass
55	15	Pass	Pass
56	13	Pass	Pass
56	14	Pass	Pass
56	15	Pass	Pass
57	13	Pass	Pass
57	14	Pass	Pass
57	15	Pass	Pass
58	13	Pass	Pass

58	14	Pass	Pass
58	15	Pass	Pass
59	13	Pass	Pass
59	14	Pass	Pass
59	15	Pass	Pass
59	30	Pass	Pass
59	31	Pass	Pass
59	32	Pass	Pass
60	13	Pass	Pass
60	14	Pass	Pass
60	15	Pass	Pass
60	30	Pass	Pass
60	31	Pass	Pass
60	32	Pass	Pass
61	13	Pass	Pass
61	14	Pass	Pass
61	15	Pass	Pass
61	30	Pass	Pass
61	31	Pass	Pass
61	32	Pass	Pass
62	13	Pass	Pass
62	14	Pass	Pass
62	15	Pass	Pass
62	30	Pass	Pass
62	31	Pass	Pass
62	32	Pass	Pass
63	13	Pass	Pass
63	14	Pass	Pass
63	15	Pass	Pass
63	31	Pass	Pass
64	13	Pass	Pass
64	14	Pass	Pass
64	15	Pass	Pass
64	30	Pass	Pass
64	31	Pass	Pass
64	32	Pass	Pass
65	13	Pass	Pass
65	14	Pass	Pass
65	15	Pass	Pass
65	30	Pass	Pass
65	31	Pass	Pass
65	32	Pass	Pass
65	33	Pass	Pass
66	13	Pass	Pass
66	14	Pass	Pass
66	15	Pass	Pass
66	30	Pass	Pass
66	31	Pass	Pass
66	32	Pass	Pass
66	36	Pass	Pass
67	13	Pass	Pass
67	14	Pass	Pass
67	15	Pass	Pass
67	30	Pass	Pass
67	31	Pass	Pass
67	32	Pass	Pass
67	36	Pass	Pass

68	13	Pass	Pass
68	14	Pass	Pass
68	15	Pass	Pass
68	30	Pass	Pass
68	31	Pass	Pass
68	32	Pass	Pass
68	36	Pass	Pass
69	13	Pass	Pass
69	14	Pass	Pass
69	15	Pass	Pass
69	30	Pass	Pass
69	31	Pass	Pass
69	32	Pass	Pass
69	36	Pass	Pass
70	13	Pass	Pass
70	14	Pass	Pass
70	15	Pass	Pass
70	30	Pass	Pass
70	31	Pass	Pass
70	32	Pass	Pass
70	33	Pass	Pass
71	13	Pass	Pass
71	14	Pass	Pass
71	15	Pass	Pass
71	30	Pass	Pass
71	31	Pass	Pass
71	32	Pass	Pass
72	13	Pass	Pass
72	14	Pass	Pass
72	15	Pass	Pass
72	30	Pass	Pass
72	31	Pass	Pass
72	32	Pass	Pass
73	13	Pass	Pass
73	14	Pass	Pass
73	15	Pass	Pass
73	30	Pass	Pass
73	31	Pass	Pass
74	13	Pass	Pass
74	14	Pass	Pass
74	15	Pass	Pass
74	30	Pass	Pass
74	31	Pass	Pass
75	13	Pass	Pass
75	14	Pass	Pass
75	15	Pass	Pass
75	30	Pass	Pass
75	31	Pass	Pass
76	13	Pass	Pass
76	14	Pass	Pass
76	15	Pass	Pass
76	16	Pass	Pass
76	17	Pass	Pass
76	30	Pass	Pass
76	31	Pass	Pass
77	13	Pass	Pass
77	14	Pass	Pass

77	15	Pass	Pass
77	16	Pass	Pass
77	17	Pass	Pass
77	30	Pass	Pass
77	31	Pass	Pass
78	13	Pass	Pass
78	14	Pass	Pass
78	15	Pass	Pass
78	16	Pass	Pass
78	17	Pass	Pass
78	30	Pass	Pass
78	31	Pass	Pass
79	13	Pass	Pass
79	14	Pass	Pass
79	15	Pass	Pass
79	30	Pass	Pass
79	31	Pass	Pass
80	13	Pass	Pass
80	14	Pass	Pass
80	15	Pass	Pass
80	30	Pass	Pass
80	31	Pass	Pass
81	13	Pass	Pass
81	14	Pass	Pass
81	15	Pass	Pass
81	30	Pass	Pass
81	31	Pass	Pass
82	13	Pass	Pass
82	14	Pass	Pass
82	15	Pass	Pass
82	16	Pass	Pass
82	17	Pass	Pass
82	18	Pass	Pass
82	19	Pass	Pass
82	20	Pass	Pass
82	21	Pass	Pass
82	29	Pass	Pass
82	30	Pass	Pass
82	31	Pass	Pass
83	13	Pass	Pass
83	14	Pass	Pass
83	15	Pass	Pass
83	21	Pass	Pass
83	30	Pass	Pass
83	31	Pass	Pass
84	13	Pass	Pass
84	14	Pass	Pass
84	15	Pass	Pass
84	21	Pass	Pass
84	30	Pass	Pass
84	31	Pass	Pass
85	13	Pass	Pass
85	14	Pass	Pass
85	15	Pass	Pass
85	21	Pass	Pass
85	30	Pass	Pass
86	13	Pass	Pass

86	14	Pass	Pass
86	15	Pass	Pass
86	21	Pass	Pass
86	30	Pass	Pass
87	13	Pass	Pass
87	14	Pass	Pass
87	15	Pass	Pass
87	30	Pass	Pass
88	13	Pass	Pass
88	14	Pass	Pass
88	15	Pass	Pass
88	30	Pass	Pass
89	13	Pass	Pass
89	14	Pass	Pass
89	15	Pass	Pass
89	30	Pass	Pass
90	13	Pass	Pass
90	14	Pass	Pass
90	15	Pass	Pass
90	30	Pass	Pass
91	13	Pass	Pass
91	14	Pass	Pass
91	15	Pass	Pass
91	16	Pass	Pass
91	30	Pass	Pass
92	13	Pass	Pass
92	14	Pass	Pass
92	15	Pass	Pass
92	16	Pass	Pass
92	30	Pass	Pass
93	13	Pass	Pass
93	14	Pass	Pass
93	15	Pass	Pass
93	16	Pass	Pass
93	30	Pass	Pass
94	13	Pass	Pass
94	14	Pass	Pass
94	15	Pass	Pass
94	16	Pass	Pass
94	26	Pass	Pass
94	30	Pass	Pass
95	13	Pass	Pass
95	14	Pass	Pass
95	15	Pass	Pass
95	16	Pass	Pass
95	26	Pass	Pass
95	30	Pass	Pass
96	13	Pass	Pass
96	14	Pass	Pass
96	15	Pass	Pass
96	26	Pass	Pass
96	30	Pass	Pass
97	13	Pass	Pass
97	14	Pass	Pass
97	15	Pass	Pass
97	26	Pass	Pass
97	30	Pass	Pass

98	13	Pass	Pass
98	14	Pass	Pass
98	15	Pass	Pass
98	26	Pass	Pass
98	27	Pass	Pass
98	28	Pass	Pass
98	29	Pass	Pass
98	30	Pass	Pass
99	13	Pass	Pass
99	14	Pass	Pass
99	15	Pass	Pass
99	16	Pass	Pass
99	17	Pass	Pass
99	18	Pass	Pass
99	19	Pass	Pass
99	20	Pass	Pass
99	21	Pass	Pass
99	22	Pass	Pass
99	23	Pass	Pass
99	26	Pass	Pass
99	30	Pass	Pass
100	13	Pass	Pass
100	14	Pass	Pass
100	15	Pass	Pass
100	23	Pass	Pass
100	24	Pass	Pass
100	25	Pass	Pass
100	26	Pass	Pass
100	30	Pass	Pass
101	13	Pass	Pass
101	14	Pass	Pass
101	15	Pass	Pass
101	16	Pass	Pass
101	17	Pass	Pass
101	18	Pass	Pass
101	19	Pass	Pass
101	20	Pass	Pass
101	21	Pass	Pass
101	22	Pass	Pass
101	23	Pass	Pass
101	26	Pass	Pass
101	30	Pass	Pass
102	13	Pass	Pass
102	14	Pass	Pass
102	15	Pass	Pass
102	26	Pass	Pass
102	30	Pass	Pass
103	13	Pass	Pass
103	14	Pass	Pass
103	15	Pass	Pass
103	26	Pass	Pass
103	30	Pass	Pass
104	13	Pass	Pass
104	14	Pass	Pass
104	15	Pass	Pass
104	26	Pass	Pass
104	30	Pass	Pass

105	13	Pass	Pass
105	14	Pass	Pass
105	15	Pass	Pass
105	26	Pass	Pass
105	30	Pass	Pass
106	13	Pass	Pass
106	14	Pass	Pass
106	15	Pass	Pass
106	26	Pass	Pass
106	27	Pass	Pass
106	30	Pass	Pass
106	39	Pass	Pass
107	13	Pass	Pass
107	14	Pass	Pass
107	15	Pass	Pass
107	22	Pass	Pass
107	26	Pass	Pass
107	30	Pass	Pass
107	39	Pass	Pass
108	13	Pass	Pass
108	14	Pass	Pass
108	15	Pass	Pass
108	22	Pass	Pass
108	26	Pass	Pass
108	30	Pass	Pass
108	39	Pass	Pass
109	13	Pass	Pass
109	14	Pass	Pass
109	15	Pass	Pass
109	22	Pass	Pass
109	26	Pass	Pass
109	30	Pass	Pass
109	39	Pass	Pass
110	13	Pass	Pass
110	14	Pass	Pass
110	15	Pass	Pass
110	22	Pass	Pass
110	26	Pass	Pass
110	39	Pass	Pass
111	13	Pass	Pass
111	14	Pass	Pass
111	15	Pass	Pass
111	22	Pass	Pass
111	26	Pass	Pass
111	39	Pass	Pass
112	13	Pass	Pass
112	14	Pass	Pass
112	15	Pass	Pass
112	22	Pass	Pass
112	26	Pass	Pass
112	39	Pass	Pass
113	13	Pass	Pass
113	14	Pass	Pass
113	15	Pass	Pass
113	26	Pass	Pass
113	27	Pass	Pass
113	39	Pass	Pass

114	13	Pass	Pass
114	14	Pass	Pass
114	15	Pass	Pass
114	26	Pass	Pass
114	39	Pass	Pass
115	13	Pass	Pass
115	14	Pass	Pass
115	15	Pass	Pass
115	26	Pass	Pass
115	39	Pass	Pass
116	13	Pass	Pass
116	14	Pass	Pass
116	15	Pass	Pass
116	26	Pass	Pass
116	39	Pass	Pass
117	13	Pass	Pass
117	14	Pass	Pass
117	15	Pass	Pass
117	26	Pass	Pass
117	39	Pass	Pass
118	13	Pass	Pass
118	14	Pass	Pass
118	15	Pass	Pass
118	20	Pass	Pass
118	26	Pass	Pass
118	39	Pass	Pass
119	13	Pass	Pass
119	14	Pass	Pass
119	15	Pass	Pass
119	20	Pass	Pass
119	26	Pass	Pass
119	39	Pass	Pass
120	13	Pass	Pass
120	14	Pass	Pass
120	15	Pass	Pass
120	16	Pass	Pass
120	26	Pass	Pass
120	39	Pass	Pass
121	13	Pass	Pass
121	14	Pass	Pass
121	26	Pass	Pass
121	39	Pass	Pass
122	13	Pass	Pass
122	14	Pass	Pass
122	26	Pass	Pass
122	39	Pass	Pass
123	13	Pass	Pass
123	14	Pass	Pass
123	15	Pass	Pass
123	16	Pass	Pass
123	17	Pass	Pass
123	18	Pass	Pass
123	19	Pass	Pass
123	20	Pass	Pass
123	21	Pass	Pass
123	22	Pass	Pass
123	23	Pass	Pass

123	24	Pass	Pass
123	25	Pass	Pass
123	26	Pass	Pass
123	27	Pass	Pass
123	28	Pass	Pass
123	29	Pass	Pass
123	30	Pass	Pass
123	31	Pass	Pass
123	32	Pass	Pass
123	33	Pass	Pass
123	34	Pass	Pass
123	35	Pass	Pass
123	36	Pass	Pass
123	37	Pass	Pass
123	38	Pass	Pass
123	39	Pass	Pass
124	13	Pass	Pass
124	14	Pass	Pass
124	23	Pass	Pass
125	13	Pass	Pass
125	14	Pass	Pass
125	23	Pass	Pass
126	13	Pass	Pass
126	14	Pass	Pass
126	23	Pass	Pass
127	13	Pass	Pass
127	14	Pass	Pass
127	23	Pass	Pass
128	13	Pass	Pass
128	14	Pass	Pass
128	23	Pass	Pass
129	13	Pass	Pass
129	14	Pass	Pass
129	23	Pass	Pass
130	8	Pass	Pass
130	9	Pass	Pass
130	10	Pass	Pass
130	11	Pass	Pass
130	12	Pass	Pass
130	13	Pass	Pass
130	14	Pass	Pass
130	23	Pass	Pass
131	14	Pass	Pass
131	23	Pass	Pass
132	14	Pass	Pass
132	23	Pass	Pass
133	14	Pass	Pass
133	23	Pass	Pass
134	14	Pass	Pass
134	23	Pass	Pass
135	14	Pass	Pass
136	14	Pass	Pass
137	14	Pass	Pass
138	14	Pass	Pass
139	14	Pass	Pass
140	14	Pass	Pass
141	14	Pass	Pass

142	14	Pass	Pass
143	14	Pass	Pass
144	14	Pass	Pass
145	14	Pass	Pass
146	14	Pass	Pass
147	14	Pass	Pass
148	14	Pass	Pass
149	14	Pass	Pass
150	14	Pass	Pass
151	14	Pass	Pass
152	14	Pass	Pass
153	14	Pass	Pass
154	14	Pass	Pass
155	14	Pass	Pass
156	14	Pass	Pass
157	14	Pass	Pass
158	14	Pass	Pass
159	14	Pass	Pass
160	14	Pass	Pass
161	14	Pass	Pass
162	14	Pass	Pass
163	14	Pass	Pass
164	14	Pass	Pass
165	14	Pass	Pass
166	14	Pass	Pass

Appendix F-2

Tables of Criteria Passing for Striped Bass Larvae Habitat Suitability

May 1997

20th %ile of Clyo Flow

Fisheries Review Group

1. Table F.7.1 Striped Bass Larvae salinity and D.O. criteria passing for existing and deepening (6 ft) scenarios within the analyzed period May 1 - May 31, 1997

```
HABITAT REQUIREMENTS:
RM 10-31; Depth Average
D.O. May (MG/L):10th %ile >=4.5
Salinity 50th %ile >=3 & <= 9 ppt

                    Savannah Harbor Estuary
  Analyzed period: MAY       1 - MAY      31, Year 1997
```

Segments J	Segments I	Baseline Scenario Salinity	Baseline Scenario D.O.	Project Scenario Salinity	Project Scenario D.O.
47	13	Fail	Fail	Fail	Fail
47	14	Fail	Fail	Fail	Fail
47	15	Fail	Fail	Fail	Fail
47	16	Fail	Fail	Fail	Fail
47	17	Fail	Fail	Fail	Fail
48	13	Fail	Fail	Fail	Fail
48	14	Fail	Fail	Fail	Fail
48	15	Fail	Fail	Fail	Fail
48	16	Fail	Fail	Fail	Fail
48	17	Fail	Fail	Fail	Fail
49	13	Fail	Fail	Fail	Fail
49	14	Fail	Fail	Fail	Fail
49	15	Fail	Fail	Fail	Fail
49	16	Fail	Fail	Fail	Fail
49	17	Fail	Fail	Fail	Fail
50	13	Fail	Fail	Fail	Fail
50	14	Fail	Fail	Fail	Fail
50	15	Fail	Fail	Fail	Fail
50	16	Fail	Fail	Fail	Fail
50	17	Fail	Fail	Fail	Fail
50	18	Fail	Fail	Fail	Fail
51	13	Fail	Fail	Fail	Fail
51	14	Fail	Fail	Fail	Fail
51	15	Fail	Fail	Fail	Fail
52	13	Fail	Fail	Fail	Fail
52	14	Fail	Fail	Fail	Fail
52	15	Fail	Fail	Fail	Fail
53	13	Fail	Fail	Fail	Fail
53	14	Fail	Fail	Fail	Fail
53	15	Fail	Fail	Fail	Fail
54	13	Fail	Fail	Fail	Fail
54	14	Fail	Fail	Fail	Fail
54	15	Fail	Fail	Fail	Fail
55	13	Fail	Fail	Fail	Fail
55	14	Fail	Fail	Fail	Fail
55	15	Fail	Fail	Fail	Fail
56	13	Fail	Fail	Fail	Fail
56	14	Fail	Fail	Fail	Fail
56	15	Fail	Fail	Fail	Fail
57	13	Fail	Fail	Fail	Fail
57	14	Fail	Fail	Fail	Fail

57	15	Fail	Fail	Fail	Fail
58	13	Fail	Fail	Fail	Fail
58	14	Fail	Fail	Fail	Fail
58	15	Pass	Fail	Fail	Fail
59	13	Fail	Fail	Fail	Fail
59	14	Fail	Fail	Fail	Fail
59	15	Pass	Fail	Fail	Fail
59	30	Fail	Fail	Fail	Fail
59	31	Fail	Fail	Fail	Fail
59	32	Fail	Fail	Fail	Fail
60	13	Pass	Fail	Fail	Fail
60	14	Fail	Fail	Fail	Fail
60	15	Pass	Fail	Fail	Fail
60	30	Fail	Fail	Fail	Fail
60	31	Fail	Fail	Fail	Fail
60	32	Fail	Fail	Fail	Fail
61	13	Pass	Fail	Fail	Fail
61	14	Fail	Fail	Fail	Fail
61	15	Pass	Fail	Fail	Fail
61	30	Fail	Fail	Fail	Fail
61	31	Fail	Fail	Fail	Fail
61	32	Fail	Fail	Fail	Fail
62	13	Pass	Fail	Fail	Fail
62	14	Fail	Fail	Fail	Fail
62	15	Pass	Fail	Fail	Fail
62	30	Fail	Fail	Fail	Fail
62	31	Fail	Fail	Fail	Fail
62	32	Fail	Fail	Fail	Fail
63	13	Pass	Fail	Fail	Fail
63	14	Fail	Fail	Fail	Fail
63	15	Pass	Fail	Fail	Fail
63	31	Fail	Fail	Fail	Fail
64	13	Pass	Fail	Fail	Fail
64	14	Fail	Fail	Fail	Fail
64	15	Pass	Fail	Fail	Fail
64	30	Fail	Fail	Fail	Fail
64	31	Fail	Fail	Fail	Fail
64	32	Fail	Fail	Fail	Fail
65	13	Pass	Fail	Fail	Fail
65	14	Fail	Fail	Fail	Fail
65	15	Pass	Fail	Fail	Fail
65	30	Fail	Fail	Fail	Fail
65	31	Fail	Fail	Fail	Fail
65	32	Fail	Fail	Fail	Fail
65	33	Fail	Fail	Fail	Fail
66	13	Pass	Fail	Fail	Fail
66	14	Fail	Fail	Fail	Fail
66	15	Pass	Fail	Pass	Fail
66	30	Fail	Fail	Fail	Fail
66	31	Fail	Fail	Fail	Fail
66	32	Fail	Fail	Fail	Fail
66	36	Fail	Fail	Fail	Fail
67	13	Pass	Fail	Fail	Fail
67	14	Fail	Fail	Fail	Fail
67	15	Pass	Fail	Pass	Fail
67	30	Fail	Fail	Fail	Fail
67	31	Fail	Fail	Fail	Fail

67	32	Fail	Fail	Fail	Fail
67	36	Fail	Fail	Fail	Fail
68	13	Pass	Fail	Fail	Fail
68	14	Fail	Fail	Fail	Fail
68	15	Pass	Pass	Pass	Pass
68	30	Fail	Fail	Fail	Fail
68	31	Fail	Fail	Fail	Fail
68	32	Fail	Fail	Fail	Fail
68	36	Fail	Fail	Fail	Fail
69	13	Pass	Fail	Fail	Fail
69	14	Fail	Fail	Fail	Fail
69	15	Pass	Fail	Fail	Fail
69	30	Fail	Fail	Fail	Fail
69	31	Fail	Fail	Fail	Fail
69	32	Fail	Fail	Fail	Fail
69	36	Fail	Fail	Fail	Fail
70	13	Pass	Fail	Pass	Fail
70	14	Fail	Fail	Fail	Fail
70	15	Pass	Fail	Pass	Fail
70	30	Pass	Fail	Fail	Fail
70	31	Pass	Fail	Fail	Fail
70	32	Pass	Fail	Fail	Fail
70	33	Fail	Fail	Fail	Fail
71	13	Pass	Fail	Fail	Fail
71	14	Fail	Fail	Fail	Fail
71	15	Pass	Fail	Pass	Fail
71	30	Pass	Fail	Fail	Fail
71	31	Pass	Fail	Fail	Fail
71	32	Pass	Fail	Fail	Fail
72	13	Pass	Fail	Fail	Fail
72	14	Pass	Fail	Fail	Fail
72	15	Pass	Fail	Pass	Fail
72	30	Pass	Fail	Fail	Fail
72	31	Pass	Fail	Fail	Fail
72	32	Pass	Fail	Fail	Fail
73	13	Pass	Fail	Fail	Fail
73	14	Pass	Fail	Fail	Fail
73	15	Pass	Fail	Pass	Fail
73	30	Pass	Fail	Fail	Fail
73	31	Pass	Fail	Fail	Fail
74	13	Pass	Fail	Pass	Fail
74	14	Pass	Fail	Fail	Fail
74	15	Pass	Pass	Pass	Pass
74	30	Pass	Fail	Pass	Fail
74	31	Pass	Fail	Fail	Fail
75	13	Pass	Fail	Pass	Fail
75	14	Pass	Fail	Fail	Fail
75	15	Pass	Pass	Pass	Fail
75	30	Pass	Fail	Pass	Fail
75	31	Pass	Fail	Fail	Fail
76	13	Pass	Pass	Pass	Fail
76	14	Pass	Pass	Fail	Fail
76	15	Pass	Fail	Fail	Fail
76	16	Pass	Fail	Fail	Fail
76	17	Pass	Fail	Fail	Fail
76	30	Pass	Fail	Pass	Fail
76	31	Pass	Fail	Pass	Fail

77	13	Pass	Pass	Pass	Fail
77	14	Pass	Pass	Fail	Fail
77	15	Pass	Fail	Fail	Fail
77	16	Pass	Fail	Fail	Fail
77	17	Pass	Fail	Fail	Fail
77	30	Pass	Fail	Pass	Fail
77	31	Pass	Fail	Pass	Fail
78	13	Pass	Pass	Pass	Fail
78	14	Pass	Pass	Fail	Fail
78	15	Pass	Fail	Fail	Fail
78	16	Pass	Fail	Fail	Fail
78	17	Pass	Fail	Fail	Fail
78	30	Pass	Fail	Pass	Fail
78	31	Pass	Fail	Pass	Fail
79	13	Pass	Pass	Pass	Pass
79	14	Pass	Pass	Fail	Fail
79	15	Pass	Fail	Fail	Fail
79	30	Pass	Fail	Pass	Fail
79	31	Pass	Fail	Pass	Fail
80	13	Pass	Pass	Pass	Pass
80	14	Pass	Pass	Fail	Fail
80	15	Pass	Pass	Pass	Fail
80	30	Pass	Fail	Pass	Fail
80	31	Pass	Fail	Pass	Fail
81	13	Pass	Pass	Pass	Fail
81	14	Pass	Pass	Fail	Fail
81	15	Pass	Pass	Pass	Pass
81	30	Pass	Fail	Pass	Fail
81	31	Pass	Fail	Pass	Fail
82	13	Pass	Pass	Pass	Fail
82	14	Pass	Pass	Fail	Fail
82	15	Pass	Pass	Pass	Pass
82	16	Pass	Pass	Pass	Pass
82	17	Pass	Pass	Pass	Pass
82	18	Pass	Pass	Pass	Pass
82	19	Fail	Pass	Pass	Pass
82	20	Fail	Pass	Pass	Pass
82	21	Fail	Pass	Pass	Pass
82	29	Pass	Fail	Pass	Fail
82	30	Pass	Fail	Pass	Fail
82	31	Pass	Fail	Pass	Fail
83	13	Pass	Pass	Pass	Fail
83	14	Pass	Pass	Fail	Fail
83	15	Pass	Pass	Pass	Pass
83	21	Fail	Pass	Pass	Pass
83	30	Pass	Fail	Pass	Fail
83	31	Fail	Fail	Pass	Fail
84	13	Pass	Pass	Pass	Fail
84	14	Pass	Pass	Fail	Fail
84	15	Pass	Pass	Pass	Pass
84	21	Fail	Pass	Pass	Pass
84	30	Fail	Fail	Pass	Fail
84	31	Fail	Fail	Pass	Fail
85	13	Pass	Pass	Pass	Pass
85	14	Pass	Pass	Pass	Fail
85	15	Fail	Pass	Pass	Pass
85	21	Fail	Pass	Pass	Pass

85	30	Fail	Fail	Pass	Fail
86	13	Fail	Pass	Pass	Fail
86	14	Pass	Pass	Pass	Fail
86	15	Fail	Pass	Pass	Pass
86	21	Fail	Pass	Pass	Pass
86	30	Fail	Fail	Pass	Fail
87	13	Fail	Pass	Pass	Fail
87	14	Pass	Pass	Pass	Fail
87	15	Fail	Pass	Pass	Pass
87	30	Fail	Fail	Pass	Fail
88	13	Fail	Pass	Pass	Pass
88	14	Pass	Pass	Pass	Fail
88	15	Fail	Pass	Pass	Pass
88	30	Fail	Fail	Pass	Fail
89	13	Fail	Pass	Pass	Pass
89	14	Fail	Pass	Pass	Fail
89	15	Fail	Pass	Pass	Pass
89	30	Fail	Fail	Fail	Fail
90	13	Fail	Pass	Pass	Pass
90	14	Fail	Pass	Pass	Fail
90	15	Fail	Pass	Pass	Pass
90	30	Fail	Fail	Fail	Fail
91	13	Fail	Pass	Pass	Pass
91	14	Fail	Pass	Pass	Fail
91	15	Fail	Pass	Pass	Pass
91	16	Fail	Pass	Pass	Pass
91	30	Fail	Fail	Fail	Fail
92	13	Fail	Pass	Pass	Pass
92	14	Fail	Pass	Pass	Pass
92	15	Fail	Pass	Pass	Pass
92	16	Fail	Pass	Pass	Pass
92	30	Fail	Fail	Fail	Fail
93	13	Fail	Pass	Pass	Pass
93	14	Fail	Pass	Pass	Pass
93	15	Fail	Pass	Pass	Pass
93	16	Fail	Pass	Pass	Pass
93	30	Fail	Fail	Fail	Fail
94	13	Fail	Pass	Pass	Pass
94	14	Fail	Pass	Pass	Pass
94	15	Fail	Pass	Pass	Pass
94	16	Fail	Pass	Pass	Pass
94	26	Fail	Pass	Fail	Pass
94	30	Fail	Fail	Fail	Fail
95	13	Fail	Pass	Pass	Pass
95	14	Fail	Pass	Pass	Pass
95	15	Fail	Pass	Pass	Pass
95	16	Fail	Pass	Pass	Pass
95	26	Fail	Pass	Fail	Pass
95	30	Fail	Fail	Fail	Fail
96	13	Fail	Pass	Pass	Pass
96	14	Fail	Pass	Pass	Pass
96	15	Fail	Pass	Pass	Pass
96	26	Fail	Pass	Fail	Pass
96	30	Fail	Pass	Fail	Fail
97	13	Fail	Pass	Pass	Pass
97	14	Fail	Pass	Pass	Pass
97	15	Fail	Pass	Pass	Pass

97	26	Fail	Pass	Fail	Pass
97	30	Fail	Fail	Fail	Fail
98	13	Fail	Pass	Pass	Pass
98	14	Fail	Pass	Pass	Pass
98	15	Fail	Pass	Pass	Pass
98	26	Fail	Pass	Fail	Pass
98	27	Fail	Fail	Fail	Fail
98	28	Fail	Fail	Fail	Fail
98	29	Fail	Fail	Fail	Fail
98	30	Fail	Pass	Fail	Fail
99	13	Fail	Pass	Pass	Pass
99	14	Fail	Pass	Pass	Pass
99	15	Fail	Pass	Pass	Pass
99	16	Fail	Pass	Pass	Pass
99	17	Fail	Pass	Pass	Pass
99	18	Fail	Pass	Pass	Pass
99	19	Fail	Pass	Pass	Pass
99	20	Fail	Pass	Pass	Pass
99	21	Fail	Pass	Fail	Pass
99	22	Fail	Pass	Fail	Pass
99	23	Fail	Pass	Fail	Pass
99	26	Fail	Pass	Fail	Pass
99	30	Fail	Pass	Fail	Fail
100	13	Fail	Pass	Fail	Pass
100	14	Fail	Pass	Pass	Pass
100	15	Fail	Pass	Pass	Pass
100	23	Fail	Pass	Fail	Pass
100	24	Fail	Pass	Fail	Pass
100	25	Fail	Pass	Fail	Pass
100	26	Fail	Pass	Fail	Pass
100	30	Fail	Pass	Fail	Fail
101	13	Fail	Pass	Fail	Pass
101	14	Fail	Pass	Pass	Pass
101	15	Fail	Pass	Pass	Pass
101	16	Fail	Pass	Pass	Pass
101	17	Fail	Pass	Pass	Pass
101	18	Fail	Pass	Pass	Pass
101	19	Fail	Pass	Pass	Pass
101	20	Fail	Pass	Pass	Pass
101	21	Fail	Pass	Fail	Pass
101	22	Fail	Pass	Fail	Pass
101	23	Fail	Pass	Fail	Pass
101	26	Fail	Pass	Fail	Pass
101	30	Fail	Pass	Fail	Fail
102	13	Fail	Pass	Fail	Pass
102	14	Fail	Pass	Fail	Pass
102	15	Fail	Pass	Fail	Pass
102	26	Fail	Pass	Fail	Pass
102	30	Fail	Pass	Fail	Fail
103	13	Fail	Pass	Fail	Pass
103	14	Fail	Pass	Fail	Pass
103	15	Fail	Pass	Fail	Pass
103	26	Fail	Pass	Fail	Pass
103	30	Fail	Pass	Fail	Fail
104	13	Fail	Pass	Fail	Pass
104	14	Fail	Pass	Fail	Pass
104	15	Fail	Pass	Fail	Pass

104	26	Fail	Pass	Fail	Pass
104	30	Fail	Pass	Fail	Fail
105	13	Fail	Pass	Fail	Pass
105	14	Fail	Pass	Fail	Pass
105	15	Fail	Pass	Fail	Pass
105	26	Fail	Pass	Fail	Pass
105	30	Fail	Pass	Fail	Fail
106	13	Fail	Pass	Fail	Pass
106	14	Fail	Pass	Fail	Pass
106	15	Fail	Pass	Fail	Pass
106	26	Fail	Pass	Fail	Pass
106	27	Fail	Pass	Fail	Pass
106	30	Fail	Pass	Fail	Fail
106	39	Fail	Pass	Fail	Fail
107	13	Fail	Pass	Fail	Pass
107	14	Fail	Pass	Fail	Pass
107	15	Fail	Pass	Fail	Pass
107	22	Fail	Pass	Fail	Pass
107	26	Fail	Pass	Fail	Pass
107	30	Fail	Pass	Fail	Fail
107	39	Fail	Pass	Fail	Pass
108	13	Fail	Pass	Fail	Pass
108	14	Fail	Pass	Fail	Pass
108	15	Fail	Pass	Fail	Pass
108	22	Fail	Pass	Fail	Pass
108	26	Fail	Pass	Fail	Pass
108	30	Fail	Pass	Fail	Fail
108	39	Fail	Pass	Fail	Pass
109	13	Fail	Pass	Fail	Pass
109	14	Fail	Pass	Fail	Pass
109	15	Fail	Pass	Fail	Pass
109	22	Fail	Pass	Fail	Pass
109	26	Fail	Pass	Fail	Pass
109	30	Fail	Pass	Fail	Pass
109	39	Fail	Pass	Fail	Pass
110	13	Fail	Pass	Fail	Pass
110	14	Fail	Pass	Fail	Pass
110	15	Fail	Pass	Fail	Pass
110	22	Fail	Pass	Fail	Pass
110	26	Fail	Pass	Fail	Pass
110	39	Fail	Pass	Fail	Pass
111	13	Fail	Pass	Fail	Pass
111	14	Fail	Pass	Fail	Pass
111	15	Fail	Pass	Fail	Pass
111	22	Fail	Pass	Fail	Pass
111	26	Fail	Pass	Fail	Pass
111	39	Fail	Pass	Fail	Pass
112	13	Fail	Pass	Fail	Pass
112	14	Fail	Pass	Fail	Pass
112	15	Fail	Pass	Fail	Pass
112	22	Fail	Pass	Fail	Pass
112	26	Fail	Pass	Fail	Pass
112	39	Fail	Pass	Fail	Pass
113	13	Fail	Pass	Fail	Pass
113	14	Fail	Pass	Fail	Pass
113	15	Fail	Pass	Fail	Pass
113	26	Fail	Pass	Fail	Pass

113	27	Fail	Pass	Fail	Pass
113	39	Fail	Pass	Fail	Pass
114	13	Fail	Pass	Fail	Pass
114	14	Fail	Pass	Fail	Pass
114	15	Fail	Pass	Fail	Pass
114	26	Fail	Pass	Fail	Pass
114	39	Fail	Pass	Fail	Pass
115	13	Fail	Pass	Fail	Pass
115	14	Fail	Pass	Fail	Pass
115	15	Fail	Pass	Fail	Pass
115	26	Fail	Pass	Fail	Pass
115	39	Fail	Pass	Fail	Pass
116	13	Fail	Pass	Fail	Pass
116	14	Fail	Pass	Fail	Pass
116	15	Fail	Pass	Fail	Pass
116	26	Fail	Pass	Fail	Pass
116	39	Fail	Pass	Fail	Pass
117	13	Fail	Pass	Fail	Pass
117	14	Fail	Pass	Fail	Pass
117	15	Fail	Pass	Fail	Pass
117	26	Fail	Pass	Fail	Pass
117	39	Fail	Pass	Fail	Pass
118	13	Fail	Pass	Fail	Pass
118	14	Fail	Pass	Fail	Pass
118	15	Fail	Pass	Fail	Pass
118	20	Fail	Pass	Fail	Pass
118	26	Fail	Pass	Fail	Pass
118	39	Fail	Pass	Fail	Pass
119	13	Fail	Pass	Fail	Pass
119	14	Fail	Pass	Fail	Pass
119	15	Fail	Pass	Fail	Pass
119	20	Fail	Pass	Fail	Pass
119	26	Fail	Pass	Fail	Pass
119	39	Fail	Pass	Fail	Pass
120	13	Fail	Pass	Fail	Pass
120	14	Fail	Pass	Fail	Pass
120	15	Fail	Pass	Fail	Pass
120	16	Fail	Pass	Fail	Pass
120	26	Fail	Pass	Fail	Pass
120	39	Fail	Pass	Fail	Pass
121	13	Fail	Pass	Fail	Pass
121	14	Fail	Pass	Fail	Pass
121	26	Fail	Pass	Fail	Pass
121	39	Fail	Pass	Fail	Pass
122	13	Fail	Pass	Fail	Pass
122	14	Fail	Pass	Fail	Pass
122	26	Fail	Pass	Fail	Pass
122	39	Fail	Pass	Fail	Pass
123	13	Fail	Pass	Fail	Pass
123	14	Fail	Pass	Fail	Pass
123	15	Fail	Pass	Fail	Pass
123	16	Fail	Pass	Fail	Pass
123	17	Fail	Pass	Fail	Pass
123	18	Fail	Pass	Fail	Pass
123	19	Fail	Pass	Fail	Pass
123	20	Fail	Pass	Fail	Pass
123	21	Fail	Pass	Fail	Pass

123	22	Fail	Pass	Fail	Pass
123	23	Fail	Pass	Fail	Pass
123	24	Fail	Pass	Fail	Pass
123	25	Fail	Pass	Fail	Pass
123	26	Fail	Pass	Fail	Pass
123	27	Fail	Pass	Fail	Pass
123	28	Fail	Pass	Fail	Pass
123	29	Fail	Pass	Fail	Pass
123	30	Fail	Pass	Fail	Pass
123	31	Fail	Pass	Fail	Pass
123	32	Fail	Pass	Fail	Pass
123	33	Fail	Pass	Fail	Pass
123	34	Fail	Pass	Fail	Pass
123	35	Fail	Pass	Fail	Pass
123	36	Fail	Pass	Fail	Pass
123	37	Fail	Pass	Fail	Pass
123	38	Fail	Pass	Fail	Pass
123	39	Fail	Pass	Fail	Pass
124	13	Fail	Pass	Fail	Pass
124	14	Fail	Pass	Fail	Pass
124	23	Fail	Pass	Fail	Pass
125	13	Fail	Pass	Fail	Pass
125	14	Fail	Pass	Fail	Pass
125	23	Fail	Pass	Fail	Pass
126	13	Fail	Pass	Fail	Pass
126	14	Fail	Pass	Fail	Pass
126	23	Fail	Pass	Fail	Pass
127	13	Fail	Pass	Fail	Pass
127	14	Fail	Pass	Fail	Pass
127	23	Fail	Pass	Fail	Pass
128	13	Fail	Pass	Fail	Pass
128	14	Fail	Pass	Fail	Pass
128	23	Fail	Pass	Fail	Pass
129	13	Fail	Pass	Fail	Pass
129	14	Fail	Pass	Fail	Pass
129	23	Fail	Pass	Fail	Pass
130	8	Fail	Fail	Fail	Fail
130	9	Fail	Fail	Fail	Fail
130	10	Fail	Pass	Fail	Pass
130	11	Fail	Pass	Fail	Pass
130	12	Fail	Pass	Fail	Pass
130	13	Fail	Pass	Fail	Pass
130	14	Fail	Pass	Fail	Pass
130	23	Fail	Pass	Fail	Pass
131	14	Fail	Pass	Fail	Pass
131	23	Fail	Pass	Fail	Pass
132	14	Fail	Pass	Fail	Pass
132	23	Fail	Pass	Fail	Pass
133	14	Fail	Pass	Fail	Pass
133	23	Fail	Pass	Fail	Pass
134	14	Fail	Pass	Fail	Pass
134	23	Fail	Pass	Fail	Pass
135	14	Fail	Pass	Fail	Pass
136	14	Fail	Pass	Fail	Pass
137	14	Fail	Pass	Fail	Pass
138	14	Fail	Pass	Fail	Pass

2. Table F.7.2 Striped Bass Larvae salinity and D.O. criteria passing for existing and deepening (4 ft) scenarios within the analyzed period May 1 - May 31, 1997

HABITAT REQUIREMENTS:
RM 10-31; Depth Average
D.O. May (MG/L):10th %ile >=4.5
Salinity 50th %ile >=3 & <= 9 ppt

Savannah Harbor Estuary
Analyzed period: MAY 1 - MAY 31, Year 1997

Segments J	Segments I	Baseline Scenario Salinity	Baseline Scenario D.O.	Project Scenario Salinity	Project Scenario D.O.
47	13	Fail	Fail	Fail	Fail
47	14	Fail	Fail	Fail	Fail
47	15	Fail	Fail	Fail	Fail
47	16	Fail	Fail	Fail	Fail
47	17	Fail	Fail	Fail	Fail
48	13	Fail	Fail	Fail	Fail
48	14	Fail	Fail	Fail	Fail
48	15	Fail	Fail	Fail	Fail
48	16	Fail	Fail	Fail	Fail
48	17	Fail	Fail	Fail	Fail
49	13	Fail	Fail	Fail	Fail
49	14	Fail	Fail	Fail	Fail
49	15	Fail	Fail	Fail	Fail
49	16	Fail	Fail	Fail	Fail
49	17	Fail	Fail	Fail	Fail
50	13	Fail	Fail	Fail	Fail
50	14	Fail	Fail	Fail	Fail
50	15	Fail	Fail	Fail	Fail
50	16	Fail	Fail	Fail	Fail
50	17	Fail	Fail	Fail	Fail
50	18	Fail	Fail	Fail	Fail
51	13	Fail	Fail	Fail	Fail
51	14	Fail	Fail	Fail	Fail
51	15	Fail	Fail	Fail	Fail
52	13	Fail	Fail	Fail	Fail
52	14	Fail	Fail	Fail	Fail
52	15	Fail	Fail	Fail	Fail
53	13	Fail	Fail	Fail	Fail
53	14	Fail	Fail	Fail	Fail
53	15	Fail	Fail	Fail	Fail
54	13	Fail	Fail	Fail	Fail
54	14	Fail	Fail	Fail	Fail
54	15	Fail	Fail	Fail	Fail
55	13	Fail	Fail	Fail	Fail
55	14	Fail	Fail	Fail	Fail
55	15	Fail	Fail	Fail	Fail
56	13	Fail	Fail	Fail	Fail
56	14	Fail	Fail	Fail	Fail
56	15	Fail	Fail	Fail	Fail
57	13	Fail	Fail	Fail	Fail
57	14	Fail	Fail	Fail	Fail

57	15	Fail	Fail	Fail	Fail
58	13	Fail	Fail	Fail	Fail
58	14	Fail	Fail	Fail	Fail
58	15	Pass	Fail	Fail	Fail
59	13	Fail	Fail	Fail	Fail
59	14	Fail	Fail	Fail	Fail
59	15	Pass	Fail	Fail	Fail
59	30	Fail	Fail	Fail	Fail
59	31	Fail	Fail	Fail	Fail
59	32	Fail	Fail	Fail	Fail
60	13	Pass	Fail	Fail	Fail
60	14	Fail	Fail	Fail	Fail
60	15	Pass	Fail	Fail	Fail
60	30	Fail	Fail	Fail	Fail
60	31	Fail	Fail	Fail	Fail
60	32	Fail	Fail	Fail	Fail
61	13	Pass	Fail	Fail	Fail
61	14	Fail	Fail	Fail	Fail
61	15	Pass	Fail	Pass	Fail
61	30	Fail	Fail	Fail	Fail
61	31	Fail	Fail	Fail	Fail
61	32	Fail	Fail	Fail	Fail
62	13	Pass	Fail	Fail	Fail
62	14	Fail	Fail	Fail	Fail
62	15	Pass	Fail	Pass	Fail
62	30	Fail	Fail	Fail	Fail
62	31	Fail	Fail	Fail	Fail
62	32	Fail	Fail	Fail	Fail
63	13	Pass	Fail	Fail	Fail
63	14	Fail	Fail	Fail	Fail
63	15	Pass	Fail	Pass	Fail
63	31	Fail	Fail	Fail	Fail
64	13	Pass	Fail	Fail	Fail
64	14	Fail	Fail	Fail	Fail
64	15	Pass	Fail	Pass	Fail
64	30	Fail	Fail	Fail	Fail
64	31	Fail	Fail	Fail	Fail
64	32	Fail	Fail	Fail	Fail
65	13	Pass	Fail	Fail	Fail
65	14	Fail	Fail	Fail	Fail
65	15	Pass	Fail	Pass	Fail
65	30	Fail	Fail	Fail	Fail
65	31	Fail	Fail	Fail	Fail
65	32	Fail	Fail	Fail	Fail
65	33	Fail	Fail	Fail	Fail
66	13	Pass	Fail	Pass	Fail
66	14	Fail	Fail	Fail	Fail
66	15	Pass	Fail	Pass	Fail
66	30	Fail	Fail	Fail	Fail
66	31	Fail	Fail	Fail	Fail
66	32	Fail	Fail	Fail	Fail
66	36	Fail	Fail	Fail	Fail
67	13	Pass	Fail	Pass	Fail
67	14	Fail	Fail	Fail	Fail
67	15	Pass	Fail	Pass	Fail
67	30	Fail	Fail	Fail	Fail
67	31	Fail	Fail	Fail	Fail

67	32	Fail	Fail	Fail	Fail
67	36	Fail	Fail	Fail	Fail
68	13	Pass	Fail	Pass	Fail
68	14	Fail	Fail	Fail	Fail
68	15	Pass	Pass	Pass	Fail
68	30	Fail	Fail	Fail	Fail
68	31	Fail	Fail	Fail	Fail
68	32	Fail	Fail	Fail	Fail
68	36	Fail	Fail	Fail	Fail
69	13	Pass	Fail	Pass	Fail
69	14	Fail	Fail	Fail	Fail
69	15	Pass	Fail	Pass	Fail
69	30	Fail	Fail	Fail	Fail
69	31	Fail	Fail	Fail	Fail
69	32	Fail	Fail	Fail	Fail
69	36	Fail	Fail	Fail	Fail
70	13	Pass	Fail	Pass	Fail
70	14	Fail	Fail	Fail	Fail
70	15	Pass	Fail	Pass	Fail
70	30	Pass	Fail	Fail	Fail
70	31	Pass	Fail	Fail	Fail
70	32	Pass	Fail	Fail	Fail
70	33	Fail	Fail	Fail	Fail
71	13	Pass	Fail	Pass	Fail
71	14	Fail	Fail	Fail	Fail
71	15	Pass	Fail	Pass	Fail
71	30	Pass	Fail	Fail	Fail
71	31	Pass	Fail	Fail	Fail
71	32	Pass	Fail	Fail	Fail
72	13	Pass	Fail	Pass	Fail
72	14	Pass	Fail	Fail	Fail
72	15	Pass	Fail	Pass	Fail
72	30	Pass	Fail	Fail	Fail
72	31	Pass	Fail	Fail	Fail
72	32	Pass	Fail	Fail	Fail
73	13	Pass	Fail	Pass	Fail
73	14	Pass	Fail	Fail	Fail
73	15	Pass	Fail	Pass	Fail
73	30	Pass	Fail	Pass	Fail
73	31	Pass	Fail	Fail	Fail
74	13	Pass	Fail	Pass	Fail
74	14	Pass	Fail	Fail	Fail
74	15	Pass	Pass	Pass	Pass
74	30	Pass	Fail	Pass	Fail
74	31	Pass	Fail	Fail	Fail
75	13	Pass	Fail	Pass	Fail
75	14	Pass	Fail	Fail	Fail
75	15	Pass	Pass	Pass	Pass
75	30	Pass	Fail	Pass	Fail
75	31	Pass	Fail	Pass	Fail
76	13	Pass	Pass	Pass	Fail
76	14	Pass	Pass	Fail	Fail
76	15	Pass	Fail	Fail	Fail
76	16	Pass	Fail	Fail	Fail
76	17	Pass	Fail	Pass	Fail
76	30	Pass	Fail	Pass	Fail
76	31	Pass	Fail	Pass	Fail

77	13	Pass	Pass	Pass	Fail
77	14	Pass	Pass	Fail	Fail
77	15	Pass	Fail	Fail	Fail
77	16	Pass	Fail	Fail	Fail
77	17	Pass	Fail	Pass	Fail
77	30	Pass	Fail	Pass	Fail
77	31	Pass	Fail	Pass	Fail
78	13	Pass	Pass	Pass	Pass
78	14	Pass	Pass	Fail	Fail
78	15	Pass	Fail	Fail	Fail
78	16	Pass	Fail	Fail	Fail
78	17	Pass	Fail	Pass	Fail
78	30	Pass	Fail	Pass	Fail
78	31	Pass	Fail	Pass	Fail
79	13	Pass	Pass	Pass	Pass
79	14	Pass	Pass	Fail	Fail
79	15	Pass	Fail	Pass	Fail
79	30	Pass	Fail	Pass	Fail
79	31	Pass	Fail	Pass	Fail
80	13	Pass	Pass	Pass	Pass
80	14	Pass	Pass	Pass	Fail
80	15	Pass	Pass	Pass	Fail
80	30	Pass	Fail	Pass	Fail
80	31	Pass	Fail	Pass	Fail
81	13	Pass	Pass	Pass	Pass
81	14	Pass	Pass	Pass	Fail
81	15	Pass	Pass	Pass	Pass
81	30	Pass	Fail	Pass	Fail
81	31	Pass	Fail	Pass	Fail
82	13	Pass	Pass	Pass	Fail
82	14	Pass	Pass	Pass	Fail
82	15	Pass	Pass	Pass	Pass
82	16	Pass	Pass	Pass	Pass
82	17	Pass	Pass	Pass	Pass
82	18	Pass	Pass	Pass	Pass
82	19	Fail	Pass	Pass	Pass
82	20	Fail	Pass	Pass	Pass
82	21	Fail	Pass	Pass	Pass
82	29	Pass	Fail	Pass	Fail
82	30	Pass	Fail	Pass	Fail
82	31	Pass	Fail	Pass	Fail
83	13	Pass	Pass	Pass	Fail
83	14	Pass	Pass	Pass	Fail
83	15	Pass	Pass	Pass	Pass
83	21	Fail	Pass	Pass	Pass
83	30	Pass	Fail	Pass	Fail
83	31	Fail	Fail	Pass	Fail
84	13	Pass	Pass	Pass	Pass
84	14	Pass	Pass	Pass	Pass
84	15	Pass	Pass	Pass	Pass
84	21	Fail	Pass	Pass	Pass
84	30	Fail	Fail	Pass	Fail
84	31	Fail	Fail	Pass	Fail
85	13	Pass	Pass	Pass	Pass
85	14	Pass	Pass	Pass	Pass
85	15	Fail	Pass	Pass	Pass
85	21	Fail	Pass	Pass	Pass

85	30	Fail	Fail	Pass	Fail
86	13	Fail	Pass	Pass	Pass
86	14	Pass	Pass	Pass	Pass
86	15	Fail	Pass	Pass	Pass
86	21	Fail	Pass	Fail	Pass
86	30	Fail	Fail	Fail	Fail
87	13	Fail	Pass	Pass	Pass
87	14	Pass	Pass	Pass	Pass
87	15	Fail	Pass	Pass	Pass
87	30	Fail	Fail	Fail	Fail
88	13	Fail	Pass	Pass	Pass
88	14	Pass	Pass	Pass	Pass
88	15	Fail	Pass	Pass	Pass
88	30	Fail	Fail	Fail	Fail
89	13	Fail	Pass	Pass	Pass
89	14	Fail	Pass	Pass	Pass
89	15	Fail	Pass	Pass	Pass
89	30	Fail	Fail	Fail	Fail
90	13	Fail	Pass	Pass	Pass
90	14	Fail	Pass	Pass	Pass
90	15	Fail	Pass	Pass	Pass
90	30	Fail	Fail	Fail	Fail
91	13	Fail	Pass	Pass	Pass
91	14	Fail	Pass	Pass	Pass
91	15	Fail	Pass	Pass	Pass
91	16	Fail	Pass	Pass	Pass
91	30	Fail	Fail	Fail	Fail
92	13	Fail	Pass	Pass	Pass
92	14	Fail	Pass	Pass	Pass
92	15	Fail	Pass	Pass	Pass
92	16	Fail	Pass	Pass	Pass
92	30	Fail	Fail	Fail	Fail
93	13	Fail	Pass	Pass	Pass
93	14	Fail	Pass	Pass	Pass
93	15	Fail	Pass	Pass	Pass
93	16	Fail	Pass	Pass	Pass
93	30	Fail	Fail	Fail	Fail
94	13	Fail	Pass	Pass	Pass
94	14	Fail	Pass	Pass	Pass
94	15	Fail	Pass	Pass	Pass
94	16	Fail	Pass	Pass	Pass
94	26	Fail	Pass	Fail	Pass
94	30	Fail	Fail	Fail	Fail
95	13	Fail	Pass	Pass	Pass
95	14	Fail	Pass	Pass	Pass
95	15	Fail	Pass	Pass	Pass
95	16	Fail	Pass	Pass	Pass
95	26	Fail	Pass	Fail	Pass
95	30	Fail	Fail	Fail	Fail
96	13	Fail	Pass	Pass	Pass
96	14	Fail	Pass	Pass	Pass
96	15	Fail	Pass	Pass	Pass
96	26	Fail	Pass	Fail	Pass
96	30	Fail	Pass	Fail	Fail
97	13	Fail	Pass	Pass	Pass
97	14	Fail	Pass	Pass	Pass
97	15	Fail	Pass	Fail	Pass

97	26	Fail	Pass	Fail	Pass
97	30	Fail	Fail	Fail	Fail
98	13	Fail	Pass	Pass	Pass
98	14	Fail	Pass	Pass	Pass
98	15	Fail	Pass	Fail	Pass
98	26	Fail	Pass	Fail	Pass
98	27	Fail	Fail	Fail	Fail
98	28	Fail	Fail	Fail	Fail
98	29	Fail	Fail	Fail	Fail
98	30	Fail	Pass	Fail	Fail
99	13	Fail	Pass	Fail	Pass
99	14	Fail	Pass	Pass	Pass
99	15	Fail	Pass	Pass	Pass
99	16	Fail	Pass	Pass	Pass
99	17	Fail	Pass	Pass	Pass
99	18	Fail	Pass	Pass	Pass
99	19	Fail	Pass	Pass	Pass
99	20	Fail	Pass	Fail	Pass
99	21	Fail	Pass	Fail	Pass
99	22	Fail	Pass	Fail	Pass
99	23	Fail	Pass	Fail	Pass
99	26	Fail	Pass	Fail	Pass
99	30	Fail	Pass	Fail	Fail
100	13	Fail	Pass	Fail	Pass
100	14	Fail	Pass	Pass	Pass
100	15	Fail	Pass	Pass	Pass
100	23	Fail	Pass	Fail	Pass
100	24	Fail	Pass	Fail	Pass
100	25	Fail	Pass	Fail	Pass
100	26	Fail	Pass	Fail	Pass
100	30	Fail	Pass	Fail	Fail
101	13	Fail	Pass	Fail	Pass
101	14	Fail	Pass	Fail	Pass
101	15	Fail	Pass	Fail	Pass
101	16	Fail	Pass	Pass	Pass
101	17	Fail	Pass	Pass	Pass
101	18	Fail	Pass	Pass	Pass
101	19	Fail	Pass	Fail	Pass
101	20	Fail	Pass	Fail	Pass
101	21	Fail	Pass	Fail	Pass
101	22	Fail	Pass	Fail	Pass
101	23	Fail	Pass	Fail	Pass
101	26	Fail	Pass	Fail	Pass
101	30	Fail	Pass	Fail	Fail
102	13	Fail	Pass	Fail	Pass
102	14	Fail	Pass	Fail	Pass
102	15	Fail	Pass	Fail	Pass
102	26	Fail	Pass	Fail	Pass
102	30	Fail	Pass	Fail	Fail
103	13	Fail	Pass	Fail	Pass
103	14	Fail	Pass	Fail	Pass
103	15	Fail	Pass	Fail	Pass
103	26	Fail	Pass	Fail	Pass
103	30	Fail	Pass	Fail	Fail
104	13	Fail	Pass	Fail	Pass
104	14	Fail	Pass	Fail	Pass
104	15	Fail	Pass	Fail	Pass

104	26	Fail	Pass	Fail	Pass
104	30	Fail	Pass	Fail	Pass
105	13	Fail	Pass	Fail	Pass
105	14	Fail	Pass	Fail	Pass
105	15	Fail	Pass	Fail	Pass
105	26	Fail	Pass	Fail	Pass
105	30	Fail	Pass	Fail	Pass
106	13	Fail	Pass	Fail	Pass
106	14	Fail	Pass	Fail	Pass
106	15	Fail	Pass	Fail	Pass
106	26	Fail	Pass	Fail	Pass
106	27	Fail	Pass	Fail	Pass
106	30	Fail	Pass	Fail	Pass
106	39	Fail	Pass	Fail	Pass
107	13	Fail	Pass	Fail	Pass
107	14	Fail	Pass	Fail	Pass
107	15	Fail	Pass	Fail	Pass
107	22	Fail	Pass	Fail	Pass
107	26	Fail	Pass	Fail	Pass
107	30	Fail	Pass	Fail	Pass
107	39	Fail	Pass	Fail	Pass
108	13	Fail	Pass	Fail	Pass
108	14	Fail	Pass	Fail	Pass
108	15	Fail	Pass	Fail	Pass
108	22	Fail	Pass	Fail	Pass
108	26	Fail	Pass	Fail	Pass
108	30	Fail	Pass	Fail	Pass
108	39	Fail	Pass	Fail	Pass
109	13	Fail	Pass	Fail	Pass
109	14	Fail	Pass	Fail	Pass
109	15	Fail	Pass	Fail	Pass
109	22	Fail	Pass	Fail	Pass
109	26	Fail	Pass	Fail	Pass
109	30	Fail	Pass	Fail	Pass
109	39	Fail	Pass	Fail	Pass
110	13	Fail	Pass	Fail	Pass
110	14	Fail	Pass	Fail	Pass
110	15	Fail	Pass	Fail	Pass
110	22	Fail	Pass	Fail	Pass
110	26	Fail	Pass	Fail	Pass
110	39	Fail	Pass	Fail	Pass
111	13	Fail	Pass	Fail	Pass
111	14	Fail	Pass	Fail	Pass
111	15	Fail	Pass	Fail	Pass
111	22	Fail	Pass	Fail	Pass
111	26	Fail	Pass	Fail	Pass
111	39	Fail	Pass	Fail	Pass
112	13	Fail	Pass	Fail	Pass
112	14	Fail	Pass	Fail	Pass
112	15	Fail	Pass	Fail	Pass
112	22	Fail	Pass	Fail	Pass
112	26	Fail	Pass	Fail	Pass
112	39	Fail	Pass	Fail	Pass
113	13	Fail	Pass	Fail	Pass
113	14	Fail	Pass	Fail	Pass
113	15	Fail	Pass	Fail	Pass
113	26	Fail	Pass	Fail	Pass

113	27	Fail	Pass	Fail	Pass
113	39	Fail	Pass	Fail	Pass
114	13	Fail	Pass	Fail	Pass
114	14	Fail	Pass	Fail	Pass
114	15	Fail	Pass	Fail	Pass
114	26	Fail	Pass	Fail	Pass
114	39	Fail	Pass	Fail	Pass
115	13	Fail	Pass	Fail	Pass
115	14	Fail	Pass	Fail	Pass
115	15	Fail	Pass	Fail	Pass
115	26	Fail	Pass	Fail	Pass
115	39	Fail	Pass	Fail	Pass
116	13	Fail	Pass	Fail	Pass
116	14	Fail	Pass	Fail	Pass
116	15	Fail	Pass	Fail	Pass
116	26	Fail	Pass	Fail	Pass
116	39	Fail	Pass	Fail	Pass
117	13	Fail	Pass	Fail	Pass
117	14	Fail	Pass	Fail	Pass
117	15	Fail	Pass	Fail	Pass
117	26	Fail	Pass	Fail	Pass
117	39	Fail	Pass	Fail	Pass
118	13	Fail	Pass	Fail	Pass
118	14	Fail	Pass	Fail	Pass
118	15	Fail	Pass	Fail	Pass
118	20	Fail	Pass	Fail	Pass
118	26	Fail	Pass	Fail	Pass
118	39	Fail	Pass	Fail	Pass
119	13	Fail	Pass	Fail	Pass
119	14	Fail	Pass	Fail	Pass
119	15	Fail	Pass	Fail	Pass
119	20	Fail	Pass	Fail	Pass
119	26	Fail	Pass	Fail	Pass
119	39	Fail	Pass	Fail	Pass
120	13	Fail	Pass	Fail	Pass
120	14	Fail	Pass	Fail	Pass
120	15	Fail	Pass	Fail	Pass
120	16	Fail	Pass	Fail	Pass
120	26	Fail	Pass	Fail	Pass
120	39	Fail	Pass	Fail	Pass
121	13	Fail	Pass	Fail	Pass
121	14	Fail	Pass	Fail	Pass
121	26	Fail	Pass	Fail	Pass
121	39	Fail	Pass	Fail	Pass
122	13	Fail	Pass	Fail	Pass
122	14	Fail	Pass	Fail	Pass
122	26	Fail	Pass	Fail	Pass
122	39	Fail	Pass	Fail	Pass
123	13	Fail	Pass	Fail	Pass
123	14	Fail	Pass	Fail	Pass
123	15	Fail	Pass	Fail	Pass
123	16	Fail	Pass	Fail	Pass
123	17	Fail	Pass	Fail	Pass
123	18	Fail	Pass	Fail	Pass
123	19	Fail	Pass	Fail	Pass
123	20	Fail	Pass	Fail	Pass
123	21	Fail	Pass	Fail	Pass

123	22	Fail	Pass	Fail	Pass
123	23	Fail	Pass	Fail	Pass
123	24	Fail	Pass	Fail	Pass
123	25	Fail	Pass	Fail	Pass
123	26	Fail	Pass	Fail	Pass
123	27	Fail	Pass	Fail	Pass
123	28	Fail	Pass	Fail	Pass
123	29	Fail	Pass	Fail	Pass
123	30	Fail	Pass	Fail	Pass
123	31	Fail	Pass	Fail	Pass
123	32	Fail	Pass	Fail	Pass
123	33	Fail	Pass	Fail	Pass
123	34	Fail	Pass	Fail	Pass
123	35	Fail	Pass	Fail	Pass
123	36	Fail	Pass	Fail	Pass
123	37	Fail	Pass	Fail	Pass
123	38	Fail	Pass	Fail	Pass
123	39	Fail	Pass	Fail	Pass
124	13	Fail	Pass	Fail	Pass
124	14	Fail	Pass	Fail	Pass
124	23	Fail	Pass	Fail	Pass
125	13	Fail	Pass	Fail	Pass
125	14	Fail	Pass	Fail	Pass
125	23	Fail	Pass	Fail	Pass
126	13	Fail	Pass	Fail	Pass
126	14	Fail	Pass	Fail	Pass
126	23	Fail	Pass	Fail	Pass
127	13	Fail	Pass	Fail	Pass
127	14	Fail	Pass	Fail	Pass
127	23	Fail	Pass	Fail	Pass
128	13	Fail	Pass	Fail	Pass
128	14	Fail	Pass	Fail	Pass
128	23	Fail	Pass	Fail	Pass
129	13	Fail	Pass	Fail	Pass
129	14	Fail	Pass	Fail	Pass
129	23	Fail	Pass	Fail	Pass
130	8	Fail	Fail	Fail	Fail
130	9	Fail	Fail	Fail	Fail
130	10	Fail	Pass	Fail	Pass
130	11	Fail	Pass	Fail	Pass
130	12	Fail	Pass	Fail	Pass
130	13	Fail	Pass	Fail	Pass
130	14	Fail	Pass	Fail	Pass
130	23	Fail	Pass	Fail	Pass
131	14	Fail	Pass	Fail	Pass
131	23	Fail	Pass	Fail	Pass
132	14	Fail	Pass	Fail	Pass
132	23	Fail	Pass	Fail	Pass
133	14	Fail	Pass	Fail	Pass
133	23	Fail	Pass	Fail	Pass
134	14	Fail	Pass	Fail	Pass
134	23	Fail	Pass	Fail	Pass
135	14	Fail	Pass	Fail	Pass
136	14	Fail	Pass	Fail	Pass
137	14	Fail	Pass	Fail	Pass
138	14	Fail	Pass	Fail	Pass

3. Table F.7.3 Striped Bass Larvae salinity and D.O. criteria passing for existing and deepening (3 ft) scenarios within the analyzed period May 1 - May 31, 1997

```
HABITAT REQUIREMENTS:
RM 10-31; Depth Average
D.O. May (MG/L):10th %ile >=4.5
Salinity 50th %ile >=3 & <= 9 ppt

Savannah Harbor Estuary
   Analyzed period: MAY       1 - MAY      31, Year 1997
```

Segments J	Segments I	Baseline Scenario Salinity	Baseline Scenario D.O.	Project Scenario Salinity	Project Scenario D.O.
47	13	Fail	Fail	Fail	Fail
47	14	Fail	Fail	Fail	Fail
47	15	Fail	Fail	Fail	Fail
47	16	Fail	Fail	Fail	Fail
47	17	Fail	Fail	Fail	Fail
48	13	Fail	Fail	Fail	Fail
48	14	Fail	Fail	Fail	Fail
48	15	Fail	Fail	Fail	Fail
48	16	Fail	Fail	Fail	Fail
48	17	Fail	Fail	Fail	Fail
49	13	Fail	Fail	Fail	Fail
49	14	Fail	Fail	Fail	Fail
49	15	Fail	Fail	Fail	Fail
49	16	Fail	Fail	Fail	Fail
49	17	Fail	Fail	Fail	Fail
50	13	Fail	Fail	Fail	Fail
50	14	Fail	Fail	Fail	Fail
50	15	Fail	Fail	Fail	Fail
50	16	Fail	Fail	Fail	Fail
50	17	Fail	Fail	Fail	Fail
50	18	Fail	Fail	Fail	Fail
51	13	Fail	Fail	Fail	Fail
51	14	Fail	Fail	Fail	Fail
51	15	Fail	Fail	Fail	Fail
52	13	Fail	Fail	Fail	Fail
52	14	Fail	Fail	Fail	Fail
52	15	Fail	Fail	Fail	Fail
53	13	Fail	Fail	Fail	Fail
53	14	Fail	Fail	Fail	Fail
53	15	Fail	Fail	Fail	Fail
54	13	Fail	Fail	Fail	Fail
54	14	Fail	Fail	Fail	Fail
54	15	Fail	Fail	Fail	Fail
55	13	Fail	Fail	Fail	Fail
55	14	Fail	Fail	Fail	Fail
55	15	Fail	Fail	Fail	Fail
56	13	Fail	Fail	Fail	Fail
56	14	Fail	Fail	Fail	Fail
56	15	Fail	Fail	Fail	Fail
57	13	Fail	Fail	Fail	Fail
57	14	Fail	Fail	Fail	Fail

57	15	Fail	Fail	Fail	Fail
58	13	Fail	Fail	Fail	Fail
58	14	Fail	Fail	Fail	Fail
58	15	Pass	Fail	Fail	Fail
59	13	Fail	Fail	Fail	Fail
59	14	Fail	Fail	Fail	Fail
59	15	Pass	Fail	Fail	Fail
59	30	Fail	Fail	Fail	Fail
59	31	Fail	Fail	Fail	Fail
59	32	Fail	Fail	Fail	Fail
60	13	Pass	Fail	Fail	Fail
60	14	Fail	Fail	Fail	Fail
60	15	Pass	Fail	Pass	Fail
60	30	Fail	Fail	Fail	Fail
60	31	Fail	Fail	Fail	Fail
60	32	Fail	Fail	Fail	Fail
61	13	Pass	Fail	Fail	Fail
61	14	Fail	Fail	Fail	Fail
61	15	Pass	Fail	Pass	Fail
61	30	Fail	Fail	Fail	Fail
61	31	Fail	Fail	Fail	Fail
61	32	Fail	Fail	Fail	Fail
62	13	Pass	Fail	Fail	Fail
62	14	Fail	Fail	Fail	Fail
62	15	Pass	Fail	Pass	Fail
62	30	Fail	Fail	Fail	Fail
62	31	Fail	Fail	Fail	Fail
62	32	Fail	Fail	Fail	Fail
63	13	Pass	Fail	Fail	Fail
63	14	Fail	Fail	Fail	Fail
63	15	Pass	Fail	Pass	Fail
63	31	Fail	Fail	Fail	Fail
64	13	Pass	Fail	Fail	Fail
64	14	Fail	Fail	Fail	Fail
64	15	Pass	Fail	Pass	Fail
64	30	Fail	Fail	Fail	Fail
64	31	Fail	Fail	Fail	Fail
64	32	Fail	Fail	Fail	Fail
65	13	Pass	Fail	Pass	Fail
65	14	Fail	Fail	Fail	Fail
65	15	Pass	Fail	Pass	Fail
65	30	Fail	Fail	Fail	Fail
65	31	Fail	Fail	Fail	Fail
65	32	Fail	Fail	Fail	Fail
65	33	Fail	Fail	Fail	Fail
66	13	Pass	Fail	Pass	Fail
66	14	Fail	Fail	Fail	Fail
66	15	Pass	Fail	Pass	Fail
66	30	Fail	Fail	Fail	Fail
66	31	Fail	Fail	Fail	Fail
66	32	Fail	Fail	Fail	Fail
66	36	Fail	Fail	Fail	Fail
67	13	Pass	Fail	Pass	Fail
67	14	Fail	Fail	Fail	Fail
67	15	Pass	Fail	Pass	Fail
67	30	Fail	Fail	Fail	Fail
67	31	Fail	Fail	Fail	Fail

67	32	Fail	Fail	Fail	Fail
67	36	Fail	Fail	Fail	Fail
68	13	Pass	Fail	Pass	Fail
68	14	Fail	Fail	Fail	Fail
68	15	Pass	Pass	Pass	Pass
68	30	Fail	Fail	Fail	Fail
68	31	Fail	Fail	Fail	Fail
68	32	Fail	Fail	Fail	Fail
68	36	Fail	Fail	Fail	Fail
69	13	Pass	Fail	Pass	Fail
69	14	Fail	Fail	Fail	Fail
69	15	Pass	Fail	Pass	Fail
69	30	Fail	Fail	Fail	Fail
69	31	Fail	Fail	Fail	Fail
69	32	Fail	Fail	Fail	Fail
69	36	Fail	Fail	Fail	Fail
70	13	Pass	Fail	Pass	Fail
70	14	Fail	Fail	Fail	Fail
70	15	Pass	Fail	Pass	Fail
70	30	Pass	Fail	Fail	Fail
70	31	Pass	Fail	Fail	Fail
70	32	Pass	Fail	Fail	Fail
70	33	Fail	Fail	Fail	Fail
71	13	Pass	Fail	Pass	Fail
71	14	Fail	Fail	Fail	Fail
71	15	Pass	Fail	Pass	Fail
71	30	Pass	Fail	Fail	Fail
71	31	Pass	Fail	Fail	Fail
71	32	Pass	Fail	Fail	Fail
72	13	Pass	Fail	Pass	Fail
72	14	Pass	Fail	Fail	Fail
72	15	Pass	Fail	Pass	Fail
72	30	Pass	Fail	Pass	Fail
72	31	Pass	Fail	Fail	Fail
72	32	Pass	Fail	Fail	Fail
73	13	Pass	Fail	Pass	Fail
73	14	Pass	Fail	Fail	Fail
73	15	Pass	Fail	Pass	Fail
73	30	Pass	Fail	Pass	Fail
73	31	Pass	Fail	Fail	Fail
74	13	Pass	Fail	Pass	Fail
74	14	Pass	Fail	Fail	Fail
74	15	Pass	Pass	Pass	Pass
74	30	Pass	Fail	Pass	Fail
74	31	Pass	Fail	Pass	Fail
75	13	Pass	Fail	Pass	Fail
75	14	Pass	Fail	Fail	Fail
75	15	Pass	Pass	Pass	Pass
75	30	Pass	Fail	Pass	Fail
75	31	Pass	Fail	Pass	Fail
76	13	Pass	Pass	Pass	Fail
76	14	Pass	Pass	Pass	Fail
76	15	Pass	Fail	Pass	Fail
76	16	Pass	Fail	Pass	Fail
76	17	Pass	Fail	Pass	Fail
76	30	Pass	Fail	Pass	Fail
76	31	Pass	Fail	Pass	Fail

77	13	Pass	Pass	Pass	Fail
77	14	Pass	Pass	Pass	Fail
77	15	Pass	Fail	Fail	Fail
77	16	Pass	Fail	Pass	Fail
77	17	Pass	Fail	Pass	Fail
77	30	Pass	Fail	Pass	Fail
77	31	Pass	Fail	Pass	Fail
78	13	Pass	Pass	Pass	Pass
78	14	Pass	Pass	Pass	Fail
78	15	Pass	Fail	Fail	Fail
78	16	Pass	Fail	Fail	Fail
78	17	Pass	Fail	Pass	Fail
78	30	Pass	Fail	Pass	Fail
78	31	Pass	Fail	Pass	Fail
79	13	Pass	Pass	Pass	Pass
79	14	Pass	Pass	Pass	Fail
79	15	Pass	Fail	Pass	Fail
79	30	Pass	Fail	Pass	Fail
79	31	Pass	Fail	Pass	Fail
80	13	Pass	Pass	Pass	Pass
80	14	Pass	Pass	Pass	Fail
80	15	Pass	Pass	Pass	Fail
80	30	Pass	Fail	Pass	Fail
80	31	Pass	Fail	Pass	Fail
81	13	Pass	Pass	Pass	Pass
81	14	Pass	Pass	Pass	Pass
81	15	Pass	Pass	Pass	Pass
81	30	Pass	Fail	Pass	Fail
81	31	Pass	Fail	Pass	Fail
82	13	Pass	Pass	Pass	Fail
82	14	Pass	Pass	Pass	Pass
82	15	Pass	Pass	Pass	Pass
82	16	Pass	Pass	Pass	Pass
82	17	Pass	Pass	Pass	Pass
82	18	Pass	Pass	Pass	Pass
82	19	Fail	Pass	Pass	Pass
82	20	Fail	Pass	Pass	Pass
82	21	Fail	Pass	Pass	Pass
82	29	Pass	Fail	Pass	Fail
82	30	Pass	Fail	Pass	Fail
82	31	Pass	Fail	Pass	Fail
83	13	Pass	Pass	Pass	Fail
83	14	Pass	Pass	Pass	Pass
83	15	Pass	Pass	Pass	Pass
83	21	Fail	Pass	Pass	Pass
83	30	Pass	Fail	Pass	Fail
83	31	Fail	Fail	Pass	Fail
84	13	Pass	Pass	Pass	Pass
84	14	Pass	Pass	Pass	Pass
84	15	Pass	Pass	Pass	Pass
84	21	Fail	Pass	Pass	Pass
84	30	Fail	Fail	Pass	Fail
84	31	Fail	Fail	Pass	Fail
85	13	Pass	Pass	Pass	Pass
85	14	Pass	Pass	Pass	Pass
85	15	Fail	Pass	Pass	Pass
85	21	Fail	Pass	Fail	Pass

85	30	Fail	Fail	Fail	Fail
86	13	Fail	Pass	Pass	Pass
86	14	Pass	Pass	Pass	Pass
86	15	Fail	Pass	Pass	Pass
86	21	Fail	Pass	Fail	Pass
86	30	Fail	Fail	Fail	Fail
87	13	Fail	Pass	Pass	Pass
87	14	Pass	Pass	Pass	Pass
87	15	Fail	Pass	Pass	Pass
87	30	Fail	Fail	Fail	Fail
88	13	Fail	Pass	Pass	Pass
88	14	Pass	Pass	Pass	Pass
88	15	Fail	Pass	Pass	Pass
88	30	Fail	Fail	Fail	Fail
89	13	Fail	Pass	Pass	Pass
89	14	Fail	Pass	Pass	Pass
89	15	Fail	Pass	Pass	Pass
89	30	Fail	Fail	Fail	Fail
90	13	Fail	Pass	Fail	Pass
90	14	Fail	Pass	Pass	Pass
90	15	Fail	Pass	Pass	Pass
90	30	Fail	Fail	Fail	Fail
91	13	Fail	Pass	Fail	Pass
91	14	Fail	Pass	Pass	Pass
91	15	Fail	Pass	Pass	Pass
91	16	Fail	Pass	Pass	Pass
91	30	Fail	Fail	Fail	Fail
92	13	Fail	Pass	Fail	Pass
92	14	Fail	Pass	Pass	Pass
92	15	Fail	Pass	Pass	Pass
92	16	Fail	Pass	Pass	Pass
92	30	Fail	Fail	Fail	Fail
93	13	Fail	Pass	Fail	Pass
93	14	Fail	Pass	Pass	Pass
93	15	Fail	Pass	Pass	Pass
93	16	Fail	Pass	Pass	Pass
93	30	Fail	Fail	Fail	Fail
94	13	Fail	Pass	Fail	Pass
94	14	Fail	Pass	Pass	Pass
94	15	Fail	Pass	Pass	Pass
94	16	Fail	Pass	Pass	Pass
94	26	Fail	Pass	Fail	Pass
94	30	Fail	Fail	Fail	Fail
95	13	Fail	Pass	Fail	Pass
95	14	Fail	Pass	Pass	Pass
95	15	Fail	Pass	Fail	Pass
95	16	Fail	Pass	Pass	Pass
95	26	Fail	Pass	Fail	Pass
95	30	Fail	Fail	Fail	Fail
96	13	Fail	Pass	Fail	Pass
96	14	Fail	Pass	Pass	Pass
96	15	Fail	Pass	Fail	Pass
96	26	Fail	Pass	Fail	Pass
96	30	Fail	Pass	Fail	Fail
97	13	Fail	Pass	Fail	Pass
97	14	Fail	Pass	Fail	Pass
97	15	Fail	Pass	Fail	Pass

97	26	Fail	Pass	Fail	Pass
97	30	Fail	Fail	Fail	Fail
98	13	Fail	Pass	Fail	Pass
98	14	Fail	Pass	Fail	Pass
98	15	Fail	Pass	Fail	Pass
98	26	Fail	Pass	Fail	Pass
98	27	Fail	Fail	Fail	Fail
98	28	Fail	Fail	Fail	Fail
98	29	Fail	Fail	Fail	Fail
98	30	Fail	Pass	Fail	Pass
99	13	Fail	Pass	Fail	Pass
99	14	Fail	Pass	Pass	Pass
99	15	Fail	Pass	Fail	Pass
99	16	Fail	Pass	Pass	Pass
99	17	Fail	Pass	Pass	Pass
99	18	Fail	Pass	Pass	Pass
99	19	Fail	Pass	Fail	Pass
99	20	Fail	Pass	Fail	Pass
99	21	Fail	Pass	Fail	Pass
99	22	Fail	Pass	Fail	Pass
99	23	Fail	Pass	Fail	Pass
99	26	Fail	Pass	Fail	Pass
99	30	Fail	Pass	Fail	Fail
100	13	Fail	Pass	Fail	Pass
100	14	Fail	Pass	Fail	Pass
100	15	Fail	Pass	Fail	Pass
100	23	Fail	Pass	Fail	Pass
100	24	Fail	Pass	Fail	Pass
100	25	Fail	Pass	Fail	Pass
100	26	Fail	Pass	Fail	Pass
100	30	Fail	Pass	Fail	Fail
101	13	Fail	Pass	Fail	Pass
101	14	Fail	Pass	Fail	Pass
101	15	Fail	Pass	Fail	Pass
101	16	Fail	Pass	Pass	Pass
101	17	Fail	Pass	Pass	Pass
101	18	Fail	Pass	Fail	Pass
101	19	Fail	Pass	Fail	Pass
101	20	Fail	Pass	Fail	Pass
101	21	Fail	Pass	Fail	Pass
101	22	Fail	Pass	Fail	Pass
101	23	Fail	Pass	Fail	Pass
101	26	Fail	Pass	Fail	Pass
101	30	Fail	Pass	Fail	Pass
102	13	Fail	Pass	Fail	Pass
102	14	Fail	Pass	Fail	Pass
102	15	Fail	Pass	Fail	Pass
102	26	Fail	Pass	Fail	Pass
102	30	Fail	Pass	Fail	Pass
103	13	Fail	Pass	Fail	Pass
103	14	Fail	Pass	Fail	Pass
103	15	Fail	Pass	Fail	Pass
103	26	Fail	Pass	Fail	Pass
103	30	Fail	Pass	Fail	Pass
104	13	Fail	Pass	Fail	Pass
104	14	Fail	Pass	Fail	Pass
104	15	Fail	Pass	Fail	Pass

104	26	Fail	Pass	Fail	Pass
104	30	Fail	Pass	Fail	Pass
105	13	Fail	Pass	Fail	Pass
105	14	Fail	Pass	Fail	Pass
105	15	Fail	Pass	Fail	Pass
105	26	Fail	Pass	Fail	Pass
105	30	Fail	Pass	Fail	Pass
106	13	Fail	Pass	Fail	Pass
106	14	Fail	Pass	Fail	Pass
106	15	Fail	Pass	Fail	Pass
106	26	Fail	Pass	Fail	Pass
106	27	Fail	Pass	Fail	Pass
106	30	Fail	Pass	Fail	Pass
106	39	Fail	Pass	Fail	Pass
107	13	Fail	Pass	Fail	Pass
107	14	Fail	Pass	Fail	Pass
107	15	Fail	Pass	Fail	Pass
107	22	Fail	Pass	Fail	Pass
107	26	Fail	Pass	Fail	Pass
107	30	Fail	Pass	Fail	Pass
107	39	Fail	Pass	Fail	Pass
108	13	Fail	Pass	Fail	Pass
108	14	Fail	Pass	Fail	Pass
108	15	Fail	Pass	Fail	Pass
108	22	Fail	Pass	Fail	Pass
108	26	Fail	Pass	Fail	Pass
108	30	Fail	Pass	Fail	Pass
108	39	Fail	Pass	Fail	Pass
109	13	Fail	Pass	Fail	Pass
109	14	Fail	Pass	Fail	Pass
109	15	Fail	Pass	Fail	Pass
109	22	Fail	Pass	Fail	Pass
109	26	Fail	Pass	Fail	Pass
109	30	Fail	Pass	Fail	Pass
109	39	Fail	Pass	Fail	Pass
110	13	Fail	Pass	Fail	Pass
110	14	Fail	Pass	Fail	Pass
110	15	Fail	Pass	Fail	Pass
110	22	Fail	Pass	Fail	Pass
110	26	Fail	Pass	Fail	Pass
110	39	Fail	Pass	Fail	Pass
111	13	Fail	Pass	Fail	Pass
111	14	Fail	Pass	Fail	Pass
111	15	Fail	Pass	Fail	Pass
111	22	Fail	Pass	Fail	Pass
111	26	Fail	Pass	Fail	Pass
111	39	Fail	Pass	Fail	Pass
112	13	Fail	Pass	Fail	Pass
112	14	Fail	Pass	Fail	Pass
112	15	Fail	Pass	Fail	Pass
112	22	Fail	Pass	Fail	Pass
112	26	Fail	Pass	Fail	Pass
112	39	Fail	Pass	Fail	Pass
113	13	Fail	Pass	Fail	Pass
113	14	Fail	Pass	Fail	Pass
113	15	Fail	Pass	Fail	Pass
113	26	Fail	Pass	Fail	Pass

113	27	Fail	Pass	Fail	Pass
113	39	Fail	Pass	Fail	Pass
114	13	Fail	Pass	Fail	Pass
114	14	Fail	Pass	Fail	Pass
114	15	Fail	Pass	Fail	Pass
114	26	Fail	Pass	Fail	Pass
114	39	Fail	Pass	Fail	Pass
115	13	Fail	Pass	Fail	Pass
115	14	Fail	Pass	Fail	Pass
115	15	Fail	Pass	Fail	Pass
115	26	Fail	Pass	Fail	Pass
115	39	Fail	Pass	Fail	Pass
116	13	Fail	Pass	Fail	Pass
116	14	Fail	Pass	Fail	Pass
116	15	Fail	Pass	Fail	Pass
116	26	Fail	Pass	Fail	Pass
116	39	Fail	Pass	Fail	Pass
117	13	Fail	Pass	Fail	Pass
117	14	Fail	Pass	Fail	Pass
117	15	Fail	Pass	Fail	Pass
117	26	Fail	Pass	Fail	Pass
117	39	Fail	Pass	Fail	Pass
118	13	Fail	Pass	Fail	Pass
118	14	Fail	Pass	Fail	Pass
118	15	Fail	Pass	Fail	Pass
118	20	Fail	Pass	Fail	Pass
118	26	Fail	Pass	Fail	Pass
118	39	Fail	Pass	Fail	Pass
119	13	Fail	Pass	Fail	Pass
119	14	Fail	Pass	Fail	Pass
119	15	Fail	Pass	Fail	Pass
119	20	Fail	Pass	Fail	Pass
119	26	Fail	Pass	Fail	Pass
119	39	Fail	Pass	Fail	Pass
120	13	Fail	Pass	Fail	Pass
120	14	Fail	Pass	Fail	Pass
120	15	Fail	Pass	Fail	Pass
120	16	Fail	Pass	Fail	Pass
120	26	Fail	Pass	Fail	Pass
120	39	Fail	Pass	Fail	Pass
121	13	Fail	Pass	Fail	Pass
121	14	Fail	Pass	Fail	Pass
121	26	Fail	Pass	Fail	Pass
121	39	Fail	Pass	Fail	Pass
122	13	Fail	Pass	Fail	Pass
122	14	Fail	Pass	Fail	Pass
122	26	Fail	Pass	Fail	Pass
122	39	Fail	Pass	Fail	Pass
123	13	Fail	Pass	Fail	Pass
123	14	Fail	Pass	Fail	Pass
123	15	Fail	Pass	Fail	Pass
123	16	Fail	Pass	Fail	Pass
123	17	Fail	Pass	Fail	Pass
123	18	Fail	Pass	Fail	Pass
123	19	Fail	Pass	Fail	Pass
123	20	Fail	Pass	Fail	Pass
123	21	Fail	Pass	Fail	Pass

123	22	Fail	Pass	Fail	Pass
123	23	Fail	Pass	Fail	Pass
123	24	Fail	Pass	Fail	Pass
123	25	Fail	Pass	Fail	Pass
123	26	Fail	Pass	Fail	Pass
123	27	Fail	Pass	Fail	Pass
123	28	Fail	Pass	Fail	Pass
123	29	Fail	Pass	Fail	Pass
123	30	Fail	Pass	Fail	Pass
123	31	Fail	Pass	Fail	Pass
123	32	Fail	Pass	Fail	Pass
123	33	Fail	Pass	Fail	Pass
123	34	Fail	Pass	Fail	Pass
123	35	Fail	Pass	Fail	Pass
123	36	Fail	Pass	Fail	Pass
123	37	Fail	Pass	Fail	Pass
123	38	Fail	Pass	Fail	Pass
123	39	Fail	Pass	Fail	Pass
124	13	Fail	Pass	Fail	Pass
124	14	Fail	Pass	Fail	Pass
124	23	Fail	Pass	Fail	Pass
125	13	Fail	Pass	Fail	Pass
125	14	Fail	Pass	Fail	Pass
125	23	Fail	Pass	Fail	Pass
126	13	Fail	Pass	Fail	Pass
126	14	Fail	Pass	Fail	Pass
126	23	Fail	Pass	Fail	Pass
127	13	Fail	Pass	Fail	Pass
127	14	Fail	Pass	Fail	Pass
127	23	Fail	Pass	Fail	Pass
128	13	Fail	Pass	Fail	Pass
128	14	Fail	Pass	Fail	Pass
128	23	Fail	Pass	Fail	Pass
129	13	Fail	Pass	Fail	Pass
129	14	Fail	Pass	Fail	Pass
129	23	Fail	Pass	Fail	Pass
130	8	Fail	Fail	Fail	Fail
130	9	Fail	Fail	Fail	Fail
130	10	Fail	Pass	Fail	Pass
130	11	Fail	Pass	Fail	Pass
130	12	Fail	Pass	Fail	Pass
130	13	Fail	Pass	Fail	Pass
130	14	Fail	Pass	Fail	Pass
130	23	Fail	Pass	Fail	Pass
131	14	Fail	Pass	Fail	Pass
131	23	Fail	Pass	Fail	Pass
132	14	Fail	Pass	Fail	Pass
132	23	Fail	Pass	Fail	Pass
133	14	Fail	Pass	Fail	Pass
133	23	Fail	Pass	Fail	Pass
134	14	Fail	Pass	Fail	Pass
134	23	Fail	Pass	Fail	Pass
135	14	Fail	Pass	Fail	Pass
136	14	Fail	Pass	Fail	Pass
137	14	Fail	Pass	Fail	Pass
138	14	Fail	Pass	Fail	Pass

4. Table F.7.4 Striped Bass Larvae salinity and D.O. criteria passing for existing and deepening (2 ft) scenarios within the analyzed period May 1 - May 31, 1997

HABITAT REQUIREMENTS:
RM 10-31; Depth Average
D.O. May (MG/L):10th %ile >=4.5
Salinity 50th %ile >=3 & <= 9 ppt

Savannah Harbor Estuary
Analyzed period: MAY 1 - MAY 31, Year 1997

Segments J	Segments I	Baseline Scenario Salinity	Baseline Scenario D.O.	Project Scenario Salinity	Project Scenario D.O.
47	13	Fail	Fail	Fail	Fail
47	14	Fail	Fail	Fail	Fail
47	15	Fail	Fail	Fail	Fail
47	16	Fail	Fail	Fail	Fail
47	17	Fail	Fail	Fail	Fail
48	13	Fail	Fail	Fail	Fail
48	14	Fail	Fail	Fail	Fail
48	15	Fail	Fail	Fail	Fail
48	16	Fail	Fail	Fail	Fail
48	17	Fail	Fail	Fail	Fail
49	13	Fail	Fail	Fail	Fail
49	14	Fail	Fail	Fail	Fail
49	15	Fail	Fail	Fail	Fail
49	16	Fail	Fail	Fail	Fail
49	17	Fail	Fail	Fail	Fail
50	13	Fail	Fail	Fail	Fail
50	14	Fail	Fail	Fail	Fail
50	15	Fail	Fail	Fail	Fail
50	16	Fail	Fail	Fail	Fail
50	17	Fail	Fail	Fail	Fail
50	18	Fail	Fail	Fail	Fail
51	13	Fail	Fail	Fail	Fail
51	14	Fail	Fail	Fail	Fail
51	15	Fail	Fail	Fail	Fail
52	13	Fail	Fail	Fail	Fail
52	14	Fail	Fail	Fail	Fail
52	15	Fail	Fail	Fail	Fail
53	13	Fail	Fail	Fail	Fail
53	14	Fail	Fail	Fail	Fail
53	15	Fail	Fail	Fail	Fail
54	13	Fail	Fail	Fail	Fail
54	14	Fail	Fail	Fail	Fail
54	15	Fail	Fail	Fail	Fail
55	13	Fail	Fail	Fail	Fail
55	14	Fail	Fail	Fail	Fail
55	15	Fail	Fail	Fail	Fail
56	13	Fail	Fail	Fail	Fail
56	14	Fail	Fail	Fail	Fail
56	15	Fail	Fail	Fail	Fail
57	13	Fail	Fail	Fail	Fail
57	14	Fail	Fail	Fail	Fail

57	15	Fail	Fail	Fail	Fail
58	13	Fail	Fail	Fail	Fail
58	14	Fail	Fail	Fail	Fail
58	15	Pass	Fail	Fail	Fail
59	13	Fail	Fail	Fail	Fail
59	14	Fail	Fail	Fail	Fail
59	15	Pass	Fail	Fail	Fail
59	30	Fail	Fail	Fail	Fail
59	31	Fail	Fail	Fail	Fail
59	32	Fail	Fail	Fail	Fail
60	13	Pass	Fail	Fail	Fail
60	14	Fail	Fail	Fail	Fail
60	15	Pass	Fail	Pass	Fail
60	30	Fail	Fail	Fail	Fail
60	31	Fail	Fail	Fail	Fail
60	32	Fail	Fail	Fail	Fail
61	13	Pass	Fail	Fail	Fail
61	14	Fail	Fail	Fail	Fail
61	15	Pass	Fail	Pass	Fail
61	30	Fail	Fail	Fail	Fail
61	31	Fail	Fail	Fail	Fail
61	32	Fail	Fail	Fail	Fail
62	13	Pass	Fail	Pass	Fail
62	14	Fail	Fail	Fail	Fail
62	15	Pass	Fail	Pass	Fail
62	30	Fail	Fail	Fail	Fail
62	31	Fail	Fail	Fail	Fail
62	32	Fail	Fail	Fail	Fail
63	13	Pass	Fail	Fail	Fail
63	14	Fail	Fail	Fail	Fail
63	15	Pass	Fail	Pass	Fail
63	31	Fail	Fail	Fail	Fail
64	13	Pass	Fail	Pass	Fail
64	14	Fail	Fail	Fail	Fail
64	15	Pass	Fail	Pass	Fail
64	30	Fail	Fail	Fail	Fail
64	31	Fail	Fail	Fail	Fail
64	32	Fail	Fail	Fail	Fail
65	13	Pass	Fail	Pass	Fail
65	14	Fail	Fail	Fail	Fail
65	15	Pass	Fail	Pass	Fail
65	30	Fail	Fail	Fail	Fail
65	31	Fail	Fail	Fail	Fail
65	32	Fail	Fail	Fail	Fail
65	33	Fail	Fail	Fail	Fail
66	13	Pass	Fail	Pass	Fail
66	14	Fail	Fail	Fail	Fail
66	15	Pass	Fail	Pass	Fail
66	30	Fail	Fail	Fail	Fail
66	31	Fail	Fail	Fail	Fail
66	32	Fail	Fail	Fail	Fail
66	36	Fail	Fail	Fail	Fail
67	13	Pass	Fail	Pass	Fail
67	14	Fail	Fail	Fail	Fail
67	15	Pass	Fail	Pass	Fail
67	30	Fail	Fail	Fail	Fail
67	31	Fail	Fail	Fail	Fail

67	32	Fail	Fail	Fail	Fail
67	36	Fail	Fail	Fail	Fail
68	13	Pass	Fail	Pass	Fail
68	14	Fail	Fail	Fail	Fail
68	15	Pass	Pass	Pass	Pass
68	30	Fail	Fail	Fail	Fail
68	31	Fail	Fail	Fail	Fail
68	32	Fail	Fail	Fail	Fail
68	36	Fail	Fail	Fail	Fail
69	13	Pass	Fail	Pass	Fail
69	14	Fail	Fail	Fail	Fail
69	15	Pass	Fail	Pass	Fail
69	30	Fail	Fail	Fail	Fail
69	31	Fail	Fail	Fail	Fail
69	32	Fail	Fail	Fail	Fail
69	36	Fail	Fail	Fail	Fail
70	13	Pass	Fail	Pass	Fail
70	14	Fail	Fail	Fail	Fail
70	15	Pass	Fail	Pass	Fail
70	30	Pass	Fail	Fail	Fail
70	31	Pass	Fail	Fail	Fail
70	32	Pass	Fail	Fail	Fail
70	33	Fail	Fail	Fail	Fail
71	13	Pass	Fail	Pass	Fail
71	14	Fail	Fail	Fail	Fail
71	15	Pass	Fail	Pass	Fail
71	30	Pass	Fail	Fail	Fail
71	31	Pass	Fail	Fail	Fail
71	32	Pass	Fail	Pass	Fail
72	13	Pass	Fail	Pass	Fail
72	14	Pass	Fail	Fail	Fail
72	15	Pass	Fail	Pass	Fail
72	30	Pass	Fail	Pass	Fail
72	31	Pass	Fail	Fail	Fail
72	32	Pass	Fail	Pass	Fail
73	13	Pass	Fail	Pass	Fail
73	14	Pass	Fail	Fail	Fail
73	15	Pass	Fail	Pass	Fail
73	30	Pass	Fail	Pass	Fail
73	31	Pass	Fail	Fail	Fail
74	13	Pass	Fail	Pass	Fail
74	14	Pass	Fail	Fail	Fail
74	15	Pass	Pass	Pass	Pass
74	30	Pass	Fail	Pass	Fail
74	31	Pass	Fail	Pass	Fail
75	13	Pass	Fail	Pass	Fail
75	14	Pass	Fail	Pass	Fail
75	15	Pass	Pass	Pass	Pass
75	30	Pass	Fail	Pass	Fail
75	31	Pass	Fail	Pass	Fail
76	13	Pass	Pass	Pass	Pass
76	14	Pass	Pass	Pass	Fail
76	15	Pass	Fail	Pass	Fail
76	16	Pass	Fail	Pass	Fail
76	17	Pass	Fail	Pass	Fail
76	30	Pass	Fail	Pass	Fail
76	31	Pass	Fail	Pass	Fail

77	13	Pass	Pass	Pass	Fail
77	14	Pass	Pass	Pass	Pass
77	15	Pass	Fail	Pass	Fail
77	16	Pass	Fail	Pass	Fail
77	17	Pass	Fail	Pass	Fail
77	30	Pass	Fail	Pass	Fail
77	31	Pass	Fail	Pass	Fail
78	13	Pass	Pass	Pass	Pass
78	14	Pass	Pass	Pass	Pass
78	15	Pass	Fail	Pass	Fail
78	16	Pass	Fail	Pass	Fail
78	17	Pass	Fail	Pass	Fail
78	30	Pass	Fail	Pass	Fail
78	31	Pass	Fail	Pass	Fail
79	13	Pass	Pass	Pass	Pass
79	14	Pass	Pass	Pass	Fail
79	15	Pass	Fail	Pass	Fail
79	30	Pass	Fail	Pass	Fail
79	31	Pass	Fail	Pass	Fail
80	13	Pass	Pass	Pass	Pass
80	14	Pass	Pass	Pass	Pass
80	15	Pass	Pass	Pass	Pass
80	30	Pass	Fail	Pass	Fail
80	31	Pass	Fail	Pass	Fail
81	13	Pass	Pass	Pass	Pass
81	14	Pass	Pass	Pass	Pass
81	15	Pass	Pass	Pass	Pass
81	30	Pass	Fail	Pass	Fail
81	31	Pass	Fail	Pass	Fail
82	13	Pass	Pass	Pass	Fail
82	14	Pass	Pass	Pass	Pass
82	15	Pass	Pass	Pass	Pass
82	16	Pass	Pass	Pass	Pass
82	17	Pass	Pass	Pass	Pass
82	18	Pass	Pass	Pass	Pass
82	19	Fail	Pass	Pass	Pass
82	20	Fail	Pass	Pass	Pass
82	21	Fail	Pass	Pass	Pass
82	29	Pass	Fail	Pass	Fail
82	30	Pass	Fail	Pass	Fail
82	31	Pass	Fail	Pass	Fail
83	13	Pass	Pass	Pass	Fail
83	14	Pass	Pass	Pass	Pass
83	15	Pass	Pass	Pass	Pass
83	21	Fail	Pass	Pass	Pass
83	30	Pass	Fail	Pass	Fail
83	31	Fail	Fail	Pass	Fail
84	13	Pass	Pass	Pass	Pass
84	14	Pass	Pass	Pass	Pass
84	15	Pass	Pass	Pass	Pass
84	21	Fail	Pass	Fail	Pass
84	30	Fail	Fail	Pass	Fail
84	31	Fail	Fail	Fail	Fail
85	13	Pass	Pass	Pass	Pass
85	14	Pass	Pass	Pass	Pass
85	15	Fail	Pass	Pass	Pass
85	21	Fail	Pass	Fail	Pass

85	30	Fail	Fail	Fail	Fail
86	13	Fail	Pass	Pass	Pass
86	14	Pass	Pass	Pass	Pass
86	15	Fail	Pass	Pass	Pass
86	21	Fail	Pass	Fail	Pass
86	30	Fail	Fail	Fail	Fail
87	13	Fail	Pass	Pass	Pass
87	14	Pass	Pass	Pass	Pass
87	15	Fail	Pass	Pass	Pass
87	30	Fail	Fail	Fail	Fail
88	13	Fail	Pass	Fail	Pass
88	14	Pass	Pass	Pass	Pass
88	15	Fail	Pass	Pass	Pass
88	30	Fail	Fail	Fail	Fail
89	13	Fail	Pass	Fail	Pass
89	14	Fail	Pass	Pass	Pass
89	15	Fail	Pass	Pass	Pass
89	30	Fail	Fail	Fail	Fail
90	13	Fail	Pass	Fail	Pass
90	14	Fail	Pass	Pass	Pass
90	15	Fail	Pass	Pass	Pass
90	30	Fail	Fail	Fail	Fail
91	13	Fail	Pass	Fail	Pass
91	14	Fail	Pass	Pass	Pass
91	15	Fail	Pass	Pass	Pass
91	16	Fail	Pass	Pass	Pass
91	30	Fail	Fail	Fail	Fail
92	13	Fail	Pass	Fail	Pass
92	14	Fail	Pass	Pass	Pass
92	15	Fail	Pass	Pass	Pass
92	16	Fail	Pass	Pass	Pass
92	30	Fail	Fail	Fail	Fail
93	13	Fail	Pass	Fail	Pass
93	14	Fail	Pass	Pass	Pass
93	15	Fail	Pass	Fail	Pass
93	16	Fail	Pass	Pass	Pass
93	30	Fail	Fail	Fail	Fail
94	13	Fail	Pass	Fail	Pass
94	14	Fail	Pass	Pass	Pass
94	15	Fail	Pass	Fail	Pass
94	16	Fail	Pass	Fail	Pass
94	26	Fail	Pass	Fail	Pass
94	30	Fail	Fail	Fail	Fail
95	13	Fail	Pass	Fail	Pass
95	14	Fail	Pass	Pass	Pass
95	15	Fail	Pass	Fail	Pass
95	16	Fail	Pass	Fail	Pass
95	26	Fail	Pass	Fail	Pass
95	30	Fail	Fail	Fail	Fail
96	13	Fail	Pass	Fail	Pass
96	14	Fail	Pass	Fail	Pass
96	15	Fail	Pass	Fail	Pass
96	26	Fail	Pass	Fail	Pass
96	30	Fail	Pass	Fail	Fail
97	13	Fail	Pass	Fail	Pass
97	14	Fail	Pass	Fail	Pass
97	15	Fail	Pass	Fail	Pass

97	26	Fail	Pass	Fail	Pass
97	30	Fail	Fail	Fail	Fail
98	13	Fail	Pass	Fail	Pass
98	14	Fail	Pass	Fail	Pass
98	15	Fail	Pass	Fail	Pass
98	26	Fail	Pass	Fail	Pass
98	27	Fail	Fail	Fail	Fail
98	28	Fail	Fail	Fail	Fail
98	29	Fail	Fail	Fail	Fail
98	30	Fail	Pass	Fail	Pass
99	13	Fail	Pass	Fail	Pass
99	14	Fail	Pass	Fail	Pass
99	15	Fail	Pass	Fail	Pass
99	16	Fail	Pass	Fail	Pass
99	17	Fail	Pass	Pass	Pass
99	18	Fail	Pass	Fail	Pass
99	19	Fail	Pass	Fail	Pass
99	20	Fail	Pass	Fail	Pass
99	21	Fail	Pass	Fail	Pass
99	22	Fail	Pass	Fail	Pass
99	23	Fail	Pass	Fail	Pass
99	26	Fail	Pass	Fail	Pass
99	30	Fail	Pass	Fail	Fail
100	13	Fail	Pass	Fail	Pass
100	14	Fail	Pass	Fail	Pass
100	15	Fail	Pass	Fail	Pass
100	23	Fail	Pass	Fail	Pass
100	24	Fail	Pass	Fail	Pass
100	25	Fail	Pass	Fail	Pass
100	26	Fail	Pass	Fail	Pass
100	30	Fail	Pass	Fail	Pass
101	13	Fail	Pass	Fail	Pass
101	14	Fail	Pass	Fail	Pass
101	15	Fail	Pass	Fail	Pass
101	16	Fail	Pass	Fail	Pass
101	17	Fail	Pass	Pass	Pass
101	18	Fail	Pass	Fail	Pass
101	19	Fail	Pass	Fail	Pass
101	20	Fail	Pass	Fail	Pass
101	21	Fail	Pass	Fail	Pass
101	22	Fail	Pass	Fail	Pass
101	23	Fail	Pass	Fail	Pass
101	26	Fail	Pass	Fail	Pass
101	30	Fail	Pass	Fail	Pass
102	13	Fail	Pass	Fail	Pass
102	14	Fail	Pass	Fail	Pass
102	15	Fail	Pass	Fail	Pass
102	26	Fail	Pass	Fail	Pass
102	30	Fail	Pass	Fail	Pass
103	13	Fail	Pass	Fail	Pass
103	14	Fail	Pass	Fail	Pass
103	15	Fail	Pass	Fail	Pass
103	26	Fail	Pass	Fail	Pass
103	30	Fail	Pass	Fail	Pass
104	13	Fail	Pass	Fail	Pass
104	14	Fail	Pass	Fail	Pass
104	15	Fail	Pass	Fail	Pass

104	26	Fail	Pass	Fail	Pass
104	30	Fail	Pass	Fail	Pass
105	13	Fail	Pass	Fail	Pass
105	14	Fail	Pass	Fail	Pass
105	15	Fail	Pass	Fail	Pass
105	26	Fail	Pass	Fail	Pass
105	30	Fail	Pass	Fail	Pass
106	13	Fail	Pass	Fail	Pass
106	14	Fail	Pass	Fail	Pass
106	15	Fail	Pass	Fail	Pass
106	26	Fail	Pass	Fail	Pass
106	27	Fail	Pass	Fail	Pass
106	30	Fail	Pass	Fail	Pass
106	39	Fail	Pass	Fail	Pass
107	13	Fail	Pass	Fail	Pass
107	14	Fail	Pass	Fail	Pass
107	15	Fail	Pass	Fail	Pass
107	22	Fail	Pass	Fail	Pass
107	26	Fail	Pass	Fail	Pass
107	30	Fail	Pass	Fail	Pass
107	39	Fail	Pass	Fail	Pass
108	13	Fail	Pass	Fail	Pass
108	14	Fail	Pass	Fail	Pass
108	15	Fail	Pass	Fail	Pass
108	22	Fail	Pass	Fail	Pass
108	26	Fail	Pass	Fail	Pass
108	30	Fail	Pass	Fail	Pass
108	39	Fail	Pass	Fail	Pass
109	13	Fail	Pass	Fail	Pass
109	14	Fail	Pass	Fail	Pass
109	15	Fail	Pass	Fail	Pass
109	22	Fail	Pass	Fail	Pass
109	26	Fail	Pass	Fail	Pass
109	30	Fail	Pass	Fail	Pass
109	39	Fail	Pass	Fail	Pass
110	13	Fail	Pass	Fail	Pass
110	14	Fail	Pass	Fail	Pass
110	15	Fail	Pass	Fail	Pass
110	22	Fail	Pass	Fail	Pass
110	26	Fail	Pass	Fail	Pass
110	39	Fail	Pass	Fail	Pass
111	13	Fail	Pass	Fail	Pass
111	14	Fail	Pass	Fail	Pass
111	15	Fail	Pass	Fail	Pass
111	22	Fail	Pass	Fail	Pass
111	26	Fail	Pass	Fail	Pass
111	39	Fail	Pass	Fail	Pass
112	13	Fail	Pass	Fail	Pass
112	14	Fail	Pass	Fail	Pass
112	15	Fail	Pass	Fail	Pass
112	22	Fail	Pass	Fail	Pass
112	26	Fail	Pass	Fail	Pass
112	39	Fail	Pass	Fail	Pass
113	13	Fail	Pass	Fail	Pass
113	14	Fail	Pass	Fail	Pass
113	15	Fail	Pass	Fail	Pass
113	26	Fail	Pass	Fail	Pass

113	27	Fail	Pass	Fail	Pass
113	39	Fail	Pass	Fail	Pass
114	13	Fail	Pass	Fail	Pass
114	14	Fail	Pass	Fail	Pass
114	15	Fail	Pass	Fail	Pass
114	26	Fail	Pass	Fail	Pass
114	39	Fail	Pass	Fail	Pass
115	13	Fail	Pass	Fail	Pass
115	14	Fail	Pass	Fail	Pass
115	15	Fail	Pass	Fail	Pass
115	26	Fail	Pass	Fail	Pass
115	39	Fail	Pass	Fail	Pass
116	13	Fail	Pass	Fail	Pass
116	14	Fail	Pass	Fail	Pass
116	15	Fail	Pass	Fail	Pass
116	26	Fail	Pass	Fail	Pass
116	39	Fail	Pass	Fail	Pass
117	13	Fail	Pass	Fail	Pass
117	14	Fail	Pass	Fail	Pass
117	15	Fail	Pass	Fail	Pass
117	26	Fail	Pass	Fail	Pass
117	39	Fail	Pass	Fail	Pass
118	13	Fail	Pass	Fail	Pass
118	14	Fail	Pass	Fail	Pass
118	15	Fail	Pass	Fail	Pass
118	20	Fail	Pass	Fail	Pass
118	26	Fail	Pass	Fail	Pass
118	39	Fail	Pass	Fail	Pass
119	13	Fail	Pass	Fail	Pass
119	14	Fail	Pass	Fail	Pass
119	15	Fail	Pass	Fail	Pass
119	20	Fail	Pass	Fail	Pass
119	26	Fail	Pass	Fail	Pass
119	39	Fail	Pass	Fail	Pass
120	13	Fail	Pass	Fail	Pass
120	14	Fail	Pass	Fail	Pass
120	15	Fail	Pass	Fail	Pass
120	16	Fail	Pass	Fail	Pass
120	26	Fail	Pass	Fail	Pass
120	39	Fail	Pass	Fail	Pass
121	13	Fail	Pass	Fail	Pass
121	14	Fail	Pass	Fail	Pass
121	26	Fail	Pass	Fail	Pass
121	39	Fail	Pass	Fail	Pass
122	13	Fail	Pass	Fail	Pass
122	14	Fail	Pass	Fail	Pass
122	26	Fail	Pass	Fail	Pass
122	39	Fail	Pass	Fail	Pass
123	13	Fail	Pass	Fail	Pass
123	14	Fail	Pass	Fail	Pass
123	15	Fail	Pass	Fail	Pass
123	16	Fail	Pass	Fail	Pass
123	17	Fail	Pass	Fail	Pass
123	18	Fail	Pass	Fail	Pass
123	19	Fail	Pass	Fail	Pass
123	20	Fail	Pass	Fail	Pass
123	21	Fail	Pass	Fail	Pass

123	22	Fail	Pass	Fail	Pass
123	23	Fail	Pass	Fail	Pass
123	24	Fail	Pass	Fail	Pass
123	25	Fail	Pass	Fail	Pass
123	26	Fail	Pass	Fail	Pass
123	27	Fail	Pass	Fail	Pass
123	28	Fail	Pass	Fail	Pass
123	29	Fail	Pass	Fail	Pass
123	30	Fail	Pass	Fail	Pass
123	31	Fail	Pass	Fail	Pass
123	32	Fail	Pass	Fail	Pass
123	33	Fail	Pass	Fail	Pass
123	34	Fail	Pass	Fail	Pass
123	35	Fail	Pass	Fail	Pass
123	36	Fail	Pass	Fail	Pass
123	37	Fail	Pass	Fail	Pass
123	38	Fail	Pass	Fail	Pass
123	39	Fail	Pass	Fail	Pass
124	13	Fail	Pass	Fail	Pass
124	14	Fail	Pass	Fail	Pass
124	23	Fail	Pass	Fail	Pass
125	13	Fail	Pass	Fail	Pass
125	14	Fail	Pass	Fail	Pass
125	23	Fail	Pass	Fail	Pass
126	13	Fail	Pass	Fail	Pass
126	14	Fail	Pass	Fail	Pass
126	23	Fail	Pass	Fail	Pass
127	13	Fail	Pass	Fail	Pass
127	14	Fail	Pass	Fail	Pass
127	23	Fail	Pass	Fail	Pass
128	13	Fail	Pass	Fail	Pass
128	14	Fail	Pass	Fail	Pass
128	23	Fail	Pass	Fail	Pass
129	13	Fail	Pass	Fail	Pass
129	14	Fail	Pass	Fail	Pass
129	23	Fail	Pass	Fail	Pass
130	8	Fail	Fail	Fail	Fail
130	9	Fail	Fail	Fail	Fail
130	10	Fail	Pass	Fail	Pass
130	11	Fail	Pass	Fail	Pass
130	12	Fail	Pass	Fail	Pass
130	13	Fail	Pass	Fail	Pass
130	14	Fail	Pass	Fail	Pass
130	23	Fail	Pass	Fail	Pass
131	14	Fail	Pass	Fail	Pass
131	23	Fail	Pass	Fail	Pass
132	14	Fail	Pass	Fail	Pass
132	23	Fail	Pass	Fail	Pass
133	14	Fail	Pass	Fail	Pass
133	23	Fail	Pass	Fail	Pass
134	14	Fail	Pass	Fail	Pass
134	23	Fail	Pass	Fail	Pass
135	14	Fail	Pass	Fail	Pass
136	14	Fail	Pass	Fail	Pass
137	14	Fail	Pass	Fail	Pass
138	14	Fail	Pass	Fail	Pass

Appendix G

MAY 1997

50th Percentile of Clyo Flow

Habitat Analysis Output

Fisheries Review Group

1. Table G.1. Comparisons of American Shad and Striped Bass Larvae habitat areas for existing and deepening (6 ft) scenarios and 50 %ile Clyo Flow within the analyzed period May 1 – May 31, 1997

	Baseline Scenario		Project Scenario		% Change
American Shad	19.962807	km2	19.962807	km2	0.0
Bass Larvae	2.423079	km2	2.089141	km2	-13.8

2. Table G.2. Comparisons of American Shad and Striped Bass Larvae habitat areas for existing and deepening (4 ft) scenarios and 50 %ile Clyo Flow within the analyzed period May 1 – May 31, 1997

	Baseline Scenario		Project Scenario		% Change
American Shad	19.962807	km2	19.962807	km2	0.0
Bass Larvae	2.423079	km2	1.913411	km2	-21.0

3. Table G.3. Comparisons of American Shad and Striped Bass Larvae habitat areas for existing and deepening (3 ft) scenarios and 50 %ile Clyo Flow within the analyzed period May 1 – May 31, 1997

	Baseline Scenario		Project Scenario		% Change
American Shad	19.962807	km2	19.962807	km2	0.0
Bass Larvae	2.423079	km2	1.971823	km2	-18.6

4. Table G.4. Comparisons of American Shad and Striped Bass Larvae habitat areas for existing and deepening (2 ft) scenarios and 50 %ile Clyo flow within the analyzed period May 1 – May 31, 1997

	Baseline Scenario		Project Scenario		% Change
American Shad	19.962807	km2	19.962807	km2	0.0
Bass Larvae	2.423079	km2	2.094973	km2	-13.5

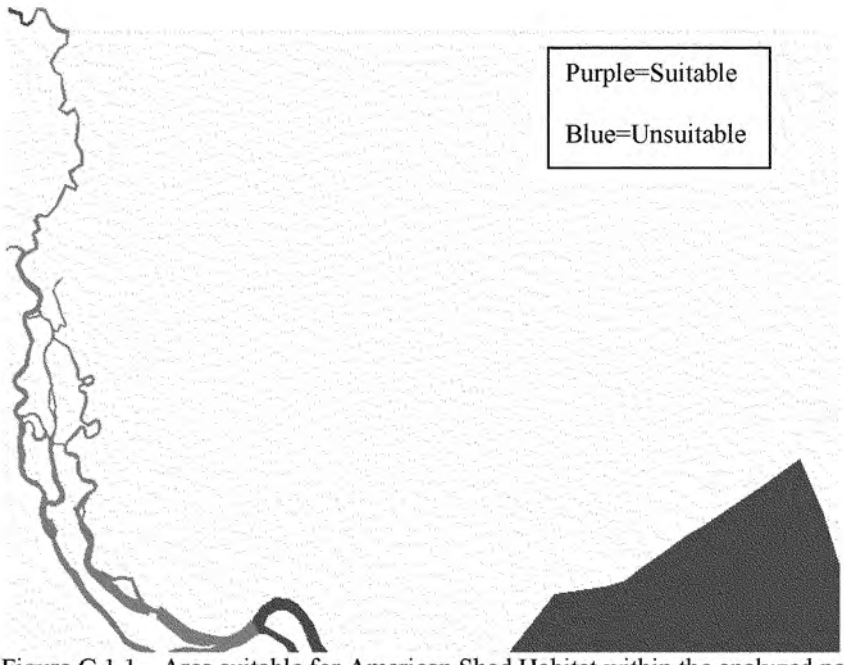
5. Table G.6.1 American Shad D.O. criteria passing for existing and deepening (6 ft, 4 ft, 3 ft, and 2 ft) scenarios within the analyzed period May 1 - May 31, 1997
(See Appendix G-1)

6. Table G.7.1 Striped Bass Larvae salinity and D.O. criteria passing for existing and deepening (6 ft) scenarios within the analyzed period May 1 - May 31, 1997
(See Appendix G-2)

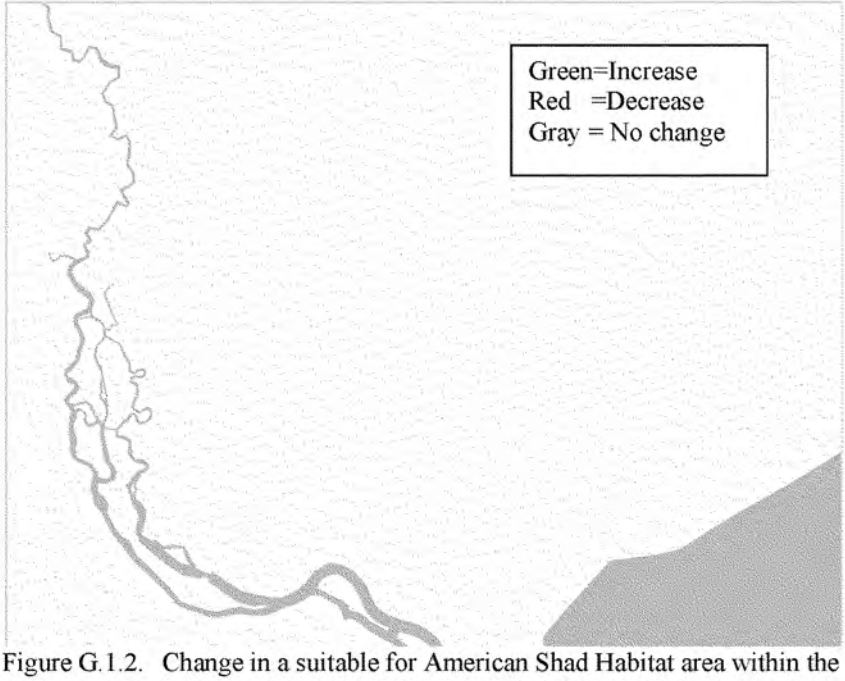
7. Table G.7.2 Striped Bass Larvae salinity and D.O. criteria passing for existing and deepening (4 ft) scenarios within the analyzed period May 1 - May 31, 1997
(See Appendix G-2)

8. Table G.7.3 Striped Bass Larvae salinity and D.O. criteria passing for existing and deepening (3 ft) scenarios within the analyzed period May 1 - May 31, 1997
(See Appendix G-2)

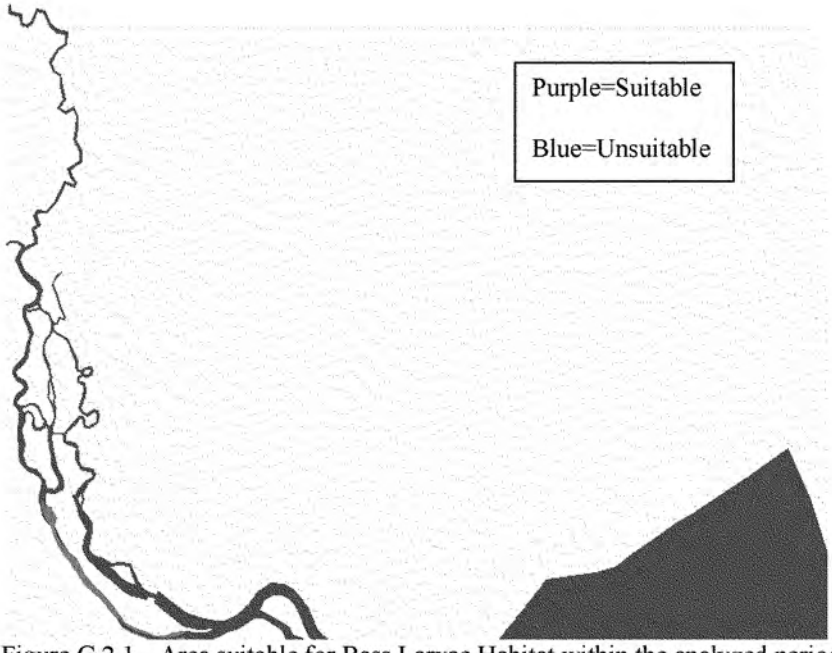
9. Table G.7.4 Striped Bass Larvae salinity and D.O. criteria passing for existing and deepening (2 ft) scenarios within the analyzed period May 1 - May 31, 1997
(See Appendix G-2)



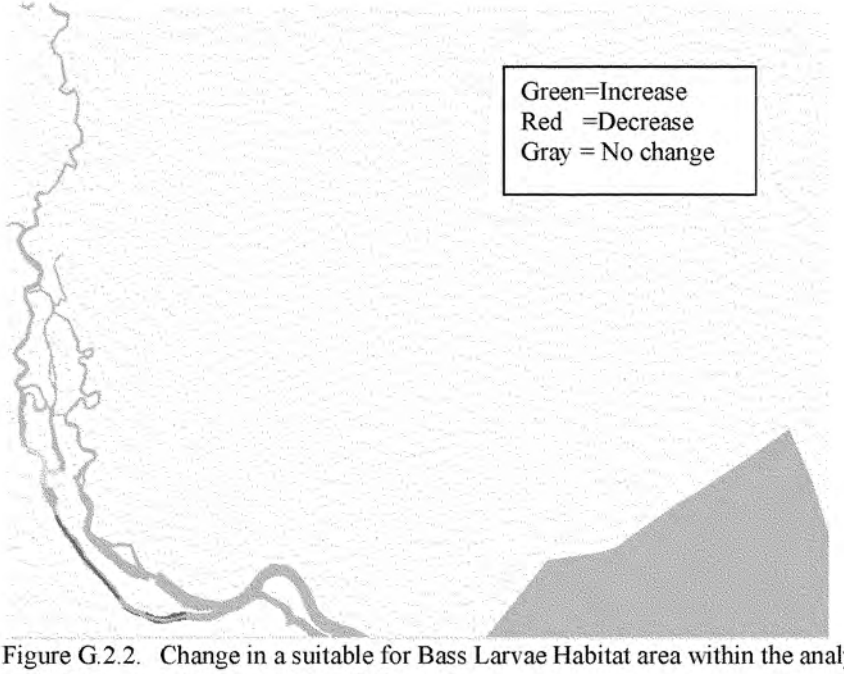
10. Figure G.1.1. Area suitable for American Shad Habitat within the analyzed period May 1 – May 31, 1997: Existing bathymetry



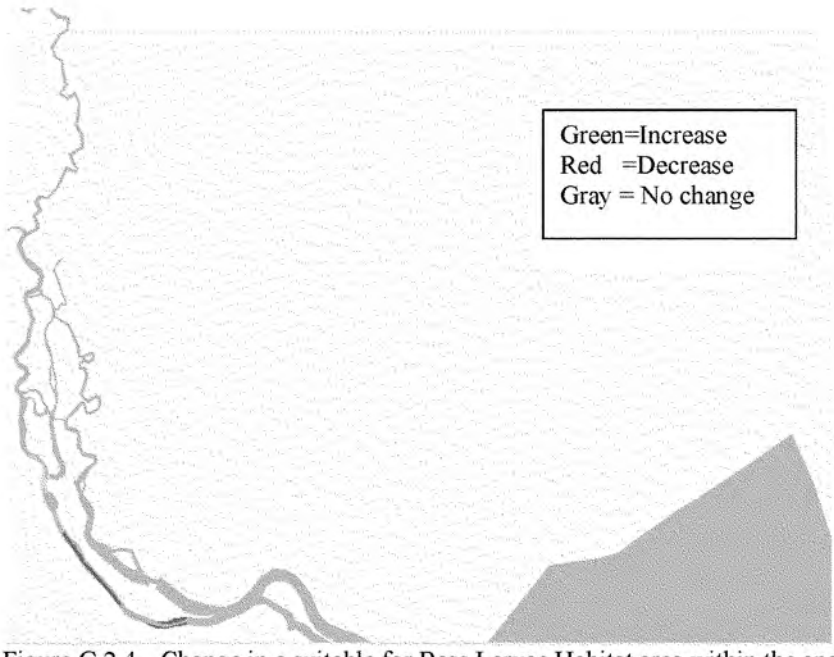
11. Figure G.1.2. Change in a suitable for American Shad Habitat area within the analyzed period May 1 - May 31, 1999 : 6 ft, 4 ft, 3 ft, and 2 ft deepening



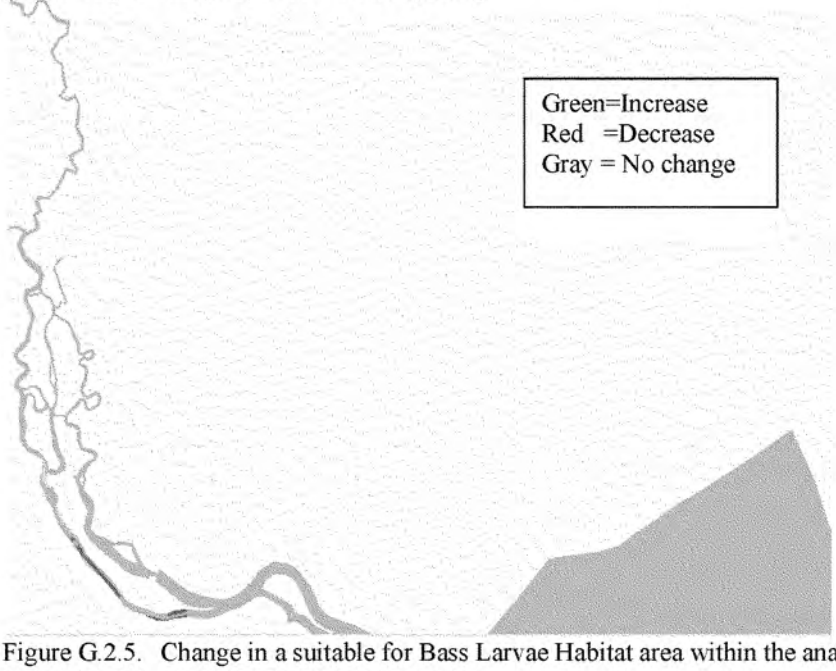
12. Figure G.2.1. Area suitable for Bass Larvae Habitat within the analyzed period May 1 – May 31, 1997: Existing bathymetry



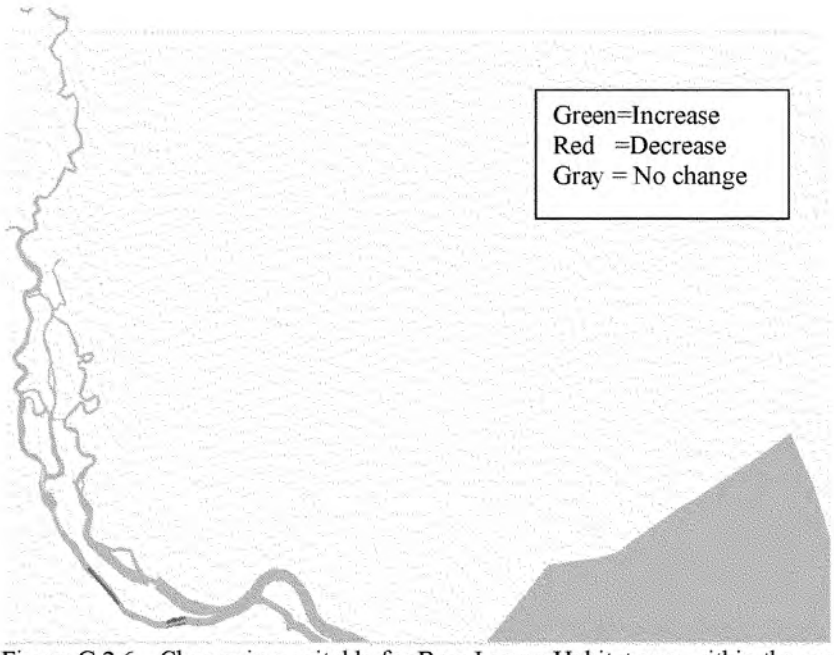
13. Figure G.2.2. Change in a suitable for Bass Larvae Habitat area within the analyzed period May 1 - May 31, 1999 : 6 ft deepening



14. Figure G.2.4. Change in a suitable for Bass Larvae Habitat area within the analyzed period May 1 - May 31, 1999 : 4 ft deepening



15. Figure G.2.5. Change in a suitable for Bass Larvae Habitat area within the analyzed period May 1 - May 31, 1999 : 3 ft deepening



16. Figure G.2.6. Change in a suitable for Bass Larvae Habitat area within the analyzed period May 1 - May 31, 1999 : 2 ft deepening

Appendix G-1

Tables of Criteria Passing for American Shad Habitat Suitability

May 1997

50th %ile of Clyo Flow

Fisheries Review Group

1. Table G.6.1 American Shad D.O. criteria passing for existing and deepening (6 ft, 4 ft, 3 ft, and 2 ft) scenarios within the analyzed period May 1 - May 31, 1997

HABITAT REQUIREMENTS:
RM 10-40; Top half of water column
D.O. January, May, and August (MG/L):10th %ile >=4.0

Savannah Harbor Estuary

Segments J	Segments I	Baseline Scenario D.O.	Project Scenario D.O.
47	13	Pass	Pass
47	14	Pass	Pass
47	15	Pass	Pass
47	16	Pass	Pass
47	17	Pass	Pass
48	13	Pass	Pass
48	14	Pass	Pass
48	15	Pass	Pass
48	16	Pass	Pass
48	17	Pass	Pass
49	13	Pass	Pass
49	14	Pass	Pass
49	15	Pass	Pass
49	16	Pass	Pass
49	17	Pass	Pass
50	13	Pass	Pass
50	14	Pass	Pass
50	15	Pass	Pass
50	16	Pass	Pass
50	17	Pass	Pass
50	18	Pass	Pass
51	13	Pass	Pass
51	14	Pass	Pass
51	15	Pass	Pass
52	13	Pass	Pass
52	14	Pass	Pass
52	15	Pass	Pass
53	13	Pass	Pass
53	14	Pass	Pass
53	15	Pass	Pass
54	13	Pass	Pass
54	14	Pass	Pass
54	15	Pass	Pass
55	13	Pass	Pass
55	14	Pass	Pass
55	15	Pass	Pass
56	13	Pass	Pass
56	14	Pass	Pass
56	15	Pass	Pass
57	13	Pass	Pass
57	14	Pass	Pass
57	15	Pass	Pass

58	13	Pass	Pass
58	14	Pass	Pass
58	15	Pass	Pass
59	13	Pass	Pass
59	14	Pass	Pass
59	15	Pass	Pass
59	30	Pass	Pass
59	31	Pass	Pass
59	32	Pass	Pass
60	13	Pass	Pass
60	14	Pass	Pass
60	15	Pass	Pass
60	30	Pass	Pass
60	31	Pass	Pass
60	32	Pass	Pass
61	13	Pass	Pass
61	14	Pass	Pass
61	15	Pass	Pass
61	30	Pass	Pass
61	31	Pass	Pass
61	32	Pass	Pass
62	13	Pass	Pass
62	14	Pass	Pass
62	15	Pass	Pass
62	30	Pass	Pass
62	31	Pass	Pass
62	32	Pass	Pass
63	13	Pass	Pass
63	14	Pass	Pass
63	15	Pass	Pass
63	31	Pass	Pass
64	13	Pass	Pass
64	14	Pass	Pass
64	15	Pass	Pass
64	30	Pass	Pass
64	31	Pass	Pass
64	32	Pass	Pass
65	13	Pass	Pass
65	14	Pass	Pass
65	15	Pass	Pass
65	30	Pass	Pass
65	31	Pass	Pass
65	32	Pass	Pass
65	33	Pass	Pass
66	13	Pass	Pass
66	14	Pass	Pass
66	15	Pass	Pass
66	30	Pass	Pass
66	31	Pass	Pass
66	32	Pass	Pass
66	36	Pass	Pass
67	13	Pass	Pass
67	14	Pass	Pass
67	15	Pass	Pass
67	30	Pass	Pass
67	31	Pass	Pass
67	32	Pass	Pass

67	36	Pass	Pass
68	13	Pass	Pass
68	14	Pass	Pass
68	15	Pass	Pass
68	30	Pass	Pass
68	31	Pass	Pass
68	32	Pass	Pass
68	36	Pass	Pass
69	13	Pass	Pass
69	14	Pass	Pass
69	15	Pass	Pass
69	30	Pass	Pass
69	31	Pass	Pass
69	32	Pass	Pass
69	36	Pass	Pass
70	13	Pass	Pass
70	14	Pass	Pass
70	15	Pass	Pass
70	30	Pass	Pass
70	31	Pass	Pass
70	32	Pass	Pass
70	33	Pass	Pass
71	13	Pass	Pass
71	14	Pass	Pass
71	15	Pass	Pass
71	30	Pass	Pass
71	31	Pass	Pass
71	32	Pass	Pass
72	13	Pass	Pass
72	14	Pass	Pass
72	15	Pass	Pass
72	30	Pass	Pass
72	31	Pass	Pass
72	32	Pass	Pass
73	13	Pass	Pass
73	14	Pass	Pass
73	15	Pass	Pass
73	30	Pass	Pass
73	31	Pass	Pass
74	13	Pass	Pass
74	14	Pass	Pass
74	15	Pass	Pass
74	30	Pass	Pass
74	31	Pass	Pass
75	13	Pass	Pass
75	14	Pass	Pass
75	15	Pass	Pass
75	30	Pass	Pass
75	31	Pass	Pass
76	13	Pass	Pass
76	14	Pass	Pass
76	15	Pass	Pass
76	16	Pass	Pass
76	17	Pass	Pass
76	30	Pass	Pass
76	31	Pass	Pass
77	13	Pass	Pass

77	14	Pass	Pass
77	15	Pass	Pass
77	16	Pass	Pass
77	17	Pass	Pass
77	30	Pass	Pass
77	31	Pass	Pass
78	13	Pass	Pass
78	14	Pass	Pass
78	15	Pass	Pass
78	16	Pass	Pass
78	17	Pass	Pass
78	30	Pass	Pass
78	31	Pass	Pass
79	13	Pass	Pass
79	14	Pass	Pass
79	15	Pass	Pass
79	30	Pass	Pass
79	31	Pass	Pass
80	13	Pass	Pass
80	14	Pass	Pass
80	15	Pass	Pass
80	30	Pass	Pass
80	31	Pass	Pass
81	13	Pass	Pass
81	14	Pass	Pass
81	15	Pass	Pass
81	30	Pass	Pass
81	31	Pass	Pass
82	13	Pass	Pass
82	14	Pass	Pass
82	15	Pass	Pass
82	16	Pass	Pass
82	17	Pass	Pass
82	18	Pass	Pass
82	19	Pass	Pass
82	20	Pass	Pass
82	21	Pass	Pass
82	29	Pass	Pass
82	30	Pass	Pass
82	31	Pass	Pass
83	13	Pass	Pass
83	14	Pass	Pass
83	15	Pass	Pass
83	21	Pass	Pass
83	30	Pass	Pass
83	31	Pass	Pass
84	13	Pass	Pass
84	14	Pass	Pass
84	15	Pass	Pass
84	21	Pass	Pass
84	30	Pass	Pass
84	31	Pass	Pass
85	13	Pass	Pass
85	14	Pass	Pass
85	15	Pass	Pass
85	21	Pass	Pass
85	30	Pass	Pass

86	13	Pass	Pass
86	14	Pass	Pass
86	15	Pass	Pass
86	21	Pass	Pass
86	30	Pass	Pass
87	13	Pass	Pass
87	14	Pass	Pass
87	15	Pass	Pass
87	30	Pass	Pass
88	13	Pass	Pass
88	14	Pass	Pass
88	15	Pass	Pass
88	30	Pass	Pass
89	13	Pass	Pass
89	14	Pass	Pass
89	15	Pass	Pass
89	30	Pass	Pass
90	13	Pass	Pass
90	14	Pass	Pass
90	15	Pass	Pass
90	30	Pass	Pass
91	13	Pass	Pass
91	14	Pass	Pass
91	15	Pass	Pass
91	16	Pass	Pass
91	30	Pass	Pass
92	13	Pass	Pass
92	14	Pass	Pass
92	15	Pass	Pass
92	16	Pass	Pass
92	30	Pass	Pass
93	13	Pass	Pass
93	14	Pass	Pass
93	15	Pass	Pass
93	16	Pass	Pass
93	30	Pass	Pass
94	13	Pass	Pass
94	14	Pass	Pass
94	15	Pass	Pass
94	16	Pass	Pass
94	26	Pass	Pass
94	30	Pass	Pass
95	13	Pass	Pass
95	14	Pass	Pass
95	15	Pass	Pass
95	16	Pass	Pass
95	26	Pass	Pass
95	30	Pass	Pass
96	13	Pass	Pass
96	14	Pass	Pass
96	15	Pass	Pass
96	26	Pass	Pass
96	30	Pass	Pass
97	13	Pass	Pass
97	14	Pass	Pass
97	15	Pass	Pass
97	26	Pass	Pass

97	30	Pass	Pass
98	13	Pass	Pass
98	14	Pass	Pass
98	15	Pass	Pass
98	26	Pass	Pass
98	27	Pass	Pass
98	28	Pass	Pass
98	29	Pass	Pass
98	30	Pass	Pass
99	13	Pass	Pass
99	14	Pass	Pass
99	15	Pass	Pass
99	16	Pass	Pass
99	17	Pass	Pass
99	18	Pass	Pass
99	19	Pass	Pass
99	20	Pass	Pass
99	21	Pass	Pass
99	22	Pass	Pass
99	23	Pass	Pass
99	26	Pass	Pass
99	30	Pass	Pass
100	13	Pass	Pass
100	14	Pass	Pass
100	15	Pass	Pass
100	23	Pass	Pass
100	24	Pass	Pass
100	25	Pass	Pass
100	26	Pass	Pass
100	30	Pass	Pass
101	13	Pass	Pass
101	14	Pass	Pass
101	15	Pass	Pass
101	16	Pass	Pass
101	17	Pass	Pass
101	18	Pass	Pass
101	19	Pass	Pass
101	20	Pass	Pass
101	21	Pass	Pass
101	22	Pass	Pass
101	23	Pass	Pass
101	26	Pass	Pass
101	30	Pass	Pass
102	13	Pass	Pass
102	14	Pass	Pass
102	15	Pass	Pass
102	26	Pass	Pass
102	30	Pass	Pass
103	13	Pass	Pass
103	14	Pass	Pass
103	15	Pass	Pass
103	26	Pass	Pass
103	30	Pass	Pass
104	13	Pass	Pass
104	14	Pass	Pass
104	15	Pass	Pass
104	26	Pass	Pass

104	30	Pass	Pass
105	13	Pass	Pass
105	14	Pass	Pass
105	15	Pass	Pass
105	26	Pass	Pass
105	30	Pass	Pass
106	13	Pass	Pass
106	14	Pass	Pass
106	15	Pass	Pass
106	26	Pass	Pass
106	27	Pass	Pass
106	30	Pass	Pass
106	39	Pass	Pass
107	13	Pass	Pass
107	14	Pass	Pass
107	15	Pass	Pass
107	22	Pass	Pass
107	26	Pass	Pass
107	30	Pass	Pass
107	39	Pass	Pass
108	13	Pass	Pass
108	14	Pass	Pass
108	15	Pass	Pass
108	22	Pass	Pass
108	26	Pass	Pass
108	30	Pass	Pass
108	39	Pass	Pass
109	13	Pass	Pass
109	14	Pass	Pass
109	15	Pass	Pass
109	22	Pass	Pass
109	26	Pass	Pass
109	30	Pass	Pass
109	39	Pass	Pass
110	13	Pass	Pass
110	14	Pass	Pass
110	15	Pass	Pass
110	22	Pass	Pass
110	26	Pass	Pass
110	39	Pass	Pass
111	13	Pass	Pass
111	14	Pass	Pass
111	15	Pass	Pass
111	22	Pass	Pass
111	26	Pass	Pass
111	39	Pass	Pass
112	13	Pass	Pass
112	14	Pass	Pass
112	15	Pass	Pass
112	22	Pass	Pass
112	26	Pass	Pass
112	39	Pass	Pass
113	13	Pass	Pass
113	14	Pass	Pass
113	15	Pass	Pass
113	26	Pass	Pass
113	27	Pass	Pass

113	39	Pass	Pass
114	13	Pass	Pass
114	14	Pass	Pass
114	15	Pass	Pass
114	26	Pass	Pass
114	39	Pass	Pass
115	13	Pass	Pass
115	14	Pass	Pass
115	15	Pass	Pass
115	26	Pass	Pass
115	39	Pass	Pass
116	13	Pass	Pass
116	14	Pass	Pass
116	15	Pass	Pass
116	26	Pass	Pass
116	39	Pass	Pass
117	13	Pass	Pass
117	14	Pass	Pass
117	15	Pass	Pass
117	26	Pass	Pass
117	39	Pass	Pass
118	13	Pass	Pass
118	14	Pass	Pass
118	15	Pass	Pass
118	20	Pass	Pass
118	26	Pass	Pass
118	39	Pass	Pass
119	13	Pass	Pass
119	14	Pass	Pass
119	15	Pass	Pass
119	20	Pass	Pass
119	26	Pass	Pass
119	39	Pass	Pass
120	13	Pass	Pass
120	14	Pass	Pass
120	15	Pass	Pass
120	16	Pass	Pass
120	26	Pass	Pass
120	39	Pass	Pass
121	13	Pass	Pass
121	14	Pass	Pass
121	26	Pass	Pass
121	39	Pass	Pass
122	13	Pass	Pass
122	14	Pass	Pass
122	26	Pass	Pass
122	39	Pass	Pass
123	13	Pass	Pass
123	14	Pass	Pass
123	15	Pass	Pass
123	16	Pass	Pass
123	17	Pass	Pass
123	18	Pass	Pass
123	19	Pass	Pass
123	20	Pass	Pass
123	21	Pass	Pass
123	22	Pass	Pass

123	23	Pass	Pass
123	24	Pass	Pass
123	25	Pass	Pass
123	26	Pass	Pass
123	27	Pass	Pass
123	28	Pass	Pass
123	29	Pass	Pass
123	30	Pass	Pass
123	31	Pass	Pass
123	32	Pass	Pass
123	33	Pass	Pass
123	34	Pass	Pass
123	35	Pass	Pass
123	36	Pass	Pass
123	37	Pass	Pass
123	38	Pass	Pass
123	39	Pass	Pass
124	13	Pass	Pass
124	14	Pass	Pass
124	23	Pass	Pass
125	13	Pass	Pass
125	14	Pass	Pass
125	23	Pass	Pass
126	13	Pass	Pass
126	14	Pass	Pass
126	23	Pass	Pass
127	13	Pass	Pass
127	14	Pass	Pass
127	23	Pass	Pass
128	13	Pass	Pass
128	14	Pass	Pass
128	23	Pass	Pass
129	13	Pass	Pass
129	14	Pass	Pass
129	23	Pass	Pass
130	8	Pass	Pass
130	9	Pass	Pass
130	10	Pass	Pass
130	11	Pass	Pass
130	12	Pass	Pass
130	13	Pass	Pass
130	14	Pass	Pass
130	23	Pass	Pass
131	14	Pass	Pass
131	23	Pass	Pass
132	14	Pass	Pass
132	23	Pass	Pass
133	14	Pass	Pass
133	23	Pass	Pass
134	14	Pass	Pass
134	23	Pass	Pass
135	14	Pass	Pass
136	14	Pass	Pass
137	14	Pass	Pass
138	14	Pass	Pass
139	14	Pass	Pass
140	14	Pass	Pass

141	14	Pass	Pass
142	14	Pass	Pass
143	14	Pass	Pass
144	14	Pass	Pass
145	14	Pass	Pass
146	14	Pass	Pass
147	14	Pass	Pass
148	14	Pass	Pass
149	14	Pass	Pass
150	14	Pass	Pass
151	14	Pass	Pass
152	14	Pass	Pass
153	14	Pass	Pass
154	14	Pass	Pass
155	14	Pass	Pass
156	14	Pass	Pass
157	14	Pass	Pass
158	14	Pass	Pass
159	14	Pass	Pass
160	14	Pass	Pass
161	14	Pass	Pass
162	14	Pass	Pass
163	14	Pass	Pass
164	14	Pass	Pass
165	14	Pass	Pass
166	14	Pass	Pass

Appendix G-2

Tables of Criteria Passing for Striped Bass Larvae Habitat Suitability

May 1997

50th %ile of Clyo Flow

Fisheries Review Group

1. Table G.7.1 Striped Bass Larvae salinity and D.O. criteria passing for existing and deepening (6 ft) scenarios within the analyzed period May 1 - May 31, 1997

HABITAT REQUIREMENTS:
RM 10-31; Depth Average
D.O. May (MG/L):10th %ile >=4.5
Salinity 50th %ile >=3 & <= 9 ppt

Savannah Harbor Estuary
Analyzed period: MAY 1 - MAY 31, Year 1997

Segments J	Segments I	Baseline Scenario Salinity	Baseline Scenario D.O.	Project Scenario Salinity	Project Scenario D.O.
47	13	Fail	Pass	Fail	Pass
47	14	Fail	Pass	Fail	Pass
47	15	Fail	Pass	Fail	Pass
47	16	Fail	Pass	Fail	Pass
47	17	Fail	Pass	Fail	Pass
48	13	Fail	Pass	Fail	Pass
48	14	Fail	Pass	Fail	Pass
48	15	Fail	Pass	Fail	Pass
48	16	Fail	Pass	Fail	Pass
48	17	Fail	Pass	Fail	Pass
49	13	Fail	Pass	Fail	Pass
49	14	Fail	Pass	Fail	Pass
49	15	Fail	Pass	Fail	Pass
49	16	Fail	Pass	Fail	Pass
49	17	Fail	Pass	Fail	Pass
50	13	Fail	Pass	Fail	Pass
50	14	Fail	Pass	Fail	Pass
50	15	Fail	Pass	Fail	Pass
50	16	Fail	Pass	Fail	Pass
50	17	Fail	Pass	Fail	Pass
50	18	Pass	Fail	Fail	Fail
51	13	Fail	Pass	Fail	Pass
51	14	Fail	Pass	Fail	Pass
51	15	Fail	Pass	Fail	Pass
52	13	Fail	Pass	Fail	Pass
52	14	Fail	Pass	Fail	Pass
52	15	Fail	Pass	Fail	Pass
53	13	Fail	Pass	Fail	Pass
53	14	Fail	Pass	Fail	Pass
53	15	Fail	Pass	Fail	Pass
54	13	Pass	Pass	Fail	Pass
54	14	Fail	Pass	Fail	Pass
54	15	Pass	Pass	Fail	Pass
55	13	Pass	Pass	Fail	Pass
55	14	Fail	Pass	Fail	Pass
55	15	Pass	Pass	Fail	Pass
56	13	Pass	Pass	Fail	Pass
56	14	Fail	Pass	Fail	Pass
56	15	Pass	Pass	Fail	Pass
57	13	Pass	Pass	Fail	Pass
57	14	Fail	Pass	Fail	Pass

57	15	Pass	Pass	Fail	Pass
58	13	Pass	Pass	Fail	Pass
58	14	Fail	Pass	Fail	Pass
58	15	Pass	Pass	Pass	Pass
59	13	Pass	Pass	Fail	Pass
59	14	Fail	Pass	Fail	Pass
59	15	Pass	Pass	Pass	Pass
59	30	Fail	Fail	Fail	Fail
59	31	Fail	Fail	Fail	Fail
59	32	Fail	Fail	Fail	Fail
60	13	Pass	Pass	Pass	Pass
60	14	Fail	Pass	Fail	Pass
60	15	Pass	Pass	Pass	Pass
60	30	Pass	Fail	Fail	Fail
60	31	Fail	Fail	Fail	Fail
60	32	Fail	Fail	Fail	Fail
61	13	Pass	Pass	Pass	Pass
61	14	Pass	Pass	Fail	Pass
61	15	Pass	Pass	Pass	Pass
61	30	Pass	Fail	Fail	Fail
61	31	Fail	Fail	Fail	Fail
61	32	Pass	Fail	Fail	Fail
62	13	Pass	Pass	Pass	Pass
62	14	Pass	Pass	Fail	Pass
62	15	Pass	Pass	Pass	Pass
62	30	Pass	Fail	Fail	Fail
62	31	Fail	Fail	Fail	Fail
62	32	Pass	Fail	Fail	Fail
63	13	Pass	Pass	Pass	Pass
63	14	Pass	Pass	Fail	Pass
63	15	Pass	Pass	Pass	Pass
63	31	Pass	Fail	Fail	Fail
64	13	Pass	Pass	Pass	Pass
64	14	Pass	Pass	Fail	Pass
64	15	Pass	Pass	Pass	Pass
64	30	Pass	Fail	Fail	Fail
64	31	Pass	Fail	Fail	Fail
64	32	Fail	Fail	Fail	Fail
65	13	Pass	Pass	Pass	Pass
65	14	Pass	Pass	Fail	Pass
65	15	Pass	Pass	Pass	Pass
65	30	Pass	Fail	Fail	Fail
65	31	Pass	Fail	Fail	Fail
65	32	Pass	Fail	Fail	Fail
65	33	Fail	Fail	Fail	Fail
66	13	Pass	Pass	Pass	Pass
66	14	Pass	Pass	Fail	Pass
66	15	Pass	Pass	Pass	Pass
66	30	Pass	Fail	Fail	Fail
66	31	Pass	Fail	Fail	Fail
66	32	Pass	Fail	Fail	Fail
66	36	Pass	Fail	Fail	Fail
67	13	Pass	Pass	Pass	Pass
67	14	Pass	Pass	Fail	Pass
67	15	Pass	Pass	Pass	Pass
67	30	Pass	Fail	Fail	Fail
67	31	Pass	Fail	Fail	Fail

67	32	Pass	Fail	Fail	Fail
67	36	Pass	Fail	Fail	Fail
68	13	Pass	Pass	Pass	Pass
68	14	Pass	Pass	Fail	Pass
68	15	Pass	Pass	Pass	Pass
68	30	Pass	Fail	Fail	Fail
68	31	Pass	Fail	Fail	Fail
68	32	Pass	Fail	Fail	Fail
68	36	Pass	Fail	Fail	Fail
69	13	Pass	Pass	Pass	Pass
69	14	Pass	Pass	Fail	Pass
69	15	Pass	Pass	Pass	Pass
69	30	Pass	Fail	Fail	Fail
69	31	Pass	Fail	Fail	Fail
69	32	Pass	Fail	Fail	Fail
69	36	Pass	Fail	Fail	Fail
70	13	Pass	Pass	Pass	Pass
70	14	Pass	Pass	Fail	Pass
70	15	Pass	Pass	Pass	Pass
70	30	Pass	Fail	Fail	Fail
70	31	Pass	Fail	Pass	Fail
70	32	Pass	Fail	Pass	Fail
70	33	Pass	Fail	Fail	Fail
71	13	Pass	Pass	Pass	Pass
71	14	Pass	Pass	Fail	Pass
71	15	Pass	Pass	Pass	Pass
71	30	Pass	Fail	Pass	Fail
71	31	Pass	Fail	Pass	Fail
71	32	Pass	Fail	Pass	Fail
72	13	Pass	Pass	Pass	Pass
72	14	Pass	Pass	Fail	Pass
72	15	Pass	Pass	Pass	Pass
72	30	Pass	Fail	Pass	Fail
72	31	Pass	Fail	Pass	Fail
72	32	Pass	Fail	Pass	Fail
73	13	Pass	Pass	Pass	Pass
73	14	Pass	Pass	Fail	Pass
73	15	Fail	Pass	Pass	Pass
73	30	Pass	Fail	Pass	Fail
73	31	Pass	Fail	Pass	Fail
74	13	Pass	Pass	Pass	Pass
74	14	Pass	Pass	Fail	Pass
74	15	Fail	Pass	Pass	Pass
74	30	Pass	Fail	Pass	Fail
74	31	Pass	Fail	Pass	Fail
75	13	Pass	Pass	Pass	Pass
75	14	Pass	Pass	Pass	Pass
75	15	Fail	Pass	Pass	Pass
75	30	Pass	Fail	Pass	Fail
75	31	Pass	Fail	Pass	Fail
76	13	Fail	Pass	Pass	Pass
76	14	Pass	Pass	Pass	Pass
76	15	Pass	Pass	Pass	Pass
76	16	Pass	Pass	Pass	Pass
76	17	Pass	Pass	Pass	Pass
76	30	Pass	Fail	Pass	Fail
76	31	Pass	Fail	Pass	Fail

77	13	Fail	Pass	Pass	Pass
77	14	Pass	Pass	Pass	Pass
77	15	Pass	Pass	Pass	Pass
77	16	Pass	Pass	Pass	Pass
77	17	Pass	Pass	Pass	Pass
77	30	Pass	Fail	Pass	Fail
77	31	Pass	Fail	Pass	Fail
78	13	Fail	Pass	Pass	Pass
78	14	Pass	Pass	Pass	Pass
78	15	Pass	Pass	Pass	Pass
78	16	Pass	Pass	Pass	Pass
78	17	Pass	Pass	Pass	Pass
78	30	Pass	Fail	Pass	Fail
78	31	Pass	Fail	Pass	Fail
79	13	Fail	Pass	Pass	Pass
79	14	Pass	Pass	Pass	Pass
79	15	Fail	Pass	Pass	Pass
79	30	Fail	Fail	Pass	Fail
79	31	Pass	Fail	Pass	Fail
80	13	Fail	Pass	Pass	Pass
80	14	Fail	Pass	Pass	Pass
80	15	Fail	Pass	Pass	Pass
80	30	Fail	Fail	Pass	Fail
80	31	Fail	Fail	Pass	Fail
81	13	Fail	Pass	Pass	Pass
81	14	Fail	Pass	Pass	Pass
81	15	Fail	Pass	Pass	Pass
81	30	Fail	Fail	Pass	Fail
81	31	Fail	Fail	Pass	Fail
82	13	Fail	Pass	Pass	Pass
82	14	Fail	Pass	Pass	Pass
82	15	Fail	Pass	Pass	Pass
82	16	Fail	Pass	Pass	Pass
82	17	Fail	Pass	Pass	Pass
82	18	Fail	Pass	Pass	Pass
82	19	Fail	Pass	Pass	Pass
82	20	Fail	Pass	Pass	Pass
82	21	Fail	Pass	Fail	Pass
82	29	Fail	Fail	Pass	Fail
82	30	Fail	Fail	Pass	Fail
82	31	Fail	Pass	Pass	Fail
83	13	Fail	Pass	Pass	Pass
83	14	Fail	Pass	Pass	Pass
83	15	Fail	Pass	Pass	Pass
83	21	Fail	Pass	Fail	Pass
83	30	Fail	Fail	Pass	Fail
83	31	Fail	Pass	Fail	Pass
84	13	Fail	Pass	Pass	Pass
84	14	Fail	Pass	Pass	Pass
84	15	Fail	Pass	Pass	Pass
84	21	Fail	Pass	Fail	Pass
84	30	Fail	Fail	Fail	Fail
84	31	Fail	Pass	Fail	Pass
85	13	Fail	Pass	Pass	Pass
85	14	Fail	Pass	Pass	Pass
85	15	Fail	Pass	Pass	Pass
85	21	Fail	Pass	Fail	Pass

85	30	Fail	Fail	Fail	Fail
86	13	Fail	Pass	Pass	Pass
86	14	Fail	Pass	Pass	Pass
86	15	Fail	Pass	Pass	Pass
86	21	Fail	Pass	Fail	Pass
86	30	Fail	Fail	Fail	Fail
87	13	Fail	Pass	Fail	Pass
87	14	Fail	Pass	Pass	Pass
87	15	Fail	Pass	Pass	Pass
87	30	Fail	Fail	Fail	Fail
88	13	Fail	Pass	Fail	Pass
88	14	Fail	Pass	Pass	Pass
88	15	Fail	Pass	Pass	Pass
88	30	Fail	Fail	Fail	Fail
89	13	Fail	Pass	Fail	Pass
89	14	Fail	Pass	Pass	Pass
89	15	Fail	Pass	Fail	Pass
89	30	Fail	Pass	Fail	Fail
90	13	Fail	Pass	Fail	Pass
90	14	Fail	Pass	Pass	Pass
90	15	Fail	Pass	Fail	Pass
90	30	Fail	Pass	Fail	Pass
91	13	Fail	Pass	Fail	Pass
91	14	Fail	Pass	Pass	Pass
91	15	Fail	Pass	Fail	Pass
91	16	Fail	Pass	Fail	Pass
91	30	Fail	Pass	Fail	Pass
92	13	Fail	Pass	Fail	Pass
92	14	Fail	Pass	Pass	Pass
92	15	Fail	Pass	Fail	Pass
92	16	Fail	Pass	Fail	Pass
92	30	Fail	Pass	Fail	Pass
93	13	Fail	Pass	Fail	Pass
93	14	Fail	Pass	Fail	Pass
93	15	Fail	Pass	Fail	Pass
93	16	Fail	Pass	Fail	Pass
93	30	Fail	Pass	Fail	Pass
94	13	Fail	Pass	Fail	Pass
94	14	Fail	Pass	Fail	Pass
94	15	Fail	Pass	Fail	Pass
94	16	Fail	Pass	Fail	Pass
94	26	Fail	Pass	Fail	Pass
94	30	Fail	Pass	Fail	Pass
95	13	Fail	Pass	Fail	Pass
95	14	Fail	Pass	Fail	Pass
95	15	Fail	Pass	Fail	Pass
95	16	Fail	Pass	Fail	Pass
95	26	Fail	Pass	Fail	Pass
95	30	Fail	Pass	Fail	Pass
96	13	Fail	Pass	Fail	Pass
96	14	Fail	Pass	Fail	Pass
96	15	Fail	Pass	Fail	Pass
96	26	Fail	Pass	Fail	Pass
96	30	Fail	Pass	Fail	Pass
97	13	Fail	Pass	Fail	Pass
97	14	Fail	Pass	Fail	Pass
97	15	Fail	Pass	Fail	Pass

97	26	Fail	Pass	Fail	Pass
97	30	Fail	Pass	Fail	Pass
98	13	Fail	Pass	Fail	Pass
98	14	Fail	Pass	Fail	Pass
98	15	Fail	Pass	Fail	Pass
98	26	Fail	Pass	Fail	Pass
98	27	Fail	Pass	Fail	Pass
98	28	Fail	Pass	Fail	Pass
98	29	Fail	Pass	Fail	Pass
98	30	Fail	Pass	Fail	Pass
99	13	Fail	Pass	Fail	Pass
99	14	Fail	Pass	Fail	Pass
99	15	Fail	Pass	Fail	Pass
99	16	Fail	Pass	Fail	Pass
99	17	Fail	Pass	Fail	Pass
99	18	Fail	Pass	Fail	Pass
99	19	Fail	Pass	Fail	Pass
99	20	Fail	Pass	Fail	Pass
99	21	Fail	Pass	Fail	Pass
99	22	Fail	Pass	Fail	Pass
99	23	Fail	Pass	Fail	Pass
99	26	Fail	Pass	Fail	Pass
99	30	Fail	Pass	Fail	Pass
100	13	Fail	Pass	Fail	Pass
100	14	Fail	Pass	Fail	Pass
100	15	Fail	Pass	Fail	Pass
100	23	Fail	Pass	Fail	Pass
100	24	Fail	Pass	Fail	Pass
100	25	Fail	Pass	Fail	Pass
100	26	Fail	Pass	Fail	Pass
100	30	Fail	Pass	Fail	Pass
101	13	Fail	Pass	Fail	Pass
101	14	Fail	Pass	Fail	Pass
101	15	Fail	Pass	Fail	Pass
101	16	Fail	Pass	Fail	Pass
101	17	Fail	Pass	Fail	Pass
101	18	Fail	Pass	Fail	Pass
101	19	Fail	Pass	Fail	Pass
101	20	Fail	Pass	Fail	Pass
101	21	Fail	Pass	Fail	Pass
101	22	Fail	Pass	Fail	Pass
101	23	Fail	Pass	Fail	Pass
101	26	Fail	Pass	Fail	Pass
101	30	Fail	Pass	Fail	Pass
102	13	Fail	Pass	Fail	Pass
102	14	Fail	Pass	Fail	Pass
102	15	Fail	Pass	Fail	Pass
102	26	Fail	Pass	Fail	Pass
102	30	Fail	Pass	Fail	Pass
103	13	Fail	Pass	Fail	Pass
103	14	Fail	Pass	Fail	Pass
103	15	Fail	Pass	Fail	Pass
103	26	Fail	Pass	Fail	Pass
103	30	Fail	Pass	Fail	Pass
104	13	Fail	Pass	Fail	Pass
104	14	Fail	Pass	Fail	Pass
104	15	Fail	Pass	Fail	Pass

104	26	Fail	Pass	Fail	Pass
104	30	Fail	Pass	Fail	Pass
105	13	Fail	Pass	Fail	Pass
105	14	Fail	Pass	Fail	Pass
105	15	Fail	Pass	Fail	Pass
105	26	Fail	Pass	Fail	Pass
105	30	Fail	Pass	Fail	Pass
106	13	Fail	Pass	Fail	Pass
106	14	Fail	Pass	Fail	Pass
106	15	Fail	Pass	Fail	Pass
106	26	Fail	Pass	Fail	Pass
106	27	Fail	Pass	Fail	Pass
106	30	Fail	Pass	Fail	Pass
106	39	Fail	Pass	Fail	Pass
107	13	Fail	Pass	Fail	Pass
107	14	Fail	Pass	Fail	Pass
107	15	Fail	Pass	Fail	Pass
107	22	Fail	Pass	Fail	Pass
107	26	Fail	Pass	Fail	Pass
107	30	Fail	Pass	Fail	Pass
107	39	Fail	Pass	Fail	Pass
108	13	Fail	Pass	Fail	Pass
108	14	Fail	Pass	Fail	Pass
108	15	Fail	Pass	Fail	Pass
108	22	Fail	Pass	Fail	Pass
108	26	Fail	Pass	Fail	Pass
108	30	Fail	Pass	Fail	Pass
108	39	Fail	Pass	Fail	Pass
109	13	Fail	Pass	Fail	Pass
109	14	Fail	Pass	Fail	Pass
109	15	Fail	Pass	Fail	Pass
109	22	Fail	Pass	Fail	Pass
109	26	Fail	Pass	Fail	Pass
109	30	Fail	Pass	Fail	Pass
109	39	Fail	Pass	Fail	Pass
110	13	Fail	Pass	Fail	Pass
110	14	Fail	Pass	Fail	Pass
110	15	Fail	Pass	Fail	Pass
110	22	Fail	Pass	Fail	Pass
110	26	Fail	Pass	Fail	Pass
110	39	Fail	Pass	Fail	Pass
111	13	Fail	Pass	Fail	Pass
111	14	Fail	Pass	Fail	Pass
111	15	Fail	Pass	Fail	Pass
111	22	Fail	Pass	Fail	Pass
111	26	Fail	Pass	Fail	Pass
111	39	Fail	Pass	Fail	Pass
112	13	Fail	Pass	Fail	Pass
112	14	Fail	Pass	Fail	Pass
112	15	Fail	Pass	Fail	Pass
112	22	Fail	Pass	Fail	Pass
112	26	Fail	Pass	Fail	Pass
112	39	Fail	Pass	Fail	Pass
113	13	Fail	Pass	Fail	Pass
113	14	Fail	Pass	Fail	Pass
113	15	Fail	Pass	Fail	Pass
113	26	Fail	Pass	Fail	Pass

113	27	Fail	Pass	Fail	Pass
113	39	Fail	Pass	Fail	Pass
114	13	Fail	Pass	Fail	Pass
114	14	Fail	Pass	Fail	Pass
114	15	Fail	Pass	Fail	Pass
114	26	Fail	Pass	Fail	Pass
114	39	Fail	Pass	Fail	Pass
115	13	Fail	Pass	Fail	Pass
115	14	Fail	Pass	Fail	Pass
115	15	Fail	Pass	Fail	Pass
115	26	Fail	Pass	Fail	Pass
115	39	Fail	Pass	Fail	Pass
116	13	Fail	Pass	Fail	Pass
116	14	Fail	Pass	Fail	Pass
116	15	Fail	Pass	Fail	Pass
116	26	Fail	Pass	Fail	Pass
116	39	Fail	Pass	Fail	Pass
117	13	Fail	Pass	Fail	Pass
117	14	Fail	Pass	Fail	Pass
117	15	Fail	Pass	Fail	Pass
117	26	Fail	Pass	Fail	Pass
117	39	Fail	Pass	Fail	Pass
118	13	Fail	Pass	Fail	Pass
118	14	Fail	Pass	Fail	Pass
118	15	Fail	Pass	Fail	Pass
118	20	Fail	Pass	Fail	Pass
118	26	Fail	Pass	Fail	Pass
118	39	Fail	Pass	Fail	Pass
119	13	Fail	Pass	Fail	Pass
119	14	Fail	Pass	Fail	Pass
119	15	Fail	Pass	Fail	Pass
119	20	Fail	Pass	Fail	Pass
119	26	Fail	Pass	Fail	Pass
119	39	Fail	Pass	Fail	Pass
120	13	Fail	Pass	Fail	Pass
120	14	Fail	Pass	Fail	Pass
120	15	Fail	Pass	Fail	Pass
120	16	Fail	Pass	Fail	Pass
120	26	Fail	Pass	Fail	Pass
120	39	Fail	Pass	Fail	Pass
121	13	Fail	Pass	Fail	Pass
121	14	Fail	Pass	Fail	Pass
121	26	Fail	Pass	Fail	Pass
121	39	Fail	Pass	Fail	Pass
122	13	Fail	Pass	Fail	Pass
122	14	Fail	Pass	Fail	Pass
122	26	Fail	Pass	Fail	Pass
122	39	Fail	Pass	Fail	Pass
123	13	Fail	Pass	Fail	Pass
123	14	Fail	Pass	Fail	Pass
123	15	Fail	Pass	Fail	Pass
123	16	Fail	Pass	Fail	Pass
123	17	Fail	Pass	Fail	Pass
123	18	Fail	Pass	Fail	Pass
123	19	Fail	Pass	Fail	Pass
123	20	Fail	Pass	Fail	Pass
123	21	Fail	Pass	Fail	Pass

123	22	Fail	Pass	Fail	Pass
123	23	Fail	Pass	Fail	Pass
123	24	Fail	Pass	Fail	Pass
123	25	Fail	Pass	Fail	Pass
123	26	Fail	Pass	Fail	Pass
123	27	Fail	Pass	Fail	Pass
123	28	Fail	Pass	Fail	Pass
123	29	Fail	Pass	Fail	Pass
123	30	Fail	Pass	Fail	Pass
123	31	Fail	Pass	Fail	Pass
123	32	Fail	Pass	Fail	Pass
123	33	Fail	Pass	Fail	Pass
123	34	Fail	Pass	Fail	Pass
123	35	Fail	Pass	Fail	Pass
123	36	Fail	Pass	Fail	Pass
123	37	Fail	Pass	Fail	Pass
123	38	Fail	Pass	Fail	Pass
123	39	Fail	Pass	Fail	Pass
124	13	Fail	Pass	Fail	Pass
124	14	Fail	Pass	Fail	Pass
124	23	Fail	Pass	Fail	Pass
125	13	Fail	Pass	Fail	Pass
125	14	Fail	Pass	Fail	Pass
125	23	Fail	Pass	Fail	Pass
126	13	Fail	Pass	Fail	Pass
126	14	Fail	Pass	Fail	Pass
126	23	Fail	Pass	Fail	Pass
127	13	Fail	Pass	Fail	Pass
127	14	Fail	Pass	Fail	Pass
127	23	Fail	Pass	Fail	Pass
128	13	Fail	Pass	Fail	Pass
128	14	Fail	Pass	Fail	Pass
128	23	Fail	Pass	Fail	Pass
129	13	Fail	Pass	Fail	Pass
129	14	Fail	Pass	Fail	Pass
129	23	Fail	Pass	Fail	Pass
130	8	Fail	Fail	Fail	Fail
130	9	Fail	Fail	Fail	Fail
130	10	Fail	Pass	Fail	Pass
130	11	Fail	Pass	Fail	Pass
130	12	Fail	Pass	Fail	Pass
130	13	Fail	Pass	Fail	Pass
130	14	Fail	Pass	Fail	Pass
130	23	Fail	Pass	Fail	Pass
131	14	Fail	Pass	Fail	Pass
131	23	Fail	Pass	Fail	Pass
132	14	Fail	Pass	Fail	Pass
132	23	Fail	Pass	Fail	Pass
133	14	Fail	Pass	Fail	Pass
133	23	Fail	Pass	Fail	Pass
134	14	Fail	Pass	Fail	Pass
134	23	Fail	Pass	Fail	Pass
135	14	Fail	Pass	Fail	Pass
136	14	Fail	Pass	Fail	Pass
137	14	Fail	Pass	Fail	Pass
138	14	Fail	Pass	Fail	Pass

2. Table G.7.2 Striped Bass Larvae salinity and D.O. criteria passing for existing and deepening (4 ft) scenarios within the analyzed period May 1 - May 31, 1997

HABITAT REQUIREMENTS:
RM 10-31; Depth Average
D.O. May (MG/L):10th %ile >=4.5
Salinity 50th %ile >=3 & <= 9 ppt

Savannah Harbor Estuary
Analyzed period: MAY 1 - MAY 31, Year 1997

Segments J	Segments I	Baseline Scenario Salinity	Baseline Scenario D.O.	Project Scenario Salinity	Project Scenario D.O.
47	13	Fail	Pass	Fail	Pass
47	14	Fail	Pass	Fail	Pass
47	15	Fail	Pass	Fail	Pass
47	16	Fail	Pass	Fail	Pass
47	17	Fail	Pass	Fail	Pass
48	13	Fail	Pass	Fail	Pass
48	14	Fail	Pass	Fail	Pass
48	15	Fail	Pass	Fail	Pass
48	16	Fail	Pass	Fail	Pass
48	17	Fail	Pass	Fail	Pass
49	13	Fail	Pass	Fail	Pass
49	14	Fail	Pass	Fail	Pass
49	15	Fail	Pass	Fail	Pass
49	16	Fail	Pass	Fail	Pass
49	17	Fail	Pass	Fail	Pass
50	13	Fail	Pass	Fail	Pass
50	14	Fail	Pass	Fail	Pass
50	15	Fail	Pass	Fail	Pass
50	16	Fail	Pass	Fail	Pass
50	17	Fail	Pass	Fail	Pass
50	18	Pass	Fail	Fail	Fail
51	13	Fail	Pass	Fail	Pass
51	14	Fail	Pass	Fail	Pass
51	15	Fail	Pass	Fail	Pass
52	13	Fail	Pass	Fail	Pass
52	14	Fail	Pass	Fail	Pass
52	15	Fail	Pass	Fail	Pass
53	13	Fail	Pass	Fail	Pass
53	14	Fail	Pass	Fail	Pass
53	15	Fail	Pass	Fail	Pass
54	13	Pass	Pass	Fail	Pass
54	14	Fail	Pass	Fail	Pass
54	15	Pass	Pass	Fail	Pass
55	13	Pass	Pass	Fail	Pass
55	14	Fail	Pass	Fail	Pass
55	15	Pass	Pass	Fail	Pass
56	13	Pass	Pass	Fail	Pass
56	14	Fail	Pass	Fail	Pass
56	15	Pass	Pass	Fail	Pass
57	13	Pass	Pass	Fail	Pass
57	14	Fail	Pass	Fail	Pass

57	15	Pass	Pass	Pass	Pass
58	13	Pass	Pass	Pass	Pass
58	14	Fail	Pass	Fail	Pass
58	15	Pass	Pass	Pass	Pass
59	13	Pass	Pass	Pass	Pass
59	14	Fail	Pass	Fail	Pass
59	15	Pass	Pass	Pass	Pass
59	30	Fail	Fail	Fail	Fail
59	31	Fail	Fail	Fail	Fail
59	32	Fail	Fail	Fail	Fail
60	13	Pass	Pass	Pass	Pass
60	14	Fail	Pass	Fail	Pass
60	15	Pass	Pass	Pass	Pass
60	30	Pass	Fail	Fail	Fail
60	31	Fail	Fail	Fail	Fail
60	32	Fail	Fail	Fail	Fail
61	13	Pass	Pass	Pass	Pass
61	14	Pass	Pass	Fail	Pass
61	15	Pass	Pass	Pass	Pass
61	30	Pass	Fail	Fail	Fail
61	31	Fail	Fail	Fail	Fail
61	32	Pass	Fail	Fail	Fail
62	13	Pass	Pass	Pass	Pass
62	14	Pass	Pass	Fail	Pass
62	15	Pass	Pass	Pass	Pass
62	30	Pass	Fail	Fail	Fail
62	31	Fail	Fail	Fail	Fail
62	32	Pass	Fail	Fail	Fail
63	13	Pass	Pass	Pass	Pass
63	14	Pass	Pass	Fail	Pass
63	15	Pass	Pass	Pass	Pass
63	31	Pass	Fail	Fail	Fail
64	13	Pass	Pass	Pass	Pass
64	14	Pass	Pass	Fail	Pass
64	15	Pass	Pass	Pass	Pass
64	30	Pass	Fail	Fail	Fail
64	31	Pass	Fail	Fail	Fail
64	32	Fail	Fail	Fail	Fail
65	13	Pass	Pass	Pass	Pass
65	14	Pass	Pass	Fail	Pass
65	15	Pass	Pass	Pass	Pass
65	30	Pass	Fail	Fail	Fail
65	31	Pass	Fail	Fail	Fail
65	32	Pass	Fail	Fail	Fail
65	33	Fail	Fail	Fail	Fail
66	13	Pass	Pass	Pass	Pass
66	14	Pass	Pass	Fail	Pass
66	15	Pass	Pass	Pass	Pass
66	30	Pass	Fail	Fail	Fail
66	31	Pass	Fail	Fail	Fail
66	32	Pass	Fail	Fail	Fail
66	36	Pass	Fail	Fail	Fail
67	13	Pass	Pass	Pass	Pass
67	14	Pass	Pass	Fail	Pass
67	15	Pass	Pass	Pass	Pass
67	30	Pass	Fail	Fail	Fail
67	31	Pass	Fail	Fail	Fail

67	32	Pass	Fail	Fail	Fail
67	36	Pass	Fail	Fail	Fail
68	13	Pass	Pass	Pass	Pass
68	14	Pass	Pass	Fail	Pass
68	15	Pass	Pass	Pass	Pass
68	30	Pass	Fail	Pass	Fail
68	31	Pass	Fail	Fail	Fail
68	32	Pass	Fail	Pass	Fail
68	36	Pass	Fail	Fail	Fail
69	13	Pass	Pass	Pass	Pass
69	14	Pass	Pass	Fail	Pass
69	15	Pass	Pass	Pass	Pass
69	30	Pass	Fail	Pass	Fail
69	31	Pass	Fail	Pass	Fail
69	32	Pass	Fail	Pass	Fail
69	36	Pass	Fail	Fail	Fail
70	13	Pass	Pass	Pass	Pass
70	14	Pass	Pass	Fail	Pass
70	15	Pass	Pass	Pass	Pass
70	30	Pass	Fail	Pass	Fail
70	31	Pass	Fail	Pass	Fail
70	32	Pass	Fail	Pass	Fail
70	33	Pass	Fail	Pass	Fail
71	13	Pass	Pass	Pass	Pass
71	14	Pass	Pass	Fail	Pass
71	15	Pass	Pass	Pass	Pass
71	30	Pass	Fail	Pass	Fail
71	31	Pass	Fail	Pass	Fail
71	32	Pass	Fail	Pass	Fail
72	13	Pass	Pass	Pass	Pass
72	14	Pass	Pass	Fail	Pass
72	15	Pass	Pass	Pass	Pass
72	30	Pass	Fail	Pass	Fail
72	31	Pass	Fail	Pass	Fail
72	32	Pass	Fail	Pass	Fail
73	13	Pass	Pass	Pass	Pass
73	14	Pass	Pass	Pass	Pass
73	15	Fail	Pass	Pass	Pass
73	30	Pass	Fail	Pass	Fail
73	31	Pass	Fail	Pass	Fail
74	13	Pass	Pass	Pass	Pass
74	14	Pass	Pass	Pass	Pass
74	15	Fail	Pass	Pass	Pass
74	30	Pass	Fail	Pass	Fail
74	31	Pass	Fail	Pass	Fail
75	13	Pass	Pass	Pass	Pass
75	14	Pass	Pass	Pass	Pass
75	15	Fail	Pass	Pass	Pass
75	30	Pass	Fail	Pass	Fail
75	31	Pass	Fail	Pass	Fail
76	13	Fail	Pass	Pass	Pass
76	14	Pass	Pass	Pass	Pass
76	15	Pass	Pass	Pass	Pass
76	16	Pass	Pass	Pass	Pass
76	17	Pass	Pass	Pass	Pass
76	30	Pass	Fail	Pass	Fail
76	31	Pass	Fail	Pass	Fail

77	13	Fail	Pass	Pass	Pass
77	14	Pass	Pass	Pass	Pass
77	15	Pass	Pass	Pass	Pass
77	16	Pass	Pass	Pass	Pass
77	17	Pass	Pass	Pass	Pass
77	30	Pass	Fail	Pass	Fail
77	31	Pass	Fail	Pass	Fail
78	13	Fail	Pass	Pass	Pass
78	14	Pass	Pass	Pass	Pass
78	15	Pass	Pass	Pass	Pass
78	16	Pass	Pass	Pass	Pass
78	17	Pass	Pass	Pass	Pass
78	30	Pass	Fail	Pass	Fail
78	31	Pass	Fail	Pass	Fail
79	13	Fail	Pass	Pass	Pass
79	14	Pass	Pass	Pass	Pass
79	15	Fail	Pass	Pass	Pass
79	30	Fail	Fail	Pass	Fail
79	31	Pass	Fail	Pass	Fail
80	13	Fail	Pass	Pass	Pass
80	14	Fail	Pass	Pass	Pass
80	15	Fail	Pass	Pass	Pass
80	30	Fail	Fail	Pass	Fail
80	31	Fail	Fail	Pass	Fail
81	13	Fail	Pass	Pass	Pass
81	14	Fail	Pass	Pass	Pass
81	15	Fail	Pass	Pass	Pass
81	30	Fail	Fail	Pass	Fail
81	31	Fail	Fail	Fail	Fail
82	13	Fail	Pass	Pass	Pass
82	14	Fail	Pass	Pass	Pass
82	15	Fail	Pass	Fail	Pass
82	16	Fail	Pass	Pass	Pass
82	17	Fail	Pass	Fail	Pass
82	18	Fail	Pass	Fail	Pass
82	19	Fail	Pass	Fail	Pass
82	20	Fail	Pass	Fail	Pass
82	21	Fail	Pass	Fail	Pass
82	29	Fail	Fail	Pass	Fail
82	30	Fail	Fail	Pass	Fail
82	31	Fail	Pass	Fail	Pass
83	13	Fail	Pass	Pass	Pass
83	14	Fail	Pass	Pass	Pass
83	15	Fail	Pass	Fail	Pass
83	21	Fail	Pass	Fail	Pass
83	30	Fail	Fail	Fail	Fail
83	31	Fail	Pass	Fail	Pass
84	13	Fail	Pass	Fail	Pass
84	14	Fail	Pass	Pass	Pass
84	15	Fail	Pass	Fail	Pass
84	21	Fail	Pass	Fail	Pass
84	30	Fail	Fail	Fail	Fail
84	31	Fail	Pass	Fail	Pass
85	13	Fail	Pass	Fail	Pass
85	14	Fail	Pass	Pass	Pass
85	15	Fail	Pass	Fail	Pass
85	21	Fail	Pass	Fail	Pass

85	30	Fail	Fail	Fail	Fail
86	13	Fail	Pass	Fail	Pass
86	14	Fail	Pass	Pass	Pass
86	15	Fail	Pass	Fail	Pass
86	21	Fail	Pass	Fail	Pass
86	30	Fail	Fail	Fail	Fail
87	13	Fail	Pass	Fail	Pass
87	14	Fail	Pass	Pass	Pass
87	15	Fail	Pass	Fail	Pass
87	30	Fail	Fail	Fail	Fail
88	13	Fail	Pass	Fail	Pass
88	14	Fail	Pass	Fail	Pass
88	15	Fail	Pass	Fail	Pass
88	30	Fail	Fail	Fail	Fail
89	13	Fail	Pass	Fail	Pass
89	14	Fail	Pass	Fail	Pass
89	15	Fail	Pass	Fail	Pass
89	30	Fail	Pass	Fail	Fail
90	13	Fail	Pass	Fail	Pass
90	14	Fail	Pass	Fail	Pass
90	15	Fail	Pass	Fail	Pass
90	30	Fail	Pass	Fail	Pass
91	13	Fail	Pass	Fail	Pass
91	14	Fail	Pass	Fail	Pass
91	15	Fail	Pass	Fail	Pass
91	16	Fail	Pass	Fail	Pass
91	30	Fail	Pass	Fail	Pass
92	13	Fail	Pass	Fail	Pass
92	14	Fail	Pass	Fail	Pass
92	15	Fail	Pass	Fail	Pass
92	16	Fail	Pass	Fail	Pass
92	30	Fail	Pass	Fail	Pass
93	13	Fail	Pass	Fail	Pass
93	14	Fail	Pass	Fail	Pass
93	15	Fail	Pass	Fail	Pass
93	16	Fail	Pass	Fail	Pass
93	30	Fail	Pass	Fail	Pass
94	13	Fail	Pass	Fail	Pass
94	14	Fail	Pass	Fail	Pass
94	15	Fail	Pass	Fail	Pass
94	16	Fail	Pass	Fail	Pass
94	26	Fail	Pass	Fail	Pass
94	30	Fail	Pass	Fail	Pass
95	13	Fail	Pass	Fail	Pass
95	14	Fail	Pass	Fail	Pass
95	15	Fail	Pass	Fail	Pass
95	16	Fail	Pass	Fail	Pass
95	26	Fail	Pass	Fail	Pass
95	30	Fail	Pass	Fail	Pass
96	13	Fail	Pass	Fail	Pass
96	14	Fail	Pass	Fail	Pass
96	15	Fail	Pass	Fail	Pass
96	26	Fail	Pass	Fail	Pass
96	30	Fail	Pass	Fail	Pass
97	13	Fail	Pass	Fail	Pass
97	14	Fail	Pass	Fail	Pass
97	15	Fail	Pass	Fail	Pass

97	26	Fail	Pass	Fail	Pass
97	30	Fail	Pass	Fail	Pass
98	13	Fail	Pass	Fail	Pass
98	14	Fail	Pass	Fail	Pass
98	15	Fail	Pass	Fail	Pass
98	26	Fail	Pass	Fail	Pass
98	27	Fail	Pass	Fail	Pass
98	28	Fail	Pass	Fail	Pass
98	29	Fail	Pass	Fail	Pass
98	30	Fail	Pass	Fail	Pass
99	13	Fail	Pass	Fail	Pass
99	14	Fail	Pass	Fail	Pass
99	15	Fail	Pass	Fail	Pass
99	16	Fail	Pass	Fail	Pass
99	17	Fail	Pass	Fail	Pass
99	18	Fail	Pass	Fail	Pass
99	19	Fail	Pass	Fail	Pass
99	20	Fail	Pass	Fail	Pass
99	21	Fail	Pass	Fail	Pass
99	22	Fail	Pass	Fail	Pass
99	23	Fail	Pass	Fail	Pass
99	26	Fail	Pass	Fail	Pass
99	30	Fail	Pass	Fail	Pass
100	13	Fail	Pass	Fail	Pass
100	14	Fail	Pass	Fail	Pass
100	15	Fail	Pass	Fail	Pass
100	23	Fail	Pass	Fail	Pass
100	24	Fail	Pass	Fail	Pass
100	25	Fail	Pass	Fail	Pass
100	26	Fail	Pass	Fail	Pass
100	30	Fail	Pass	Fail	Pass
101	13	Fail	Pass	Fail	Pass
101	14	Fail	Pass	Fail	Pass
101	15	Fail	Pass	Fail	Pass
101	16	Fail	Pass	Fail	Pass
101	17	Fail	Pass	Fail	Pass
101	18	Fail	Pass	Fail	Pass
101	19	Fail	Pass	Fail	Pass
101	20	Fail	Pass	Fail	Pass
101	21	Fail	Pass	Fail	Pass
101	22	Fail	Pass	Fail	Pass
101	23	Fail	Pass	Fail	Pass
101	26	Fail	Pass	Fail	Pass
101	30	Fail	Pass	Fail	Pass
102	13	Fail	Pass	Fail	Pass
102	14	Fail	Pass	Fail	Pass
102	15	Fail	Pass	Fail	Pass
102	26	Fail	Pass	Fail	Pass
102	30	Fail	Pass	Fail	Pass
103	13	Fail	Pass	Fail	Pass
103	14	Fail	Pass	Fail	Pass
103	15	Fail	Pass	Fail	Pass
103	26	Fail	Pass	Fail	Pass
103	30	Fail	Pass	Fail	Pass
104	13	Fail	Pass	Fail	Pass
104	14	Fail	Pass	Fail	Pass
104	15	Fail	Pass	Fail	Pass

104	26	Fail	Pass	Fail	Pass
104	30	Fail	Pass	Fail	Pass
105	13	Fail	Pass	Fail	Pass
105	14	Fail	Pass	Fail	Pass
105	15	Fail	Pass	Fail	Pass
105	26	Fail	Pass	Fail	Pass
105	30	Fail	Pass	Fail	Pass
106	13	Fail	Pass	Fail	Pass
106	14	Fail	Pass	Fail	Pass
106	15	Fail	Pass	Fail	Pass
106	26	Fail	Pass	Fail	Pass
106	27	Fail	Pass	Fail	Pass
106	30	Fail	Pass	Fail	Pass
106	39	Fail	Pass	Fail	Pass
107	13	Fail	Pass	Fail	Pass
107	14	Fail	Pass	Fail	Pass
107	15	Fail	Pass	Fail	Pass
107	22	Fail	Pass	Fail	Pass
107	26	Fail	Pass	Fail	Pass
107	30	Fail	Pass	Fail	Pass
107	39	Fail	Pass	Fail	Pass
108	13	Fail	Pass	Fail	Pass
108	14	Fail	Pass	Fail	Pass
108	15	Fail	Pass	Fail	Pass
108	22	Fail	Pass	Fail	Pass
108	26	Fail	Pass	Fail	Pass
108	30	Fail	Pass	Fail	Pass
108	39	Fail	Pass	Fail	Pass
109	13	Fail	Pass	Fail	Pass
109	14	Fail	Pass	Fail	Pass
109	15	Fail	Pass	Fail	Pass
109	22	Fail	Pass	Fail	Pass
109	26	Fail	Pass	Fail	Pass
109	30	Fail	Pass	Fail	Pass
109	39	Fail	Pass	Fail	Pass
110	13	Fail	Pass	Fail	Pass
110	14	Fail	Pass	Fail	Pass
110	15	Fail	Pass	Fail	Pass
110	22	Fail	Pass	Fail	Pass
110	26	Fail	Pass	Fail	Pass
110	39	Fail	Pass	Fail	Pass
111	13	Fail	Pass	Fail	Pass
111	14	Fail	Pass	Fail	Pass
111	15	Fail	Pass	Fail	Pass
111	22	Fail	Pass	Fail	Pass
111	26	Fail	Pass	Fail	Pass
111	39	Fail	Pass	Fail	Pass
112	13	Fail	Pass	Fail	Pass
112	14	Fail	Pass	Fail	Pass
112	15	Fail	Pass	Fail	Pass
112	22	Fail	Pass	Fail	Pass
112	26	Fail	Pass	Fail	Pass
112	39	Fail	Pass	Fail	Pass
113	13	Fail	Pass	Fail	Pass
113	14	Fail	Pass	Fail	Pass
113	15	Fail	Pass	Fail	Pass
113	26	Fail	Pass	Fail	Pass

113	27	Fail	Pass	Fail	Pass
113	39	Fail	Pass	Fail	Pass
114	13	Fail	Pass	Fail	Pass
114	14	Fail	Pass	Fail	Pass
114	15	Fail	Pass	Fail	Pass
114	26	Fail	Pass	Fail	Pass
114	39	Fail	Pass	Fail	Pass
115	13	Fail	Pass	Fail	Pass
115	14	Fail	Pass	Fail	Pass
115	15	Fail	Pass	Fail	Pass
115	26	Fail	Pass	Fail	Pass
115	39	Fail	Pass	Fail	Pass
116	13	Fail	Pass	Fail	Pass
116	14	Fail	Pass	Fail	Pass
116	15	Fail	Pass	Fail	Pass
116	26	Fail	Pass	Fail	Pass
116	39	Fail	Pass	Fail	Pass
117	13	Fail	Pass	Fail	Pass
117	14	Fail	Pass	Fail	Pass
117	15	Fail	Pass	Fail	Pass
117	26	Fail	Pass	Fail	Pass
117	39	Fail	Pass	Fail	Pass
118	13	Fail	Pass	Fail	Pass
118	14	Fail	Pass	Fail	Pass
118	15	Fail	Pass	Fail	Pass
118	20	Fail	Pass	Fail	Pass
118	26	Fail	Pass	Fail	Pass
118	39	Fail	Pass	Fail	Pass
119	13	Fail	Pass	Fail	Pass
119	14	Fail	Pass	Fail	Pass
119	15	Fail	Pass	Fail	Pass
119	20	Fail	Pass	Fail	Pass
119	26	Fail	Pass	Fail	Pass
119	39	Fail	Pass	Fail	Pass
120	13	Fail	Pass	Fail	Pass
120	14	Fail	Pass	Fail	Pass
120	15	Fail	Pass	Fail	Pass
120	16	Fail	Pass	Fail	Pass
120	26	Fail	Pass	Fail	Pass
120	39	Fail	Pass	Fail	Pass
121	13	Fail	Pass	Fail	Pass
121	14	Fail	Pass	Fail	Pass
121	26	Fail	Pass	Fail	Pass
121	39	Fail	Pass	Fail	Pass
122	13	Fail	Pass	Fail	Pass
122	14	Fail	Pass	Fail	Pass
122	26	Fail	Pass	Fail	Pass
122	39	Fail	Pass	Fail	Pass
123	13	Fail	Pass	Fail	Pass
123	14	Fail	Pass	Fail	Pass
123	15	Fail	Pass	Fail	Pass
123	16	Fail	Pass	Fail	Pass
123	17	Fail	Pass	Fail	Pass
123	18	Fail	Pass	Fail	Pass
123	19	Fail	Pass	Fail	Pass
123	20	Fail	Pass	Fail	Pass
123	21	Fail	Pass	Fail	Pass

123	22	Fail	Pass	Fail	Pass
123	23	Fail	Pass	Fail	Pass
123	24	Fail	Pass	Fail	Pass
123	25	Fail	Pass	Fail	Pass
123	26	Fail	Pass	Fail	Pass
123	27	Fail	Pass	Fail	Pass
123	28	Fail	Pass	Fail	Pass
123	29	Fail	Pass	Fail	Pass
123	30	Fail	Pass	Fail	Pass
123	31	Fail	Pass	Fail	Pass
123	32	Fail	Pass	Fail	Pass
123	33	Fail	Pass	Fail	Pass
123	34	Fail	Pass	Fail	Pass
123	35	Fail	Pass	Fail	Pass
123	36	Fail	Pass	Fail	Pass
123	37	Fail	Pass	Fail	Pass
123	38	Fail	Pass	Fail	Pass
123	39	Fail	Pass	Fail	Pass
124	13	Fail	Pass	Fail	Pass
124	14	Fail	Pass	Fail	Pass
124	23	Fail	Pass	Fail	Pass
125	13	Fail	Pass	Fail	Pass
125	14	Fail	Pass	Fail	Pass
125	23	Fail	Pass	Fail	Pass
126	13	Fail	Pass	Fail	Pass
126	14	Fail	Pass	Fail	Pass
126	23	Fail	Pass	Fail	Pass
127	13	Fail	Pass	Fail	Pass
127	14	Fail	Pass	Fail	Pass
127	23	Fail	Pass	Fail	Pass
128	13	Fail	Pass	Fail	Pass
128	14	Fail	Pass	Fail	Pass
128	23	Fail	Pass	Fail	Pass
129	13	Fail	Pass	Fail	Pass
129	14	Fail	Pass	Fail	Pass
129	23	Fail	Pass	Fail	Pass
130	8	Fail	Fail	Fail	Fail
130	9	Fail	Fail	Fail	Fail
130	10	Fail	Pass	Fail	Pass
130	11	Fail	Pass	Fail	Pass
130	12	Fail	Pass	Fail	Pass
130	13	Fail	Pass	Fail	Pass
130	14	Fail	Pass	Fail	Pass
130	23	Fail	Pass	Fail	Pass
131	14	Fail	Pass	Fail	Pass
131	23	Fail	Pass	Fail	Pass
132	14	Fail	Pass	Fail	Pass
132	23	Fail	Pass	Fail	Pass
133	14	Fail	Pass	Fail	Pass
133	23	Fail	Pass	Fail	Pass
134	14	Fail	Pass	Fail	Pass
134	23	Fail	Pass	Fail	Pass
135	14	Fail	Pass	Fail	Pass
136	14	Fail	Pass	Fail	Pass
137	14	Fail	Pass	Fail	Pass
138	14	Fail	Pass	Fail	Pass

3. Table G.7.3 Striped Bass Larvae salinity and D.O. criteria passing for existing and deepening (3 ft) scenarios within the analyzed period May 1 - May 31, 1997

HABITAT REQUIREMENTS:
RM 10-31; Depth Average
D.O. May (MG/L):10th %ile >=4.5
Salinity 50th %ile >=3 & <= 9 ppt

Savannah Harbor Estuary
Analyzed period: MAY 1 - MAY 31, Year 1997

Segments J	Segments I	Baseline Scenario Salinity	Baseline Scenario D.O.	Project Scenario Salinity	Project Scenario D.O.
47	13	Fail	Pass	Fail	Pass
47	14	Fail	Pass	Fail	Pass
47	15	Fail	Pass	Fail	Pass
47	16	Fail	Pass	Fail	Pass
47	17	Fail	Pass	Fail	Pass
48	13	Fail	Pass	Fail	Pass
48	14	Fail	Pass	Fail	Pass
48	15	Fail	Pass	Fail	Pass
48	16	Fail	Pass	Fail	Pass
48	17	Fail	Pass	Fail	Pass
49	13	Fail	Pass	Fail	Pass
49	14	Fail	Pass	Fail	Pass
49	15	Fail	Pass	Fail	Pass
49	16	Fail	Pass	Fail	Pass
49	17	Fail	Pass	Fail	Pass
50	13	Fail	Pass	Fail	Pass
50	14	Fail	Pass	Fail	Pass
50	15	Fail	Pass	Fail	Pass
50	16	Fail	Pass	Fail	Pass
50	17	Fail	Pass	Fail	Pass
50	18	Pass	Fail	Fail	Fail
51	13	Fail	Pass	Fail	Pass
51	14	Fail	Pass	Fail	Pass
51	15	Fail	Pass	Fail	Pass
52	13	Fail	Pass	Fail	Pass
52	14	Fail	Pass	Fail	Pass
52	15	Fail	Pass	Fail	Pass
53	13	Fail	Pass	Fail	Pass
53	14	Fail	Pass	Fail	Pass
53	15	Fail	Pass	Fail	Pass
54	13	Pass	Pass	Fail	Pass
54	14	Fail	Pass	Fail	Pass
54	15	Pass	Pass	Fail	Pass
55	13	Pass	Pass	Fail	Pass
55	14	Fail	Pass	Fail	Pass
55	15	Pass	Pass	Fail	Pass
56	13	Pass	Pass	Fail	Pass
56	14	Fail	Pass	Fail	Pass
56	15	Pass	Pass	Pass	Pass
57	13	Pass	Pass	Fail	Pass
57	14	Fail	Pass	Fail	Pass

57	15	Pass	Pass	Pass	Pass
58	13	Pass	Pass	Pass	Pass
58	14	Fail	Pass	Fail	Pass
58	15	Pass	Pass	Pass	Pass
59	13	Pass	Pass	Pass	Pass
59	14	Fail	Pass	Fail	Pass
59	15	Pass	Pass	Pass	Pass
59	30	Fail	Fail	Fail	Fail
59	31	Fail	Fail	Fail	Fail
59	32	Fail	Fail	Fail	Fail
60	13	Pass	Pass	Pass	Pass
60	14	Fail	Pass	Fail	Pass
60	15	Pass	Pass	Pass	Pass
60	30	Pass	Fail	Fail	Fail
60	31	Fail	Fail	Fail	Fail
60	32	Fail	Fail	Fail	Fail
61	13	Pass	Pass	Pass	Pass
61	14	Pass	Pass	Fail	Pass
61	15	Pass	Pass	Pass	Pass
61	30	Pass	Fail	Fail	Fail
61	31	Fail	Fail	Fail	Fail
61	32	Pass	Fail	Fail	Fail
62	13	Pass	Pass	Pass	Pass
62	14	Pass	Pass	Fail	Pass
62	15	Pass	Pass	Pass	Pass
62	30	Pass	Fail	Fail	Fail
62	31	Fail	Fail	Fail	Fail
62	32	Pass	Fail	Fail	Fail
63	13	Pass	Pass	Pass	Pass
63	14	Pass	Pass	Fail	Pass
63	15	Pass	Pass	Pass	Pass
63	31	Pass	Fail	Fail	Fail
64	13	Pass	Pass	Pass	Pass
64	14	Pass	Pass	Fail	Pass
64	15	Pass	Pass	Pass	Pass
64	30	Pass	Fail	Fail	Fail
64	31	Pass	Fail	Fail	Fail
64	32	Fail	Fail	Fail	Fail
65	13	Pass	Pass	Pass	Pass
65	14	Pass	Pass	Fail	Pass
65	15	Pass	Pass	Pass	Pass
65	30	Pass	Fail	Fail	Fail
65	31	Pass	Fail	Fail	Fail
65	32	Pass	Fail	Fail	Fail
65	33	Fail	Fail	Fail	Fail
66	13	Pass	Pass	Pass	Pass
66	14	Pass	Pass	Fail	Pass
66	15	Pass	Pass	Pass	Pass
66	30	Pass	Fail	Fail	Fail
66	31	Pass	Fail	Fail	Fail
66	32	Pass	Fail	Fail	Fail
66	36	Pass	Fail	Fail	Fail
67	13	Pass	Pass	Pass	Pass
67	14	Pass	Pass	Fail	Pass
67	15	Pass	Pass	Pass	Pass
67	30	Pass	Fail	Pass	Fail
67	31	Pass	Fail	Pass	Fail

67	32	Pass	Fail	Fail	Fail
67	36	Pass	Fail	Fail	Fail
68	13	Pass	Pass	Pass	Pass
68	14	Pass	Pass	Fail	Pass
68	15	Pass	Pass	Pass	Pass
68	30	Pass	Fail	Pass	Fail
68	31	Pass	Fail	Pass	Fail
68	32	Pass	Fail	Pass	Fail
68	36	Pass	Fail	Fail	Fail
69	13	Pass	Pass	Pass	Pass
69	14	Pass	Pass	Pass	Pass
69	15	Pass	Pass	Pass	Pass
69	30	Pass	Fail	Pass	Fail
69	31	Pass	Fail	Pass	Fail
69	32	Pass	Fail	Pass	Fail
69	36	Pass	Fail	Fail	Fail
70	13	Pass	Pass	Pass	Pass
70	14	Pass	Pass	Fail	Pass
70	15	Pass	Pass	Pass	Pass
70	30	Pass	Fail	Pass	Fail
70	31	Pass	Fail	Pass	Fail
70	32	Pass	Fail	Pass	Fail
70	33	Pass	Fail	Pass	Fail
71	13	Pass	Pass	Pass	Pass
71	14	Pass	Pass	Pass	Pass
71	15	Pass	Pass	Pass	Pass
71	30	Pass	Fail	Pass	Fail
71	31	Pass	Fail	Pass	Fail
71	32	Pass	Fail	Pass	Fail
72	13	Pass	Pass	Pass	Pass
72	14	Pass	Pass	Pass	Pass
72	15	Pass	Pass	Pass	Pass
72	30	Pass	Fail	Pass	Fail
72	31	Pass	Fail	Pass	Fail
72	32	Pass	Fail	Pass	Fail
73	13	Pass	Pass	Pass	Pass
73	14	Pass	Pass	Pass	Pass
73	15	Fail	Pass	Pass	Pass
73	30	Pass	Fail	Pass	Fail
73	31	Pass	Fail	Pass	Fail
74	13	Pass	Pass	Pass	Pass
74	14	Pass	Pass	Pass	Pass
74	15	Fail	Pass	Pass	Pass
74	30	Pass	Fail	Pass	Fail
74	31	Pass	Fail	Pass	Fail
75	13	Pass	Pass	Pass	Pass
75	14	Pass	Pass	Pass	Pass
75	15	Fail	Pass	Pass	Pass
75	30	Pass	Fail	Pass	Fail
75	31	Pass	Fail	Pass	Fail
76	13	Fail	Pass	Pass	Pass
76	14	Pass	Pass	Pass	Pass
76	15	Pass	Pass	Pass	Pass
76	16	Pass	Pass	Pass	Pass
76	17	Pass	Pass	Pass	Pass
76	30	Pass	Fail	Pass	Fail
76	31	Pass	Fail	Pass	Fail

77	13	Fail	Pass	Pass	Pass
77	14	Pass	Pass	Pass	Pass
77	15	Pass	Pass	Pass	Pass
77	16	Pass	Pass	Pass	Pass
77	17	Pass	Pass	Pass	Pass
77	30	Pass	Fail	Pass	Fail
77	31	Pass	Fail	Pass	Fail
78	13	Fail	Pass	Pass	Pass
78	14	Pass	Pass	Pass	Pass
78	15	Pass	Pass	Pass	Pass
78	16	Pass	Pass	Pass	Pass
78	17	Pass	Pass	Pass	Pass
78	30	Pass	Fail	Pass	Fail
78	31	Pass	Fail	Pass	Fail
79	13	Fail	Pass	Fail	Pass
79	14	Pass	Pass	Pass	Pass
79	15	Fail	Pass	Pass	Pass
79	30	Fail	Fail	Pass	Fail
79	31	Pass	Fail	Pass	Fail
80	13	Fail	Pass	Fail	Pass
80	14	Fail	Pass	Pass	Pass
80	15	Fail	Pass	Pass	Pass
80	30	Fail	Fail	Pass	Fail
80	31	Fail	Fail	Fail	Fail
81	13	Fail	Pass	Fail	Pass
81	14	Fail	Pass	Pass	Pass
81	15	Fail	Pass	Pass	Pass
81	30	Fail	Fail	Fail	Fail
81	31	Fail	Fail	Fail	Fail
82	13	Fail	Pass	Pass	Pass
82	14	Fail	Pass	Pass	Pass
82	15	Fail	Pass	Fail	Pass
82	16	Fail	Pass	Fail	Pass
82	17	Fail	Pass	Fail	Pass
82	18	Fail	Pass	Fail	Pass
82	19	Fail	Pass	Fail	Pass
82	20	Fail	Pass	Fail	Pass
82	21	Fail	Pass	Fail	Pass
82	29	Fail	Fail	Fail	Fail
82	30	Fail	Fail	Fail	Fail
82	31	Fail	Pass	Fail	Fail
83	13	Fail	Pass	Fail	Pass
83	14	Fail	Pass	Pass	Pass
83	15	Fail	Pass	Fail	Pass
83	21	Fail	Pass	Fail	Pass
83	30	Fail	Fail	Fail	Fail
83	31	Fail	Pass	Fail	Pass
84	13	Fail	Pass	Fail	Pass
84	14	Fail	Pass	Pass	Pass
84	15	Fail	Pass	Fail	Pass
84	21	Fail	Pass	Fail	Pass
84	30	Fail	Fail	Fail	Fail
84	31	Fail	Pass	Fail	Pass
85	13	Fail	Pass	Fail	Pass
85	14	Fail	Pass	Pass	Pass
85	15	Fail	Pass	Fail	Pass
85	21	Fail	Pass	Fail	Pass

85	30	Fail	Fail	Fail	Fail
86	13	Fail	Pass	Fail	Pass
86	14	Fail	Pass	Pass	Pass
86	15	Fail	Pass	Fail	Pass
86	21	Fail	Pass	Fail	Pass
86	30	Fail	Fail	Fail	Fail
87	13	Fail	Pass	Fail	Pass
87	14	Fail	Pass	Fail	Pass
87	15	Fail	Pass	Fail	Pass
87	30	Fail	Fail	Fail	Fail
88	13	Fail	Pass	Fail	Pass
88	14	Fail	Pass	Fail	Pass
88	15	Fail	Pass	Fail	Pass
88	30	Fail	Fail	Fail	Fail
89	13	Fail	Pass	Fail	Pass
89	14	Fail	Pass	Fail	Pass
89	15	Fail	Pass	Fail	Pass
89	30	Fail	Pass	Fail	Fail
90	13	Fail	Pass	Fail	Pass
90	14	Fail	Pass	Fail	Pass
90	15	Fail	Pass	Fail	Pass
90	30	Fail	Pass	Fail	Pass
91	13	Fail	Pass	Fail	Pass
91	14	Fail	Pass	Fail	Pass
91	15	Fail	Pass	Fail	Pass
91	16	Fail	Pass	Fail	Pass
91	30	Fail	Pass	Fail	Pass
92	13	Fail	Pass	Fail	Pass
92	14	Fail	Pass	Fail	Pass
92	15	Fail	Pass	Fail	Pass
92	16	Fail	Pass	Fail	Pass
92	30	Fail	Pass	Fail	Pass
93	13	Fail	Pass	Fail	Pass
93	14	Fail	Pass	Fail	Pass
93	15	Fail	Pass	Fail	Pass
93	16	Fail	Pass	Fail	Pass
93	30	Fail	Pass	Fail	Pass
94	13	Fail	Pass	Fail	Pass
94	14	Fail	Pass	Fail	Pass
94	15	Fail	Pass	Fail	Pass
94	16	Fail	Pass	Fail	Pass
94	26	Fail	Pass	Fail	Pass
94	30	Fail	Pass	Fail	Pass
95	13	Fail	Pass	Fail	Pass
95	14	Fail	Pass	Fail	Pass
95	15	Fail	Pass	Fail	Pass
95	16	Fail	Pass	Fail	Pass
95	26	Fail	Pass	Fail	Pass
95	30	Fail	Pass	Fail	Pass
96	13	Fail	Pass	Fail	Pass
96	14	Fail	Pass	Fail	Pass
96	15	Fail	Pass	Fail	Pass
96	26	Fail	Pass	Fail	Pass
96	30	Fail	Pass	Fail	Pass
97	13	Fail	Pass	Fail	Pass
97	14	Fail	Pass	Fail	Pass
97	15	Fail	Pass	Fail	Pass

97	26	Fail	Pass	Fail	Pass
97	30	Fail	Pass	Fail	Pass
98	13	Fail	Pass	Fail	Pass
98	14	Fail	Pass	Fail	Pass
98	15	Fail	Pass	Fail	Pass
98	26	Fail	Pass	Fail	Pass
98	27	Fail	Pass	Fail	Pass
98	28	Fail	Pass	Fail	Pass
98	29	Fail	Pass	Fail	Pass
98	30	Fail	Pass	Fail	Pass
99	13	Fail	Pass	Fail	Pass
99	14	Fail	Pass	Fail	Pass
99	15	Fail	Pass	Fail	Pass
99	16	Fail	Pass	Fail	Pass
99	17	Fail	Pass	Fail	Pass
99	18	Fail	Pass	Fail	Pass
99	19	Fail	Pass	Fail	Pass
99	20	Fail	Pass	Fail	Pass
99	21	Fail	Pass	Fail	Pass
99	22	Fail	Pass	Fail	Pass
99	23	Fail	Pass	Fail	Pass
99	26	Fail	Pass	Fail	Pass
99	30	Fail	Pass	Fail	Pass
100	13	Fail	Pass	Fail	Pass
100	14	Fail	Pass	Fail	Pass
100	15	Fail	Pass	Fail	Pass
100	23	Fail	Pass	Fail	Pass
100	24	Fail	Pass	Fail	Pass
100	25	Fail	Pass	Fail	Pass
100	26	Fail	Pass	Fail	Pass
100	30	Fail	Pass	Fail	Pass
101	13	Fail	Pass	Fail	Pass
101	14	Fail	Pass	Fail	Pass
101	15	Fail	Pass	Fail	Pass
101	16	Fail	Pass	Fail	Pass
101	17	Fail	Pass	Fail	Pass
101	18	Fail	Pass	Fail	Pass
101	19	Fail	Pass	Fail	Pass
101	20	Fail	Pass	Fail	Pass
101	21	Fail	Pass	Fail	Pass
101	22	Fail	Pass	Fail	Pass
101	23	Fail	Pass	Fail	Pass
101	26	Fail	Pass	Fail	Pass
101	30	Fail	Pass	Fail	Pass
102	13	Fail	Pass	Fail	Pass
102	14	Fail	Pass	Fail	Pass
102	15	Fail	Pass	Fail	Pass
102	26	Fail	Pass	Fail	Pass
102	30	Fail	Pass	Fail	Pass
103	13	Fail	Pass	Fail	Pass
103	14	Fail	Pass	Fail	Pass
103	15	Fail	Pass	Fail	Pass
103	26	Fail	Pass	Fail	Pass
103	30	Fail	Pass	Fail	Pass
104	13	Fail	Pass	Fail	Pass
104	14	Fail	Pass	Fail	Pass
104	15	Fail	Pass	Fail	Pass

104	26	Fail	Pass	Fail	Pass
104	30	Fail	Pass	Fail	Pass
105	13	Fail	Pass	Fail	Pass
105	14	Fail	Pass	Fail	Pass
105	15	Fail	Pass	Fail	Pass
105	26	Fail	Pass	Fail	Pass
105	30	Fail	Pass	Fail	Pass
106	13	Fail	Pass	Fail	Pass
106	14	Fail	Pass	Fail	Pass
106	15	Fail	Pass	Fail	Pass
106	26	Fail	Pass	Fail	Pass
106	27	Fail	Pass	Fail	Pass
106	30	Fail	Pass	Fail	Pass
106	39	Fail	Pass	Fail	Pass
107	13	Fail	Pass	Fail	Pass
107	14	Fail	Pass	Fail	Pass
107	15	Fail	Pass	Fail	Pass
107	22	Fail	Pass	Fail	Pass
107	26	Fail	Pass	Fail	Pass
107	30	Fail	Pass	Fail	Pass
107	39	Fail	Pass	Fail	Pass
108	13	Fail	Pass	Fail	Pass
108	14	Fail	Pass	Fail	Pass
108	15	Fail	Pass	Fail	Pass
108	22	Fail	Pass	Fail	Pass
108	26	Fail	Pass	Fail	Pass
108	30	Fail	Pass	Fail	Pass
108	39	Fail	Pass	Fail	Pass
109	13	Fail	Pass	Fail	Pass
109	14	Fail	Pass	Fail	Pass
109	15	Fail	Pass	Fail	Pass
109	22	Fail	Pass	Fail	Pass
109	26	Fail	Pass	Fail	Pass
109	30	Fail	Pass	Fail	Pass
109	39	Fail	Pass	Fail	Pass
110	13	Fail	Pass	Fail	Pass
110	14	Fail	Pass	Fail	Pass
110	15	Fail	Pass	Fail	Pass
110	22	Fail	Pass	Fail	Pass
110	26	Fail	Pass	Fail	Pass
110	39	Fail	Pass	Fail	Pass
111	13	Fail	Pass	Fail	Pass
111	14	Fail	Pass	Fail	Pass
111	15	Fail	Pass	Fail	Pass
111	22	Fail	Pass	Fail	Pass
111	26	Fail	Pass	Fail	Pass
111	39	Fail	Pass	Fail	Pass
112	13	Fail	Pass	Fail	Pass
112	14	Fail	Pass	Fail	Pass
112	15	Fail	Pass	Fail	Pass
112	22	Fail	Pass	Fail	Pass
112	26	Fail	Pass	Fail	Pass
112	39	Fail	Pass	Fail	Pass
113	13	Fail	Pass	Fail	Pass
113	14	Fail	Pass	Fail	Pass
113	15	Fail	Pass	Fail	Pass
113	26	Fail	Pass	Fail	Pass

113	27	Fail	Pass	Fail	Pass
113	39	Fail	Pass	Fail	Pass
114	13	Fail	Pass	Fail	Pass
114	14	Fail	Pass	Fail	Pass
114	15	Fail	Pass	Fail	Pass
114	26	Fail	Pass	Fail	Pass
114	39	Fail	Pass	Fail	Pass
115	13	Fail	Pass	Fail	Pass
115	14	Fail	Pass	Fail	Pass
115	15	Fail	Pass	Fail	Pass
115	26	Fail	Pass	Fail	Pass
115	39	Fail	Pass	Fail	Pass
116	13	Fail	Pass	Fail	Pass
116	14	Fail	Pass	Fail	Pass
116	15	Fail	Pass	Fail	Pass
116	26	Fail	Pass	Fail	Pass
116	39	Fail	Pass	Fail	Pass
117	13	Fail	Pass	Fail	Pass
117	14	Fail	Pass	Fail	Pass
117	15	Fail	Pass	Fail	Pass
117	26	Fail	Pass	Fail	Pass
117	39	Fail	Pass	Fail	Pass
118	13	Fail	Pass	Fail	Pass
118	14	Fail	Pass	Fail	Pass
118	15	Fail	Pass	Fail	Pass
118	20	Fail	Pass	Fail	Pass
118	26	Fail	Pass	Fail	Pass
118	39	Fail	Pass	Fail	Pass
119	13	Fail	Pass	Fail	Pass
119	14	Fail	Pass	Fail	Pass
119	15	Fail	Pass	Fail	Pass
119	20	Fail	Pass	Fail	Pass
119	26	Fail	Pass	Fail	Pass
119	39	Fail	Pass	Fail	Pass
120	13	Fail	Pass	Fail	Pass
120	14	Fail	Pass	Fail	Pass
120	15	Fail	Pass	Fail	Pass
120	16	Fail	Pass	Fail	Pass
120	26	Fail	Pass	Fail	Pass
120	39	Fail	Pass	Fail	Pass
121	13	Fail	Pass	Fail	Pass
121	14	Fail	Pass	Fail	Pass
121	26	Fail	Pass	Fail	Pass
121	39	Fail	Pass	Fail	Pass
122	13	Fail	Pass	Fail	Pass
122	14	Fail	Pass	Fail	Pass
122	26	Fail	Pass	Fail	Pass
122	39	Fail	Pass	Fail	Pass
123	13	Fail	Pass	Fail	Pass
123	14	Fail	Pass	Fail	Pass
123	15	Fail	Pass	Fail	Pass
123	16	Fail	Pass	Fail	Pass
123	17	Fail	Pass	Fail	Pass
123	18	Fail	Pass	Fail	Pass
123	19	Fail	Pass	Fail	Pass
123	20	Fail	Pass	Fail	Pass
123	21	Fail	Pass	Fail	Pass

123	22	Fail	Pass	Fail	Pass
123	23	Fail	Pass	Fail	Pass
123	24	Fail	Pass	Fail	Pass
123	25	Fail	Pass	Fail	Pass
123	26	Fail	Pass	Fail	Pass
123	27	Fail	Pass	Fail	Pass
123	28	Fail	Pass	Fail	Pass
123	29	Fail	Pass	Fail	Pass
123	30	Fail	Pass	Fail	Pass
123	31	Fail	Pass	Fail	Pass
123	32	Fail	Pass	Fail	Pass
123	33	Fail	Pass	Fail	Pass
123	34	Fail	Pass	Fail	Pass
123	35	Fail	Pass	Fail	Pass
123	36	Fail	Pass	Fail	Pass
123	37	Fail	Pass	Fail	Pass
123	38	Fail	Pass	Fail	Pass
123	39	Fail	Pass	Fail	Pass
124	13	Fail	Pass	Fail	Pass
124	14	Fail	Pass	Fail	Pass
124	23	Fail	Pass	Fail	Pass
125	13	Fail	Pass	Fail	Pass
125	14	Fail	Pass	Fail	Pass
125	23	Fail	Pass	Fail	Pass
126	13	Fail	Pass	Fail	Pass
126	14	Fail	Pass	Fail	Pass
126	23	Fail	Pass	Fail	Pass
127	13	Fail	Pass	Fail	Pass
127	14	Fail	Pass	Fail	Pass
127	23	Fail	Pass	Fail	Pass
128	13	Fail	Pass	Fail	Pass
128	14	Fail	Pass	Fail	Pass
128	23	Fail	Pass	Fail	Pass
129	13	Fail	Pass	Fail	Pass
129	14	Fail	Pass	Fail	Pass
129	23	Fail	Pass	Fail	Pass
130	8	Fail	Fail	Fail	Fail
130	9	Fail	Fail	Fail	Fail
130	10	Fail	Pass	Fail	Pass
130	11	Fail	Pass	Fail	Pass
130	12	Fail	Pass	Fail	Pass
130	13	Fail	Pass	Fail	Pass
130	14	Fail	Pass	Fail	Pass
130	23	Fail	Pass	Fail	Pass
131	14	Fail	Pass	Fail	Pass
131	23	Fail	Pass	Fail	Pass
132	14	Fail	Pass	Fail	Pass
132	23	Fail	Pass	Fail	Pass
133	14	Fail	Pass	Fail	Pass
133	23	Fail	Pass	Fail	Pass
134	14	Fail	Pass	Fail	Pass
134	23	Fail	Pass	Fail	Pass
135	14	Fail	Pass	Fail	Pass
136	14	Fail	Pass	Fail	Pass
137	14	Fail	Pass	Fail	Pass
138	14	Fail	Pass	Fail	Pass

4. Table G.7.4 Striped Bass Larvae salinity and D.O. criteria passing for existing and deepening (2 ft) scenarios within the analyzed period May 1 - May 31, 1997

HABITAT REQUIREMENTS:
RM 10-31; Depth Average
D.O. May (MG/L):10th %ile >=4.5
Salinity 50th %ile >=3 & <= 9 ppt

Savannah Harbor Estuary
Analyzed period: MAY 1 - MAY 31, Year 1997

Segments J	Segments I	Baseline Scenario Salinity	Baseline Scenario D.O.	Project Scenario Salinity	Project Scenario D.O.
47	13	Fail	Pass	Fail	Pass
47	14	Fail	Pass	Fail	Pass
47	15	Fail	Pass	Fail	Pass
47	16	Fail	Pass	Fail	Pass
47	17	Fail	Pass	Fail	Pass
48	13	Fail	Pass	Fail	Pass
48	14	Fail	Pass	Fail	Pass
48	15	Fail	Pass	Fail	Pass
48	16	Fail	Pass	Fail	Pass
48	17	Fail	Pass	Fail	Pass
49	13	Fail	Pass	Fail	Pass
49	14	Fail	Pass	Fail	Pass
49	15	Fail	Pass	Fail	Pass
49	16	Fail	Pass	Fail	Pass
49	17	Fail	Pass	Fail	Pass
50	13	Fail	Pass	Fail	Pass
50	14	Fail	Pass	Fail	Pass
50	15	Fail	Pass	Fail	Pass
50	16	Fail	Pass	Fail	Pass
50	17	Fail	Pass	Fail	Pass
50	18	Pass	Fail	Fail	Fail
51	13	Fail	Pass	Fail	Pass
51	14	Fail	Pass	Fail	Pass
51	15	Fail	Pass	Fail	Pass
52	13	Fail	Pass	Fail	Pass
52	14	Fail	Pass	Fail	Pass
52	15	Fail	Pass	Fail	Pass
53	13	Fail	Pass	Fail	Pass
53	14	Fail	Pass	Fail	Pass
53	15	Fail	Pass	Fail	Pass
54	13	Pass	Pass	Fail	Pass
54	14	Fail	Pass	Fail	Pass
54	15	Pass	Pass	Fail	Pass
55	13	Pass	Pass	Fail	Pass
55	14	Fail	Pass	Fail	Pass
55	15	Pass	Pass	Fail	Pass
56	13	Pass	Pass	Pass	Pass
56	14	Fail	Pass	Fail	Pass
56	15	Pass	Pass	Pass	Pass
57	13	Pass	Pass	Pass	Pass
57	14	Fail	Pass	Fail	Pass

57	15	Pass	Pass	Pass	Pass
58	13	Pass	Pass	Pass	Pass
58	14	Fail	Pass	Fail	Pass
58	15	Pass	Pass	Pass	Pass
59	13	Pass	Pass	Pass	Pass
59	14	Fail	Pass	Fail	Pass
59	15	Pass	Pass	Pass	Pass
59	30	Fail	Fail	Fail	Fail
59	31	Fail	Fail	Fail	Fail
59	32	Fail	Fail	Fail	Fail
60	13	Pass	Pass	Pass	Pass
60	14	Fail	Pass	Fail	Pass
60	15	Pass	Pass	Pass	Pass
60	30	Pass	Fail	Fail	Fail
60	31	Fail	Fail	Fail	Fail
60	32	Fail	Fail	Fail	Fail
61	13	Pass	Pass	Pass	Pass
61	14	Pass	Pass	Fail	Pass
61	15	Pass	Pass	Pass	Pass
61	30	Pass	Fail	Fail	Fail
61	31	Fail	Fail	Fail	Fail
61	32	Pass	Fail	Fail	Fail
62	13	Pass	Pass	Pass	Pass
62	14	Pass	Pass	Fail	Pass
62	15	Pass	Pass	Pass	Pass
62	30	Pass	Fail	Fail	Fail
62	31	Fail	Fail	Fail	Fail
62	32	Pass	Fail	Fail	Fail
63	13	Pass	Pass	Pass	Pass
63	14	Pass	Pass	Fail	Pass
63	15	Pass	Pass	Pass	Pass
63	31	Pass	Fail	Fail	Fail
64	13	Pass	Pass	Pass	Pass
64	14	Pass	Pass	Fail	Pass
64	15	Pass	Pass	Pass	Pass
64	30	Pass	Fail	Fail	Fail
64	31	Pass	Fail	Fail	Fail
64	32	Fail	Fail	Fail	Fail
65	13	Pass	Pass	Pass	Pass
65	14	Pass	Pass	Fail	Pass
65	15	Pass	Pass	Pass	Pass
65	30	Pass	Fail	Pass	Fail
65	31	Pass	Fail	Fail	Fail
65	32	Pass	Fail	Fail	Fail
65	33	Fail	Fail	Fail	Fail
66	13	Pass	Pass	Pass	Pass
66	14	Pass	Pass	Pass	Pass
66	15	Pass	Pass	Pass	Pass
66	30	Pass	Fail	Pass	Fail
66	31	Pass	Fail	Pass	Fail
66	32	Pass	Fail	Pass	Fail
66	36	Pass	Fail	Fail	Fail
67	13	Pass	Pass	Pass	Pass
67	14	Pass	Pass	Pass	Pass
67	15	Pass	Pass	Pass	Pass
67	30	Pass	Fail	Pass	Fail
67	31	Pass	Fail	Pass	Fail

67	32	Pass	Fail	Pass	Fail
67	36	Pass	Fail	Fail	Fail
68	13	Pass	Pass	Pass	Pass
68	14	Pass	Pass	Pass	Pass
68	15	Pass	Pass	Pass	Pass
68	30	Pass	Fail	Pass	Fail
68	31	Pass	Fail	Pass	Fail
68	32	Pass	Fail	Pass	Fail
68	36	Pass	Fail	Fail	Fail
69	13	Pass	Pass	Pass	Pass
69	14	Pass	Pass	Pass	Pass
69	15	Pass	Pass	Pass	Pass
69	30	Pass	Fail	Pass	Fail
69	31	Pass	Fail	Pass	Fail
69	32	Pass	Fail	Pass	Fail
69	36	Pass	Fail	Fail	Fail
70	13	Pass	Pass	Pass	Pass
70	14	Pass	Pass	Pass	Pass
70	15	Pass	Pass	Pass	Pass
70	30	Pass	Fail	Pass	Fail
70	31	Pass	Fail	Pass	Fail
70	32	Pass	Fail	Pass	Fail
70	33	Pass	Fail	Pass	Fail
71	13	Pass	Pass	Pass	Pass
71	14	Pass	Pass	Pass	Pass
71	15	Pass	Pass	Pass	Pass
71	30	Pass	Fail	Pass	Fail
71	31	Pass	Fail	Pass	Fail
71	32	Pass	Fail	Pass	Fail
72	13	Pass	Pass	Pass	Pass
72	14	Pass	Pass	Pass	Pass
72	15	Pass	Pass	Pass	Pass
72	30	Pass	Fail	Pass	Fail
72	31	Pass	Fail	Pass	Fail
72	32	Pass	Fail	Pass	Fail
73	13	Pass	Pass	Pass	Pass
73	14	Pass	Pass	Pass	Pass
73	15	Fail	Pass	Pass	Pass
73	30	Pass	Fail	Pass	Fail
73	31	Pass	Fail	Pass	Fail
74	13	Pass	Pass	Pass	Pass
74	14	Pass	Pass	Pass	Pass
74	15	Fail	Pass	Pass	Pass
74	30	Pass	Fail	Pass	Fail
74	31	Pass	Fail	Pass	Fail
75	13	Pass	Pass	Pass	Pass
75	14	Pass	Pass	Pass	Pass
75	15	Fail	Pass	Pass	Pass
75	30	Pass	Fail	Pass	Fail
75	31	Pass	Fail	Pass	Fail
76	13	Fail	Pass	Pass	Pass
76	14	Pass	Pass	Pass	Pass
76	15	Pass	Pass	Pass	Pass
76	16	Pass	Pass	Pass	Pass
76	17	Pass	Pass	Pass	Pass
76	30	Pass	Fail	Pass	Fail
76	31	Pass	Fail	Pass	Fail

77	13	Fail	Pass	Fail	Pass
77	14	Pass	Pass	Pass	Pass
77	15	Pass	Pass	Pass	Pass
77	16	Pass	Pass	Pass	Pass
77	17	Pass	Pass	Pass	Pass
77	30	Pass	Fail	Pass	Fail
77	31	Pass	Fail	Pass	Fail
78	13	Fail	Pass	Fail	Pass
78	14	Pass	Pass	Pass	Pass
78	15	Pass	Pass	Pass	Pass
78	16	Pass	Pass	Pass	Pass
78	17	Pass	Pass	Pass	Pass
78	30	Pass	Fail	Pass	Fail
78	31	Pass	Fail	Pass	Fail
79	13	Fail	Pass	Fail	Pass
79	14	Pass	Pass	Pass	Pass
79	15	Fail	Pass	Pass	Pass
79	30	Fail	Fail	Pass	Fail
79	31	Pass	Fail	Pass	Fail
80	13	Fail	Pass	Fail	Pass
80	14	Fail	Pass	Pass	Pass
80	15	Fail	Pass	Pass	Pass
80	30	Fail	Fail	Pass	Fail
80	31	Fail	Fail	Fail	Fail
81	13	Fail	Pass	Fail	Pass
81	14	Fail	Pass	Pass	Pass
81	15	Fail	Pass	Fail	Pass
81	30	Fail	Fail	Fail	Fail
81	31	Fail	Fail	Fail	Pass
82	13	Fail	Pass	Fail	Pass
82	14	Fail	Pass	Pass	Pass
82	15	Fail	Pass	Fail	Pass
82	16	Fail	Pass	Fail	Pass
82	17	Fail	Pass	Fail	Pass
82	18	Fail	Pass	Fail	Pass
82	19	Fail	Pass	Fail	Pass
82	20	Fail	Pass	Fail	Pass
82	21	Fail	Pass	Fail	Pass
82	29	Fail	Fail	Fail	Fail
82	30	Fail	Fail	Fail	Fail
82	31	Fail	Pass	Fail	Pass
83	13	Fail	Pass	Fail	Pass
83	14	Fail	Pass	Pass	Pass
83	15	Fail	Pass	Fail	Pass
83	21	Fail	Pass	Fail	Pass
83	30	Fail	Fail	Fail	Fail
83	31	Fail	Pass	Fail	Pass
84	13	Fail	Pass	Fail	Pass
84	14	Fail	Pass	Fail	Pass
84	15	Fail	Pass	Fail	Pass
84	21	Fail	Pass	Fail	Pass
84	30	Fail	Fail	Fail	Fail
84	31	Fail	Pass	Fail	Pass
85	13	Fail	Pass	Fail	Pass
85	14	Fail	Pass	Fail	Pass
85	15	Fail	Pass	Fail	Pass
85	21	Fail	Pass	Fail	Pass

85	30	Fail	Fail	Fail	Fail
86	13	Fail	Pass	Fail	Pass
86	14	Fail	Pass	Fail	Pass
86	15	Fail	Pass	Fail	Pass
86	21	Fail	Pass	Fail	Pass
86	30	Fail	Fail	Fail	Fail
87	13	Fail	Pass	Fail	Pass
87	14	Fail	Pass	Fail	Pass
87	15	Fail	Pass	Fail	Pass
87	30	Fail	Fail	Fail	Fail
88	13	Fail	Pass	Fail	Pass
88	14	Fail	Pass	Fail	Pass
88	15	Fail	Pass	Fail	Pass
88	30	Fail	Fail	Fail	Fail
89	13	Fail	Pass	Fail	Pass
89	14	Fail	Pass	Fail	Pass
89	15	Fail	Pass	Fail	Pass
89	30	Fail	Pass	Fail	Fail
90	13	Fail	Pass	Fail	Pass
90	14	Fail	Pass	Fail	Pass
90	15	Fail	Pass	Fail	Pass
90	30	Fail	Pass	Fail	Pass
91	13	Fail	Pass	Fail	Pass
91	14	Fail	Pass	Fail	Pass
91	15	Fail	Pass	Fail	Pass
91	16	Fail	Pass	Fail	Pass
91	30	Fail	Pass	Fail	Pass
92	13	Fail	Pass	Fail	Pass
92	14	Fail	Pass	Fail	Pass
92	15	Fail	Pass	Fail	Pass
92	16	Fail	Pass	Fail	Pass
92	30	Fail	Pass	Fail	Pass
93	13	Fail	Pass	Fail	Pass
93	14	Fail	Pass	Fail	Pass
93	15	Fail	Pass	Fail	Pass
93	16	Fail	Pass	Fail	Pass
93	30	Fail	Pass	Fail	Pass
94	13	Fail	Pass	Fail	Pass
94	14	Fail	Pass	Fail	Pass
94	15	Fail	Pass	Fail	Pass
94	16	Fail	Pass	Fail	Pass
94	26	Fail	Pass	Fail	Pass
94	30	Fail	Pass	Fail	Pass
95	13	Fail	Pass	Fail	Pass
95	14	Fail	Pass	Fail	Pass
95	15	Fail	Pass	Fail	Pass
95	16	Fail	Pass	Fail	Pass
95	26	Fail	Pass	Fail	Pass
95	30	Fail	Pass	Fail	Pass
96	13	Fail	Pass	Fail	Pass
96	14	Fail	Pass	Fail	Pass
96	15	Fail	Pass	Fail	Pass
96	26	Fail	Pass	Fail	Pass
96	30	Fail	Pass	Fail	Pass
97	13	Fail	Pass	Fail	Pass
97	14	Fail	Pass	Fail	Pass
97	15	Fail	Pass	Fail	Pass

97	26	Fail	Pass	Fail	Pass
97	30	Fail	Pass	Fail	Pass
98	13	Fail	Pass	Fail	Pass
98	14	Fail	Pass	Fail	Pass
98	15	Fail	Pass	Fail	Pass
98	26	Fail	Pass	Fail	Pass
98	27	Fail	Pass	Fail	Pass
98	28	Fail	Pass	Fail	Pass
98	29	Fail	Pass	Fail	Pass
98	30	Fail	Pass	Fail	Pass
99	13	Fail	Pass	Fail	Pass
99	14	Fail	Pass	Fail	Pass
99	15	Fail	Pass	Fail	Pass
99	16	Fail	Pass	Fail	Pass
99	17	Fail	Pass	Fail	Pass
99	18	Fail	Pass	Fail	Pass
99	19	Fail	Pass	Fail	Pass
99	20	Fail	Pass	Fail	Pass
99	21	Fail	Pass	Fail	Pass
99	22	Fail	Pass	Fail	Pass
99	23	Fail	Pass	Fail	Pass
99	26	Fail	Pass	Fail	Pass
99	30	Fail	Pass	Fail	Pass
100	13	Fail	Pass	Fail	Pass
100	14	Fail	Pass	Fail	Pass
100	15	Fail	Pass	Fail	Pass
100	23	Fail	Pass	Fail	Pass
100	24	Fail	Pass	Fail	Pass
100	25	Fail	Pass	Fail	Pass
100	26	Fail	Pass	Fail	Pass
100	30	Fail	Pass	Fail	Pass
101	13	Fail	Pass	Fail	Pass
101	14	Fail	Pass	Fail	Pass
101	15	Fail	Pass	Fail	Pass
101	16	Fail	Pass	Fail	Pass
101	17	Fail	Pass	Fail	Pass
101	18	Fail	Pass	Fail	Pass
101	19	Fail	Pass	Fail	Pass
101	20	Fail	Pass	Fail	Pass
101	21	Fail	Pass	Fail	Pass
101	22	Fail	Pass	Fail	Pass
101	23	Fail	Pass	Fail	Pass
101	26	Fail	Pass	Fail	Pass
101	30	Fail	Pass	Fail	Pass
102	13	Fail	Pass	Fail	Pass
102	14	Fail	Pass	Fail	Pass
102	15	Fail	Pass	Fail	Pass
102	26	Fail	Pass	Fail	Pass
102	30	Fail	Pass	Fail	Pass
103	13	Fail	Pass	Fail	Pass
103	14	Fail	Pass	Fail	Pass
103	15	Fail	Pass	Fail	Pass
103	26	Fail	Pass	Fail	Pass
103	30	Fail	Pass	Fail	Pass
104	13	Fail	Pass	Fail	Pass
104	14	Fail	Pass	Fail	Pass
104	15	Fail	Pass	Fail	Pass

104	26	Fail	Pass	Fail	Pass
104	30	Fail	Pass	Fail	Pass
105	13	Fail	Pass	Fail	Pass
105	14	Fail	Pass	Fail	Pass
105	15	Fail	Pass	Fail	Pass
105	26	Fail	Pass	Fail	Pass
105	30	Fail	Pass	Fail	Pass
106	13	Fail	Pass	Fail	Pass
106	14	Fail	Pass	Fail	Pass
106	15	Fail	Pass	Fail	Pass
106	26	Fail	Pass	Fail	Pass
106	27	Fail	Pass	Fail	Pass
106	30	Fail	Pass	Fail	Pass
106	39	Fail	Pass	Fail	Pass
107	13	Fail	Pass	Fail	Pass
107	14	Fail	Pass	Fail	Pass
107	15	Fail	Pass	Fail	Pass
107	22	Fail	Pass	Fail	Pass
107	26	Fail	Pass	Fail	Pass
107	30	Fail	Pass	Fail	Pass
107	39	Fail	Pass	Fail	Pass
108	13	Fail	Pass	Fail	Pass
108	14	Fail	Pass	Fail	Pass
108	15	Fail	Pass	Fail	Pass
108	22	Fail	Pass	Fail	Pass
108	26	Fail	Pass	Fail	Pass
108	30	Fail	Pass	Fail	Pass
108	39	Fail	Pass	Fail	Pass
109	13	Fail	Pass	Fail	Pass
109	14	Fail	Pass	Fail	Pass
109	15	Fail	Pass	Fail	Pass
109	22	Fail	Pass	Fail	Pass
109	26	Fail	Pass	Fail	Pass
109	30	Fail	Pass	Fail	Pass
109	39	Fail	Pass	Fail	Pass
110	13	Fail	Pass	Fail	Pass
110	14	Fail	Pass	Fail	Pass
110	15	Fail	Pass	Fail	Pass
110	22	Fail	Pass	Fail	Pass
110	26	Fail	Pass	Fail	Pass
110	39	Fail	Pass	Fail	Pass
111	13	Fail	Pass	Fail	Pass
111	14	Fail	Pass	Fail	Pass
111	15	Fail	Pass	Fail	Pass
111	22	Fail	Pass	Fail	Pass
111	26	Fail	Pass	Fail	Pass
111	39	Fail	Pass	Fail	Pass
112	13	Fail	Pass	Fail	Pass
112	14	Fail	Pass	Fail	Pass
112	15	Fail	Pass	Fail	Pass
112	22	Fail	Pass	Fail	Pass
112	26	Fail	Pass	Fail	Pass
112	39	Fail	Pass	Fail	Pass
113	13	Fail	Pass	Fail	Pass
113	14	Fail	Pass	Fail	Pass
113	15	Fail	Pass	Fail	Pass
113	26	Fail	Pass	Fail	Pass

113	27	Fail	Pass	Fail	Pass
113	39	Fail	Pass	Fail	Pass
114	13	Fail	Pass	Fail	Pass
114	14	Fail	Pass	Fail	Pass
114	15	Fail	Pass	Fail	Pass
114	26	Fail	Pass	Fail	Pass
114	39	Fail	Pass	Fail	Pass
115	13	Fail	Pass	Fail	Pass
115	14	Fail	Pass	Fail	Pass
115	15	Fail	Pass	Fail	Pass
115	26	Fail	Pass	Fail	Pass
115	39	Fail	Pass	Fail	Pass
116	13	Fail	Pass	Fail	Pass
116	14	Fail	Pass	Fail	Pass
116	15	Fail	Pass	Fail	Pass
116	26	Fail	Pass	Fail	Pass
116	39	Fail	Pass	Fail	Pass
117	13	Fail	Pass	Fail	Pass
117	14	Fail	Pass	Fail	Pass
117	15	Fail	Pass	Fail	Pass
117	26	Fail	Pass	Fail	Pass
117	39	Fail	Pass	Fail	Pass
118	13	Fail	Pass	Fail	Pass
118	14	Fail	Pass	Fail	Pass
118	15	Fail	Pass	Fail	Pass
118	20	Fail	Pass	Fail	Pass
118	26	Fail	Pass	Fail	Pass
118	39	Fail	Pass	Fail	Pass
119	13	Fail	Pass	Fail	Pass
119	14	Fail	Pass	Fail	Pass
119	15	Fail	Pass	Fail	Pass
119	20	Fail	Pass	Fail	Pass
119	26	Fail	Pass	Fail	Pass
119	39	Fail	Pass	Fail	Pass
120	13	Fail	Pass	Fail	Pass
120	14	Fail	Pass	Fail	Pass
120	15	Fail	Pass	Fail	Pass
120	16	Fail	Pass	Fail	Pass
120	26	Fail	Pass	Fail	Pass
120	39	Fail	Pass	Fail	Pass
121	13	Fail	Pass	Fail	Pass
121	14	Fail	Pass	Fail	Pass
121	26	Fail	Pass	Fail	Pass
121	39	Fail	Pass	Fail	Pass
122	13	Fail	Pass	Fail	Pass
122	14	Fail	Pass	Fail	Pass
122	26	Fail	Pass	Fail	Pass
122	39	Fail	Pass	Fail	Pass
123	13	Fail	Pass	Fail	Pass
123	14	Fail	Pass	Fail	Pass
123	15	Fail	Pass	Fail	Pass
123	16	Fail	Pass	Fail	Pass
123	17	Fail	Pass	Fail	Pass
123	18	Fail	Pass	Fail	Pass
123	19	Fail	Pass	Fail	Pass
123	20	Fail	Pass	Fail	Pass
123	21	Fail	Pass	Fail	Pass

123	22	Fail	Pass	Fail	Pass
123	23	Fail	Pass	Fail	Pass
123	24	Fail	Pass	Fail	Pass
123	25	Fail	Pass	Fail	Pass
123	26	Fail	Pass	Fail	Pass
123	27	Fail	Pass	Fail	Pass
123	28	Fail	Pass	Fail	Pass
123	29	Fail	Pass	Fail	Pass
123	30	Fail	Pass	Fail	Pass
123	31	Fail	Pass	Fail	Pass
123	32	Fail	Pass	Fail	Pass
123	33	Fail	Pass	Fail	Pass
123	34	Fail	Pass	Fail	Pass
123	35	Fail	Pass	Fail	Pass
123	36	Fail	Pass	Fail	Pass
123	37	Fail	Pass	Fail	Pass
123	38	Fail	Pass	Fail	Pass
123	39	Fail	Pass	Fail	Pass
124	13	Fail	Pass	Fail	Pass
124	14	Fail	Pass	Fail	Pass
124	23	Fail	Pass	Fail	Pass
125	13	Fail	Pass	Fail	Pass
125	14	Fail	Pass	Fail	Pass
125	23	Fail	Pass	Fail	Pass
126	13	Fail	Pass	Fail	Pass
126	14	Fail	Pass	Fail	Pass
126	23	Fail	Pass	Fail	Pass
127	13	Fail	Pass	Fail	Pass
127	14	Fail	Pass	Fail	Pass
127	23	Fail	Pass	Fail	Pass
128	13	Fail	Pass	Fail	Pass
128	14	Fail	Pass	Fail	Pass
128	23	Fail	Pass	Fail	Pass
129	13	Fail	Pass	Fail	Pass
129	14	Fail	Pass	Fail	Pass
129	23	Fail	Pass	Fail	Pass
130	8	Fail	Fail	Fail	Fail
130	9	Fail	Fail	Fail	Fail
130	10	Fail	Pass	Fail	Pass
130	11	Fail	Pass	Fail	Pass
130	12	Fail	Pass	Fail	Pass
130	13	Fail	Pass	Fail	Pass
130	14	Fail	Pass	Fail	Pass
130	23	Fail	Pass	Fail	Pass
131	14	Fail	Pass	Fail	Pass
131	23	Fail	Pass	Fail	Pass
132	14	Fail	Pass	Fail	Pass
132	23	Fail	Pass	Fail	Pass
133	14	Fail	Pass	Fail	Pass
133	23	Fail	Pass	Fail	Pass
134	14	Fail	Pass	Fail	Pass
134	23	Fail	Pass	Fail	Pass
135	14	Fail	Pass	Fail	Pass
136	14	Fail	Pass	Fail	Pass
137	14	Fail	Pass	Fail	Pass
138	14	Fail	Pass	Fail	Pass

Appendix H

EXISTING AND DEEPENING SCENARIOS

MAY 1997

80th Percentile of Clyo Flow

Habitat Analysis Output

Fisheries Review Group

1. Table H.1. Comparisons of American Shad and Striped Bass Larvae habitat areas for existing and deepening (6 ft) scenarios and 80 %ile Clyo Flow within the analyzed period May 1 – May 31, 1997

	Baseline Scenario		Project Scenario		% Change
American Shad	19.962807	km2	19.962807	km2	0.0
Bass Larvae	4.048194	km2	4.291442	km2	6.0

2. Table H.2. Comparisons of American Shad and Striped Bass Larvae habitat areas for existing and deepening (4 ft) scenarios and 80 %ile Clyo Flow within the analyzed period May 1 – May 31, 1997

	Baseline Scenario		Project Scenario		% Change
American Shad	19.962807	km2	19.962807	km2	0.0
Bass Larvae	4.048194	km2	3.853718	km2	-4.8

3. Table H.3. Comparisons of American Shad and Striped Bass Larvae habitat areas for existing and deepening (3 ft) scenarios and 80 %ile Clyo Flow within the analyzed period May 1 – May 31, 1997

	Baseline Scenario		Project Scenario		% Change
American Shad	19.962807	km2	19.962807	km2	0.0
Bass Larvae	4.048194	km2	3.762414	km2	-7.1

4. Table H.4. Comparisons of American Shad and Striped Bass Larvae habitat areas for existing and deepening (2 ft) scenarios and 80 %ile Clyo flow within the analyzed period May 1 – May 31, 1997

	Baseline Scenario		Project Scenario		% Change
American Shad	19.962807	km2	19.962807	km2	0.0
Bass Larvae	4.048194	km2	4.003932	km2	-1.1

5. Table H.6.1 American Shad D.O. criteria passing for existing and deepening (6 ft) scenarios within the analyzed period May 1 - May 31, 1997
(See Appendix H-1)

6. Table H.6.2 American Shad D.O. criteria passing for existing and deepening (4 ft) scenarios within the analyzed period May 1 - May 31, 1997
(See Appendix H-1)

7. Table H.6.3 American Shad D.O. criteria passing for existing and deepening (3 ft) scenarios within the analyzed period May 1 - May 31, 1997

(See Appendix H-1)

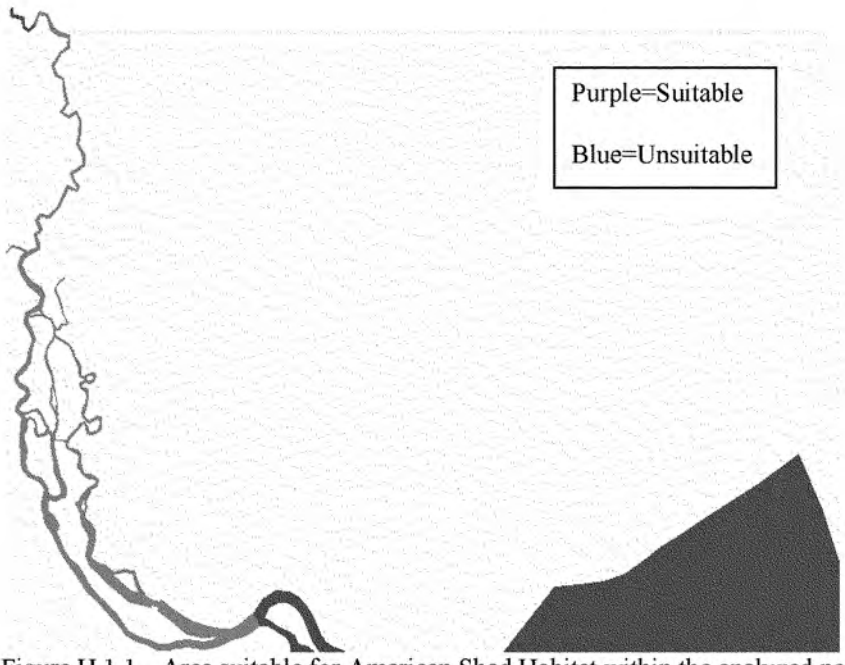
8. Table H.6.4 American Shad D.O. criteria passing for existing and deepening (2 ft) scenarios within the analyzed period May 1 - May 31, 1997
(See Appendix H-1)

9. Table H.7.1 Striped Bass Larvae salinity and D.O. criteria passing for existing and deepening (6 ft) scenarios within the analyzed period May 1 - May 31, 1997
(See Appendix H-2)

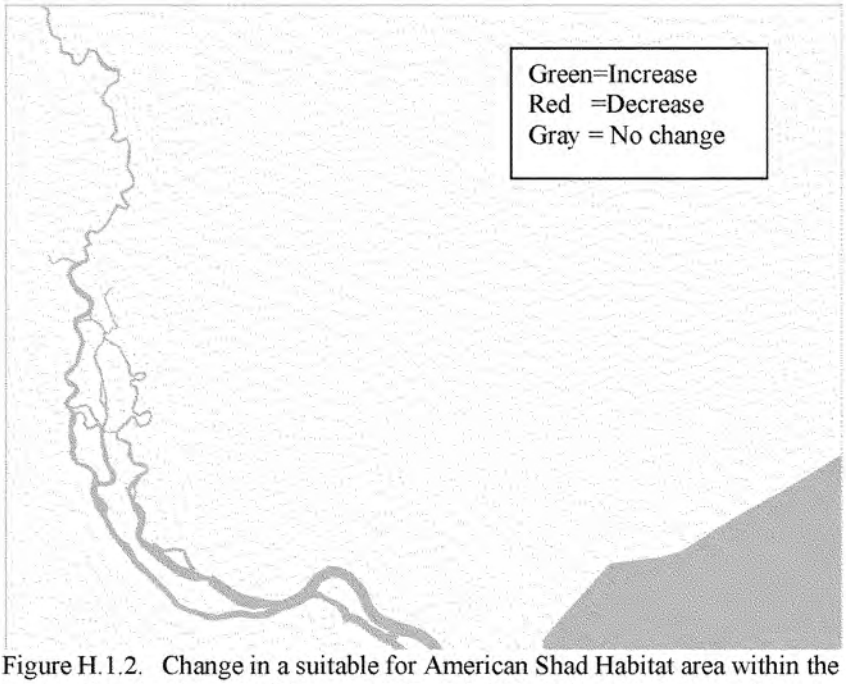
10. Table H.7.2 Striped Bass Larvae salinity and D.O. criteria passing for existing and deepening (4 ft) scenarios within the analyzed period May 1 - May 31, 1997
(See Appendix H-2)

11. Table H.7.3 Striped Bass Larvae salinity and D.O. criteria passing for existing and deepening (3 ft) scenarios within the analyzed period May 1 - May 31, 1997
(See Appendix H-2)

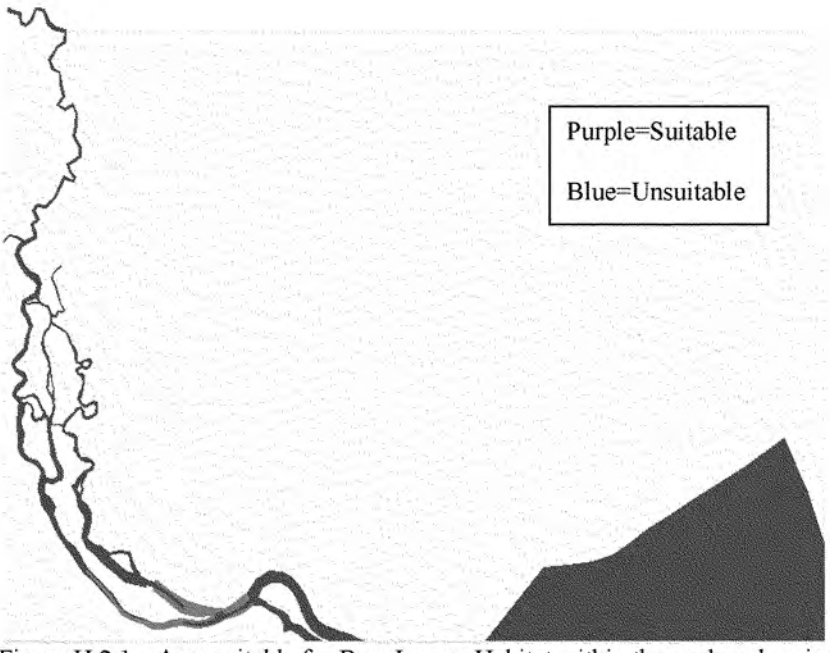
12. Table H.7.4 Striped Bass Larvae salinity and D.O. criteria passing for existing and deepening (2 ft) scenarios within the analyzed period May 1 - May 31, 1997
(See Appendix H-2)



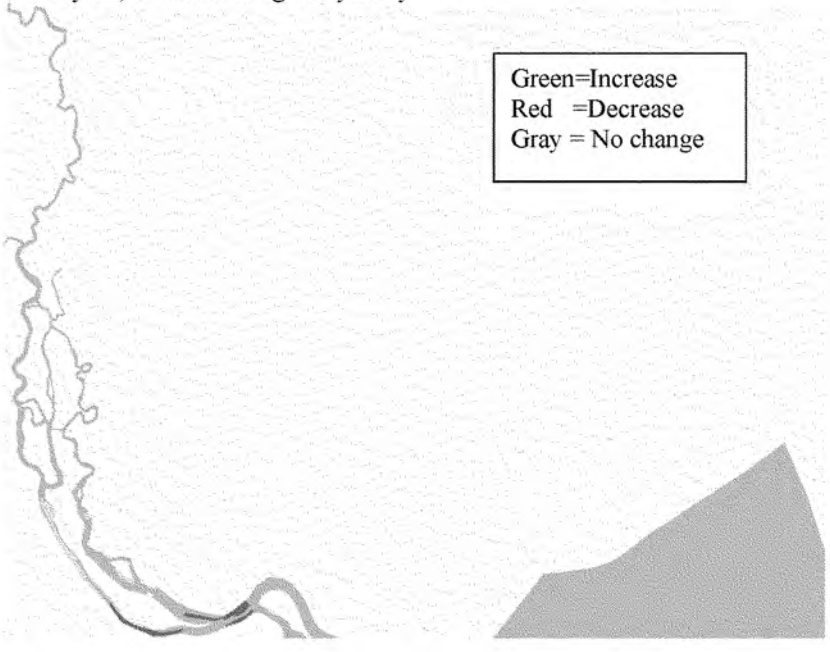
13. Figure H.1.1. Area suitable for American Shad Habitat within the analyzed period May 1 – May 31, 1997: Existing bathymetry



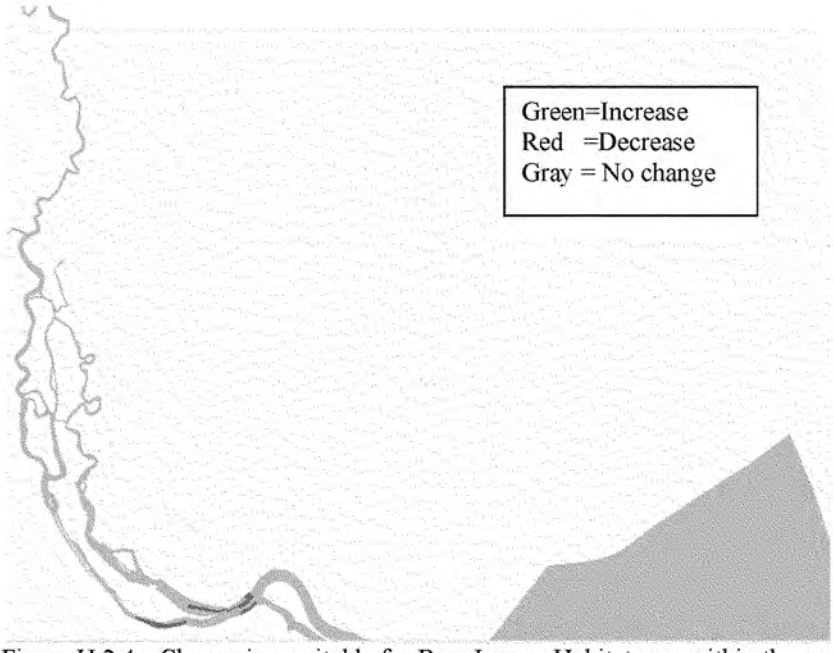
14. Figure H.1.2. Change in a suitable for American Shad Habitat area within the analyzed period May 1 - May 31, 1999 : 6 ft, 4 ft, 3 ft, and 2 ft deepening



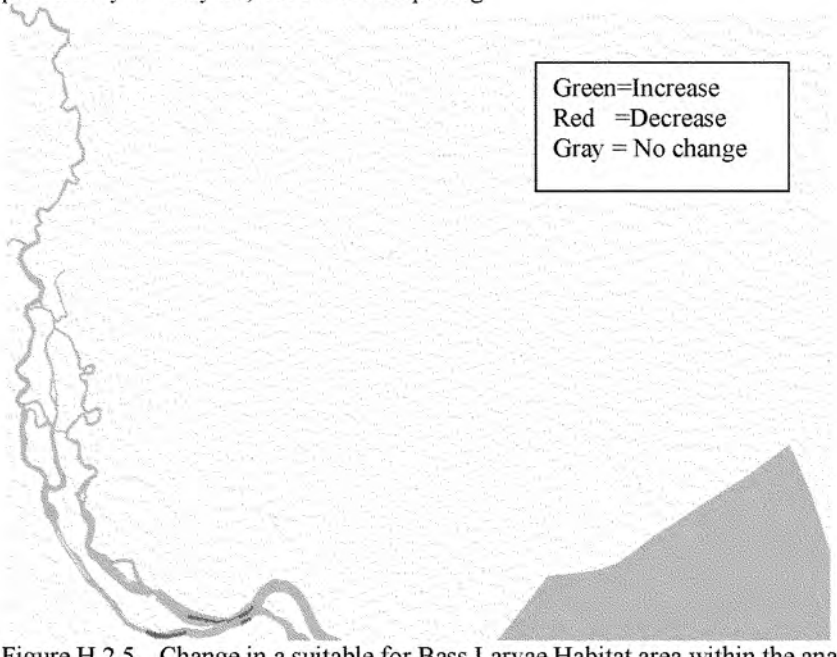
15. Figure H.2.1. Area suitable for Bass Larvae Habitat within the analyzed period May 1 – May 31, 1997: Existing bathymetry



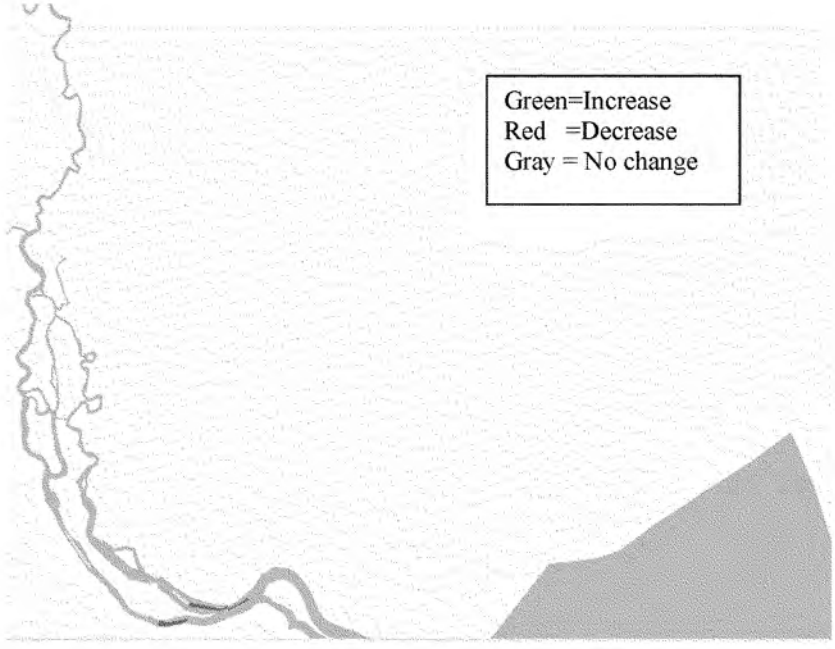
16. Figure H.2.2. Change in a suitable for Bass Larvae Habitat area within the analyzed period May 1 - May 31, 1999 : 6 ft deepening



17. Figure H.2.4. Change in a suitable for Bass Larvae Habitat area within the analyzed period May 1 - May 31, 1999 : 4 ft deepening



18. Figure H.2.5. Change in a suitable for Bass Larvae Habitat area within the analyzed period May 1 - May 31, 1999 : 3 ft deepening



19. Figure H.2.6. Change in a suitable for Bass Larvae Habitat area within the analyzed period May 1 - May 31, 1999 : 2 ft deepening

Appendix H-1

Tables of Criteria Passing for American Shad Habitat Suitability

May 1997

80th %ile of Clyo Flow

Fisheries Review Group

1. Table H.6.1 American Shad D.O. criteria passing for existing and deepening (6 ft, 4 ft, 3 ft, and 2 ft) scenarios within the analyzed period May 1 - May 31, 1997

HABITAT REQUIREMENTS:
RM 10-40; Top half of water column
D.O. January, May, and August (MG/L):10th %ile >=4.0

Savannah Harbor Estuary

Segments J	Segments I	Baseline Scenario D.O.	Project Scenario D.O.
47	13	Pass	Pass
47	14	Pass	Pass
47	15	Pass	Pass
47	16	Pass	Pass
47	17	Pass	Pass
48	13	Pass	Pass
48	14	Pass	Pass
48	15	Pass	Pass
48	16	Pass	Pass
48	17	Pass	Pass
49	13	Pass	Pass
49	14	Pass	Pass
49	15	Pass	Pass
49	16	Pass	Pass
49	17	Pass	Pass
50	13	Pass	Pass
50	14	Pass	Pass
50	15	Pass	Pass
50	16	Pass	Pass
50	17	Pass	Pass
50	18	Pass	Pass
51	13	Pass	Pass
51	14	Pass	Pass
51	15	Pass	Pass
52	13	Pass	Pass
52	14	Pass	Pass
52	15	Pass	Pass
53	13	Pass	Pass
53	14	Pass	Pass
53	15	Pass	Pass
54	13	Pass	Pass
54	14	Pass	Pass
54	15	Pass	Pass
55	13	Pass	Pass
55	14	Pass	Pass
55	15	Pass	Pass
56	13	Pass	Pass
56	14	Pass	Pass
56	15	Pass	Pass
57	13	Pass	Pass
57	14	Pass	Pass
57	15	Pass	Pass
58	13	Pass	Pass

58	14	Pass	Pass
58	15	Pass	Pass
59	13	Pass	Pass
59	14	Pass	Pass
59	15	Pass	Pass
59	30	Pass	Pass
59	31	Pass	Pass
59	32	Pass	Pass
60	13	Pass	Pass
60	14	Pass	Pass
60	15	Pass	Pass
60	30	Pass	Pass
60	31	Pass	Pass
60	32	Pass	Pass
61	13	Pass	Pass
61	14	Pass	Pass
61	15	Pass	Pass
61	30	Pass	Pass
61	31	Pass	Pass
61	32	Pass	Pass
62	13	Pass	Pass
62	14	Pass	Pass
62	15	Pass	Pass
62	30	Pass	Pass
62	31	Pass	Pass
62	32	Pass	Pass
63	13	Pass	Pass
63	14	Pass	Pass
63	15	Pass	Pass
63	31	Pass	Pass
64	13	Pass	Pass
64	14	Pass	Pass
64	15	Pass	Pass
64	30	Pass	Pass
64	31	Pass	Pass
64	32	Pass	Pass
65	13	Pass	Pass
65	14	Pass	Pass
65	15	Pass	Pass
65	30	Pass	Pass
65	31	Pass	Pass
65	32	Pass	Pass
65	33	Pass	Pass
66	13	Pass	Pass
66	14	Pass	Pass
66	15	Pass	Pass
66	30	Pass	Pass
66	31	Pass	Pass
66	32	Pass	Pass
66	36	Pass	Pass
67	13	Pass	Pass
67	14	Pass	Pass
67	15	Pass	Pass
67	30	Pass	Pass
67	31	Pass	Pass
67	32	Pass	Pass
67	36	Pass	Pass

68	13	Pass	Pass
68	14	Pass	Pass
68	15	Pass	Pass
68	30	Pass	Pass
68	31	Pass	Pass
68	32	Pass	Pass
68	36	Pass	Pass
69	13	Pass	Pass
69	14	Pass	Pass
69	15	Pass	Pass
69	30	Pass	Pass
69	31	Pass	Pass
69	32	Pass	Pass
69	36	Pass	Pass
70	13	Pass	Pass
70	14	Pass	Pass
70	15	Pass	Pass
70	30	Pass	Pass
70	31	Pass	Pass
70	32	Pass	Pass
70	33	Pass	Pass
71	13	Pass	Pass
71	14	Pass	Pass
71	15	Pass	Pass
71	30	Pass	Pass
71	31	Pass	Pass
71	32	Pass	Pass
72	13	Pass	Pass
72	14	Pass	Pass
72	15	Pass	Pass
72	30	Pass	Pass
72	31	Pass	Pass
72	32	Pass	Pass
73	13	Pass	Pass
73	14	Pass	Pass
73	15	Pass	Pass
73	30	Pass	Pass
73	31	Pass	Pass
74	13	Pass	Pass
74	14	Pass	Pass
74	15	Pass	Pass
74	30	Pass	Pass
74	31	Pass	Pass
75	13	Pass	Pass
75	14	Pass	Pass
75	15	Pass	Pass
75	30	Pass	Pass
75	31	Pass	Pass
76	13	Pass	Pass
76	14	Pass	Pass
76	15	Pass	Pass
76	16	Pass	Pass
76	17	Pass	Pass
76	30	Pass	Pass
76	31	Pass	Pass
77	13	Pass	Pass
77	14	Pass	Pass

77	15	Pass	Pass
77	16	Pass	Pass
77	17	Pass	Pass
77	30	Pass	Pass
77	31	Pass	Pass
78	13	Pass	Pass
78	14	Pass	Pass
78	15	Pass	Pass
78	16	Pass	Pass
78	17	Pass	Pass
78	30	Pass	Pass
78	31	Pass	Pass
79	13	Pass	Pass
79	14	Pass	Pass
79	15	Pass	Pass
79	30	Pass	Pass
79	31	Pass	Pass
80	13	Pass	Pass
80	14	Pass	Pass
80	15	Pass	Pass
80	30	Pass	Pass
80	31	Pass	Pass
81	13	Pass	Pass
81	14	Pass	Pass
81	15	Pass	Pass
81	30	Pass	Pass
81	31	Pass	Pass
82	13	Pass	Pass
82	14	Pass	Pass
82	15	Pass	Pass
82	16	Pass	Pass
82	17	Pass	Pass
82	18	Pass	Pass
82	19	Pass	Pass
82	20	Pass	Pass
82	21	Pass	Pass
82	29	Pass	Pass
82	30	Pass	Pass
82	31	Pass	Pass
83	13	Pass	Pass
83	14	Pass	Pass
83	15	Pass	Pass
83	21	Pass	Pass
83	30	Pass	Pass
83	31	Pass	Pass
84	13	Pass	Pass
84	14	Pass	Pass
84	15	Pass	Pass
84	21	Pass	Pass
84	30	Pass	Pass
84	31	Pass	Pass
85	13	Pass	Pass
85	14	Pass	Pass
85	15	Pass	Pass
85	21	Pass	Pass
85	30	Pass	Pass
86	13	Pass	Pass

86	14	Pass	Pass
86	15	Pass	Pass
86	21	Pass	Pass
86	30	Pass	Pass
87	13	Pass	Pass
87	14	Pass	Pass
87	15	Pass	Pass
87	30	Pass	Pass
88	13	Pass	Pass
88	14	Pass	Pass
88	15	Pass	Pass
88	30	Pass	Pass
89	13	Pass	Pass
89	14	Pass	Pass
89	15	Pass	Pass
89	30	Pass	Pass
90	13	Pass	Pass
90	14	Pass	Pass
90	15	Pass	Pass
90	30	Pass	Pass
91	13	Pass	Pass
91	14	Pass	Pass
91	15	Pass	Pass
91	16	Pass	Pass
91	30	Pass	Pass
92	13	Pass	Pass
92	14	Pass	Pass
92	15	Pass	Pass
92	16	Pass	Pass
92	30	Pass	Pass
93	13	Pass	Pass
93	14	Pass	Pass
93	15	Pass	Pass
93	16	Pass	Pass
93	30	Pass	Pass
94	13	Pass	Pass
94	14	Pass	Pass
94	15	Pass	Pass
94	16	Pass	Pass
94	26	Pass	Pass
94	30	Pass	Pass
95	13	Pass	Pass
95	14	Pass	Pass
95	15	Pass	Pass
95	16	Pass	Pass
95	26	Pass	Pass
95	30	Pass	Pass
96	13	Pass	Pass
96	14	Pass	Pass
96	15	Pass	Pass
96	26	Pass	Pass
96	30	Pass	Pass
97	13	Pass	Pass
97	14	Pass	Pass
97	15	Pass	Pass
97	26	Pass	Pass
97	30	Pass	Pass

98	13	Pass	Pass
98	14	Pass	Pass
98	15	Pass	Pass
98	26	Pass	Pass
98	27	Pass	Pass
98	28	Pass	Pass
98	29	Pass	Pass
98	30	Pass	Pass
99	13	Pass	Pass
99	14	Pass	Pass
99	15	Pass	Pass
99	16	Pass	Pass
99	17	Pass	Pass
99	18	Pass	Pass
99	19	Pass	Pass
99	20	Pass	Pass
99	21	Pass	Pass
99	22	Pass	Pass
99	23	Pass	Pass
99	26	Pass	Pass
99	30	Pass	Pass
100	13	Pass	Pass
100	14	Pass	Pass
100	15	Pass	Pass
100	23	Pass	Pass
100	24	Pass	Pass
100	25	Pass	Pass
100	26	Pass	Pass
100	30	Pass	Pass
101	13	Pass	Pass
101	14	Pass	Pass
101	15	Pass	Pass
101	16	Pass	Pass
101	17	Pass	Pass
101	18	Pass	Pass
101	19	Pass	Pass
101	20	Pass	Pass
101	21	Pass	Pass
101	22	Pass	Pass
101	23	Pass	Pass
101	26	Pass	Pass
101	30	Pass	Pass
102	13	Pass	Pass
102	14	Pass	Pass
102	15	Pass	Pass
102	26	Pass	Pass
102	30	Pass	Pass
103	13	Pass	Pass
103	14	Pass	Pass
103	15	Pass	Pass
103	26	Pass	Pass
103	30	Pass	Pass
104	13	Pass	Pass
104	14	Pass	Pass
104	15	Pass	Pass
104	26	Pass	Pass
104	30	Pass	Pass

105	13	Pass	Pass
105	14	Pass	Pass
105	15	Pass	Pass
105	26	Pass	Pass
105	30	Pass	Pass
106	13	Pass	Pass
106	14	Pass	Pass
106	15	Pass	Pass
106	26	Pass	Pass
106	27	Pass	Pass
106	30	Pass	Pass
106	39	Pass	Pass
107	13	Pass	Pass
107	14	Pass	Pass
107	15	Pass	Pass
107	22	Pass	Pass
107	26	Pass	Pass
107	30	Pass	Pass
107	39	Pass	Pass
108	13	Pass	Pass
108	14	Pass	Pass
108	15	Pass	Pass
108	22	Pass	Pass
108	26	Pass	Pass
108	30	Pass	Pass
108	39	Pass	Pass
109	13	Pass	Pass
109	14	Pass	Pass
109	15	Pass	Pass
109	22	Pass	Pass
109	26	Pass	Pass
109	30	Pass	Pass
109	39	Pass	Pass
110	13	Pass	Pass
110	14	Pass	Pass
110	15	Pass	Pass
110	22	Pass	Pass
110	26	Pass	Pass
110	39	Pass	Pass
111	13	Pass	Pass
111	14	Pass	Pass
111	15	Pass	Pass
111	22	Pass	Pass
111	26	Pass	Pass
111	39	Pass	Pass
112	13	Pass	Pass
112	14	Pass	Pass
112	15	Pass	Pass
112	22	Pass	Pass
112	26	Pass	Pass
112	39	Pass	Pass
113	13	Pass	Pass
113	14	Pass	Pass
113	15	Pass	Pass
113	26	Pass	Pass
113	27	Pass	Pass
113	39	Pass	Pass

114	13	Pass	Pass
114	14	Pass	Pass
114	15	Pass	Pass
114	26	Pass	Pass
114	39	Pass	Pass
115	13	Pass	Pass
115	14	Pass	Pass
115	15	Pass	Pass
115	26	Pass	Pass
115	39	Pass	Pass
116	13	Pass	Pass
116	14	Pass	Pass
116	15	Pass	Pass
116	26	Pass	Pass
116	39	Pass	Pass
117	13	Pass	Pass
117	14	Pass	Pass
117	15	Pass	Pass
117	26	Pass	Pass
117	39	Pass	Pass
118	13	Pass	Pass
118	14	Pass	Pass
118	15	Pass	Pass
118	20	Pass	Pass
118	26	Pass	Pass
118	39	Pass	Pass
119	13	Pass	Pass
119	14	Pass	Pass
119	15	Pass	Pass
119	20	Pass	Pass
119	26	Pass	Pass
119	39	Pass	Pass
120	13	Pass	Pass
120	14	Pass	Pass
120	15	Pass	Pass
120	16	Pass	Pass
120	26	Pass	Pass
120	39	Pass	Pass
121	13	Pass	Pass
121	14	Pass	Pass
121	26	Pass	Pass
121	39	Pass	Pass
122	13	Pass	Pass
122	14	Pass	Pass
122	26	Pass	Pass
122	39	Pass	Pass
123	13	Pass	Pass
123	14	Pass	Pass
123	15	Pass	Pass
123	16	Pass	Pass
123	17	Pass	Pass
123	18	Pass	Pass
123	19	Pass	Pass
123	20	Pass	Pass
123	21	Pass	Pass
123	22	Pass	Pass
123	23	Pass	Pass

123	24	Pass	Pass
123	25	Pass	Pass
123	26	Pass	Pass
123	27	Pass	Pass
123	28	Pass	Pass
123	29	Pass	Pass
123	30	Pass	Pass
123	31	Pass	Pass
123	32	Pass	Pass
123	33	Pass	Pass
123	34	Pass	Pass
123	35	Pass	Pass
123	36	Pass	Pass
123	37	Pass	Pass
123	38	Pass	Pass
123	39	Pass	Pass
124	13	Pass	Pass
124	14	Pass	Pass
124	23	Pass	Pass
125	13	Pass	Pass
125	14	Pass	Pass
125	23	Pass	Pass
126	13	Pass	Pass
126	14	Pass	Pass
126	23	Pass	Pass
127	13	Pass	Pass
127	14	Pass	Pass
127	23	Pass	Pass
128	13	Pass	Pass
128	14	Pass	Pass
128	23	Pass	Pass
129	13	Pass	Pass
129	14	Pass	Pass
129	23	Pass	Pass
130	8	Pass	Pass
130	9	Pass	Pass
130	10	Pass	Pass
130	11	Pass	Pass
130	12	Pass	Pass
130	13	Pass	Pass
130	14	Pass	Pass
130	23	Pass	Pass
131	14	Pass	Pass
131	23	Pass	Pass
132	14	Pass	Pass
132	23	Pass	Pass
133	14	Pass	Pass
133	23	Pass	Pass
134	14	Pass	Pass
134	23	Pass	Pass
135	14	Pass	Pass
136	14	Pass	Pass
137	14	Pass	Pass
138	14	Pass	Pass
139	14	Pass	Pass
140	14	Pass	Pass
141	14	Pass	Pass

142	14	Pass	Pass
143	14	Pass	Pass
144	14	Pass	Pass
145	14	Pass	Pass
146	14	Pass	Pass
147	14	Pass	Pass
148	14	Pass	Pass
149	14	Pass	Pass
150	14	Pass	Pass
151	14	Pass	Pass
152	14	Pass	Pass
153	14	Pass	Pass
154	14	Pass	Pass
155	14	Pass	Pass
156	14	Pass	Pass
157	14	Pass	Pass
158	14	Pass	Pass
159	14	Pass	Pass
160	14	Pass	Pass
161	14	Pass	Pass
162	14	Pass	Pass
163	14	Pass	Pass
164	14	Pass	Pass
165	14	Pass	Pass
166	14	Pass	Pass

Appendix H-2

Tables of Criteria Passing for Striped Bass Larvae Habitat Suitability

May 1997

20th %ile of Clyo Flow

Fisheries Review Group

1. Table H.7.1 Striped Bass Larvae salinity and D.O. criteria passing for existing and deepening (6 ft) scenarios within the analyzed period May 1 - May 31, 1997

HABITAT REQUIREMENTS:
RM 10-31; Depth Average
D.O. May (MG/L):10th %ile >=4.5
Salinity 50th %ile >=3 & <= 9 ppt

Savannah Harbor Estuary

Segments J	I	Baseline Scenario Salinity	D.O.	Project Scenario Salinity	D.O.
47	13	Pass	Pass	Fail	Pass
47	14	Fail	Pass	Fail	Pass
47	15	Pass	Pass	Fail	Pass
47	16	Pass	Pass	Fail	Pass
47	17	Pass	Pass	Fail	Pass
48	13	Pass	Pass	Fail	Pass
48	14	Fail	Pass	Fail	Pass
48	15	Pass	Pass	Fail	Pass
48	16	Pass	Pass	Fail	Pass
48	17	Pass	Pass	Fail	Pass
49	13	Pass	Pass	Fail	Pass
49	14	Fail	Pass	Fail	Pass
49	15	Pass	Pass	Pass	Pass
49	16	Pass	Pass	Fail	Pass
49	17	Pass	Pass	Fail	Pass
50	13	Pass	Pass	Pass	Pass
50	14	Fail	Pass	Fail	Pass
50	15	Fail	Pass	Fail	Pass
50	16	Fail	Pass	Fail	Pass
50	17	Pass	Pass	Fail	Pass
50	18	Pass	Pass	Pass	Pass
51	13	Pass	Pass	Pass	Pass
51	14	Fail	Pass	Fail	Pass
51	15	Pass	Pass	Pass	Pass
52	13	Pass	Pass	Pass	Pass
52	14	Fail	Pass	Fail	Pass
52	15	Pass	Pass	Pass	Pass
53	13	Pass	Pass	Pass	Pass
53	14	Fail	Pass	Fail	Pass
53	15	Pass	Pass	Pass	Pass
54	13	Pass	Pass	Pass	Pass
54	14	Pass	Pass	Fail	Pass
54	15	Pass	Pass	Pass	Pass
55	13	Pass	Pass	Pass	Pass
55	14	Pass	Pass	Fail	Pass
55	15	Pass	Pass	Pass	Pass
56	13	Pass	Pass	Pass	Pass
56	14	Pass	Pass	Fail	Pass
56	15	Pass	Pass	Pass	Pass
57	13	Pass	Pass	Pass	Pass
57	14	Pass	Pass	Fail	Pass
57	15	Pass	Pass	Pass	Pass

58	13	Pass	Pass	Pass	Pass
58	14	Pass	Pass	Fail	Pass
58	15	Fail	Pass	Pass	Pass
59	13	Pass	Pass	Pass	Pass
59	14	Pass	Pass	Fail	Pass
59	15	Fail	Pass	Pass	Pass
59	30	Pass	Pass	Pass	Pass
59	31	Pass	Pass	Fail	Pass
59	32	Pass	Pass	Pass	Pass
60	13	Fail	Pass	Pass	Pass
60	14	Pass	Pass	Fail	Pass
60	15	Fail	Pass	Pass	Pass
60	30	Pass	Pass	Pass	Pass
60	31	Pass	Pass	Fail	Pass
60	32	Pass	Pass	Pass	Pass
61	13	Fail	Pass	Pass	Pass
61	14	Pass	Pass	Fail	Pass
61	15	Fail	Pass	Pass	Pass
61	30	Pass	Pass	Pass	Pass
61	31	Pass	Fail	Fail	Pass
61	32	Pass	Pass	Pass	Pass
62	13	Fail	Pass	Pass	Pass
62	14	Pass	Pass	Pass	Pass
62	15	Fail	Pass	Pass	Pass
62	30	Pass	Pass	Pass	Pass
62	31	Pass	Fail	Fail	Fail
62	32	Pass	Pass	Pass	Pass
63	13	Fail	Pass	Pass	Pass
63	14	Pass	Pass	Pass	Pass
63	15	Fail	Pass	Pass	Pass
63	31	Pass	Fail	Pass	Fail
64	13	Fail	Pass	Pass	Pass
64	14	Pass	Pass	Pass	Pass
64	15	Fail	Pass	Pass	Pass
64	30	Pass	Fail	Pass	Fail
64	31	Pass	Fail	Pass	Fail
64	32	Pass	Fail	Pass	Fail
65	13	Fail	Pass	Pass	Pass
65	14	Pass	Pass	Pass	Pass
65	15	Fail	Pass	Pass	Pass
65	30	Pass	Fail	Pass	Fail
65	31	Pass	Fail	Pass	Fail
65	32	Pass	Fail	Pass	Fail
65	33	Pass	Fail	Pass	Fail
66	13	Fail	Pass	Pass	Pass
66	14	Fail	Pass	Pass	Pass
66	15	Fail	Pass	Fail	Pass
66	30	Pass	Fail	Pass	Fail
66	31	Pass	Fail	Pass	Fail
66	32	Pass	Fail	Pass	Pass
66	36	Pass	Fail	Pass	Fail
67	13	Fail	Pass	Pass	Pass
67	14	Fail	Pass	Pass	Pass
67	15	Fail	Pass	Fail	Pass
67	30	Pass	Fail	Pass	Fail
67	31	Pass	Fail	Pass	Fail
67	32	Pass	Fail	Pass	Pass

67	36	Pass	Fail	Pass	Fail
68	13	Fail	Pass	Pass	Pass
68	14	Fail	Pass	Pass	Pass
68	15	Fail	Pass	Fail	Pass
68	30	Pass	Fail	Pass	Fail
68	31	Pass	Fail	Pass	Fail
68	32	Pass	Fail	Pass	Pass
68	36	Pass	Fail	Pass	Fail
69	13	Fail	Pass	Pass	Pass
69	14	Fail	Pass	Pass	Pass
69	15	Fail	Pass	Pass	Pass
69	30	Pass	Fail	Pass	Fail
69	31	Pass	Fail	Pass	Fail
69	32	Pass	Fail	Pass	Fail
69	36	Pass	Fail	Pass	Fail
70	13	Fail	Pass	Fail	Pass
70	14	Fail	Pass	Pass	Pass
70	15	Fail	Pass	Pass	Pass
70	30	Pass	Fail	Pass	Fail
70	31	Pass	Fail	Pass	Fail
70	32	Pass	Fail	Pass	Fail
70	33	Pass	Fail	Pass	Fail
71	13	Fail	Pass	Pass	Pass
71	14	Fail	Pass	Pass	Pass
71	15	Fail	Pass	Fail	Pass
71	30	Pass	Fail	Pass	Fail
71	31	Pass	Fail	Pass	Fail
71	32	Pass	Fail	Pass	Fail
72	13	Fail	Pass	Pass	Pass
72	14	Fail	Pass	Pass	Pass
72	15	Fail	Pass	Fail	Pass
72	30	Pass	Fail	Pass	Fail
72	31	Pass	Fail	Pass	Fail
72	32	Pass	Fail	Pass	Fail
73	13	Fail	Pass	Pass	Pass
73	14	Fail	Pass	Pass	Pass
73	15	Fail	Pass	Fail	Pass
73	30	Pass	Fail	Pass	Fail
73	31	Pass	Fail	Pass	Fail
74	13	Fail	Pass	Pass	Pass
74	14	Fail	Pass	Pass	Pass
74	15	Fail	Pass	Fail	Pass
74	30	Fail	Fail	Pass	Fail
74	31	Pass	Fail	Pass	Fail
75	13	Fail	Pass	Fail	Pass
75	14	Fail	Pass	Pass	Pass
75	15	Fail	Pass	Fail	Pass
75	30	Fail	Fail	Pass	Fail
75	31	Fail	Fail	Pass	Fail
76	13	Fail	Pass	Fail	Pass
76	14	Fail	Pass	Pass	Pass
76	15	Fail	Pass	Pass	Pass
76	16	Fail	Pass	Pass	Pass
76	17	Fail	Pass	Pass	Pass
76	30	Fail	Fail	Pass	Fail
76	31	Fail	Fail	Pass	Fail
77	13	Fail	Pass	Fail	Pass

77	14	Fail	Pass	Pass	Pass
77	15	Fail	Pass	Pass	Pass
77	16	Fail	Pass	Pass	Pass
77	17	Fail	Pass	Pass	Pass
77	30	Fail	Fail	Pass	Fail
77	31	Fail	Pass	Pass	Pass
78	13	Fail	Pass	Fail	Pass
78	14	Fail	Pass	Pass	Pass
78	15	Fail	Pass	Pass	Pass
78	16	Fail	Pass	Pass	Pass
78	17	Fail	Pass	Pass	Pass
78	30	Fail	Fail	Fail	Fail
78	31	Fail	Pass	Fail	Pass
79	13	Fail	Pass	Fail	Pass
79	14	Fail	Pass	Pass	Pass
79	15	Fail	Pass	Fail	Pass
79	30	Fail	Fail	Fail	Fail
79	31	Fail	Pass	Fail	Pass
80	13	Fail	Pass	Fail	Pass
80	14	Fail	Pass	Fail	Pass
80	15	Fail	Pass	Fail	Pass
80	30	Fail	Fail	Fail	Fail
80	31	Fail	Pass	Fail	Pass
81	13	Fail	Pass	Fail	Pass
81	14	Fail	Pass	Fail	Pass
81	15	Fail	Pass	Fail	Pass
81	30	Fail	Fail	Fail	Fail
81	31	Fail	Pass	Fail	Pass
82	13	Fail	Pass	Fail	Pass
82	14	Fail	Pass	Fail	Pass
82	15	Fail	Pass	Fail	Pass
82	16	Fail	Pass	Fail	Pass
82	17	Fail	Pass	Fail	Pass
82	18	Fail	Pass	Fail	Pass
82	19	Fail	Pass	Fail	Pass
82	20	Fail	Pass	Fail	Pass
82	21	Fail	Pass	Fail	Pass
82	29	Fail	Fail	Fail	Fail
82	30	Fail	Pass	Fail	Fail
82	31	Fail	Pass	Fail	Pass
83	13	Fail	Pass	Fail	Pass
83	14	Fail	Pass	Fail	Pass
83	15	Fail	Pass	Fail	Pass
83	21	Fail	Pass	Fail	Pass
83	30	Fail	Pass	Fail	Fail
83	31	Fail	Pass	Fail	Pass
84	13	Fail	Pass	Fail	Pass
84	14	Fail	Pass	Fail	Pass
84	15	Fail	Pass	Fail	Pass
84	21	Fail	Pass	Fail	Pass
84	30	Fail	Pass	Fail	Pass
84	31	Fail	Pass	Fail	Pass
85	13	Fail	Pass	Fail	Pass
85	14	Fail	Pass	Fail	Pass
85	15	Fail	Pass	Fail	Pass
85	21	Fail	Pass	Fail	Pass
85	30	Fail	Pass	Fail	Pass

86	13	Fail	Pass	Fail	Pass
86	14	Fail	Pass	Fail	Pass
86	15	Fail	Pass	Fail	Pass
86	21	Fail	Pass	Fail	Pass
86	30	Fail	Pass	Fail	Pass
87	13	Fail	Pass	Fail	Pass
87	14	Fail	Pass	Fail	Pass
87	15	Fail	Pass	Fail	Pass
87	30	Fail	Pass	Fail	Pass
88	13	Fail	Pass	Fail	Pass
88	14	Fail	Pass	Fail	Pass
88	15	Fail	Pass	Fail	Pass
88	30	Fail	Pass	Fail	Pass
89	13	Fail	Pass	Fail	Pass
89	14	Fail	Pass	Fail	Pass
89	15	Fail	Pass	Fail	Pass
89	30	Fail	Pass	Fail	Pass
90	13	Fail	Pass	Fail	Pass
90	14	Fail	Pass	Fail	Pass
90	15	Fail	Pass	Fail	Pass
90	30	Fail	Pass	Fail	Pass
91	13	Fail	Pass	Fail	Pass
91	14	Fail	Pass	Fail	Pass
91	15	Fail	Pass	Fail	Pass
91	16	Fail	Pass	Fail	Pass
91	30	Fail	Pass	Fail	Pass
92	13	Fail	Pass	Fail	Pass
92	14	Fail	Pass	Fail	Pass
92	15	Fail	Pass	Fail	Pass
92	16	Fail	Pass	Fail	Pass
92	30	Fail	Pass	Fail	Pass
93	13	Fail	Pass	Fail	Pass
93	14	Fail	Pass	Fail	Pass
93	15	Fail	Pass	Fail	Pass
93	16	Fail	Pass	Fail	Pass
93	30	Fail	Pass	Fail	Pass
94	13	Fail	Pass	Fail	Pass
94	14	Fail	Pass	Fail	Pass
94	15	Fail	Pass	Fail	Pass
94	16	Fail	Pass	Fail	Pass
94	26	Fail	Pass	Fail	Pass
94	30	Fail	Pass	Fail	Pass
95	13	Fail	Pass	Fail	Pass
95	14	Fail	Pass	Fail	Pass
95	15	Fail	Pass	Fail	Pass
95	16	Fail	Pass	Fail	Pass
95	26	Fail	Pass	Fail	Pass
95	30	Fail	Pass	Fail	Pass
96	13	Fail	Pass	Fail	Pass
96	14	Fail	Pass	Fail	Pass
96	15	Fail	Pass	Fail	Pass
96	26	Fail	Pass	Fail	Pass
96	30	Fail	Pass	Fail	Pass
97	13	Fail	Pass	Fail	Pass
97	14	Fail	Pass	Fail	Pass
97	15	Fail	Pass	Fail	Pass
97	26	Fail	Pass	Fail	Pass

97	30	Fail	Pass	Fail	Pass
98	13	Fail	Pass	Fail	Pass
98	14	Fail	Pass	Fail	Pass
98	15	Fail	Pass	Fail	Pass
98	26	Fail	Pass	Fail	Pass
98	27	Fail	Pass	Fail	Pass
98	28	Fail	Pass	Fail	Pass
98	29	Fail	Pass	Fail	Pass
98	30	Fail	Pass	Fail	Pass
99	13	Fail	Pass	Fail	Pass
99	14	Fail	Pass	Fail	Pass
99	15	Fail	Pass	Fail	Pass
99	16	Fail	Pass	Fail	Pass
99	17	Fail	Pass	Fail	Pass
99	18	Fail	Pass	Fail	Pass
99	19	Fail	Pass	Fail	Pass
99	20	Fail	Pass	Fail	Pass
99	21	Fail	Pass	Fail	Pass
99	22	Fail	Pass	Fail	Pass
99	23	Fail	Pass	Fail	Pass
99	26	Fail	Pass	Fail	Pass
99	30	Fail	Pass	Fail	Pass
100	13	Fail	Pass	Fail	Pass
100	14	Fail	Pass	Fail	Pass
100	15	Fail	Pass	Fail	Pass
100	23	Fail	Pass	Fail	Pass
100	24	Fail	Pass	Fail	Pass
100	25	Fail	Pass	Fail	Pass
100	26	Fail	Pass	Fail	Pass
100	30	Fail	Pass	Fail	Pass
101	13	Fail	Pass	Fail	Pass
101	14	Fail	Pass	Fail	Pass
101	15	Fail	Pass	Fail	Pass
101	16	Fail	Pass	Fail	Pass
101	17	Fail	Pass	Fail	Pass
101	18	Fail	Pass	Fail	Pass
101	19	Fail	Pass	Fail	Pass
101	20	Fail	Pass	Fail	Pass
101	21	Fail	Pass	Fail	Pass
101	22	Fail	Pass	Fail	Pass
101	23	Fail	Pass	Fail	Pass
101	26	Fail	Pass	Fail	Pass
101	30	Fail	Pass	Fail	Pass
102	13	Fail	Pass	Fail	Pass
102	14	Fail	Pass	Fail	Pass
102	15	Fail	Pass	Fail	Pass
102	26	Fail	Pass	Fail	Pass
102	30	Fail	Pass	Fail	Pass
103	13	Fail	Pass	Fail	Pass
103	14	Fail	Pass	Fail	Pass
103	15	Fail	Pass	Fail	Pass
103	26	Fail	Pass	Fail	Pass
103	30	Fail	Pass	Fail	Pass
104	13	Fail	Pass	Fail	Pass
104	14	Fail	Pass	Fail	Pass
104	15	Fail	Pass	Fail	Pass
104	26	Fail	Pass	Fail	Pass

104	30	Fail	Pass	Fail	Pass
105	13	Fail	Pass	Fail	Pass
105	14	Fail	Pass	Fail	Pass
105	15	Fail	Pass	Fail	Pass
105	26	Fail	Pass	Fail	Pass
105	30	Fail	Pass	Fail	Pass
106	13	Fail	Pass	Fail	Pass
106	14	Fail	Pass	Fail	Pass
106	15	Fail	Pass	Fail	Pass
106	26	Fail	Pass	Fail	Pass
106	27	Fail	Pass	Fail	Pass
106	30	Fail	Pass	Fail	Pass
106	39	Fail	Pass	Fail	Pass
107	13	Fail	Pass	Fail	Pass
107	14	Fail	Pass	Fail	Pass
107	15	Fail	Pass	Fail	Pass
107	22	Fail	Pass	Fail	Pass
107	26	Fail	Pass	Fail	Pass
107	30	Fail	Pass	Fail	Pass
107	39	Fail	Pass	Fail	Pass
108	13	Fail	Pass	Fail	Pass
108	14	Fail	Pass	Fail	Pass
108	15	Fail	Pass	Fail	Pass
108	22	Fail	Pass	Fail	Pass
108	26	Fail	Pass	Fail	Pass
108	30	Fail	Pass	Fail	Pass
108	39	Fail	Pass	Fail	Pass
109	13	Fail	Pass	Fail	Pass
109	14	Fail	Pass	Fail	Pass
109	15	Fail	Pass	Fail	Pass
109	22	Fail	Pass	Fail	Pass
109	26	Fail	Pass	Fail	Pass
109	30	Fail	Pass	Fail	Pass
109	39	Fail	Pass	Fail	Pass
110	13	Fail	Pass	Fail	Pass
110	14	Fail	Pass	Fail	Pass
110	15	Fail	Pass	Fail	Pass
110	22	Fail	Pass	Fail	Pass
110	26	Fail	Pass	Fail	Pass
110	39	Fail	Pass	Fail	Pass
111	13	Fail	Pass	Fail	Pass
111	14	Fail	Pass	Fail	Pass
111	15	Fail	Pass	Fail	Pass
111	22	Fail	Pass	Fail	Pass
111	26	Fail	Pass	Fail	Pass
111	39	Fail	Pass	Fail	Pass
112	13	Fail	Pass	Fail	Pass
112	14	Fail	Pass	Fail	Pass
112	15	Fail	Pass	Fail	Pass
112	22	Fail	Pass	Fail	Pass
112	26	Fail	Pass	Fail	Pass
112	39	Fail	Pass	Fail	Pass
113	13	Fail	Pass	Fail	Pass
113	14	Fail	Pass	Fail	Pass
113	15	Fail	Pass	Fail	Pass
113	26	Fail	Pass	Fail	Pass
113	27	Fail	Pass	Fail	Pass

113	39	Fail	Pass	Fail	Pass
114	13	Fail	Pass	Fail	Pass
114	14	Fail	Pass	Fail	Pass
114	15	Fail	Pass	Fail	Pass
114	26	Fail	Pass	Fail	Pass
114	39	Fail	Pass	Fail	Pass
115	13	Fail	Pass	Fail	Pass
115	14	Fail	Pass	Fail	Pass
115	15	Fail	Pass	Fail	Pass
115	26	Fail	Pass	Fail	Pass
115	39	Fail	Pass	Fail	Pass
116	13	Fail	Pass	Fail	Pass
116	14	Fail	Pass	Fail	Pass
116	15	Fail	Pass	Fail	Pass
116	26	Fail	Pass	Fail	Pass
116	39	Fail	Pass	Fail	Pass
117	13	Fail	Pass	Fail	Pass
117	14	Fail	Pass	Fail	Pass
117	15	Fail	Pass	Fail	Pass
117	26	Fail	Pass	Fail	Pass
117	39	Fail	Pass	Fail	Pass
118	13	Fail	Pass	Fail	Pass
118	14	Fail	Pass	Fail	Pass
118	15	Fail	Pass	Fail	Pass
118	20	Fail	Pass	Fail	Pass
118	26	Fail	Pass	Fail	Pass
118	39	Fail	Pass	Fail	Pass
119	13	Fail	Pass	Fail	Pass
119	14	Fail	Pass	Fail	Pass
119	15	Fail	Pass	Fail	Pass
119	20	Fail	Pass	Fail	Pass
119	26	Fail	Pass	Fail	Pass
119	39	Fail	Pass	Fail	Pass
120	13	Fail	Pass	Fail	Pass
120	14	Fail	Pass	Fail	Pass
120	15	Fail	Pass	Fail	Pass
120	16	Fail	Pass	Fail	Pass
120	26	Fail	Pass	Fail	Pass
120	39	Fail	Pass	Fail	Pass
121	13	Fail	Pass	Fail	Pass
121	14	Fail	Pass	Fail	Pass
121	26	Fail	Pass	Fail	Pass
121	39	Fail	Pass	Fail	Pass
122	13	Fail	Pass	Fail	Pass
122	14	Fail	Pass	Fail	Pass
122	26	Fail	Pass	Fail	Pass
122	39	Fail	Pass	Fail	Pass
123	13	Fail	Pass	Fail	Pass
123	14	Fail	Pass	Fail	Pass
123	15	Fail	Pass	Fail	Pass
123	16	Fail	Pass	Fail	Pass
123	17	Fail	Pass	Fail	Pass
123	18	Fail	Pass	Fail	Pass
123	19	Fail	Pass	Fail	Pass
123	20	Fail	Pass	Fail	Pass
123	21	Fail	Pass	Fail	Pass
123	22	Fail	Pass	Fail	Pass

123	23	Fail	Pass	Fail	Pass
123	24	Fail	Pass	Fail	Pass
123	25	Fail	Pass	Fail	Pass
123	26	Fail	Pass	Fail	Pass
123	27	Fail	Pass	Fail	Pass
123	28	Fail	Pass	Fail	Pass
123	29	Fail	Pass	Fail	Pass
123	30	Fail	Pass	Fail	Pass
123	31	Fail	Pass	Fail	Pass
123	32	Fail	Pass	Fail	Pass
123	33	Fail	Pass	Fail	Pass
123	34	Fail	Pass	Fail	Pass
123	35	Fail	Pass	Fail	Pass
123	36	Fail	Pass	Fail	Pass
123	37	Fail	Pass	Fail	Pass
123	38	Fail	Pass	Fail	Pass
123	39	Fail	Pass	Fail	Pass
124	13	Fail	Pass	Fail	Pass
124	14	Fail	Pass	Fail	Pass
124	23	Fail	Pass	Fail	Pass
125	13	Fail	Pass	Fail	Pass
125	14	Fail	Pass	Fail	Pass
125	23	Fail	Pass	Fail	Pass
126	13	Fail	Pass	Fail	Pass
126	14	Fail	Pass	Fail	Pass
126	23	Fail	Pass	Fail	Pass
127	13	Fail	Pass	Fail	Pass
127	14	Fail	Pass	Fail	Pass
127	23	Fail	Pass	Fail	Pass
128	13	Fail	Pass	Fail	Pass
128	14	Fail	Pass	Fail	Pass
128	23	Fail	Pass	Fail	Pass
129	13	Fail	Pass	Fail	Pass
129	14	Fail	Pass	Fail	Pass
129	23	Fail	Pass	Fail	Pass
130	8	Fail	Fail	Fail	Fail
130	9	Fail	Pass	Fail	Pass
130	10	Fail	Pass	Fail	Pass
130	11	Fail	Pass	Fail	Pass
130	12	Fail	Pass	Fail	Pass
130	13	Fail	Pass	Fail	Pass
130	14	Fail	Pass	Fail	Pass
130	23	Fail	Pass	Fail	Pass
131	14	Fail	Pass	Fail	Pass
131	23	Fail	Pass	Fail	Pass
132	14	Fail	Pass	Fail	Pass
132	23	Fail	Pass	Fail	Pass
133	14	Fail	Pass	Fail	Pass
133	23	Fail	Pass	Fail	Pass
134	14	Fail	Pass	Fail	Pass
134	23	Fail	Pass	Fail	Pass
135	14	Fail	Pass	Fail	Pass
136	14	Fail	Pass	Fail	Pass
137	14	Fail	Pass	Fail	Pass
138	14	Fail	Pass	Fail	Pass

2. Table H.7.2 Striped Bass Larvae salinity and D.O. criteria passing for existing and deepening (4 ft) scenarios within the analyzed period May 1 - May 31, 1997

HABITAT REQUIREMENTS:
RM 10-31; Depth Average
D.O. May (MG/L):10th %ile >=4.5
Salinity 50th %ile >=3 & <= 9 ppt

Savannah Harbor Estuary

Segments J	Segments I	Baseline Scenario Salinity	Baseline Scenario D.O.	Project Scenario Salinity	Project Scenario D.O.
47	13	Pass	Pass	Fail	Pass
47	14	Fail	Pass	Fail	Pass
47	15	Pass	Pass	Fail	Pass
47	16	Pass	Pass	Fail	Pass
47	17	Pass	Pass	Fail	Pass
48	13	Pass	Pass	Fail	Pass
48	14	Fail	Pass	Fail	Pass
48	15	Pass	Pass	Fail	Pass
48	16	Pass	Pass	Fail	Pass
48	17	Pass	Pass	Pass	Pass
49	13	Pass	Pass	Pass	Pass
49	14	Fail	Pass	Fail	Pass
49	15	Pass	Pass	Pass	Pass
49	16	Pass	Pass	Fail	Pass
49	17	Pass	Pass	Pass	Pass
50	13	Pass	Pass	Pass	Pass
50	14	Fail	Pass	Fail	Pass
50	15	Fail	Pass	Fail	Pass
50	16	Fail	Pass	Fail	Pass
50	17	Pass	Pass	Fail	Pass
50	18	Pass	Pass	Pass	Pass
51	13	Pass	Pass	Pass	Pass
51	14	Fail	Pass	Fail	Pass
51	15	Pass	Pass	Pass	Pass
52	13	Pass	Pass	Pass	Pass
52	14	Fail	Pass	Fail	Pass
52	15	Pass	Pass	Pass	Pass
53	13	Pass	Pass	Pass	Pass
53	14	Fail	Pass	Fail	Pass
53	15	Pass	Pass	Pass	Pass
54	13	Pass	Pass	Pass	Pass
54	14	Pass	Pass	Fail	Pass
54	15	Pass	Pass	Pass	Pass
55	13	Pass	Pass	Pass	Pass
55	14	Pass	Pass	Fail	Pass
55	15	Pass	Pass	Pass	Pass
56	13	Pass	Pass	Pass	Pass
56	14	Pass	Pass	Fail	Pass
56	15	Pass	Pass	Pass	Pass
57	13	Pass	Pass	Pass	Pass

57	14	Pass	Pass	Fail	Pass
57	15	Pass	Pass	Pass	Pass
58	13	Pass	Pass	Pass	Pass
58	14	Pass	Pass	Fail	Pass
58	15	Fail	Pass	Pass	Pass
59	13	Pass	Pass	Pass	Pass
59	14	Pass	Pass	Pass	Pass
59	15	Fail	Pass	Pass	Pass
59	30	Pass	Pass	Pass	Pass
59	31	Pass	Pass	Fail	Pass
59	32	Pass	Pass	Pass	Pass
60	13	Fail	Pass	Pass	Pass
60	14	Pass	Pass	Pass	Pass
60	15	Fail	Pass	Pass	Pass
60	30	Pass	Pass	Pass	Pass
60	31	Pass	Pass	Fail	Pass
60	32	Pass	Pass	Pass	Pass
61	13	Fail	Pass	Pass	Pass
61	14	Pass	Pass	Pass	Pass
61	15	Fail	Pass	Pass	Pass
61	30	Pass	Pass	Pass	Pass
61	31	Pass	Fail	Fail	Pass
61	32	Pass	Pass	Pass	Pass
62	13	Fail	Pass	Pass	Pass
62	14	Pass	Pass	Pass	Pass
62	15	Fail	Pass	Fail	Pass
62	30	Pass	Pass	Pass	Pass
62	31	Pass	Fail	Pass	Fail
62	32	Pass	Pass	Pass	Pass
63	13	Fail	Pass	Pass	Pass
63	14	Pass	Pass	Pass	Pass
63	15	Fail	Pass	Pass	Pass
63	31	Pass	Fail	Pass	Fail
64	13	Fail	Pass	Pass	Pass
64	14	Pass	Pass	Pass	Pass
64	15	Fail	Pass	Fail	Pass
64	30	Pass	Fail	Pass	Fail
64	31	Pass	Fail	Pass	Fail
64	32	Pass	Fail	Pass	Fail
65	13	Fail	Pass	Pass	Pass
65	14	Pass	Pass	Pass	Pass
65	15	Fail	Pass	Fail	Pass
65	30	Pass	Fail	Pass	Fail
65	31	Pass	Fail	Pass	Fail
65	32	Pass	Fail	Pass	Fail
65	33	Pass	Fail	Pass	Fail
66	13	Fail	Pass	Pass	Pass
66	14	Fail	Pass	Pass	Pass
66	15	Fail	Pass	Fail	Pass
66	30	Pass	Fail	Pass	Fail
66	31	Pass	Fail	Pass	Fail
66	32	Pass	Fail	Pass	Fail
66	36	Pass	Fail	Pass	Fail
67	13	Fail	Pass	Fail	Pass
67	14	Fail	Pass	Pass	Pass
67	15	Fail	Pass	Fail	Pass
67	30	Pass	Fail	Pass	Fail

67	31	Pass	Fail	Pass	Fail
67	32	Pass	Fail	Pass	Pass
67	36	Pass	Fail	Pass	Fail
68	13	Fail	Pass	Fail	Pass
68	14	Fail	Pass	Pass	Pass
68	15	Fail	Pass	Fail	Pass
68	30	Pass	Fail	Pass	Fail
68	31	Pass	Fail	Pass	Fail
68	32	Pass	Fail	Pass	Pass
68	36	Pass	Fail	Pass	Fail
69	13	Fail	Pass	Fail	Pass
69	14	Fail	Pass	Pass	Pass
69	15	Fail	Pass	Fail	Pass
69	30	Pass	Fail	Pass	Fail
69	31	Pass	Fail	Pass	Fail
69	32	Pass	Fail	Pass	Fail
69	36	Pass	Fail	Pass	Fail
70	13	Fail	Pass	Fail	Pass
70	14	Fail	Pass	Pass	Pass
70	15	Fail	Pass	Fail	Pass
70	30	Pass	Fail	Pass	Fail
70	31	Pass	Fail	Pass	Fail
70	32	Pass	Fail	Pass	Fail
70	33	Pass	Fail	Pass	Fail
71	13	Fail	Pass	Fail	Pass
71	14	Fail	Pass	Pass	Pass
71	15	Fail	Pass	Fail	Pass
71	30	Pass	Fail	Pass	Fail
71	31	Pass	Fail	Pass	Fail
71	32	Pass	Fail	Pass	Fail
72	13	Fail	Pass	Fail	Pass
72	14	Fail	Pass	Pass	Pass
72	15	Fail	Pass	Fail	Pass
72	30	Pass	Fail	Pass	Fail
72	31	Pass	Fail	Pass	Fail
72	32	Pass	Fail	Pass	Fail
73	13	Fail	Pass	Fail	Pass
73	14	Fail	Pass	Pass	Pass
73	15	Fail	Pass	Fail	Pass
73	30	Pass	Fail	Pass	Fail
73	31	Pass	Fail	Pass	Fail
74	13	Fail	Pass	Fail	Pass
74	14	Fail	Pass	Pass	Pass
74	15	Fail	Pass	Fail	Pass
74	30	Fail	Fail	Pass	Fail
74	31	Pass	Fail	Pass	Fail
75	13	Fail	Pass	Fail	Pass
75	14	Fail	Pass	Pass	Pass
75	15	Fail	Pass	Fail	Pass
75	30	Fail	Fail	Pass	Fail
75	31	Fail	Fail	Pass	Fail
76	13	Fail	Pass	Fail	Pass
76	14	Fail	Pass	Fail	Pass
76	15	Fail	Pass	Fail	Pass
76	16	Fail	Pass	Fail	Pass
76	17	Fail	Pass	Fail	Pass
76	30	Fail	Fail	Pass	Fail

76	31	Fail	Fail	Pass	Fail
77	13	Fail	Pass	Fail	Pass
77	14	Fail	Pass	Fail	Pass
77	15	Fail	Pass	Pass	Pass
77	16	Fail	Pass	Fail	Pass
77	17	Fail	Pass	Fail	Pass
77	30	Fail	Fail	Fail	Fail
77	31	Fail	Pass	Fail	Pass
78	13	Fail	Pass	Fail	Pass
78	14	Fail	Pass	Fail	Pass
78	15	Fail	Pass	Fail	Pass
78	16	Fail	Pass	Fail	Pass
78	17	Fail	Pass	Fail	Pass
78	30	Fail	Fail	Fail	Fail
78	31	Fail	Pass	Fail	Pass
79	13	Fail	Pass	Fail	Pass
79	14	Fail	Pass	Fail	Pass
79	15	Fail	Pass	Fail	Pass
79	30	Fail	Fail	Fail	Fail
79	31	Fail	Pass	Fail	Pass
80	13	Fail	Pass	Fail	Pass
80	14	Fail	Pass	Fail	Pass
80	15	Fail	Pass	Fail	Pass
80	30	Fail	Fail	Fail	Fail
80	31	Fail	Pass	Fail	Pass
81	13	Fail	Pass	Fail	Pass
81	14	Fail	Pass	Fail	Pass
81	15	Fail	Pass	Fail	Pass
81	30	Fail	Fail	Fail	Fail
81	31	Fail	Pass	Fail	Pass
82	13	Fail	Pass	Fail	Pass
82	14	Fail	Pass	Fail	Pass
82	15	Fail	Pass	Fail	Pass
82	16	Fail	Pass	Fail	Pass
82	17	Fail	Pass	Fail	Pass
82	18	Fail	Pass	Fail	Pass
82	19	Fail	Pass	Fail	Pass
82	20	Fail	Pass	Fail	Pass
82	21	Fail	Pass	Fail	Pass
82	29	Fail	Fail	Fail	Fail
82	30	Fail	Pass	Fail	Fail
82	31	Fail	Pass	Fail	Pass
83	13	Fail	Pass	Fail	Pass
83	14	Fail	Pass	Fail	Pass
83	15	Fail	Pass	Fail	Pass
83	21	Fail	Pass	Fail	Pass
83	30	Fail	Pass	Fail	Pass
83	31	Fail	Pass	Fail	Pass
84	13	Fail	Pass	Fail	Pass
84	14	Fail	Pass	Fail	Pass
84	15	Fail	Pass	Fail	Pass
84	21	Fail	Pass	Fail	Pass
84	30	Fail	Pass	Fail	Pass
84	31	Fail	Pass	Fail	Pass
85	13	Fail	Pass	Fail	Pass
85	14	Fail	Pass	Fail	Pass
85	15	Fail	Pass	Fail	Pass

85	21	Fail	Pass	Fail	Pass
85	30	Fail	Pass	Fail	Pass
86	13	Fail	Pass	Fail	Pass
86	14	Fail	Pass	Fail	Pass
86	15	Fail	Pass	Fail	Pass
86	21	Fail	Pass	Fail	Pass
86	30	Fail	Pass	Fail	Pass
87	13	Fail	Pass	Fail	Pass
87	14	Fail	Pass	Fail	Pass
87	15	Fail	Pass	Fail	Pass
87	30	Fail	Pass	Fail	Pass
88	13	Fail	Pass	Fail	Pass
88	14	Fail	Pass	Fail	Pass
88	15	Fail	Pass	Fail	Pass
88	30	Fail	Pass	Fail	Pass
89	13	Fail	Pass	Fail	Pass
89	14	Fail	Pass	Fail	Pass
89	15	Fail	Pass	Fail	Pass
89	30	Fail	Pass	Fail	Pass
90	13	Fail	Pass	Fail	Pass
90	14	Fail	Pass	Fail	Pass
90	15	Fail	Pass	Fail	Pass
90	30	Fail	Pass	Fail	Pass
91	13	Fail	Pass	Fail	Pass
91	14	Fail	Pass	Fail	Pass
91	15	Fail	Pass	Fail	Pass
91	16	Fail	Pass	Fail	Pass
91	30	Fail	Pass	Fail	Pass
92	13	Fail	Pass	Fail	Pass
92	14	Fail	Pass	Fail	Pass
92	15	Fail	Pass	Fail	Pass
92	16	Fail	Pass	Fail	Pass
92	30	Fail	Pass	Fail	Pass
93	13	Fail	Pass	Fail	Pass
93	14	Fail	Pass	Fail	Pass
93	15	Fail	Pass	Fail	Pass
93	16	Fail	Pass	Fail	Pass
93	30	Fail	Pass	Fail	Pass
94	13	Fail	Pass	Fail	Pass
94	14	Fail	Pass	Fail	Pass
94	15	Fail	Pass	Fail	Pass
94	16	Fail	Pass	Fail	Pass
94	26	Fail	Pass	Fail	Pass
94	30	Fail	Pass	Fail	Pass
95	13	Fail	Pass	Fail	Pass
95	14	Fail	Pass	Fail	Pass
95	15	Fail	Pass	Fail	Pass
95	16	Fail	Pass	Fail	Pass
95	26	Fail	Pass	Fail	Pass
95	30	Fail	Pass	Fail	Pass
96	13	Fail	Pass	Fail	Pass
96	14	Fail	Pass	Fail	Pass
96	15	Fail	Pass	Fail	Pass
96	26	Fail	Pass	Fail	Pass
96	30	Fail	Pass	Fail	Pass
97	13	Fail	Pass	Fail	Pass
97	14	Fail	Pass	Fail	Pass

97	15	Fail	Pass	Fail	Pass
97	26	Fail	Pass	Fail	Pass
97	30	Fail	Pass	Fail	Pass
98	13	Fail	Pass	Fail	Pass
98	14	Fail	Pass	Fail	Pass
98	15	Fail	Pass	Fail	Pass
98	26	Fail	Pass	Fail	Pass
98	27	Fail	Pass	Fail	Pass
98	28	Fail	Pass	Fail	Pass
98	29	Fail	Pass	Fail	Pass
98	30	Fail	Pass	Fail	Pass
99	13	Fail	Pass	Fail	Pass
99	14	Fail	Pass	Fail	Pass
99	15	Fail	Pass	Fail	Pass
99	16	Fail	Pass	Fail	Pass
99	17	Fail	Pass	Fail	Pass
99	18	Fail	Pass	Fail	Pass
99	19	Fail	Pass	Fail	Pass
99	20	Fail	Pass	Fail	Pass
99	21	Fail	Pass	Fail	Pass
99	22	Fail	Pass	Fail	Pass
99	23	Fail	Pass	Fail	Pass
99	26	Fail	Pass	Fail	Pass
99	30	Fail	Pass	Fail	Pass
100	13	Fail	Pass	Fail	Pass
100	14	Fail	Pass	Fail	Pass
100	15	Fail	Pass	Fail	Pass
100	23	Fail	Pass	Fail	Pass
100	24	Fail	Pass	Fail	Pass
100	25	Fail	Pass	Fail	Pass
100	26	Fail	Pass	Fail	Pass
100	30	Fail	Pass	Fail	Pass
101	13	Fail	Pass	Fail	Pass
101	14	Fail	Pass	Fail	Pass
101	15	Fail	Pass	Fail	Pass
101	16	Fail	Pass	Fail	Pass
101	17	Fail	Pass	Fail	Pass
101	18	Fail	Pass	Fail	Pass
101	19	Fail	Pass	Fail	Pass
101	20	Fail	Pass	Fail	Pass
101	21	Fail	Pass	Fail	Pass
101	22	Fail	Pass	Fail	Pass
101	23	Fail	Pass	Fail	Pass
101	26	Fail	Pass	Fail	Pass
101	30	Fail	Pass	Fail	Pass
102	13	Fail	Pass	Fail	Pass
102	14	Fail	Pass	Fail	Pass
102	15	Fail	Pass	Fail	Pass
102	26	Fail	Pass	Fail	Pass
102	30	Fail	Pass	Fail	Pass
103	13	Fail	Pass	Fail	Pass
103	14	Fail	Pass	Fail	Pass
103	15	Fail	Pass	Fail	Pass
103	26	Fail	Pass	Fail	Pass
103	30	Fail	Pass	Fail	Pass
104	13	Fail	Pass	Fail	Pass
104	14	Fail	Pass	Fail	Pass

104	15	Fail	Pass	Fail	Pass
104	26	Fail	Pass	Fail	Pass
104	30	Fail	Pass	Fail	Pass
105	13	Fail	Pass	Fail	Pass
105	14	Fail	Pass	Fail	Pass
105	15	Fail	Pass	Fail	Pass
105	26	Fail	Pass	Fail	Pass
105	30	Fail	Pass	Fail	Pass
106	13	Fail	Pass	Fail	Pass
106	14	Fail	Pass	Fail	Pass
106	15	Fail	Pass	Fail	Pass
106	26	Fail	Pass	Fail	Pass
106	27	Fail	Pass	Fail	Pass
106	30	Fail	Pass	Fail	Pass
106	39	Fail	Pass	Fail	Pass
107	13	Fail	Pass	Fail	Pass
107	14	Fail	Pass	Fail	Pass
107	15	Fail	Pass	Fail	Pass
107	22	Fail	Pass	Fail	Pass
107	26	Fail	Pass	Fail	Pass
107	30	Fail	Pass	Fail	Pass
107	39	Fail	Pass	Fail	Pass
108	13	Fail	Pass	Fail	Pass
108	14	Fail	Pass	Fail	Pass
108	15	Fail	Pass	Fail	Pass
108	22	Fail	Pass	Fail	Pass
108	26	Fail	Pass	Fail	Pass
108	30	Fail	Pass	Fail	Pass
108	39	Fail	Pass	Fail	Pass
109	13	Fail	Pass	Fail	Pass
109	14	Fail	Pass	Fail	Pass
109	15	Fail	Pass	Fail	Pass
109	22	Fail	Pass	Fail	Pass
109	26	Fail	Pass	Fail	Pass
109	30	Fail	Pass	Fail	Pass
109	39	Fail	Pass	Fail	Pass
110	13	Fail	Pass	Fail	Pass
110	14	Fail	Pass	Fail	Pass
110	15	Fail	Pass	Fail	Pass
110	22	Fail	Pass	Fail	Pass
110	26	Fail	Pass	Fail	Pass
110	39	Fail	Pass	Fail	Pass
111	13	Fail	Pass	Fail	Pass
111	14	Fail	Pass	Fail	Pass
111	15	Fail	Pass	Fail	Pass
111	22	Fail	Pass	Fail	Pass
111	26	Fail	Pass	Fail	Pass
111	39	Fail	Pass	Fail	Pass
112	13	Fail	Pass	Fail	Pass
112	14	Fail	Pass	Fail	Pass
112	15	Fail	Pass	Fail	Pass
112	22	Fail	Pass	Fail	Pass
112	26	Fail	Pass	Fail	Pass
112	39	Fail	Pass	Fail	Pass
113	13	Fail	Pass	Fail	Pass
113	14	Fail	Pass	Fail	Pass
113	15	Fail	Pass	Fail	Pass

113	26	Fail	Pass	Fail	Pass
113	27	Fail	Pass	Fail	Pass
113	39	Fail	Pass	Fail	Pass
114	13	Fail	Pass	Fail	Pass
114	14	Fail	Pass	Fail	Pass
114	15	Fail	Pass	Fail	Pass
114	26	Fail	Pass	Fail	Pass
114	39	Fail	Pass	Fail	Pass
115	13	Fail	Pass	Fail	Pass
115	14	Fail	Pass	Fail	Pass
115	15	Fail	Pass	Fail	Pass
115	26	Fail	Pass	Fail	Pass
115	39	Fail	Pass	Fail	Pass
116	13	Fail	Pass	Fail	Pass
116	14	Fail	Pass	Fail	Pass
116	15	Fail	Pass	Fail	Pass
116	26	Fail	Pass	Fail	Pass
116	39	Fail	Pass	Fail	Pass
117	13	Fail	Pass	Fail	Pass
117	14	Fail	Pass	Fail	Pass
117	15	Fail	Pass	Fail	Pass
117	26	Fail	Pass	Fail	Pass
117	39	Fail	Pass	Fail	Pass
118	13	Fail	Pass	Fail	Pass
118	14	Fail	Pass	Fail	Pass
118	15	Fail	Pass	Fail	Pass
118	20	Fail	Pass	Fail	Pass
118	26	Fail	Pass	Fail	Pass
118	39	Fail	Pass	Fail	Pass
119	13	Fail	Pass	Fail	Pass
119	14	Fail	Pass	Fail	Pass
119	15	Fail	Pass	Fail	Pass
119	20	Fail	Pass	Fail	Pass
119	26	Fail	Pass	Fail	Pass
119	39	Fail	Pass	Fail	Pass
120	13	Fail	Pass	Fail	Pass
120	14	Fail	Pass	Fail	Pass
120	15	Fail	Pass	Fail	Pass
120	16	Fail	Pass	Fail	Pass
120	26	Fail	Pass	Fail	Pass
120	39	Fail	Pass	Fail	Pass
121	13	Fail	Pass	Fail	Pass
121	14	Fail	Pass	Fail	Pass
121	26	Fail	Pass	Fail	Pass
121	39	Fail	Pass	Fail	Pass
122	13	Fail	Pass	Fail	Pass
122	14	Fail	Pass	Fail	Pass
122	26	Fail	Pass	Fail	Pass
122	39	Fail	Pass	Fail	Pass
123	13	Fail	Pass	Fail	Pass
123	14	Fail	Pass	Fail	Pass
123	15	Fail	Pass	Fail	Pass
123	16	Fail	Pass	Fail	Pass
123	17	Fail	Pass	Fail	Pass
123	18	Fail	Pass	Fail	Pass
123	19	Fail	Pass	Fail	Pass
123	20	Fail	Pass	Fail	Pass

123	21	Fail	Pass	Fail	Pass
123	22	Fail	Pass	Fail	Pass
123	23	Fail	Pass	Fail	Pass
123	24	Fail	Pass	Fail	Pass
123	25	Fail	Pass	Fail	Pass
123	26	Fail	Pass	Fail	Pass
123	27	Fail	Pass	Fail	Pass
123	28	Fail	Pass	Fail	Pass
123	29	Fail	Pass	Fail	Pass
123	30	Fail	Pass	Fail	Pass
123	31	Fail	Pass	Fail	Pass
123	32	Fail	Pass	Fail	Pass
123	33	Fail	Pass	Fail	Pass
123	34	Fail	Pass	Fail	Pass
123	35	Fail	Pass	Fail	Pass
123	36	Fail	Pass	Fail	Pass
123	37	Fail	Pass	Fail	Pass
123	38	Fail	Pass	Fail	Pass
123	39	Fail	Pass	Fail	Pass
124	13	Fail	Pass	Fail	Pass
124	14	Fail	Pass	Fail	Pass
124	23	Fail	Pass	Fail	Pass
125	13	Fail	Pass	Fail	Pass
125	14	Fail	Pass	Fail	Pass
125	23	Fail	Pass	Fail	Pass
126	13	Fail	Pass	Fail	Pass
126	14	Fail	Pass	Fail	Pass
126	23	Fail	Pass	Fail	Pass
127	13	Fail	Pass	Fail	Pass
127	14	Fail	Pass	Fail	Pass
127	23	Fail	Pass	Fail	Pass
128	13	Fail	Pass	Fail	Pass
128	14	Fail	Pass	Fail	Pass
128	23	Fail	Pass	Fail	Pass
129	13	Fail	Pass	Fail	Pass
129	14	Fail	Pass	Fail	Pass
129	23	Fail	Pass	Fail	Pass
130	8	Fail	Fail	Fail	Fail
130	9	Fail	Pass	Fail	Pass
130	10	Fail	Pass	Fail	Pass
130	11	Fail	Pass	Fail	Pass
130	12	Fail	Pass	Fail	Pass
130	13	Fail	Pass	Fail	Pass
130	14	Fail	Pass	Fail	Pass
130	23	Fail	Pass	Fail	Pass
131	14	Fail	Pass	Fail	Pass
131	23	Fail	Pass	Fail	Pass
132	14	Fail	Pass	Fail	Pass
132	23	Fail	Pass	Fail	Pass
133	14	Fail	Pass	Fail	Pass
133	23	Fail	Pass	Fail	Pass
134	14	Fail	Pass	Fail	Pass
134	23	Fail	Pass	Fail	Pass
135	14	Fail	Pass	Fail	Pass
136	14	Fail	Pass	Fail	Pass
137	14	Fail	Pass	Fail	Pass
138	14	Fail	Pass	Fail	Pass

3. Table H.7.3 Striped Bass Larvae salinity and D.O. criteria passing for existing and deepening (3 ft) scenarios within the analyzed period May 1 - May 31, 1997

HABITAT REQUIREMENTS:
RM 10-31; Depth Average
D.O. May (MG/L):10th %ile >=4.5
Salinity 50th %ile >=3 & <= 9 ppt

Savannah Harbor Estuary

Segments		Baseline Scenario		Project Scenario	
J	I	Salinity	D.O.	Salinity	D.O.
47	13	Pass	Pass	Pass	Pass
47	14	Fail	Pass	Fail	Pass
47	15	Pass	Pass	Fail	Pass
47	16	Pass	Pass	Pass	Pass
47	17	Pass	Pass	Pass	Pass
48	13	Pass	Pass	Fail	Pass
48	14	Fail	Pass	Fail	Pass
48	15	Pass	Pass	Fail	Pass
48	16	Pass	Pass	Fail	Pass
48	17	Pass	Pass	Pass	Pass
49	13	Pass	Pass	Pass	Pass
49	14	Fail	Pass	Fail	Pass
49	15	Pass	Pass	Pass	Pass
49	16	Pass	Pass	Fail	Pass
49	17	Pass	Pass	Pass	Pass
50	13	Pass	Pass	Pass	Pass
50	14	Fail	Pass	Fail	Pass
50	15	Fail	Pass	Fail	Pass
50	16	Fail	Pass	Fail	Pass
50	17	Pass	Pass	Fail	Pass
50	18	Pass	Pass	Pass	Pass
51	13	Pass	Pass	Pass	Pass
51	14	Fail	Pass	Fail	Pass
51	15	Pass	Pass	Pass	Pass
52	13	Pass	Pass	Pass	Pass
52	14	Fail	Pass	Fail	Pass
52	15	Pass	Pass	Pass	Pass
53	13	Pass	Pass	Pass	Pass
53	14	Fail	Pass	Fail	Pass
53	15	Pass	Pass	Pass	Pass
54	13	Pass	Pass	Pass	Pass
54	14	Pass	Pass	Fail	Pass
54	15	Pass	Pass	Pass	Pass
55	13	Pass	Pass	Pass	Pass
55	14	Pass	Pass	Fail	Pass
55	15	Pass	Pass	Pass	Pass
56	13	Pass	Pass	Pass	Pass
56	14	Pass	Pass	Fail	Pass
56	15	Pass	Pass	Pass	Pass
57	13	Pass	Pass	Pass	Pass
57	14	Pass	Pass	Fail	Pass

57	15	Pass	Pass	Pass	Pass
58	13	Pass	Pass	Pass	Pass
58	14	Pass	Pass	Pass	Pass
58	15	Fail	Pass	Pass	Pass
59	13	Pass	Pass	Pass	Pass
59	14	Pass	Pass	Pass	Pass
59	15	Fail	Pass	Pass	Pass
59	30	Pass	Pass	Pass	Pass
59	31	Pass	Pass	Fail	Pass
59	32	Pass	Pass	Pass	Pass
60	13	Fail	Pass	Pass	Pass
60	14	Pass	Pass	Pass	Pass
60	15	Fail	Pass	Pass	Pass
60	30	Pass	Pass	Pass	Pass
60	31	Pass	Pass	Fail	Pass
60	32	Pass	Pass	Pass	Pass
61	13	Fail	Pass	Pass	Pass
61	14	Pass	Pass	Pass	Pass
61	15	Fail	Pass	Fail	Pass
61	30	Pass	Pass	Pass	Pass
61	31	Pass	Fail	Fail	Pass
61	32	Pass	Pass	Pass	Pass
62	13	Fail	Pass	Pass	Pass
62	14	Pass	Pass	Pass	Pass
62	15	Fail	Pass	Fail	Pass
62	30	Pass	Pass	Pass	Pass
62	31	Pass	Fail	Pass	Fail
62	32	Pass	Pass	Pass	Pass
63	13	Fail	Pass	Pass	Pass
63	14	Pass	Pass	Pass	Pass
63	15	Fail	Pass	Fail	Pass
63	31	Pass	Fail	Pass	Fail
64	13	Fail	Pass	Pass	Pass
64	14	Pass	Pass	Pass	Pass
64	15	Fail	Pass	Fail	Pass
64	30	Pass	Fail	Pass	Fail
64	31	Pass	Fail	Pass	Fail
64	32	Pass	Fail	Pass	Fail
65	13	Fail	Pass	Fail	Pass
65	14	Pass	Pass	Pass	Pass
65	15	Fail	Pass	Fail	Pass
65	30	Pass	Fail	Pass	Fail
65	31	Pass	Fail	Pass	Fail
65	32	Pass	Fail	Pass	Fail
65	33	Pass	Fail	Pass	Fail
66	13	Fail	Pass	Fail	Pass
66	14	Fail	Pass	Pass	Pass
66	15	Fail	Pass	Fail	Pass
66	30	Pass	Fail	Pass	Fail
66	31	Pass	Fail	Pass	Fail
66	32	Pass	Fail	Pass	Fail
66	36	Pass	Fail	Pass	Fail
67	13	Fail	Pass	Fail	Pass
67	14	Fail	Pass	Pass	Pass
67	15	Fail	Pass	Fail	Pass
67	30	Pass	Fail	Pass	Fail
67	31	Pass	Fail	Pass	Fail

67	32	Pass	Fail	Pass	Pass
67	36	Pass	Fail	Pass	Fail
68	13	Fail	Pass	Fail	Pass
68	14	Fail	Pass	Pass	Pass
68	15	Fail	Pass	Fail	Pass
68	30	Pass	Fail	Pass	Fail
68	31	Pass	Fail	Pass	Fail
68	32	Pass	Fail	Pass	Fail
68	36	Pass	Fail	Pass	Fail
69	13	Fail	Pass	Fail	Pass
69	14	Fail	Pass	Pass	Pass
69	15	Fail	Pass	Fail	Pass
69	30	Pass	Fail	Pass	Fail
69	31	Pass	Fail	Pass	Fail
69	32	Pass	Fail	Pass	Fail
69	36	Pass	Fail	Pass	Fail
70	13	Fail	Pass	Fail	Pass
70	14	Fail	Pass	Pass	Pass
70	15	Fail	Pass	Fail	Pass
70	30	Pass	Fail	Pass	Fail
70	31	Pass	Fail	Pass	Fail
70	32	Pass	Fail	Pass	Fail
70	33	Pass	Fail	Pass	Fail
71	13	Fail	Pass	Fail	Pass
71	14	Fail	Pass	Pass	Pass
71	15	Fail	Pass	Fail	Pass
71	30	Pass	Fail	Pass	Fail
71	31	Pass	Fail	Pass	Fail
71	32	Pass	Fail	Pass	Fail
72	13	Fail	Pass	Fail	Pass
72	14	Fail	Pass	Pass	Pass
72	15	Fail	Pass	Fail	Pass
72	30	Pass	Fail	Pass	Fail
72	31	Pass	Fail	Pass	Fail
72	32	Pass	Fail	Pass	Fail
73	13	Fail	Pass	Fail	Pass
73	14	Fail	Pass	Pass	Pass
73	15	Fail	Pass	Fail	Pass
73	30	Pass	Fail	Pass	Fail
73	31	Pass	Fail	Pass	Fail
74	13	Fail	Pass	Fail	Pass
74	14	Fail	Pass	Pass	Pass
74	15	Fail	Pass	Fail	Pass
74	30	Fail	Fail	Pass	Fail
74	31	Pass	Fail	Pass	Fail
75	13	Fail	Pass	Fail	Pass
75	14	Fail	Pass	Fail	Pass
75	15	Fail	Pass	Fail	Pass
75	30	Fail	Fail	Fail	Fail
75	31	Fail	Fail	Pass	Fail
76	13	Fail	Pass	Fail	Pass
76	14	Fail	Pass	Fail	Pass
76	15	Fail	Pass	Fail	Pass
76	16	Fail	Pass	Fail	Pass
76	17	Fail	Pass	Fail	Pass
76	30	Fail	Fail	Fail	Fail
76	31	Fail	Fail	Pass	Fail

77	13	Fail	Pass	Fail	Pass
77	14	Fail	Pass	Fail	Pass
77	15	Fail	Pass	Fail	Pass
77	16	Fail	Pass	Fail	Pass
77	17	Fail	Pass	Fail	Pass
77	30	Fail	Fail	Fail	Fail
77	31	Fail	Pass	Fail	Pass
78	13	Fail	Pass	Fail	Pass
78	14	Fail	Pass	Fail	Pass
78	15	Fail	Pass	Fail	Pass
78	16	Fail	Pass	Fail	Pass
78	17	Fail	Pass	Fail	Pass
78	30	Fail	Fail	Fail	Fail
78	31	Fail	Pass	Fail	Pass
79	13	Fail	Pass	Fail	Pass
79	14	Fail	Pass	Fail	Pass
79	15	Fail	Pass	Fail	Pass
79	30	Fail	Fail	Fail	Fail
79	31	Fail	Pass	Fail	Pass
80	13	Fail	Pass	Fail	Pass
80	14	Fail	Pass	Fail	Pass
80	15	Fail	Pass	Fail	Pass
80	30	Fail	Fail	Fail	Fail
80	31	Fail	Pass	Fail	Pass
81	13	Fail	Pass	Fail	Pass
81	14	Fail	Pass	Fail	Pass
81	15	Fail	Pass	Fail	Pass
81	30	Fail	Fail	Fail	Fail
81	31	Fail	Pass	Fail	Pass
82	13	Fail	Pass	Fail	Pass
82	14	Fail	Pass	Fail	Pass
82	15	Fail	Pass	Fail	Pass
82	16	Fail	Pass	Fail	Pass
82	17	Fail	Pass	Fail	Pass
82	18	Fail	Pass	Fail	Pass
82	19	Fail	Pass	Fail	Pass
82	20	Fail	Pass	Fail	Pass
82	21	Fail	Pass	Fail	Pass
82	29	Fail	Fail	Fail	Fail
82	30	Fail	Pass	Fail	Fail
82	31	Fail	Pass	Fail	Pass
83	13	Fail	Pass	Fail	Pass
83	14	Fail	Pass	Fail	Pass
83	15	Fail	Pass	Fail	Pass
83	21	Fail	Pass	Fail	Pass
83	30	Fail	Pass	Fail	Pass
83	31	Fail	Pass	Fail	Pass
84	13	Fail	Pass	Fail	Pass
84	14	Fail	Pass	Fail	Pass
84	15	Fail	Pass	Fail	Pass
84	21	Fail	Pass	Fail	Pass
84	30	Fail	Pass	Fail	Pass
84	31	Fail	Pass	Fail	Pass
85	13	Fail	Pass	Fail	Pass
85	14	Fail	Pass	Fail	Pass
85	15	Fail	Pass	Fail	Pass
85	21	Fail	Pass	Fail	Pass

85	30	Fail	Pass	Fail	Pass
86	13	Fail	Pass	Fail	Pass
86	14	Fail	Pass	Fail	Pass
86	15	Fail	Pass	Fail	Pass
86	21	Fail	Pass	Fail	Pass
86	30	Fail	Pass	Fail	Pass
87	13	Fail	Pass	Fail	Pass
87	14	Fail	Pass	Fail	Pass
87	15	Fail	Pass	Fail	Pass
87	30	Fail	Pass	Fail	Pass
88	13	Fail	Pass	Fail	Pass
88	14	Fail	Pass	Fail	Pass
88	15	Fail	Pass	Fail	Pass
88	30	Fail	Pass	Fail	Pass
89	13	Fail	Pass	Fail	Pass
89	14	Fail	Pass	Fail	Pass
89	15	Fail	Pass	Fail	Pass
89	30	Fail	Pass	Fail	Pass
90	13	Fail	Pass	Fail	Pass
90	14	Fail	Pass	Fail	Pass
90	15	Fail	Pass	Fail	Pass
90	30	Fail	Pass	Fail	Pass
91	13	Fail	Pass	Fail	Pass
91	14	Fail	Pass	Fail	Pass
91	15	Fail	Pass	Fail	Pass
91	16	Fail	Pass	Fail	Pass
91	30	Fail	Pass	Fail	Pass
92	13	Fail	Pass	Fail	Pass
92	14	Fail	Pass	Fail	Pass
92	15	Fail	Pass	Fail	Pass
92	16	Fail	Pass	Fail	Pass
92	30	Fail	Pass	Fail	Pass
93	13	Fail	Pass	Fail	Pass
93	14	Fail	Pass	Fail	Pass
93	15	Fail	Pass	Fail	Pass
93	16	Fail	Pass	Fail	Pass
93	30	Fail	Pass	Fail	Pass
94	13	Fail	Pass	Fail	Pass
94	14	Fail	Pass	Fail	Pass
94	15	Fail	Pass	Fail	Pass
94	16	Fail	Pass	Fail	Pass
94	26	Fail	Pass	Fail	Pass
94	30	Fail	Pass	Fail	Pass
95	13	Fail	Pass	Fail	Pass
95	14	Fail	Pass	Fail	Pass
95	15	Fail	Pass	Fail	Pass
95	16	Fail	Pass	Fail	Pass
95	26	Fail	Pass	Fail	Pass
95	30	Fail	Pass	Fail	Pass
96	13	Fail	Pass	Fail	Pass
96	14	Fail	Pass	Fail	Pass
96	15	Fail	Pass	Fail	Pass
96	26	Fail	Pass	Fail	Pass
96	30	Fail	Pass	Fail	Pass
97	13	Fail	Pass	Fail	Pass
97	14	Fail	Pass	Fail	Pass
97	15	Fail	Pass	Fail	Pass

97	26	Fail	Pass	Fail	Pass
97	30	Fail	Pass	Fail	Pass
98	13	Fail	Pass	Fail	Pass
98	14	Fail	Pass	Fail	Pass
98	15	Fail	Pass	Fail	Pass
98	26	Fail	Pass	Fail	Pass
98	27	Fail	Pass	Fail	Pass
98	28	Fail	Pass	Fail	Pass
98	29	Fail	Pass	Fail	Pass
98	30	Fail	Pass	Fail	Pass
99	13	Fail	Pass	Fail	Pass
99	14	Fail	Pass	Fail	Pass
99	15	Fail	Pass	Fail	Pass
99	16	Fail	Pass	Fail	Pass
99	17	Fail	Pass	Fail	Pass
99	18	Fail	Pass	Fail	Pass
99	19	Fail	Pass	Fail	Pass
99	20	Fail	Pass	Fail	Pass
99	21	Fail	Pass	Fail	Pass
99	22	Fail	Pass	Fail	Pass
99	23	Fail	Pass	Fail	Pass
99	26	Fail	Pass	Fail	Pass
99	30	Fail	Pass	Fail	Pass
100	13	Fail	Pass	Fail	Pass
100	14	Fail	Pass	Fail	Pass
100	15	Fail	Pass	Fail	Pass
100	23	Fail	Pass	Fail	Pass
100	24	Fail	Pass	Fail	Pass
100	25	Fail	Pass	Fail	Pass
100	26	Fail	Pass	Fail	Pass
100	30	Fail	Pass	Fail	Pass
101	13	Fail	Pass	Fail	Pass
101	14	Fail	Pass	Fail	Pass
101	15	Fail	Pass	Fail	Pass
101	16	Fail	Pass	Fail	Pass
101	17	Fail	Pass	Fail	Pass
101	18	Fail	Pass	Fail	Pass
101	19	Fail	Pass	Fail	Pass
101	20	Fail	Pass	Fail	Pass
101	21	Fail	Pass	Fail	Pass
101	22	Fail	Pass	Fail	Pass
101	23	Fail	Pass	Fail	Pass
101	26	Fail	Pass	Fail	Pass
101	30	Fail	Pass	Fail	Pass
102	13	Fail	Pass	Fail	Pass
102	14	Fail	Pass	Fail	Pass
102	15	Fail	Pass	Fail	Pass
102	26	Fail	Pass	Fail	Pass
102	30	Fail	Pass	Fail	Pass
103	13	Fail	Pass	Fail	Pass
103	14	Fail	Pass	Fail	Pass
103	15	Fail	Pass	Fail	Pass
103	26	Fail	Pass	Fail	Pass
103	30	Fail	Pass	Fail	Pass
104	13	Fail	Pass	Fail	Pass
104	14	Fail	Pass	Fail	Pass
104	15	Fail	Pass	Fail	Pass

104	26	Fail	Pass	Fail	Pass
104	30	Fail	Pass	Fail	Pass
105	13	Fail	Pass	Fail	Pass
105	14	Fail	Pass	Fail	Pass
105	15	Fail	Pass	Fail	Pass
105	26	Fail	Pass	Fail	Pass
105	30	Fail	Pass	Fail	Pass
106	13	Fail	Pass	Fail	Pass
106	14	Fail	Pass	Fail	Pass
106	15	Fail	Pass	Fail	Pass
106	26	Fail	Pass	Fail	Pass
106	27	Fail	Pass	Fail	Pass
106	30	Fail	Pass	Fail	Pass
106	39	Fail	Pass	Fail	Pass
107	13	Fail	Pass	Fail	Pass
107	14	Fail	Pass	Fail	Pass
107	15	Fail	Pass	Fail	Pass
107	22	Fail	Pass	Fail	Pass
107	26	Fail	Pass	Fail	Pass
107	30	Fail	Pass	Fail	Pass
107	39	Fail	Pass	Fail	Pass
108	13	Fail	Pass	Fail	Pass
108	14	Fail	Pass	Fail	Pass
108	15	Fail	Pass	Fail	Pass
108	22	Fail	Pass	Fail	Pass
108	26	Fail	Pass	Fail	Pass
108	30	Fail	Pass	Fail	Pass
108	39	Fail	Pass	Fail	Pass
109	13	Fail	Pass	Fail	Pass
109	14	Fail	Pass	Fail	Pass
109	15	Fail	Pass	Fail	Pass
109	22	Fail	Pass	Fail	Pass
109	26	Fail	Pass	Fail	Pass
109	30	Fail	Pass	Fail	Pass
109	39	Fail	Pass	Fail	Pass
110	13	Fail	Pass	Fail	Pass
110	14	Fail	Pass	Fail	Pass
110	15	Fail	Pass	Fail	Pass
110	22	Fail	Pass	Fail	Pass
110	26	Fail	Pass	Fail	Pass
110	39	Fail	Pass	Fail	Pass
111	13	Fail	Pass	Fail	Pass
111	14	Fail	Pass	Fail	Pass
111	15	Fail	Pass	Fail	Pass
111	22	Fail	Pass	Fail	Pass
111	26	Fail	Pass	Fail	Pass
111	39	Fail	Pass	Fail	Pass
112	13	Fail	Pass	Fail	Pass
112	14	Fail	Pass	Fail	Pass
112	15	Fail	Pass	Fail	Pass
112	22	Fail	Pass	Fail	Pass
112	26	Fail	Pass	Fail	Pass
112	39	Fail	Pass	Fail	Pass
113	13	Fail	Pass	Fail	Pass
113	14	Fail	Pass	Fail	Pass
113	15	Fail	Pass	Fail	Pass
113	26	Fail	Pass	Fail	Pass

113	27	Fail	Pass	Fail	Pass
113	39	Fail	Pass	Fail	Pass
114	13	Fail	Pass	Fail	Pass
114	14	Fail	Pass	Fail	Pass
114	15	Fail	Pass	Fail	Pass
114	26	Fail	Pass	Fail	Pass
114	39	Fail	Pass	Fail	Pass
115	13	Fail	Pass	Fail	Pass
115	14	Fail	Pass	Fail	Pass
115	15	Fail	Pass	Fail	Pass
115	26	Fail	Pass	Fail	Pass
115	39	Fail	Pass	Fail	Pass
116	13	Fail	Pass	Fail	Pass
116	14	Fail	Pass	Fail	Pass
116	15	Fail	Pass	Fail	Pass
116	26	Fail	Pass	Fail	Pass
116	39	Fail	Pass	Fail	Pass
117	13	Fail	Pass	Fail	Pass
117	14	Fail	Pass	Fail	Pass
117	15	Fail	Pass	Fail	Pass
117	26	Fail	Pass	Fail	Pass
117	39	Fail	Pass	Fail	Pass
118	13	Fail	Pass	Fail	Pass
118	14	Fail	Pass	Fail	Pass
118	15	Fail	Pass	Fail	Pass
118	20	Fail	Pass	Fail	Pass
118	26	Fail	Pass	Fail	Pass
118	39	Fail	Pass	Fail	Pass
119	13	Fail	Pass	Fail	Pass
119	14	Fail	Pass	Fail	Pass
119	15	Fail	Pass	Fail	Pass
119	20	Fail	Pass	Fail	Pass
119	26	Fail	Pass	Fail	Pass
119	39	Fail	Pass	Fail	Pass
120	13	Fail	Pass	Fail	Pass
120	14	Fail	Pass	Fail	Pass
120	15	Fail	Pass	Fail	Pass
120	16	Fail	Pass	Fail	Pass
120	26	Fail	Pass	Fail	Pass
120	39	Fail	Pass	Fail	Pass
121	13	Fail	Pass	Fail	Pass
121	14	Fail	Pass	Fail	Pass
121	26	Fail	Pass	Fail	Pass
121	39	Fail	Pass	Fail	Pass
122	13	Fail	Pass	Fail	Pass
122	14	Fail	Pass	Fail	Pass
122	26	Fail	Pass	Fail	Pass
122	39	Fail	Pass	Fail	Pass
123	13	Fail	Pass	Fail	Pass
123	14	Fail	Pass	Fail	Pass
123	15	Fail	Pass	Fail	Pass
123	16	Fail	Pass	Fail	Pass
123	17	Fail	Pass	Fail	Pass
123	18	Fail	Pass	Fail	Pass
123	19	Fail	Pass	Fail	Pass
123	20	Fail	Pass	Fail	Pass
123	21	Fail	Pass	Fail	Pass

123	22	Fail	Pass	Fail	Pass
123	23	Fail	Pass	Fail	Pass
123	24	Fail	Pass	Fail	Pass
123	25	Fail	Pass	Fail	Pass
123	26	Fail	Pass	Fail	Pass
123	27	Fail	Pass	Fail	Pass
123	28	Fail	Pass	Fail	Pass
123	29	Fail	Pass	Fail	Pass
123	30	Fail	Pass	Fail	Pass
123	31	Fail	Pass	Fail	Pass
123	32	Fail	Pass	Fail	Pass
123	33	Fail	Pass	Fail	Pass
123	34	Fail	Pass	Fail	Pass
123	35	Fail	Pass	Fail	Pass
123	36	Fail	Pass	Fail	Pass
123	37	Fail	Pass	Fail	Pass
123	38	Fail	Pass	Fail	Pass
123	39	Fail	Pass	Fail	Pass
124	13	Fail	Pass	Fail	Pass
124	14	Fail	Pass	Fail	Pass
124	23	Fail	Pass	Fail	Pass
125	13	Fail	Pass	Fail	Pass
125	14	Fail	Pass	Fail	Pass
125	23	Fail	Pass	Fail	Pass
126	13	Fail	Pass	Fail	Pass
126	14	Fail	Pass	Fail	Pass
126	23	Fail	Pass	Fail	Pass
127	13	Fail	Pass	Fail	Pass
127	14	Fail	Pass	Fail	Pass
127	23	Fail	Pass	Fail	Pass
128	13	Fail	Pass	Fail	Pass
128	14	Fail	Pass	Fail	Pass
128	23	Fail	Pass	Fail	Pass
129	13	Fail	Pass	Fail	Pass
129	14	Fail	Pass	Fail	Pass
129	23	Fail	Pass	Fail	Pass
130	8	Fail	Fail	Fail	Fail
130	9	Fail	Pass	Fail	Pass
130	10	Fail	Pass	Fail	Pass
130	11	Fail	Pass	Fail	Pass
130	12	Fail	Pass	Fail	Pass
130	13	Fail	Pass	Fail	Pass
130	14	Fail	Pass	Fail	Pass
130	23	Fail	Pass	Fail	Pass
131	14	Fail	Pass	Fail	Pass
131	23	Fail	Pass	Fail	Pass
132	14	Fail	Pass	Fail	Pass
132	23	Fail	Pass	Fail	Pass
133	14	Fail	Pass	Fail	Pass
133	23	Fail	Pass	Fail	Pass
134	14	Fail	Pass	Fail	Pass
134	23	Fail	Pass	Fail	Pass
135	14	Fail	Pass	Fail	Pass
136	14	Fail	Pass	Fail	Pass
137	14	Fail	Pass	Fail	Pass
138	14	Fail	Pass	Fail	Pass

4. Table H.7.4 Striped Bass Larvae salinity and D.O. criteria passing for existing and deepening (2 ft) scenarios within the analyzed period May 1 - May 31, 1997

HABITAT REQUIREMENTS:
RM 10-31; Depth Average
D.O. May (MG/L):10th %ile >=4.5
Salinity 50th %ile >=3 & <= 9 ppt

Savannah Harbor Estuary

Segments		Baseline Scenario		Project Scenario	
J	I	Salinity	D.O.	Salinity	D.O.
47	13	Pass	Pass	Pass	Pass
47	14	Fail	Pass	Fail	Pass
47	15	Pass	Pass	Pass	Pass
47	16	Pass	Pass	Pass	Pass
47	17	Pass	Pass	Pass	Pass
48	13	Pass	Pass	Pass	Pass
48	14	Fail	Pass	Fail	Pass
48	15	Pass	Pass	Pass	Pass
48	16	Pass	Pass	Fail	Pass
48	17	Pass	Pass	Pass	Pass
49	13	Pass	Pass	Pass	Pass
49	14	Fail	Pass	Fail	Pass
49	15	Pass	Pass	Pass	Pass
49	16	Pass	Pass	Fail	Pass
49	17	Pass	Pass	Pass	Pass
50	13	Pass	Pass	Pass	Pass
50	14	Fail	Pass	Fail	Pass
50	15	Fail	Pass	Fail	Pass
50	16	Fail	Pass	Fail	Pass
50	17	Pass	Pass	Fail	Pass
50	18	Pass	Pass	Pass	Pass
51	13	Pass	Pass	Pass	Pass
51	14	Fail	Pass	Fail	Pass
51	15	Pass	Pass	Pass	Pass
52	13	Pass	Pass	Pass	Pass
52	14	Fail	Pass	Fail	Pass
52	15	Pass	Pass	Pass	Pass
53	13	Pass	Pass	Pass	Pass
53	14	Fail	Pass	Fail	Pass
53	15	Pass	Pass	Pass	Pass
54	13	Pass	Pass	Pass	Pass
54	14	Pass	Pass	Fail	Pass
54	15	Pass	Pass	Pass	Pass
55	13	Pass	Pass	Pass	Pass
55	14	Pass	Pass	Fail	Pass
55	15	Pass	Pass	Pass	Pass
56	13	Pass	Pass	Pass	Pass
56	14	Pass	Pass	Fail	Pass
56	15	Pass	Pass	Pass	Pass
57	13	Pass	Pass	Pass	Pass
57	14	Pass	Pass	Pass	Pass

57	15	Pass	Pass	Pass	Pass
58	13	Pass	Pass	Pass	Pass
58	14	Pass	Pass	Pass	Pass
58	15	Fail	Pass	Pass	Pass
59	13	Pass	Pass	Pass	Pass
59	14	Pass	Pass	Pass	Pass
59	15	Fail	Pass	Pass	Pass
59	30	Pass	Pass	Pass	Pass
59	31	Pass	Pass	Fail	Pass
59	32	Pass	Pass	Pass	Pass
60	13	Fail	Pass	Pass	Pass
60	14	Pass	Pass	Pass	Pass
60	15	Fail	Pass	Fail	Pass
60	30	Pass	Pass	Pass	Pass
60	31	Pass	Pass	Fail	Pass
60	32	Pass	Pass	Pass	Pass
61	13	Fail	Pass	Pass	Pass
61	14	Pass	Pass	Pass	Pass
61	15	Fail	Pass	Fail	Pass
61	30	Pass	Pass	Pass	Pass
61	31	Pass	Fail	Pass	Pass
61	32	Pass	Pass	Pass	Pass
62	13	Fail	Pass	Fail	Pass
62	14	Pass	Pass	Pass	Pass
62	15	Fail	Pass	Fail	Pass
62	30	Pass	Pass	Pass	Pass
62	31	Pass	Fail	Pass	Fail
62	32	Pass	Pass	Pass	Pass
63	13	Fail	Pass	Pass	Pass
63	14	Pass	Pass	Pass	Pass
63	15	Fail	Pass	Fail	Pass
63	31	Pass	Fail	Pass	Fail
64	13	Fail	Pass	Fail	Pass
64	14	Pass	Pass	Pass	Pass
64	15	Fail	Pass	Fail	Pass
64	30	Pass	Fail	Pass	Fail
64	31	Pass	Fail	Pass	Fail
64	32	Pass	Fail	Pass	Fail
65	13	Fail	Pass	Fail	Pass
65	14	Pass	Pass	Pass	Pass
65	15	Fail	Pass	Fail	Pass
65	30	Pass	Fail	Pass	Fail
65	31	Pass	Fail	Pass	Fail
65	32	Pass	Fail	Pass	Fail
65	33	Pass	Fail	Pass	Fail
66	13	Fail	Pass	Fail	Pass
66	14	Fail	Pass	Pass	Pass
66	15	Fail	Pass	Fail	Pass
66	30	Pass	Fail	Pass	Fail
66	31	Pass	Fail	Pass	Fail
66	32	Pass	Fail	Pass	Fail
66	36	Pass	Fail	Pass	Fail
67	13	Fail	Pass	Fail	Pass
67	14	Fail	Pass	Pass	Pass
67	15	Fail	Pass	Fail	Pass
67	30	Pass	Fail	Pass	Fail
67	31	Pass	Fail	Pass	Fail

67	32	Pass	Fail	Pass	Fail
67	36	Pass	Fail	Pass	Fail
68	13	Fail	Pass	Fail	Pass
68	14	Fail	Pass	Pass	Pass
68	15	Fail	Pass	Fail	Pass
68	30	Pass	Fail	Pass	Fail
68	31	Pass	Fail	Pass	Fail
68	32	Pass	Fail	Pass	Fail
68	36	Pass	Fail	Pass	Fail
69	13	Fail	Pass	Fail	Pass
69	14	Fail	Pass	Pass	Pass
69	15	Fail	Pass	Fail	Pass
69	30	Pass	Fail	Pass	Fail
69	31	Pass	Fail	Pass	Fail
69	32	Pass	Fail	Pass	Fail
69	36	Pass	Fail	Pass	Fail
70	13	Fail	Pass	Fail	Pass
70	14	Fail	Pass	Pass	Pass
70	15	Fail	Pass	Fail	Pass
70	30	Pass	Fail	Pass	Fail
70	31	Pass	Fail	Pass	Fail
70	32	Pass	Fail	Pass	Fail
70	33	Pass	Fail	Pass	Fail
71	13	Fail	Pass	Fail	Pass
71	14	Fail	Pass	Pass	Pass
71	15	Fail	Pass	Fail	Pass
71	30	Pass	Fail	Pass	Fail
71	31	Pass	Fail	Pass	Fail
71	32	Pass	Fail	Pass	Fail
72	13	Fail	Pass	Fail	Pass
72	14	Fail	Pass	Pass	Pass
72	15	Fail	Pass	Fail	Pass
72	30	Pass	Fail	Pass	Fail
72	31	Pass	Fail	Pass	Fail
72	32	Pass	Fail	Pass	Fail
73	13	Fail	Pass	Fail	Pass
73	14	Fail	Pass	Fail	Pass
73	15	Fail	Pass	Fail	Pass
73	30	Pass	Fail	Pass	Fail
73	31	Pass	Fail	Pass	Fail
74	13	Fail	Pass	Fail	Pass
74	14	Fail	Pass	Fail	Pass
74	15	Fail	Pass	Fail	Pass
74	30	Fail	Fail	Pass	Fail
74	31	Pass	Fail	Pass	Fail
75	13	Fail	Pass	Fail	Pass
75	14	Fail	Pass	Fail	Pass
75	15	Fail	Pass	Fail	Pass
75	30	Fail	Fail	Fail	Fail
75	31	Fail	Fail	Pass	Fail
76	13	Fail	Pass	Fail	Pass
76	14	Fail	Pass	Fail	Pass
76	15	Fail	Pass	Fail	Pass
76	16	Fail	Pass	Fail	Pass
76	17	Fail	Pass	Fail	Pass
76	30	Fail	Fail	Fail	Fail
76	31	Fail	Fail	Fail	Fail

77	13	Fail	Pass	Fail	Pass
77	14	Fail	Pass	Fail	Pass
77	15	Fail	Pass	Fail	Pass
77	16	Fail	Pass	Fail	Pass
77	17	Fail	Pass	Fail	Pass
77	30	Fail	Fail	Fail	Fail
77	31	Fail	Pass	Fail	Pass
78	13	Fail	Pass	Fail	Pass
78	14	Fail	Pass	Fail	Pass
78	15	Fail	Pass	Fail	Pass
78	16	Fail	Pass	Fail	Pass
78	17	Fail	Pass	Fail	Pass
78	30	Fail	Fail	Fail	Fail
78	31	Fail	Pass	Fail	Pass
79	13	Fail	Pass	Fail	Pass
79	14	Fail	Pass	Fail	Pass
79	15	Fail	Pass	Fail	Pass
79	30	Fail	Fail	Fail	Fail
79	31	Fail	Pass	Fail	Pass
80	13	Fail	Pass	Fail	Pass
80	14	Fail	Pass	Fail	Pass
80	15	Fail	Pass	Fail	Pass
80	30	Fail	Fail	Fail	Fail
80	31	Fail	Pass	Fail	Pass
81	13	Fail	Pass	Fail	Pass
81	14	Fail	Pass	Fail	Pass
81	15	Fail	Pass	Fail	Pass
81	30	Fail	Fail	Fail	Fail
81	31	Fail	Pass	Fail	Pass
82	13	Fail	Pass	Fail	Pass
82	14	Fail	Pass	Fail	Pass
82	15	Fail	Pass	Fail	Pass
82	16	Fail	Pass	Fail	Pass
82	17	Fail	Pass	Fail	Pass
82	18	Fail	Pass	Fail	Pass
82	19	Fail	Pass	Fail	Pass
82	20	Fail	Pass	Fail	Pass
82	21	Fail	Pass	Fail	Pass
82	29	Fail	Fail	Fail	Fail
82	30	Fail	Pass	Fail	Fail
82	31	Fail	Pass	Fail	Pass
83	13	Fail	Pass	Fail	Pass
83	14	Fail	Pass	Fail	Pass
83	15	Fail	Pass	Fail	Pass
83	21	Fail	Pass	Fail	Pass
83	30	Fail	Pass	Fail	Pass
83	31	Fail	Pass	Fail	Pass
84	13	Fail	Pass	Fail	Pass
84	14	Fail	Pass	Fail	Pass
84	15	Fail	Pass	Fail	Pass
84	21	Fail	Pass	Fail	Pass
84	30	Fail	Pass	Fail	Pass
84	31	Fail	Pass	Fail	Pass
85	13	Fail	Pass	Fail	Pass
85	14	Fail	Pass	Fail	Pass
85	15	Fail	Pass	Fail	Pass
85	21	Fail	Pass	Fail	Pass

85	30	Fail	Pass	Fail	Pass
86	13	Fail	Pass	Fail	Pass
86	14	Fail	Pass	Fail	Pass
86	15	Fail	Pass	Fail	Pass
86	21	Fail	Pass	Fail	Pass
86	30	Fail	Pass	Fail	Pass
87	13	Fail	Pass	Fail	Pass
87	14	Fail	Pass	Fail	Pass
87	15	Fail	Pass	Fail	Pass
87	30	Fail	Pass	Fail	Pass
88	13	Fail	Pass	Fail	Pass
88	14	Fail	Pass	Fail	Pass
88	15	Fail	Pass	Fail	Pass
88	30	Fail	Pass	Fail	Pass
89	13	Fail	Pass	Fail	Pass
89	14	Fail	Pass	Fail	Pass
89	15	Fail	Pass	Fail	Pass
89	30	Fail	Pass	Fail	Pass
90	13	Fail	Pass	Fail	Pass
90	14	Fail	Pass	Fail	Pass
90	15	Fail	Pass	Fail	Pass
90	30	Fail	Pass	Fail	Pass
91	13	Fail	Pass	Fail	Pass
91	14	Fail	Pass	Fail	Pass
91	15	Fail	Pass	Fail	Pass
91	16	Fail	Pass	Fail	Pass
91	30	Fail	Pass	Fail	Pass
92	13	Fail	Pass	Fail	Pass
92	14	Fail	Pass	Fail	Pass
92	15	Fail	Pass	Fail	Pass
92	16	Fail	Pass	Fail	Pass
92	30	Fail	Pass	Fail	Pass
93	13	Fail	Pass	Fail	Pass
93	14	Fail	Pass	Fail	Pass
93	15	Fail	Pass	Fail	Pass
93	16	Fail	Pass	Fail	Pass
93	30	Fail	Pass	Fail	Pass
94	13	Fail	Pass	Fail	Pass
94	14	Fail	Pass	Fail	Pass
94	15	Fail	Pass	Fail	Pass
94	16	Fail	Pass	Fail	Pass
94	26	Fail	Pass	Fail	Pass
94	30	Fail	Pass	Fail	Pass
95	13	Fail	Pass	Fail	Pass
95	14	Fail	Pass	Fail	Pass
95	15	Fail	Pass	Fail	Pass
95	16	Fail	Pass	Fail	Pass
95	26	Fail	Pass	Fail	Pass
95	30	Fail	Pass	Fail	Pass
96	13	Fail	Pass	Fail	Pass
96	14	Fail	Pass	Fail	Pass
96	15	Fail	Pass	Fail	Pass
96	26	Fail	Pass	Fail	Pass
96	30	Fail	Pass	Fail	Pass
97	13	Fail	Pass	Fail	Pass
97	14	Fail	Pass	Fail	Pass
97	15	Fail	Pass	Fail	Pass

97	26	Fail	Pass	Fail	Pass
97	30	Fail	Pass	Fail	Pass
98	13	Fail	Pass	Fail	Pass
98	14	Fail	Pass	Fail	Pass
98	15	Fail	Pass	Fail	Pass
98	26	Fail	Pass	Fail	Pass
98	27	Fail	Pass	Fail	Pass
98	28	Fail	Pass	Fail	Pass
98	29	Fail	Pass	Fail	Pass
98	30	Fail	Pass	Fail	Pass
99	13	Fail	Pass	Fail	Pass
99	14	Fail	Pass	Fail	Pass
99	15	Fail	Pass	Fail	Pass
99	16	Fail	Pass	Fail	Pass
99	17	Fail	Pass	Fail	Pass
99	18	Fail	Pass	Fail	Pass
99	19	Fail	Pass	Fail	Pass
99	20	Fail	Pass	Fail	Pass
99	21	Fail	Pass	Fail	Pass
99	22	Fail	Pass	Fail	Pass
99	23	Fail	Pass	Fail	Pass
99	26	Fail	Pass	Fail	Pass
99	30	Fail	Pass	Fail	Pass
100	13	Fail	Pass	Fail	Pass
100	14	Fail	Pass	Fail	Pass
100	15	Fail	Pass	Fail	Pass
100	23	Fail	Pass	Fail	Pass
100	24	Fail	Pass	Fail	Pass
100	25	Fail	Pass	Fail	Pass
100	26	Fail	Pass	Fail	Pass
100	30	Fail	Pass	Fail	Pass
101	13	Fail	Pass	Fail	Pass
101	14	Fail	Pass	Fail	Pass
101	15	Fail	Pass	Fail	Pass
101	16	Fail	Pass	Fail	Pass
101	17	Fail	Pass	Fail	Pass
101	18	Fail	Pass	Fail	Pass
101	19	Fail	Pass	Fail	Pass
101	20	Fail	Pass	Fail	Pass
101	21	Fail	Pass	Fail	Pass
101	22	Fail	Pass	Fail	Pass
101	23	Fail	Pass	Fail	Pass
101	26	Fail	Pass	Fail	Pass
101	30	Fail	Pass	Fail	Pass
102	13	Fail	Pass	Fail	Pass
102	14	Fail	Pass	Fail	Pass
102	15	Fail	Pass	Fail	Pass
102	26	Fail	Pass	Fail	Pass
102	30	Fail	Pass	Fail	Pass
103	13	Fail	Pass	Fail	Pass
103	14	Fail	Pass	Fail	Pass
103	15	Fail	Pass	Fail	Pass
103	26	Fail	Pass	Fail	Pass
103	30	Fail	Pass	Fail	Pass
104	13	Fail	Pass	Fail	Pass
104	14	Fail	Pass	Fail	Pass
104	15	Fail	Pass	Fail	Pass

104	26	Fail	Pass	Fail	Pass
104	30	Fail	Pass	Fail	Pass
105	13	Fail	Pass	Fail	Pass
105	14	Fail	Pass	Fail	Pass
105	15	Fail	Pass	Fail	Pass
105	26	Fail	Pass	Fail	Pass
105	30	Fail	Pass	Fail	Pass
106	13	Fail	Pass	Fail	Pass
106	14	Fail	Pass	Fail	Pass
106	15	Fail	Pass	Fail	Pass
106	26	Fail	Pass	Fail	Pass
106	27	Fail	Pass	Fail	Pass
106	30	Fail	Pass	Fail	Pass
106	39	Fail	Pass	Fail	Pass
107	13	Fail	Pass	Fail	Pass
107	14	Fail	Pass	Fail	Pass
107	15	Fail	Pass	Fail	Pass
107	22	Fail	Pass	Fail	Pass
107	26	Fail	Pass	Fail	Pass
107	30	Fail	Pass	Fail	Pass
107	39	Fail	Pass	Fail	Pass
108	13	Fail	Pass	Fail	Pass
108	14	Fail	Pass	Fail	Pass
108	15	Fail	Pass	Fail	Pass
108	22	Fail	Pass	Fail	Pass
108	26	Fail	Pass	Fail	Pass
108	30	Fail	Pass	Fail	Pass
108	39	Fail	Pass	Fail	Pass
109	13	Fail	Pass	Fail	Pass
109	14	Fail	Pass	Fail	Pass
109	15	Fail	Pass	Fail	Pass
109	22	Fail	Pass	Fail	Pass
109	26	Fail	Pass	Fail	Pass
109	30	Fail	Pass	Fail	Pass
109	39	Fail	Pass	Fail	Pass
110	13	Fail	Pass	Fail	Pass
110	14	Fail	Pass	Fail	Pass
110	15	Fail	Pass	Fail	Pass
110	22	Fail	Pass	Fail	Pass
110	26	Fail	Pass	Fail	Pass
110	39	Fail	Pass	Fail	Pass
111	13	Fail	Pass	Fail	Pass
111	14	Fail	Pass	Fail	Pass
111	15	Fail	Pass	Fail	Pass
111	22	Fail	Pass	Fail	Pass
111	26	Fail	Pass	Fail	Pass
111	39	Fail	Pass	Fail	Pass
112	13	Fail	Pass	Fail	Pass
112	14	Fail	Pass	Fail	Pass
112	15	Fail	Pass	Fail	Pass
112	22	Fail	Pass	Fail	Pass
112	26	Fail	Pass	Fail	Pass
112	39	Fail	Pass	Fail	Pass
113	13	Fail	Pass	Fail	Pass
113	14	Fail	Pass	Fail	Pass
113	15	Fail	Pass	Fail	Pass
113	26	Fail	Pass	Fail	Pass

113	27	Fail	Pass	Fail	Pass
113	39	Fail	Pass	Fail	Pass
114	13	Fail	Pass	Fail	Pass
114	14	Fail	Pass	Fail	Pass
114	15	Fail	Pass	Fail	Pass
114	26	Fail	Pass	Fail	Pass
114	39	Fail	Pass	Fail	Pass
115	13	Fail	Pass	Fail	Pass
115	14	Fail	Pass	Fail	Pass
115	15	Fail	Pass	Fail	Pass
115	26	Fail	Pass	Fail	Pass
115	39	Fail	Pass	Fail	Pass
116	13	Fail	Pass	Fail	Pass
116	14	Fail	Pass	Fail	Pass
116	15	Fail	Pass	Fail	Pass
116	26	Fail	Pass	Fail	Pass
116	39	Fail	Pass	Fail	Pass
117	13	Fail	Pass	Fail	Pass
117	14	Fail	Pass	Fail	Pass
117	15	Fail	Pass	Fail	Pass
117	26	Fail	Pass	Fail	Pass
117	39	Fail	Pass	Fail	Pass
118	13	Fail	Pass	Fail	Pass
118	14	Fail	Pass	Fail	Pass
118	15	Fail	Pass	Fail	Pass
118	20	Fail	Pass	Fail	Pass
118	26	Fail	Pass	Fail	Pass
118	39	Fail	Pass	Fail	Pass
119	13	Fail	Pass	Fail	Pass
119	14	Fail	Pass	Fail	Pass
119	15	Fail	Pass	Fail	Pass
119	20	Fail	Pass	Fail	Pass
119	26	Fail	Pass	Fail	Pass
119	39	Fail	Pass	Fail	Pass
120	13	Fail	Pass	Fail	Pass
120	14	Fail	Pass	Fail	Pass
120	15	Fail	Pass	Fail	Pass
120	16	Fail	Pass	Fail	Pass
120	26	Fail	Pass	Fail	Pass
120	39	Fail	Pass	Fail	Pass
121	13	Fail	Pass	Fail	Pass
121	14	Fail	Pass	Fail	Pass
121	26	Fail	Pass	Fail	Pass
121	39	Fail	Pass	Fail	Pass
122	13	Fail	Pass	Fail	Pass
122	14	Fail	Pass	Fail	Pass
122	26	Fail	Pass	Fail	Pass
122	39	Fail	Pass	Fail	Pass
123	13	Fail	Pass	Fail	Pass
123	14	Fail	Pass	Fail	Pass
123	15	Fail	Pass	Fail	Pass
123	16	Fail	Pass	Fail	Pass
123	17	Fail	Pass	Fail	Pass
123	18	Fail	Pass	Fail	Pass
123	19	Fail	Pass	Fail	Pass
123	20	Fail	Pass	Fail	Pass
123	21	Fail	Pass	Fail	Pass

123	22	Fail	Pass	Fail	Pass
123	23	Fail	Pass	Fail	Pass
123	24	Fail	Pass	Fail	Pass
123	25	Fail	Pass	Fail	Pass
123	26	Fail	Pass	Fail	Pass
123	27	Fail	Pass	Fail	Pass
123	28	Fail	Pass	Fail	Pass
123	29	Fail	Pass	Fail	Pass
123	30	Fail	Pass	Fail	Pass
123	31	Fail	Pass	Fail	Pass
123	32	Fail	Pass	Fail	Pass
123	33	Fail	Pass	Fail	Pass
123	34	Fail	Pass	Fail	Pass
123	35	Fail	Pass	Fail	Pass
123	36	Fail	Pass	Fail	Pass
123	37	Fail	Pass	Fail	Pass
123	38	Fail	Pass	Fail	Pass
123	39	Fail	Pass	Fail	Pass
124	13	Fail	Pass	Fail	Pass
124	14	Fail	Pass	Fail	Pass
124	23	Fail	Pass	Fail	Pass
125	13	Fail	Pass	Fail	Pass
125	14	Fail	Pass	Fail	Pass
125	23	Fail	Pass	Fail	Pass
126	13	Fail	Pass	Fail	Pass
126	14	Fail	Pass	Fail	Pass
126	23	Fail	Pass	Fail	Pass
127	13	Fail	Pass	Fail	Pass
127	14	Fail	Pass	Fail	Pass
127	23	Fail	Pass	Fail	Pass
128	13	Fail	Pass	Fail	Pass
128	14	Fail	Pass	Fail	Pass
128	23	Fail	Pass	Fail	Pass
129	13	Fail	Pass	Fail	Pass
129	14	Fail	Pass	Fail	Pass
129	23	Fail	Pass	Fail	Pass
130	8	Fail	Fail	Fail	Fail
130	9	Fail	Pass	Fail	Pass
130	10	Fail	Pass	Fail	Pass
130	11	Fail	Pass	Fail	Pass
130	12	Fail	Pass	Fail	Pass
130	13	Fail	Pass	Fail	Pass
130	14	Fail	Pass	Fail	Pass
130	23	Fail	Pass	Fail	Pass
131	14	Fail	Pass	Fail	Pass
131	23	Fail	Pass	Fail	Pass
132	14	Fail	Pass	Fail	Pass
132	23	Fail	Pass	Fail	Pass
133	14	Fail	Pass	Fail	Pass
133	23	Fail	Pass	Fail	Pass
134	14	Fail	Pass	Fail	Pass
134	23	Fail	Pass	Fail	Pass
135	14	Fail	Pass	Fail	Pass
136	14	Fail	Pass	Fail	Pass
137	14	Fail	Pass	Fail	Pass
138	14	Fail	Pass	Fail	Pass

Savannah Harbor Expansion Project - Chloride Data Analysis and Model Development

PREPARED BY:

Tetra Tech, Inc.
2110 Powers Ferry Road
Suite 202
Atlanta, Georgia 30339
Phone: (770) 850-0949

PREPARED FOR:

USACE – Savannah District
100 West Oglethorpe Avenue
Savannah, Georgia 31401
Contract No: W912-HN-05-D-0014
Work Order 0018

November 15, 2006

Acknowledgments

Tetra Tech began this work under contract with the USACE Savannah District through Contract Number DACA65-99-D-0065, Delivery Order No. CV01. The final report was completed through Dial Cordy and Associates' contract with the USACE Savannah District, W912-HN-05-D-0014, Work Order 0018. Tetra Tech sincerely appreciates the review and support from the USACE Savannah District (Bill Bailey and Joe Hoke), the City of Savannah (John Sawyer and Tony Tucker), and the USGS (Paul Conrads).

Table of Contents

1.0 Introduction 3
2.0 Objectives 3
3.0 Study Area Description 3
4.0 Available Data 7
5.0 Data Analysis 13
5.1 Linear Regression 13
5.2 Flow and Chloride at Clyo in Relation to the Watershed 16
5.3 Supplemental Analysis with Water Quality Data Observed at the Intake 21
6.0 Source Assessment 23
6.1 Upstream Sources 23
6.2 Point Sources 24
6.3 Groundwater 25
7.0 Development of Chloride Model 27
8.0 Conclusions 33
9.0 References 34

List of Tables

Table 4-1 Sources and Types of Data Employed 7
Table 5-1 Linear Regression of City Chlorides and I-95 Chlorides against Flow Values from Clyo Gauge (USGS 02198500) 13
Table 5-2 Yearly Linear Regression of City Chloride Samples and Chloride Values Generated with data from the I-95 Station (USGS 02198840) 14
Table 5-3 Monthly Flow and Chloride data for Periods of Similar Annual Average Flows 15
Table 5-4 Percent Exceedances of City's Chloride Data by Year 16
Table 6-1 USGS Stations Within and Upstream of the Lower Savannah River Watershed 23
Table 6-2 Summary of Chloride Observations from USGS Stations Upstream of the Lower Savannah River Watershed 23
Table 7-1 Descriptive Statistics for the Observed Chloride and Output from the Chloride Model 29
Table 7-2 Summary of Model Results and City Observations with Respect to Various Benchmarks for Chloride Concentration (X) 31

Table 7-3 Summary of the City's Observations Relative to Predictions by the Chloride Model 32

List of Figures

Figure 3-1 Location Map of the Savannah River Watershed 4
Figure 3-2 City of Savannah I&D WTP Intake and Nearby USGS Monitoring Stations 5
Figure 3-3 City of Savannah Freshwater Intake and the USGS Station at the I-95 Bridge (02198840) 6
Figure 4-1 Chloride Values and Corresponding Flow Measurements 8
Figure 4-2 Chloride Values and Corresponding Flow Measurements for 1990 9
Figure 4-3 Chloride Values and Corresponding Flow Measurements for 1993 9
Figure 4-4 Chloride Values and Corresponding Flow Measurements for 1996 10
Figure 4-5 Chloride Values and Corresponding Flow Measurements for 2000 10
Figure 4-6 Chloride Values and Corresponding Flow Measurements for 2003 11
Figure 4-7 Illustration of the Effect of Flow and Tides on Chloride Values in the System 12
Figure 5-1 Annual Average Flow against Percentage of Samples Greater than 12 mg/L 15
Figure 5-2 Flow and Chloride Observations at Clyo, GA (USGS 02198500) 17
Figure 5-3 Correlation of Flow and Chloride Measurements at Clyo, GA (USGS 02198500) 17
Figure 5-4 Calculated Chloride Time Series at Clyo - 1990 18
Figure 5-5 Calculated Chloride Time Series at Clyo - 1993 19
Figure 5-6 Calculated Chloride Time Series at Clyo - 1996 19
Figure 5-7 Calculated Chloride Time Series at Clyo - 2000 20
Figure 5-8 Calculated Chloride Time Series at Clyo - 2003 20
Figure 5-9 Specific Conductance versus Chloride at the City's Intake 21
Figure 5-10 Regression of Specific Conductance versus Chloride at the City's Intake 22
Figure 6-1 USGS Station Locations Within and Upstream of the Lower Savannah River Watershed 24
Figure 6-2 Savannah River Wells Monitored by USGS 25
Figure 6-3 Data from USGS Well 37Q185 26
Figure 7-1 Predicted Chlorides at the Intake (1997 through 1999) 28
Figure 7-2 Predicted Chlorides at the Intake (2000 through 2003) 28
Figure 7-3 Relationship between the City's Measurements of Specific Conductivity and Chloride 29
Figure 7-4 Cumulative Chloride Distribution of the City and Model Results 30
Figure 7-5 Average Difference between Model and City Values and the Chloride Benchmark 32

1.0 Introduction

Tetra Tech, Inc. (Tetra Tech) was contracted by the United States Army Corps of Engineers (USACE) to perform a data analysis of chloride concentrations in Abercorn Creek upstream of the Interstate 95 (I-95) Bridge on the Savannah River. The purpose of the chloride data analysis was to determine a prediction of chloride concentrations (or chloride mode) on Abercorn Creek in response to downstream harbor modifications. The City of Savannah (City) owns and operates an Industrial and Domestic drinking water supply intake located on Abercorn Creek approximately two miles from the confluence with the Savannah River. The City collects samples at the water treatment plant everyday to monitor different chemical constituents in the influent.

Chloride is a major concern for the City as elevated concentrations require additional treatment, which can significantly impact existing resources. It is noted here that a chloride concentration of 12 mg/L was used throughout this document only as an assumed benchmark specifically for the purposes of this analysis. The use of this benchmark does not constitute, nor is derived from any legal standard or criterion to be achieved by the City of Savannah. Further, this benchmark does not impact the analysis of the final results and is not used as an indicator to assess the degree by which the model's output may or may not be related to the chloride measurements observed by the City. The benchmark acts only as a reference value for the purposes of this report.

The data analysis and model presented in this report describe the sources of chloride in the Savannah River and the prediction of chloride levels at the water intake based on river flows, salinity intrusion from the harbor, and other direct and indirect sources.

2.0 Objectives

The overall goal of this report is to provide an analysis of the potential for a proposed harbor modifications (i.e., deepening of the navigation channel) to cause an increase in the chloride concentrations at the City of Savannah's freshwater intake on Abercorn Creek. In addition to defining the data used in the analysis, this study will provide the following:

- Provide a statistical correlation between chloride levels at the City's intake, chloride levels at a nearby downstream station, and upstream flows.
- Illustrate the likelihood of increased chloride levels at the City's intake, based on previous deepening of the Savannah Harbor.
- Identify potential point and non-point sources of chlorides within the watershed.
- Chloride model to predict changes in concentrations at the City's intake.

3.0 Study Area Description

The Savannah River basin includes portions of North Carolina, South Carolina, and Georgia and flows through the Blue Ridge Mountain, Piedmont, and Coastal Plain provinces. The Savannah River forms the boundary between South Carolina and Georgia and begins at Hartwell Reservoir by the confluence of the Seneca and Tugaloo Rivers. From this point, it flows southeast to the port city of Savannah, Georgia where it empties into the Atlantic Ocean (River Basin Center).

The city of Savannah owns and operates the 75 Million Gallons per Day (MGD) Industrial and Domestic (I&D) Water Treatment Plant. The plant was constructed in 1947 as a 35 MGD conventional surface water treatment plant. The treatment plant and its associated processes have been improved and/or upgraded over the years to its current 75 MGD maximum capacity.

The raw water source for this facility is Abercorn Creek, a tributary of the Savannah River. Due to the proximity of Savannah to the coast, the rise and fall of daily tides causes the physical and chemical characteristics of the source water to change continuously. This constant change adds to the complexity of the treatment process and requires the highest degree of vigilance by the operations staff. Figures 3-1 through 3-3 provide a location map of the watershed, location of the water intake on Abercorn Creek, and the United States Geological Survey (USGS) data collection stations.

Figure 3-1 Location Map of the Savannah River Watershed

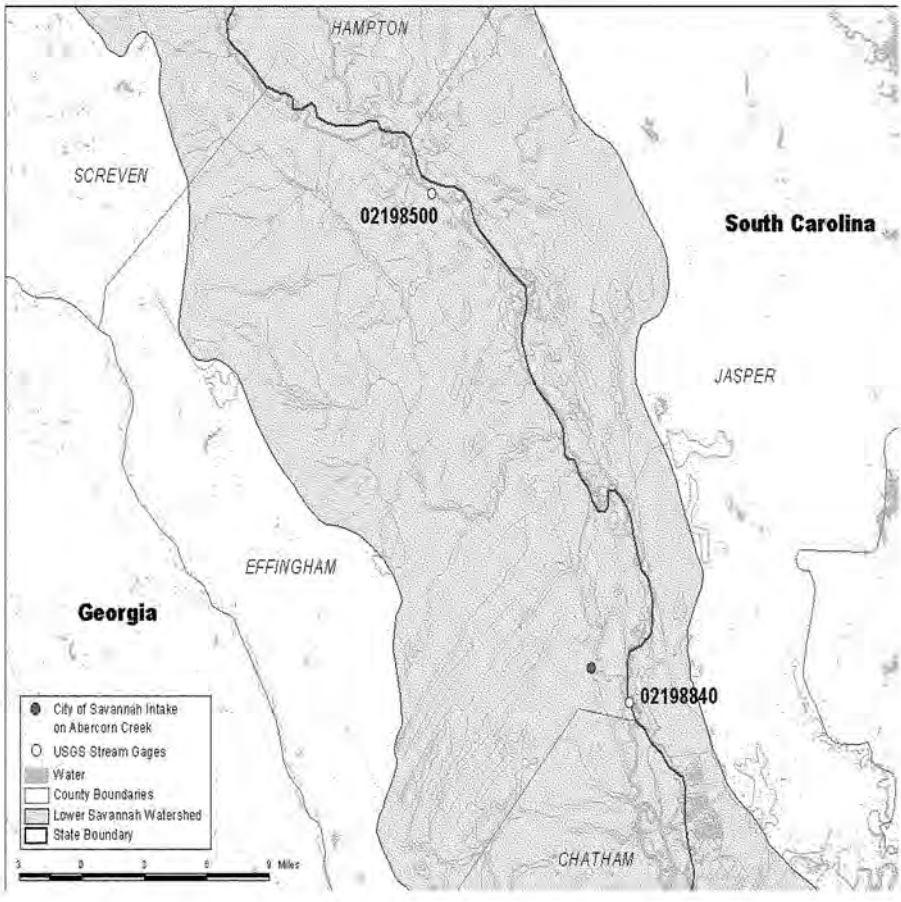


Figure 3-2 City of Savannah I&D WTP Intake and Nearby USGS Monitoring Stations

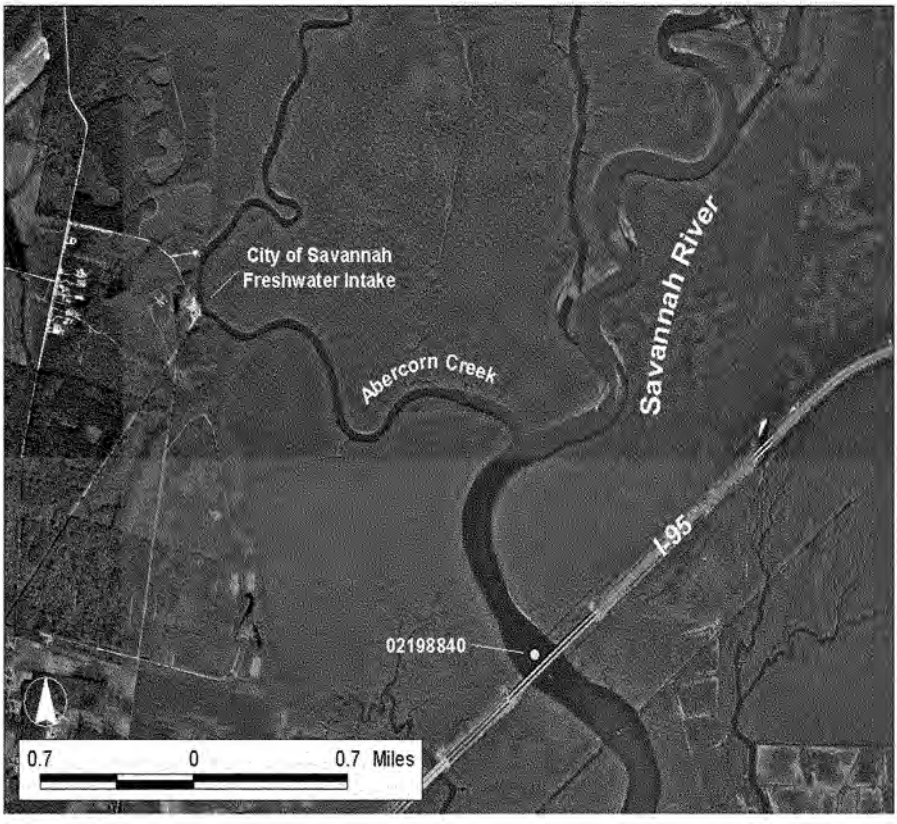


Figure 3-3 City of Savannah Freshwater Intake and the USGS Station at the I-95 Bridge (02198840)

4.0 Available Data

The sources and types of data utilized in this analysis are indicated in Table 4-1.

Table 4-1 Sources and Types of Data Employed

Agency	Station ID	Station Description	Data Employed	Period of Record
City of Savannah	---	Abercorn Creek Freshwater Intake (City)	Chloride (mg/L)	1/1988 – 12/2003
USGS	02198500	Savannah River Near Clyo, Georgia (Clyo)	Chloride (mg/L), Flow (cfs)	1/1988 – 9/2003
USGS	02198840	Savannah River Near Port Wentworth, Georgia (I-95 Bridge)	Specific Conductivity (µS/cm)	1/1988 – 12/2003
GPA	14, 18, 19	Savannah River and Abercorn Creek	Conductivity (µS/cm)	Summer 1999
USGS	several	Upper Savannah River watershed	Chloride (mg/L)	1956 - 2003

The City of Savannah obtains grab samples at the water plant rather than at the end of the intake pipe on Abercorn Creek. These samples are typically taken daily at approximately 7:30 AM during the weekdays and are measured for chloride concentrations, along with many other parameters, at the water treatment facility.

The two USGS stations used in this analysis provide upstream daily flow in the Savannah River near Clyo, Georgia (02198500), and downstream specific conductivity where I-95 crosses the Savannah River (02198840). These stations are 50 and 25 miles from the mouth of the river, respectively. The conductivity values from 02198840 were converted to chloride values, in mg/L, to allow comparison with data obtained at the City's intake. This was accomplished using a well-established algorithm developed to define the relationship of specific conductance to the chemical composition in seawater and dilutions of seawater, as in estuaries (Miller, 1988).

There can be potential interferences with the conversion of specific conductance to chloride, such as dissolved organic solids from local wetland and swamp areas. The relationships between flow, chloride, and conductivity were developed assuming that the interference is small to negligible over a longterm period. Therefore, for this analysis, it is assumed to not have a significant factor on specific conductance.

Chloride is one of the major inorganic anions, or negative ions, in saltwater and freshwater. It originates from the dissociation of salts, such as sodium chloride or calcium chloride, in water. Chlorides are binary compounds of chlorine. Chlorine chemically combines with a metal to form chloride. Salinity is the total of all non-carbonate salts dissolved in water. This is comprised mostly by chloride (55%) and sodium (31%) ions with sulfate, magnesium, calcium, potassium, and bicarbonate ions comprising the remaining 14%.

Once converted to similar units, the chloride data from the City's intake site, calculated chloride data from the I-95 bridge station, and the corresponding daily flow data from the USGS Clyo station were graphed (Figure 4-1) to provide a cursory relation between these three variables. Figure 4-1 also illustrates periods of similar trends (circled on the graph) between chloride values at the intake, and those taken at the I-95 Bridge (USGS 02198840). The chloride benchmark of 12 mg/L used specifically for this analysis is shown on all of the plots for reference.

As observed in Figure 4-1, increased flows tend to result in lower chloride levels at both the City and I-95 stations. This apparent relationship is most obvious in periods of drastically increased flows, such as in 1993, 1998, and 2003. Representative years for 1990, 1993, 1996, 2000, and 2003 are plotted in Figures 4-2 through 4-6.

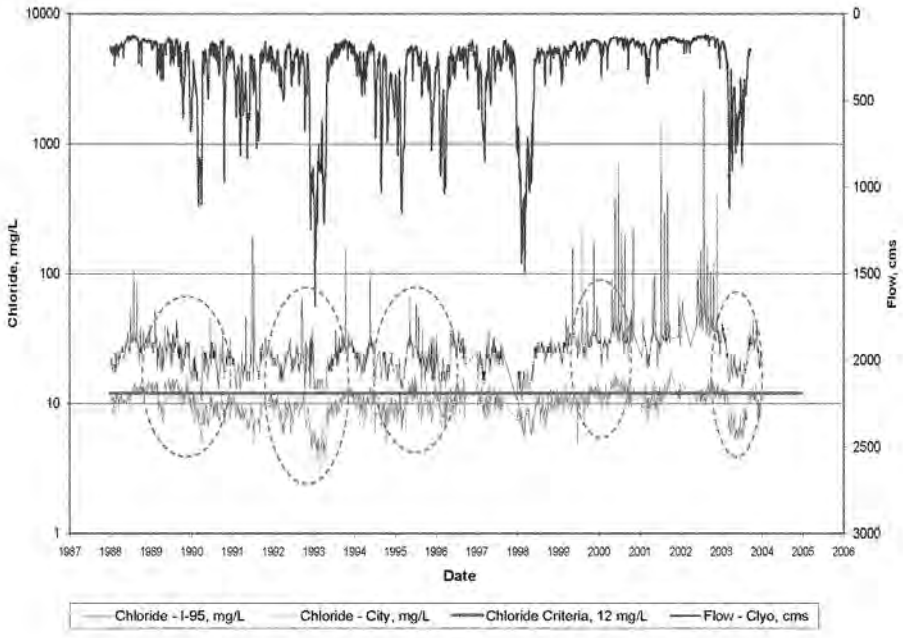


Figure 4-1 Chloride Values and Corresponding Flow Measurements

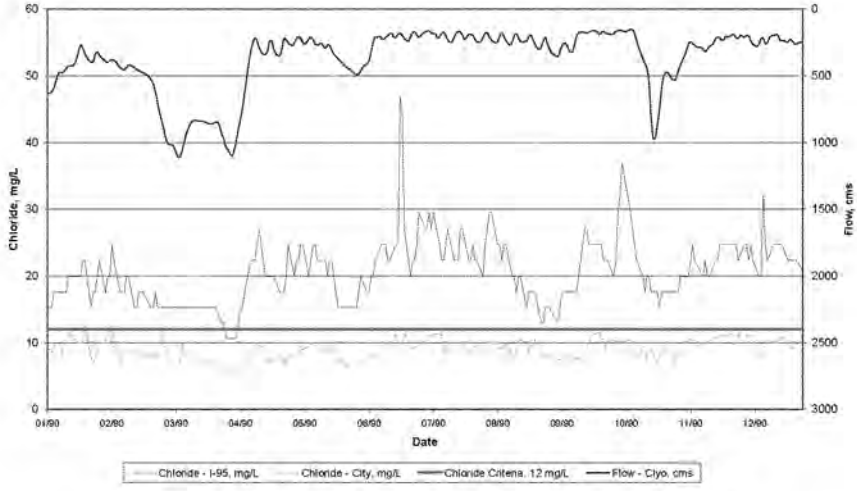


Figure 4-2 Chloride Values and Corresponding Flow Measurements for 1990

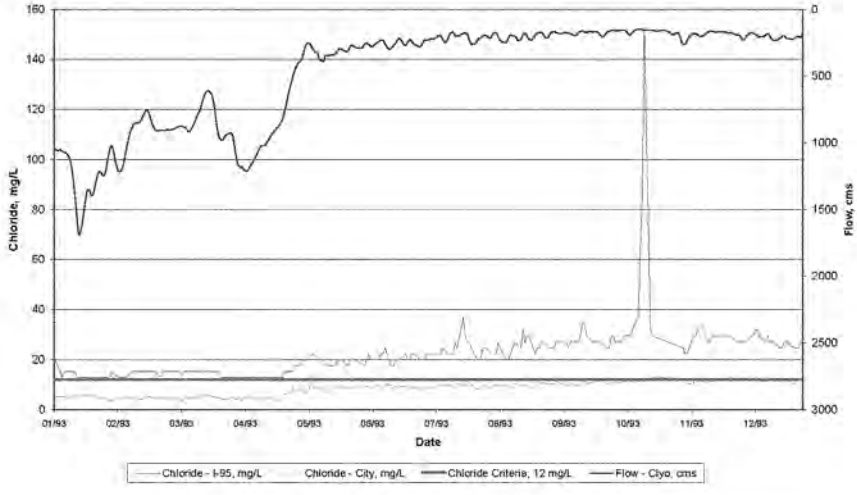


Figure 4-3 Chloride Values and Corresponding Flow Measurements for 1993

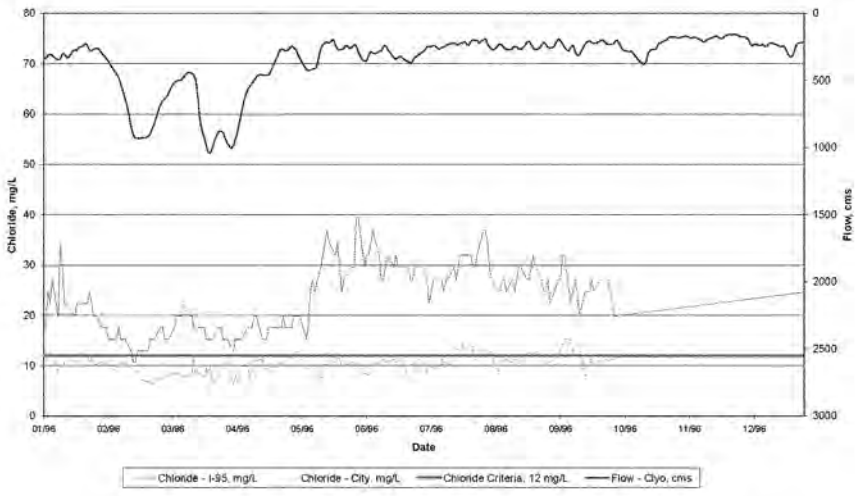


Figure 4-4 Chloride Values and Corresponding Flow Measurements for 1996

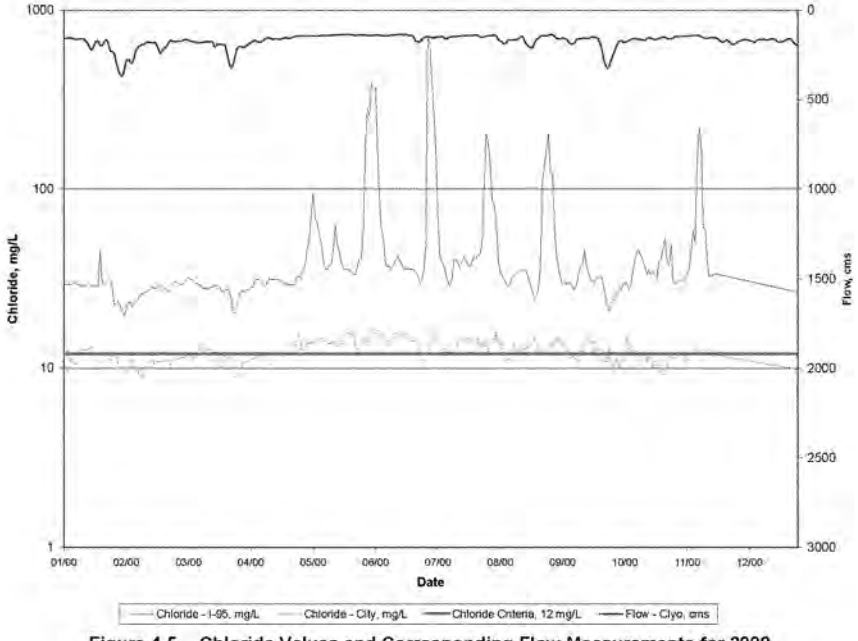


Figure 4-5 Chloride Values and Corresponding Flow Measurements for 2000

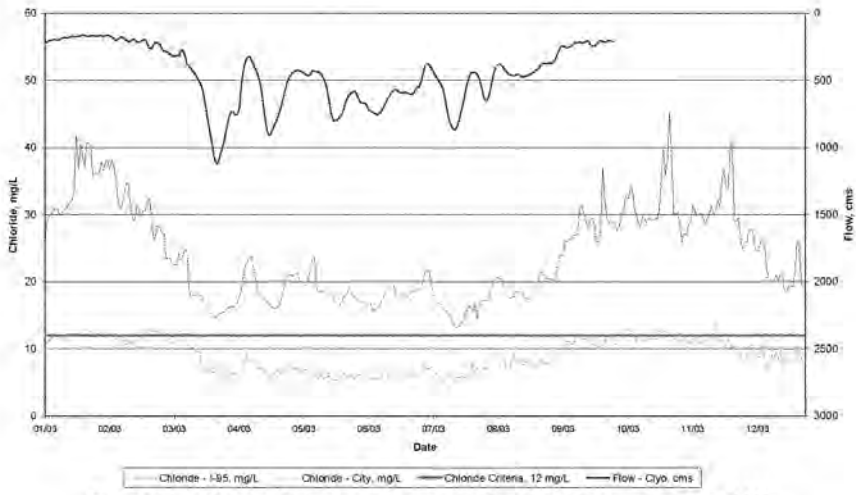


Figure 4-6 Chloride Values and Corresponding Flow Measurements for 2003

It is quite clear from the preceding graphs that at higher flows, chloride values at both stations are depressed, indicating that some saltwater intrusion is being suppressed by the increased upstream freshwater discharge, though a low-level chloride signal still remains.

At relatively lower flows, the chloride response is expectedly different. The ability for saltwater intrusion to have a greater impact on the chloride concentrations at both stations is anticipated, as upstream freshwater is not available to aid in the flushing process. Interestingly though, Figure 4-7 shows a relatively low flow period where chloride concentrations at the I-95 Bridge station exhibit tidally influenced, approximately 30-day chloride spikes, which immediately disappear with increased flow. Though lower flows do seem to correspond with slightly increased City chloride concentrations, the 30-day chloride spikes are not at all apparent there. This may imply that the impact of low flows and greater saltwater intrusion affect the I-95 station, located on the mainstem of the Savannah River, but do not have as significant an effect on chloride concentrations at a station located on Abercorn Creek, 2 miles upstream of the I-95 Bridge.

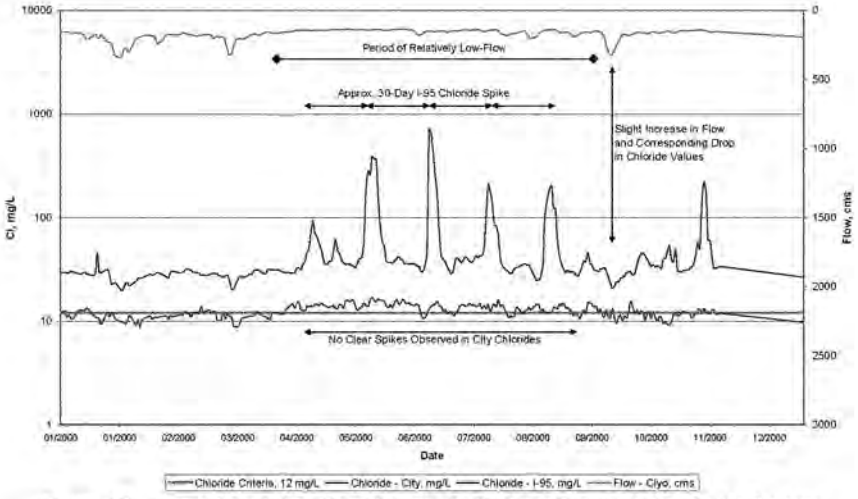


Figure 4-7 Illustration of the Effect of Flow and Tides on Chloride Values in the System

5.0 Data Analysis

5.1 Linear Regression

Specific conductance data were obtained from USGS for the I-95 Bridge location (02198840). Before proceeding further in this analysis, it was important to first establish the relation, if one exists, between the two chloride sampling stations and the corresponding daily flow measurements from the Clyo USGS station. This relation may be determined statistically in terms of a linear regression between these three variables, which was conducted for two cases; between the two chloride stations, between each chloride station, and corresponding flow measurements.

The correlation of chloride values sampled at the intake against flow values from the USGS station at Clyo, and then with chloride values from the I-95 Bridge station and flow are presented in Table 5-1 as R-squared values for the period of record and annually. The results indicate that 1998 and 2003 were the strongest years of correlation overall as evident with higher flow periods.

Table 5-1 Linear Regression of City Chlorides and I-95 Chlorides against Flow Values from Clyo Gauge (USGS 02198500)

	City CL / Flow at Clyo		I-95 CL / Flow at Clyo	
Year	r	R^2	R	R^2
ALL	-0.670	0.449	-0.148	0.022
1988	-0.422	0.178	-0.502	0.252
1989	-0.481	0.231	-0.652	0.425
1990	-0.549	0.302	-0.657	0.432
1991	-0.670	0.449	-0.213	0.045
1992	-0.733	0.537	-0.055	0.003
1993	-0.862	0.743	-0.517	0.267
1994	-0.464	0.215	-0.483	0.233
1995	-0.578	0.335	-0.577	0.332
1996	-0.572	0.327	-0.702	0.493
1997	-0.471	0.222	-0.680	0.462
1998	-0.646	0.417	-0.923	0.852
1999	-0.379	0.144	-0.285	0.081
2000	-0.503	0.253	-0.213	0.046
2001	-0.548	0.300	-0.151	0.023
2002	-0.166	0.027	-0.122	0.015
2003	-0.825	0.680	-0.831	0.691

The correlation between chloride values at the intake and those from the I-95 Bridge station are presented in Table 5-2 as R-squared values for the period of record and annually. The results indicate that 1998 and 2003 seem to have the strongest correlations, again high flow years.

Table 5-2 Yearly Linear Regression of City Chloride Samples and Chloride Values Generated with data from the I-95 Station (USGS 02198840)

	City CL / I-95 CL	
Year	r	R^2
ALL	0.147	0.022
1988	0.446	0.199
1989	0.537	0.288
1990	0.607	0.368
1991	-0.010	0.000
1992	0.169	0.029
1993	0.581	0.337
1994	0.438	0.192
1995	0.424	0.180
1996	0.406	0.165
1997	0.425	0.181
1998	0.635	0.403
1999	0.157	0.025
2000	0.276	0.076
2001	0.059	0.003
2002	-0.103	0.011
2003	0.865	0.749

The effect of flow on chloride values at both stations and can be further explained through Figure 5-1. This chart compares the average yearly flow at Clyo against the percentage of samples taken by the City at the intake that exceed the assumed chloride benchmark of 12 mg/L, for each year. From the figure, it can immediately be realized that a strong relationship exists between lower flows and higher chloride values exceeding the benchmark. In particular, this is visible in 1988, 1989, 2000, 2001, and 2002.

Further, we might also derive a potential response in chloride values from this chart due to Savannah Harbor deepening, which took place in 1994. Annual average flows between 1990 and 1992, and then between 1995 and 1997 seem relatively consistent, varying approximately between 350 and 400 cms (12,360 and 14,125 cfs). However, the percentage of chloride samples exceeding 12 mg/L for either of these periods does not display the same level of similarity. Post-1994, and thus post-deepening, with relatively similar annual average flows, had more samples at the City's intake higher than the 12 mg/L benchmark than prior to deepening activities. This strongly suggests that harbor deepening may prompt elevated salinity by allowing more saltwater intrusion upstream, therefore inducing higher chloride values at the City's intake.

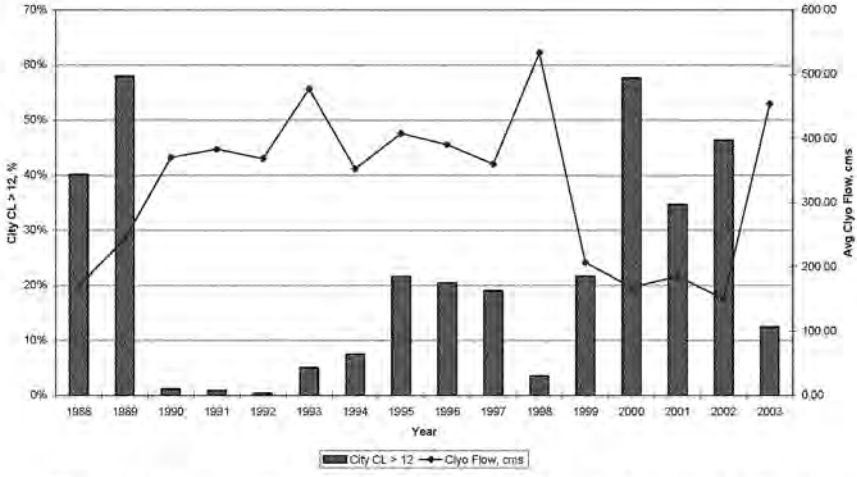


Figure 5-1 Annual Average Flow against Percentage of Samples Greater than 12 mg/L

A closer look can also be taken at monthly flows for those years with similar annual average flows; between 1990 and 1992 and between 1995 and 1997, and the exceedances of the benchmark for chlorides for each month. Table 5-3 provides a summary of this data for each year within these periods.

Table 5-3 Monthly Flow and Chloride data for Periods of Similar Annual Average Flows

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1990	Average Flow	419	555	944	400	318	239	191	225	223	406	266	230
	# CL Samples	21	19	22	21	22	21	22	23	19	22	20	18
	%>12 mg/L	9.5	5.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.6
1991	Average Flow	301	409	529	467	590	356	376	656	306	193	239	224
	# CL Samples	21	19	21	22	22	20	16	10	19	14	19	21
	%>12 mg/L	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.1	0.0	14.3
1992	Average Flow	292	278	392	358	189	296	256	288	258	421	368	1012
	# CL Samples	21	19	22	22	20	22	21	21	21	22	18	21
	%>12 mg/L	0.0	5.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.5	0.0	0.0
Harbor Deepening													
1995	Average Flow	534	593	845	283	203	245	216	295	342	324	495	524
	# CL Samples	20	19	23	20	22	22	20	23	20	21	20	20
	%>12 mg/L	0.0	10.5	0.0	10.0	81.8	54.5	55.0	0.0	0.0	14.3	0.0	30.0
1996	Average Flow	295	703	718	506	294	315	230	246	233	207	---	---
	# CL Samples	21	20	21	22	22	20	21	23	19	2	---	---
	%>12 mg/L	33.3	0.0	0.0	9.1	22.7	0.0	38.1	39.1	42.1	0.0	---	---
1997	Average Flow	350	439	627	328	358	274	244	278	---	---	---	---
	# CL Samples	21	19	21	22	21	21	22	21	---	---	---	---
	%>12 mg/L	42.9	26.3	0.0	27.3	14.3	42.9	4.5	19.0	---	---	---	---

Table 5-3 further confirms that increases in exceedances of the 12 mg/L chloride benchmark post-deepening were observed throughout the year at the City's intake, possibly due to increased saltwater intrusion. It is interesting to note though that post-deepening, dramatic increases in the percentage of exceedances of the benchmark are seen more clearly in the warmer months (May – August), which experience relatively low flows throughout each year. For example, data for 1995 shows exceedances between 55-82 percent for chloride samples taken from May through July. These months also experienced some of the lowest average flows of that year, between 203-245 cms. In 1993, pre-deepening, no exceedances were observed in these months. Table 5-4 presents the percent exceedances by year for the City's intake data along with a reference to meteorological, hydrological, and physical changes within the system.

Table 5-4 Percent Exceedances of City's Chloride Data by Year

Year	Count	Exceed 12?	Percentage	Circumstances
1988	250	99	40%	drought
1989	251	146	58%	drought
1990	251	3	1%	
1991	250	2	1%	
1992	251	1	0%	dredged Abercorn Creek
1993	252	15	6%	
1994	252	17	7%	Harbor deepening
1995	250	54	22%	
1996	191	39	20%	
1997	168	32	19%	
1998	251	9	4%	drought
1999	249	52	21%	drought
2000	328	180	55%	drought
2001	364	152	42%	drought
2002	365	172	47%	drought
2003	366	50	14%	
1988 - 2003	4289	1023	24%	

Based on the data analysis to this point, there is a definitive relationship between chloride values on Abercorn Creek and flow through the system. As demonstrated, the regressions provide high R^2 values for high flow years and a clear response is seen in the plots and tables provided. Table 5-4 also shows a relationship between low-flow years and high exceedances of chloride at the intake.

5.2 Flow and Chloride at Clyo in Relation to the Watershed

A supplemental analysis of flow and chloride data from the USGS station at Clyo (02198500) was conducted to better understand the relationship of these parameters throughout the Lower Savannah River watershed. There are a total of 28 chloride observations from this station between 1988 and 1994. By plotting these values directly against a flow time-series from the same station, as in Figure 5-2, an apparent power function between the two can be observed. A best-fit line of this nature may be plotted through the points yielding an R^2 of 0.759, indicating quite a strong relationship between flow and chlorides at this station. A plot of the data and the relationship between the two parameters is provided in Figure 5-3. The power function is represented by the following equation:

$$\mathbf{Chloride_{Flow} = 92.118 * Flow^{(-0.436)}}$$

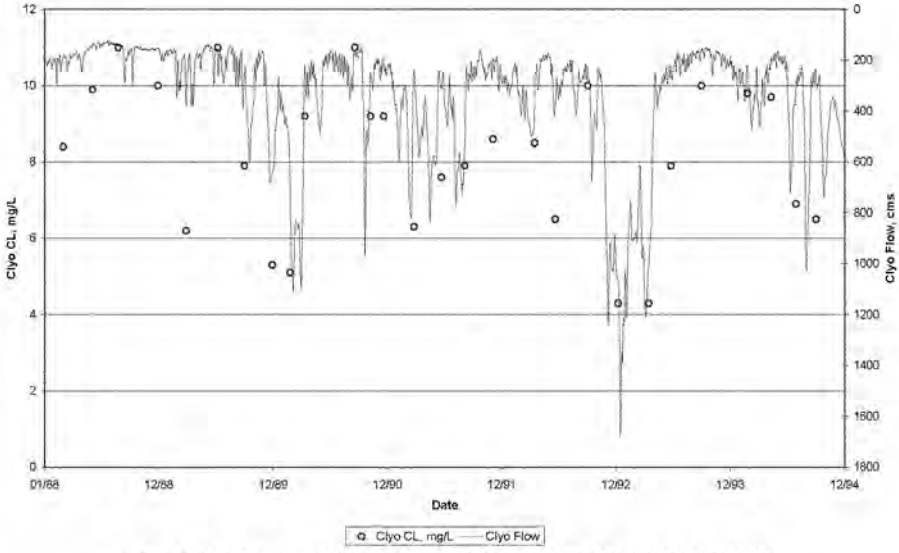


Figure 5-2 Flow and Chloride Observations at Clyo, GA (USGS 02198500)

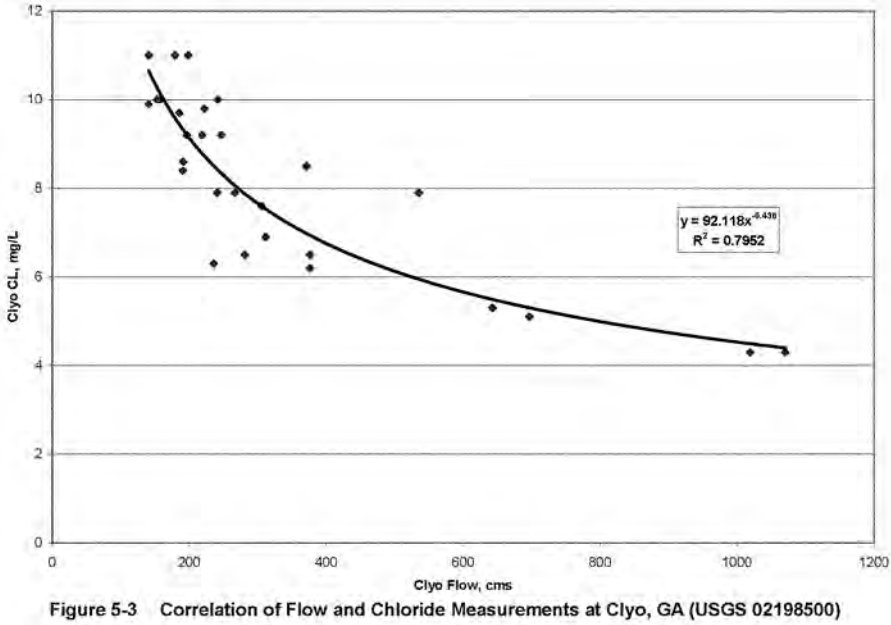


Figure 5-3 Correlation of Flow and Chloride Measurements at Clyo, GA (USGS 02198500)

The power function identified here was then used to plot a chloride time series at Clyo, and to provide a comparison in terms of trend against chloride values at Abercorn Creek intake, and those derived from specific conductance values at the I-95 Bridge. Figures 5-4 through 5-8 display the calculated chloride time series at Clyo. The calculated time series closely resembles the trend observed in measured chloride values at the Abercorn Creek intake, though it does seem to under-predict at times of relatively high flows. The time series is unable to capture chloride spikes at the intake during periods of low flow, or capture violations in the benchmark there. This indicates the possibility of additional chloride sources impacting the samples during a low flow period, thus making a statistical relationship on Clyo flows alone insufficient.

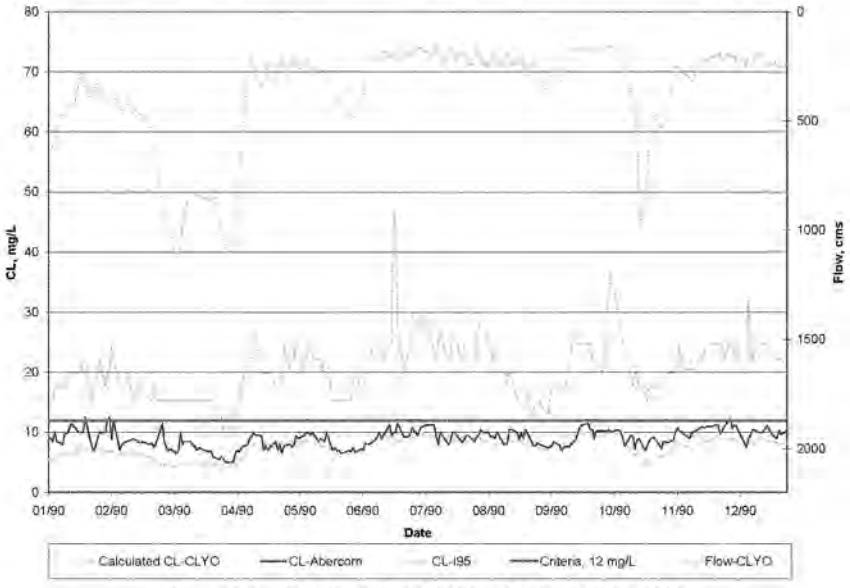


Figure 5-4 Calculated Chloride Time Series at Clyo - 1990

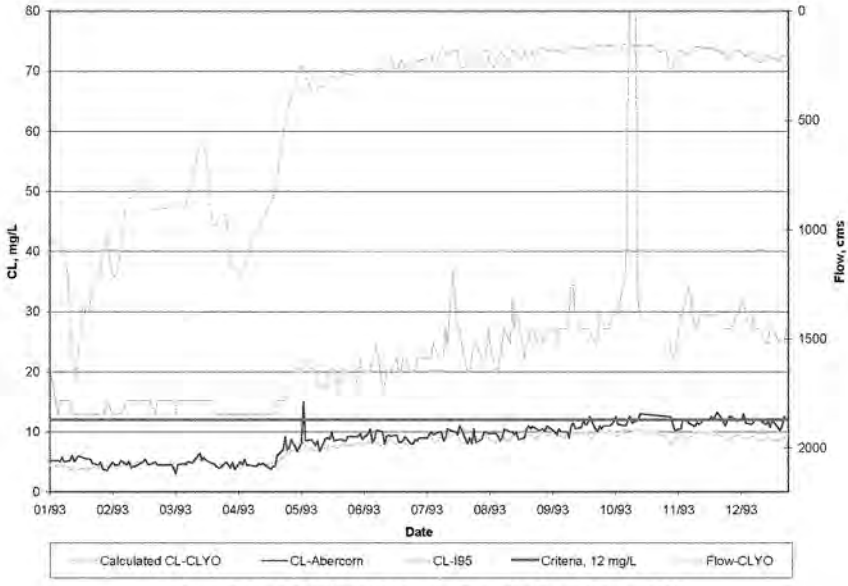


Figure 5-5 Calculated Chloride Time Series at Clyo - 1993

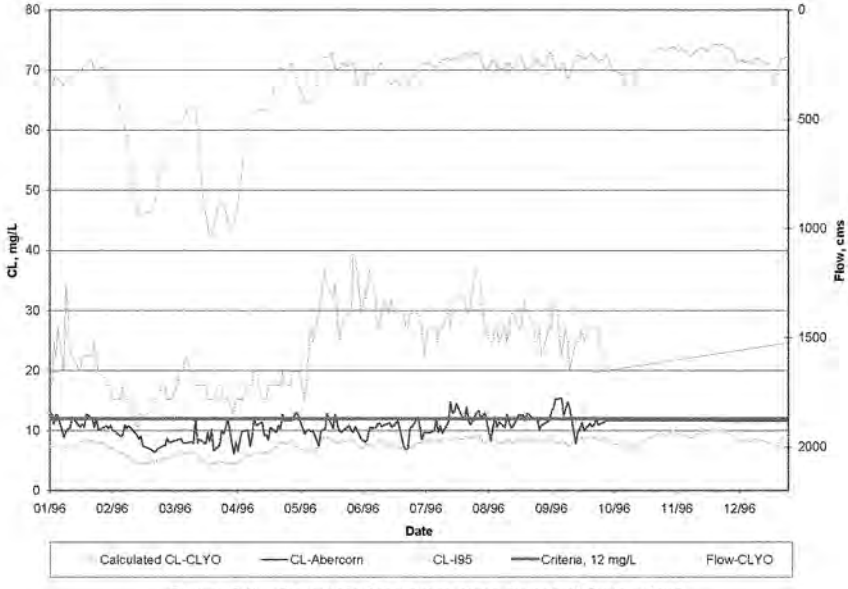


Figure 5-6 Calculated Chloride Time Series at Clyo - 1996

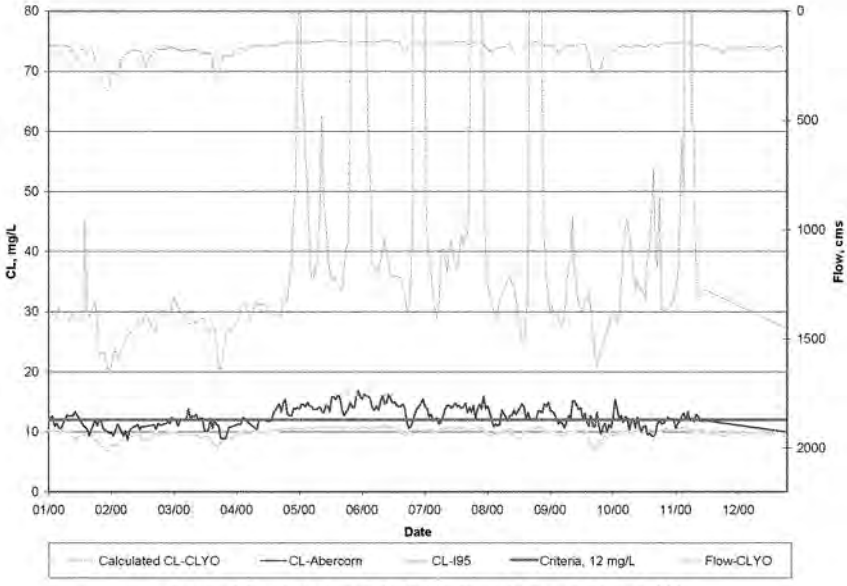


Figure 5-7 Calculated Chloride Time Series at Clyo - 2000

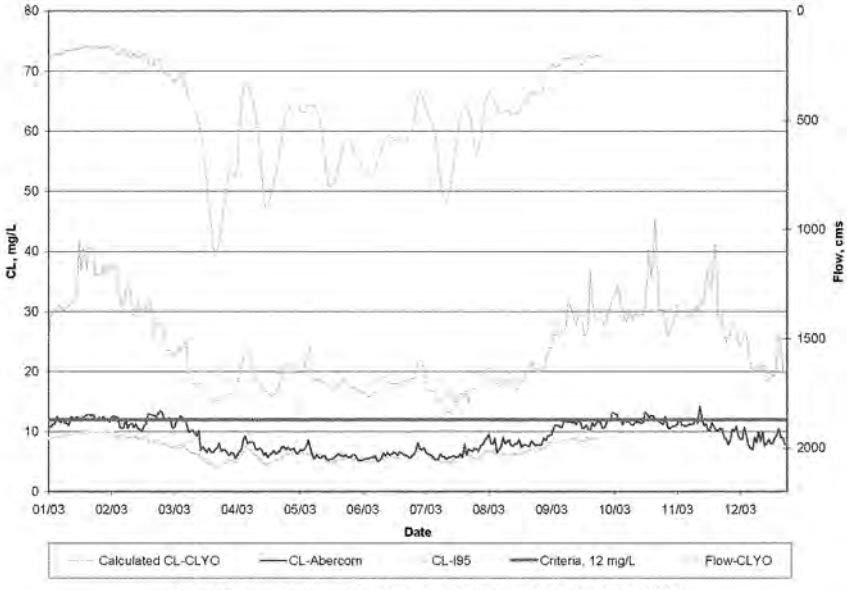


Figure 5-8 Calculated Chloride Time Series at Clyo - 2003

5.3 Supplemental Analysis with Water Quality Data Observed at the Intake

In addition to the data presented previously, the City of Savannah also measured specific conductance at the intake. Approximately 2200 corresponding records of conductance and chloride were taken by the City at the intake from 1997 through 2006. These data are provided in Figure 5-9 where the similarities in trend of the two data sets may be observed. The trend is visible in both constituents between 1998 and 2001, where a gradual increase in concentrations is seen. Then in 2001, 2003 and the end of 2004 significant reductions in concentrations are correspondingly observed in both specific conductance and chlorides.

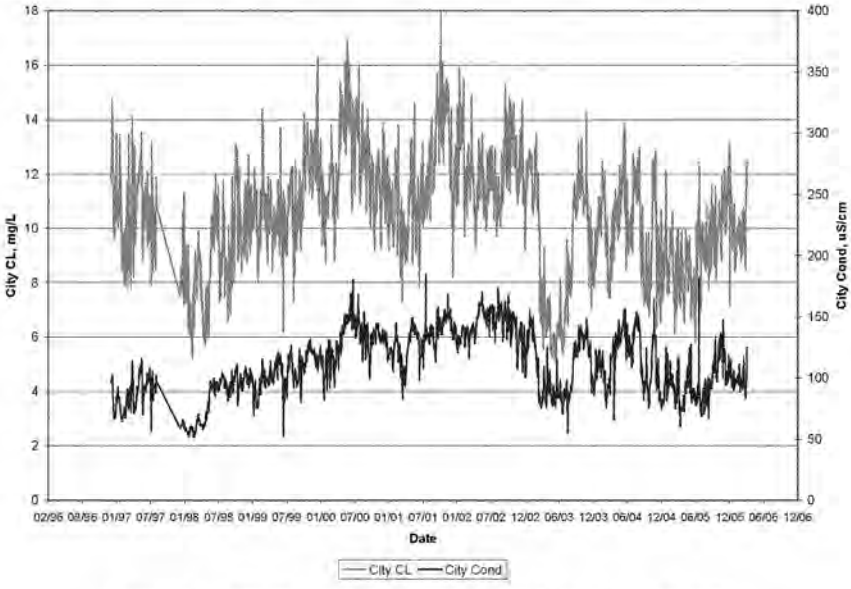


Figure 5-9 Specific Conductance versus Chloride at the City's Intake

It is assumed here that the relationship between specific conductance and chlorides observed at the intake may be used to represent the salinity influences from the harbor. By conducting a regression analysis on these constituents, a linear relationship between specific conductance and chloride concentrations at the intake may be identified. The results of this regression are shown in Figure 5-10. The regression resulted in an R-squared value of 0.49 and at a 95% confidence interval, the sample set had an error of ±0.41 mg/L. The relationship between the specific conductance and chloride concentrations at the intake based on this regression may then be represented by the following equation:

$$\mathbf{Chloride_{Salinity} = 0.0574*(Conductance) + 4.1603}$$

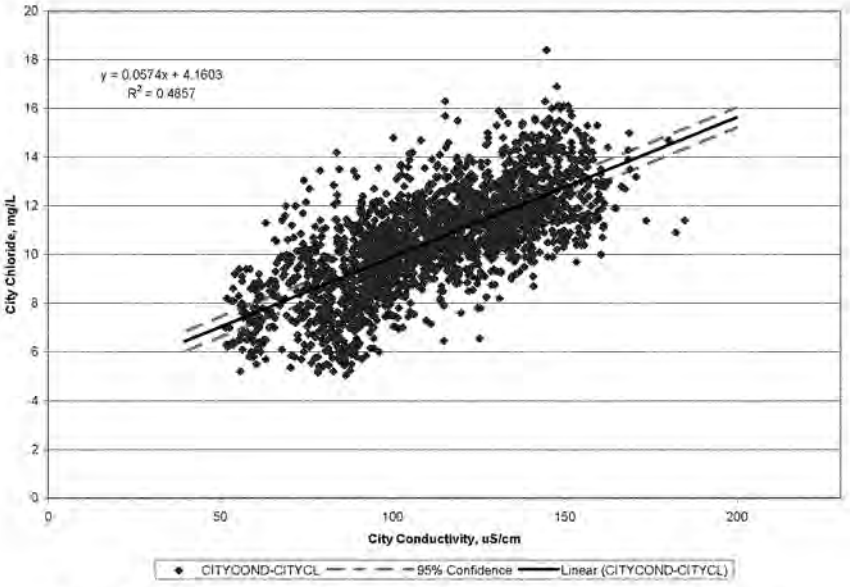


Figure 5-10 Regression of Specific Conductance versus Chloride at the City's Intake

6.0 Source Assessment

6.1 Upstream Sources

To identify whether upstream sources were contributing to chloride values in exceedance of the 12 mg/L benchmark in Abercorn Creek, all USGS stations located within and upstream of the Lower Savannah River watershed were queried and summarized. Table 6-1 and Figure 6-1 provide descriptive and locational information for each of these stations.

Chloride data from these stations were statistically examined to provide the temporal and numerical range and mean of chloride values at each station (Table 6-2). Chloride data were not available at two critical locations, 02198500 (Clyo) and 02198840 (I-95 Bridge). Though limited in sample size, the data indicates that there is a baseline value for chlorides from upstream sources, with an overall mean of 2.31 mg/L and an overall maximum of 6.5 mg/L from these stations, excluding 02198920 (Houlihan Bridge) and 02198980 (Fort Pulaski). There are no exceedances of the chloride benchmark in these samples. Though these observations are deemed additive to chloride values in the Lower Savannah River watershed, they do not suggest that upstream sources are a specific contributor to violations in chloride at the Abercorn Creek intake.

Table 6-1 USGS Stations Within and Upstream of the Lower Savannah River Watershed

Agency	Station	Station Description	Lat	Long
USGS	02187500	SAVANNAH RIVER NEAR IVA, S.C.	34.2556	82.7450
USGS	02189000	SAVANNAH RIVER NEAR CALHOUN FALLS, S. C.	34.0700	82.6417
USGS	02192500	LITTLE RIVER NEAR MT. CARMEL, SC	34.0692	82.5014
USGS	02196000	STEVENS CREEK NEAR MODOC, SC	33.7292	82.1853
USGS	02196838	BUTLER CREEK RESERVOIR AT FORT GORDON, GA	33.5150	82.0022
USGS	02197300	UPPER THREE RUNS NEAR NEW ELLENTON, SC	33.3839	81.6133
USGS	02198500	SAVANNAH RIVER NEAR CLYO, GA	32.5281	81.2689
USGS	02198840	SAVANNAH RIVER NEAR PORT WENTWORTH, GA	32.2356	81.1514
USGS	02198920	SAVANNAH RIVER AT GA 25 AT PORT WENTWORTH, GA	32.1658	81.1539
USGS	02198980	SAVANNAH RIVER AT FORT PULASKI, GA	32.0339	80.9033

Table 6-2 Summary of Chloride Observations from USGS Stations Upstream of the Lower Savannah River Watershed

	02187500	02189000	02192500	02196000	02196838	02197300	02198920*	02198980*
# Observations	34	21	2	1	1	150	33	209
First Year	1957	1956	1959	1961	1999	1967	1958	1960
Last Year	1972	1972	1961	1961	1999	1993	2003	1960
Minimum CL, mg/L	1.4	1.2	2	6.5	3.68	0.2	3.2	3.8
Maximum CL, mg/L	4.7	4.4	2	6.5	3.68	3.7	6,900	11,000
Mean CL, mg/L	2.44	2.54	2.00	6.50	3.68	2.22	2,239	4,848

* stations are located in the estuary where salinity is frequently present.

Figure 6-1 USGS Station Locations Within and Upstream of the Lower Savannah River Watershed

6.2 Point Sources

There are few industrial facilities upstream of the Abercorn Creek intake that contain chlorine in their effluent. For these facilities, any limitations or monitoring for salts such as chlorides would only be considered if there were water quality concerns, which is not the case for any current point source discharge to the Savannah River. The Fort Howard (now Georgia Pacific) discharge near Rincon would have a dilution ratio of 200-300:1 based on 7Q10 flow.

GAEPD routinely assigns total residual chlorine limits to permitted municipal discharges. The effluent permit limits can range from 0.011 mg/L (for discharges to streams with very low 7Q10 streamflows) to 0.5 mg/L, which is the maximum allowed by their guidelines, and well below 12 mg/L at the intake.

6.3 Groundwater

This assessment anticipated groundwater to be a contributing source for chlorides in Abercorn Creek. The possible presence of a local spring, or elevated groundwater-surface water interactions, in the watershed due to coastal proximity and/or prominent wetlands within the area were suspected as potential factors. The absence of a contributory spring in the area was confirmed though upon referring to detailed topographic maps of the watershed and conducting a series of discussions with the groundwater counterparts to this study.

To address groundwater-surface water interactions, a USGS study published in 1997 was referenced. The study involved twelve wells in Chatham County that were pumped and sampled to determine groundwater conditions in Georgia. Figure 6-2 shows the locations of six of these wells within the Savannah River area. One of these wells, 37Q185, is located approximately 14 miles downstream of the Abercorn Creek intake. This well was tapped at an interval of 274-360 ft below the surface and data from it is given in Figure 6-3, measured from 1985 through 1997. (Cressler, 1997) The values obtained indicated that chloride concentrations within the aquifer do not change appreciably with time and generally fluctuate around 6 mg/L, well below 12 mg/L at the intake. This suggests that a baseline chloride signal does exist in the groundwater and it may have some impact on chloride values in surface water, but it is probably not the sole cause of exceedances of the benchmark.

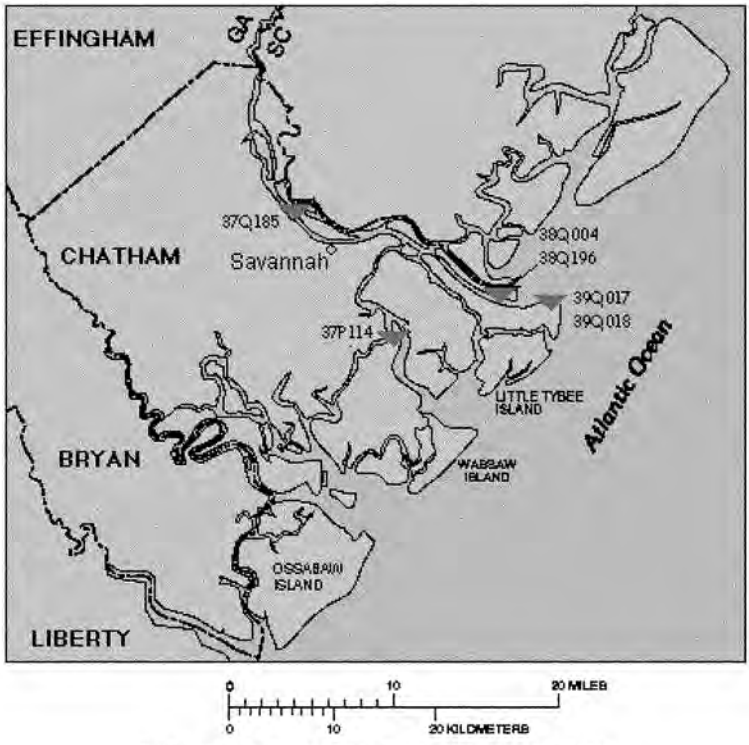


Figure 6-2 Savannah River Wells Monitored by USGS

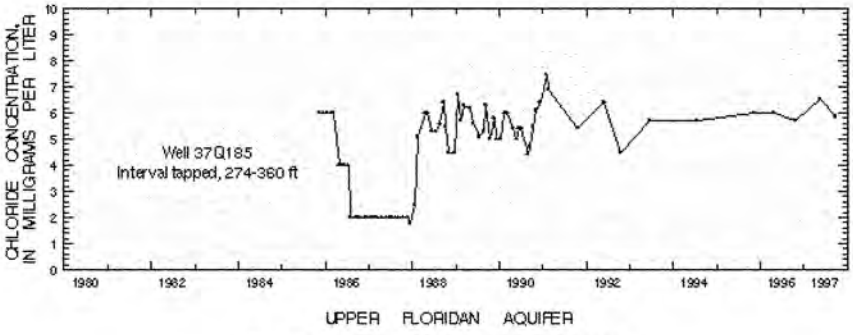


Figure 6-3 Data from USGS Well 37Q185

7.0 Development of Chloride Model

The chloride model (or prediction equation) based on flow alone was further assessed to provide more reliability in its overall function and result. It was necessary to establish a method by which all available data and a variety of analytical methods may be employed to ensure the best possible arrangement for predicting chloride. Based on the data analysis and source assessment, the chloride model will consist of two components; chlorides derived from upstream flow and those due to salinity from the harbor. The chloride model is represented as the following:

$$\mathbf{Chloride_{Intake} = Chloride_{Flow} + Chloride_{Salinity}}$$

A prior analysis had defined a direct relationship for the first component of this equation, where chloride concentrations at the USGS gage at Clyo (02198500) were written as a function of the upstream flow measured there.

$$\mathbf{Chloride_{Flow} = 92.118 * Flow^{(-0.436)}}$$

To define the second (salinity) component of the predictive equation, a 7-year, hourly time-series of salinity was obtained from the calibrated EFDC model for Savannah Harbor. The salinity time series was extracted from the middle layer of model grid cell (8,130) at the intake location and was converted by a two-step process to provide a simulated chloride time-series. This conversion may be represented by the following equation:

$$\mathbf{Salinity_{EFDC} \rightarrow Cond_{USGS} \rightarrow Chloride_{Salinity}}$$

The first step of the conversion required the application of published algorithms provided by USGS on the salinity record and resulted in a time-series of conductivity ($COND_{USGS}$) at the intake (Miller, 1988). The second step of the conversion took into account the relationship between conductivity and chloride concentrations. This relationship was developed using a regression analysis conducted on observed data for these constituents, taken at the City of Savannah's intake on Abercorn Creek. By applying this relationship, a 7-year time-series of the salinity influenced chloride concentrations at the intake was obtained. Figure 5-10 provides a graphical representation of this regression and the following equation defines the relationship between conductivity and chlorides based on this analysis:

$$\mathbf{Chloride_{Salinity} = 0.0574 * (Salinity_{EFDC} \rightarrow Cond_{USGS}) + 4.1603}$$

The resulting relationship to predict chloride concentrations at the City's intake can then be written as follows:

$$\mathbf{Chloride_{Intake} = Chloride_{Flow} + Chloride_{Salinity}}$$

$$\mathbf{Chloride_{Intake} = [92.118 * Flow^{(-0.436)}] + [0.0574 * (Salinity_{EFDC} \rightarrow Cond_{USGS}) + 4.1603]}$$

This relationship can be plotted as a time-series and is represented in Figures 7-1 and 7-2. These have been split into two separate time periods to meet data record limitations in the application and provide ease of interpretation. The predictive equation provides a relatively accurate depiction of the trend of chloride values observed at the intake (INTAKE-CL), though it does tend to overpredict some of the observations.

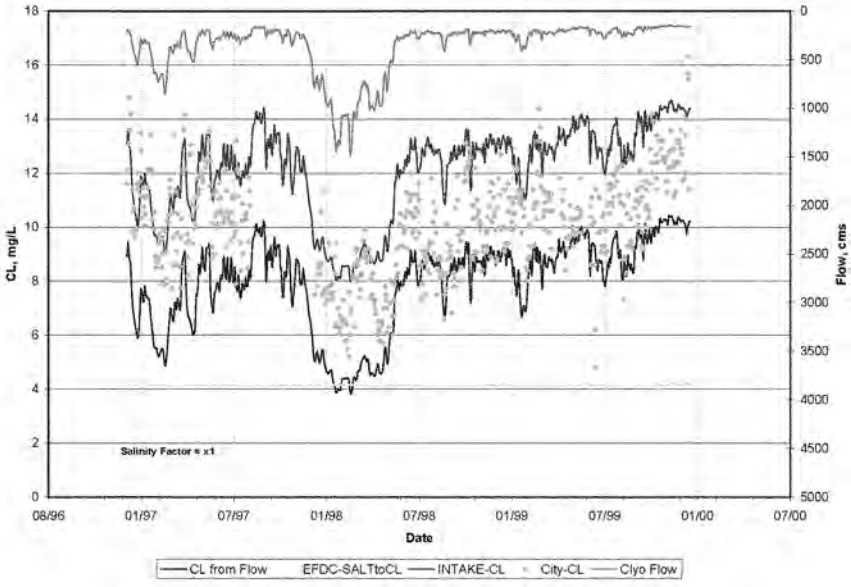


Figure 7-1 Predicted Chlorides at the Intake (1997 through 1999)

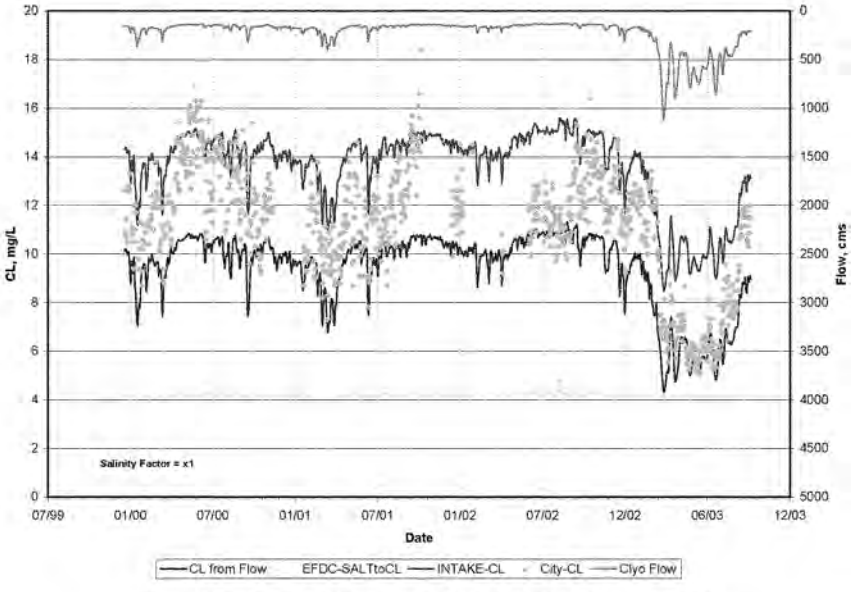


Figure 7-2 Predicted Chlorides at the Intake (2000 through 2003)

By conducting a regression analysis between the chloride values predicted by the model and the chloride measurements observed at the City's intake, a linear relationship may be identified. The results of this regression are shown in Figure 7-3. The regression resulted in an R-squared value of 0.59. The accuracy of the model can be further interpreted through a 95% confidence interval which results in a range of ±0.33 mg/L, shown in Figure 7-3.

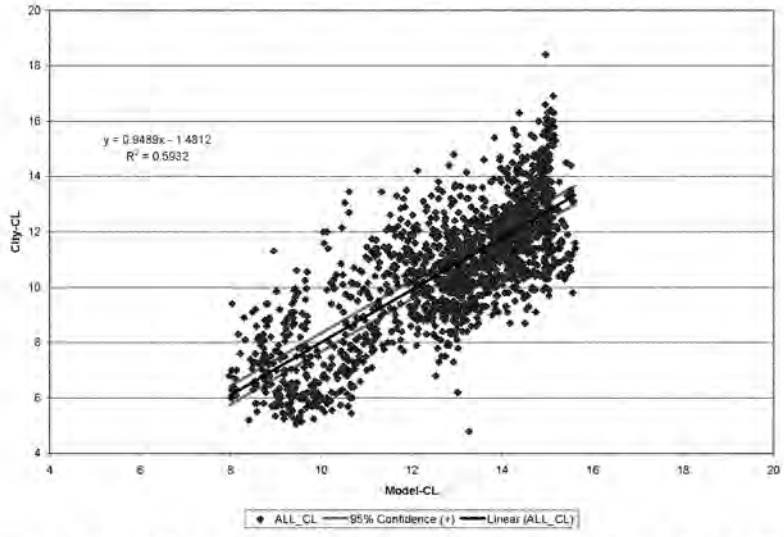


Figure 7-3 Relationship between the City's Measurements of Specific Conductivity and Chloride

Table 7-1 further provides a host of descriptive statistics for chloride measured at the intake and the output from the Chloride Model for the period of 1997 through 2003. These aid in defining the accuracy of the prediction, as well as the range of the model error.

Table 7-1 Descriptive Statistics for the Observed Chloride and Output from the Chloride Model

Statistics	CL - Observed	CL - Model
Range, mg/L	13.600	7.641
Maximum, mg/L	18.400	15.611
Mean, mg/L	10.733	12.872
Standard Deviation	2.324	1.887
Sample Variance	5.402	3.559
Standard Error (Root Mean)	0.056	0.046
R^2	0.593	
Average % Model Error	11.12	

Figure 7-4 presents a cumulative frequency distribution of the City's chloride measurements versus the chloride model results.

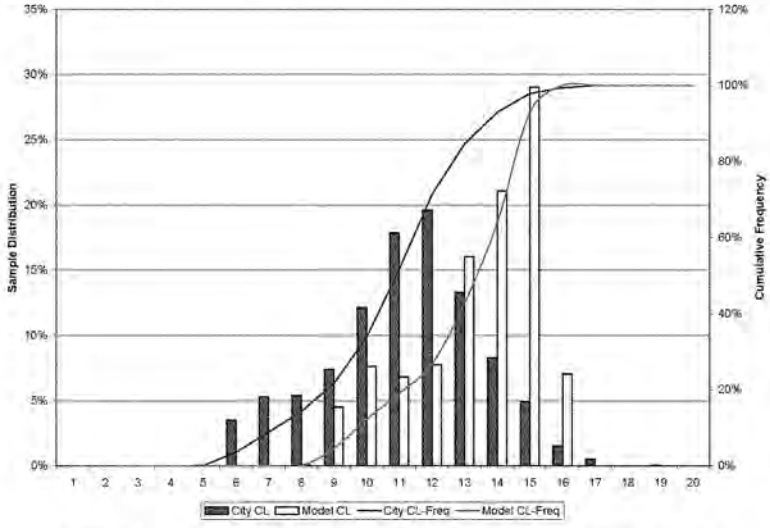


Figure 7-4 Cumulative Chloride Distribution of the City and Model Results

To further assess the Chloride Model, the predicted chlorides and the City's observations were both compared annually against various chloride concentration benchmarks (X). The concentrations used in this comparison were 8mg/L, 10 mg/L, 12 mg/L, 14 mg/L, 16 mg/L and 18 mg/L. The comparison also calculated the annual average difference by which the model results and the City's observations were higher than the benchmark. The comparison is summarized in Table 7-2.

The summary indicates that the model is able to relatively accurately mimic the number of samples that are in exceedance of the benchmark at 8 and 10 mg/L, as compared to the City's measurements. As the benchmark concentration is increased to 12 mg/L, the model is found to be over-predicting more than the City observations, though only by an average difference of about 1.4 mg/L. As the benchmark concentration is increased to 14 mg/L, the model over-predicts by an even smaller average difference, and then never gets higher than 16 mg/L. The City's observations do show occasional exceedances beyond 14 mg/L, but these are few in number and only represent average differences of between 0.3 and 1.0 mg/L. There is only one sample taken by the City that is greater than 18 mg/L indicating the infrequency of such events.

Table 7-2 Summary of Model Results and City Observations with Respect to Various Benchmarks for Chloride Concentration (X)

X - Chlorides mg/L	Year	Total Obs.	Model > X # Samples	Model > X % Samples	Model > X Avg. Difference	City > X # Samples	City > X % Samples	City > X Avg. Difference
8	1997	168	168	100.0	3.56	163	97.0	2.83
8	1998	252	251	99.6	3.12	169	67.1	1.73
8	1999	226	226	100.0	5.31	222	98.2	3.04
8	2000	288	288	100.0	6.18	288	100.0	4.56
8	2001	271	271	100.0	5.83	269	99.3	3.47
8	2002	224	224	100.0	6.69	224	100.0	4.12
8	2003	273	273	100.0	3.12	124	45.4	3.00
7 Year Summary		**1702**	**1701**	**99.9**	**4.87**	**1459**	**85.7**	**3.41**
10	1997	168	148	88.1	1.84	116	69.0	1.48
10	1998	252	152	60.3	2.61	59	23.4	1.14
10	1999	226	226	100.0	3.31	164	72.6	1.62
10	2000	288	288	100.0	4.18	270	93.8	2.77
10	2001	271	271	100.0	3.83	208	76.8	2.09
10	2002	224	224	100.0	4.69	214	95.5	2.23
10	2003	273	185	67.8	1.93	95	34.8	1.67
7 Year Summary		**1702**	**1494**	**87.8**	**3.39**	**1126**	**66.2**	**2.06**
12	1997	168	69	41.1	0.65	32	19.0	0.93
12	1998	252	133	52.8	0.83	9	3.6	0.52
12	1999	226	208	92.0	1.46	49	21.7	1.07
12	2000	288	277	96.2	2.28	166	57.6	1.74
12	2001	271	249	91.9	2.04	94	34.7	1.39
12	2002	224	222	99.1	2.71	104	46.4	1.29
12	2003	273	88	32.2	1.24	34	12.5	0.54
7 Year Summary		**1702**	**1246**	**73.2**	**1.85**	**488**	**28.7**	**1.35**
14	1997	168	0	0.0	0.00	3	1.8	0.38
14	1998	252	0	0.0	0.00	0	0.0	0.00
14	1999	226	62	27.4	0.30	5	2.2	1.22
14	2000	288	196	68.1	0.61	65	22.6	0.91
14	2001	271	151	55.7	0.50	24	8.9	1.04
14	2002	224	192	85.7	0.93	23	10.3	0.53
14	2003	273	13	4.8	0.12	0	0.0	0.00
7 Year Summary		**1702**	**614**	**36.1**	**0.64**	**120**	**7.1**	**0.87**
16	1997	168	0	0.0	0.00	0	0.0	0.00
16	1998	252	0	0.0	0.00	0	0.0	0.00
16	1999	226	0	0.0	0.00	1	0.4	0.30
16	2000	288	0	0.0	0.00	5	1.7	0.34
16	2001	271	0	0.0	0.00	3	1.1	1.03
16	2002	224	0	0.0	0.00	1	0.4	0.40
16	2003	273	0	0.0	0.00	0	0.0	0.00
7 Year Summary		**1702**	**0**	**0**	**0**	**10**	**0.6**	**0.55**
18	1997	168	0	0.0	0.00	0	0.0	0.00
18	1998	252	0	0.0	0.00	0	0.0	0.00
18	1999	226	0	0.0	0.00	0	0.0	0.00
18	2000	288	0	0.0	0.00	0	0.0	0.00
18	2001	271	0	0.0	0.00	1	0.4	0.40
18	2002	224	0	0.0	0.00	0	0.0	0.00
18	2003	273	0	0.0	0.00	0	0.0	0.00
7 Year Summary		**1702**	**0**	**0**	**0**	**1**	**0.1**	**0.40**

The annual average difference from each benchmark for the model predictions and the City's observations can also be illustrated, as in Figure 7-5. This provides a relative comparison between the two and indicates the over-prediction by the model between the 8mg/L to 12 mg/L benchmarks. The model displays an average difference relatively similar to the City's observations at the 14 mg/L benchmark. The Chloride Model never predicts values larger than the 16mg/L benchmark.

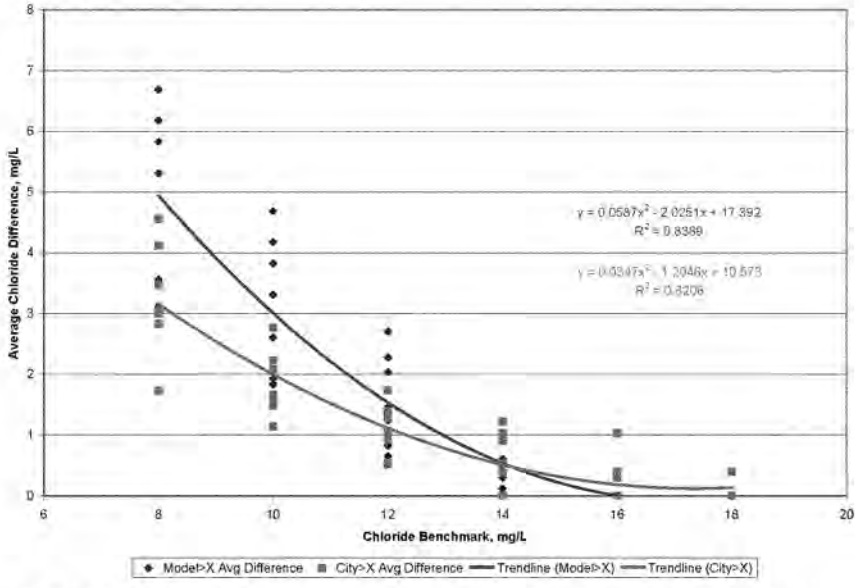


Figure 7-5 Average Difference between Model and City Values and the Chloride Benchmark

A summary of the City's chloride observations relative to the model's predictions are also provided in Table 7-3. This table illustrates the magnitude of the difference between the model's predictions and the City's observations. Of note is the largest range in chloride measurements made by the City (10.0 mg/L), which is observed when the model predicts at 13 mg/L.

Table 7-3 Summary of the City's Observations Relative to Predictions by the Chloride Model.

Model Prediction	City CL Observations at Intake, mg/L				
CL, mg/L	Average	Min	Max	Range	+/-
8	7.2	5.2	9.4	4.2	2.1
9	7.3	5.1	11.3	6.3	3.1
10	7.4	5.2	12.1	7.0	3.5
11	8.9	5.5	13.4	8.0	4.0
12	10.4	7.7	14.2	6.5	3.3
13	10.6	4.8	14.8	10.0	5.0
14	11.8	8.7	16.3	7.6	3.8
15	12.8	8.7	18.4	9.7	4.8

8.0 Conclusions

This study attempted to better understand chloride levels at the City of Savannah's freshwater intake on Abercorn Creek. It successfully met all of its anticipated objectives by providing a summary of the available data, determining the relationship between upstream flow and chloride measurements within the system, investigating the impact of past harbor deepening on chloride levels at the intake, addressing other potential sources of chlorides, and developing a predictive model for chloride concentrations.

It was immediately clear that the data available for this study were limited. The lack of flow and hourly chloride values at the City's intake required the analysis to rely on data from other locations within the watershed and to make assumptions on conditions at the intake itself. However, the analysis solidified the presumption that chloride levels at the Abercorn Creek intake are inversely related to flow in the Savannah River, as is the case throughout the system. Further, the study strengthens the suggestion that saltwater intrusion into the system plays a major factor for chloride concentrations at the intake. This is more pronounced during low flow periods. The lack of localized chloride data on Abercorn Creek limited the analysis from quantifying the magnitude by which chlorides at the intake vary due to changes in upstream flow and saltwater intrusion.

Upstream sources, point sources, and groundwater intrusion were not found to contain chloride concentrations that would directly cause exceedances of the benchmark. No point sources with relevant chloride permits were located nearby or upstream. Upstream sources displayed an overall average of 2.31 mg/L, while groundwater values fluctuated around 6 mg/L. It is likely that these sources have a cumulative impact on chloride values at the intake, but they are not responsible for samples found in exceedance of 12 mg/L.

Figure 5-2 proves that the upper Savannah River contains approximately 10 mg/L during low flows (highest of 11 mg/L) and 4 mg/L during extremely high flows (> 1,000 cms and 35,000 cfs). The lower ranges of chloride are diluted with higher inflows and watershed drainage in the basin. Therefore, it is during these critical low flow periods where the chloride is a 10 mg/L and salinity intrusion can cause an additional 2-3 mg/L to exceed 12 mg/L at the intake. The raised levels of chloride from the upper Savannah River in addition to the salinity intrusion causes the chloride on Abercorn Creek to be higher than 12 mg/L at times.

These results will be used in the future to determine impacts on chloride concentrations at the City's Intake. Based on the chloride model presented in this report, it will be included in the SHE Model Post-Processor to determine chloride concentrations on Abercorn Creek and determine how they respond to projected uses of the harbor. This chloride model presented herein will use the simulated salinity from the Enhanced Grid of the Environmental Fluid Dynamics Code (EFDC) model at the Abercorn Creek along with freshwater flow inputs at the USGS Gage near Clyo, GA to estimate a change in chloride concentration at the intake.

As discussed in this report, the chloride concentrations on Abercorn Creek are a function of chloride due to upstream Savannah River sources and salinity from the harbor. Based on the analysis, the results of the Chloride Model are accurate to ±0.33 mg/L at a 95% confidence level. In summary, the following equation combines both sources of chloride and will be used to make predictions at the City's Intake:

$$\mathbf{Chloride_{Intake} = [92.118*Flow^{(-0.436)}] + [0.0574*(Salinity_{EFDC} \rightarrow Cond_{USGS}) + 4.1603]}$$

where: $\mathbf{Chloride_{Intake}}$ is in mg/L, **Flow** is in cms and measured at USGS Clyo Gage 02198500, $\mathbf{Salinity_{EFDC}}$ is in ppt and the salinity output from the EFDC model.

9.0 References

City of Savannah, Water and Sewer Bureau, Communications and data transmittal from Tony Tucker and John Sawyer. Provided data from the City for 1988 through 2006.

Cressler, Alan M., *Ground-Water Conditions in Georgia*, U.S. Geological Survey Open-File Report 98-172, 1997.

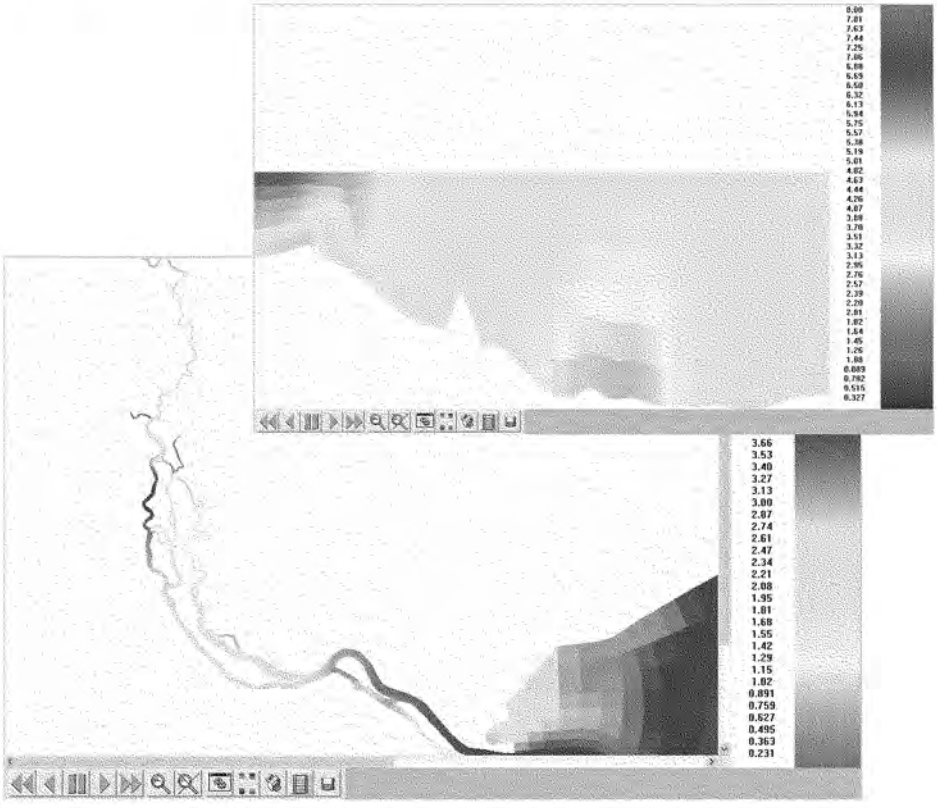
Devroe, Jay L., Probability and Statistics for Engineering and the Sciences, Duxbury Press, Fourth Edition, 1995.

Feth, J. H., Chloride in Natural Continental Water - A Review, 1981, USGS Water-Supply Paper 2176.

Miller, R., Bradford, W., Peters, N., Specific Conductance: Theoretical Considerations and Application to Analytical Quality Control, 1988, USGS Water-Supply Paper 2311.

River Center, http://www.rivercenter.uga.edu/education.htm.

Water Quality Impacts of the Savannah Harbor Expansion Project



PREPARED BY:

Tetra Tech, Inc.
2110 Powers Ferry Rd. SE, Suite 202
Atlanta, Georgia 30339
Phone: (770) 850-0949

PREPARED FOR:

USACE – Savannah District
100 West Oglethorpe Ave
Savannah, Georgia 31401
Contract No.: DACA65-99-D-0065-CV0101

February 12, 2007

Executive Summary

This report summarizes the results of evaluating the water quality impacts for the Savannah Harbor Expansion (SHE) project specifically of the harbor deepening, point sources, and Savannah River flow effects. The water quality impacts focus on dissolved oxygen and salinity regimes of the Savannah Harbor.

The Savannah Harbor hydrodynamic and water quality models were developed and finalized in a Tetra Tech report dated January 30, 2006. The models were designed based on EFDC and WASP codes. A post-processor specific to the needs of the SHE was developed by Tetra Tech to analyze the model results of various deepening scenarios and mitigation measures. This is a stand-alone program that can read EFDC and WASP output files (BMD files) and generate required output in specific formats in accordance with requirements of the USACE Savannah District and the agencies involved in the Environmental Impact Statement (EIS) Tier II review.

The hydrodynamic model runs were performed by the USACE Savannah District with the calibrated and confirmed EFDC model developed by Tetra Tech. The WASP water quality simulations were performed by Tetra Tech.

In accordance with the Scope of Work the hydrodynamic and water quality scenarios assume four major evaluations:

- Basic Evaluation (BE) – 1999 (drought year) flow, hydrological and meteorological conditions, and 2004 harbor point sources' BOD loads
- Sensitivity Analysis #1 (SA1) – 1997 (average year) flow, hydrological and meteorological conditions, and 2004 harbor point sources' BOD loads
- Sensitivity Analysis #2 (SA2) – 1999 (drought year) flow, hydrological and meteorological conditions, and 1999 harbor point sources' BOD loads
- Sensitivity Analysis #3 (SA3) – 1999 (drought year) flow, hydrological and meteorological conditions, and permitted harbor point sources' BOD loads

Scenarios of existing bathymetry and 6-, 4-, 3-, and 2-foot deepening were simulated for aforementioned conditions of Basic Evaluation and Sensitivity Analysis #1. Scenarios of existing bathymetry were simulated for Sensitivity Analyses #2 and #3. The 5-foot depth simulation was removed by the USACE Savannah District.

In accordance with the requirements of the Water Quality Review Group, the simulation periods were chosen from May 1 to October 30 of 1999 and 1997.

The total number of analyzed scenarios is 12. The model results are presented in the following Appendixes:

- Appendix A – Basic Evaluation, existing bathymetry (BE-E)
- Appendix A.1 – Basic Evaluation, 6 ft deepening bathymetry (BE-6)
- Appendix A.2 – Basic Evaluation, 4 ft deepening bathymetry (BE-4)
- Appendix A.3 – Basic Evaluation, 3 ft deepening bathymetry (BE-3)
- Appendix A.4 – Basic Evaluation, 2 ft deepening bathymetry (BE-2)
- Appendix B – Sensitivity analysis #1, existing bathymetry (SA1-E)
- Appendix B.1 – Sensitivity analysis #1, 6 ft deepening bathymetry (SA1-6)
- Appendix B.2 – Sensitivity analysis #1, 4 ft deepening bathymetry (SA1-4)

- Appendix B.3 – Sensitivity analysis #1, 3 ft deepening bathymetry (SA1-3)
- Appendix B.4 – Sensitivity analysis #1, 2 ft deepening bathymetry (SA1-2)
- Appendix C – Sensitivity analysis #2, existing bathymetry (SA2-E)
- Appendix D – Sensitivity analysis #3, existing bathymetry (SA3-E)

Table 1 CBODu Point Sources Loads in Savannah Harbor

Facility Name	Location Cell(I,j)	Loads (lbs/day)		
		2004	1999	Permitted
Hardeville	14,148	13.0	25	505.55
Fort James	14,171	5873.0	3810.46	54249.46
Weyerhayser	13,95	6797.0	809.86	30150
Garden City	13,77	32.0	122	2700.7
Whilshire	13,74	0.0	737.31	2814.79
Travis Field	13,74	27.0	129	576.35
President Street	13,54	1489.0	4398.99	16246.15
IP	15,70	143448.0	86669.75	269328
Englehard	13,52	0	0.38	0

To analyze the results of the current simulations the postprocessor was updated in accordance with the Memorandum for Record of the Meeting of Water Quality Interagency Coordination Team (June 5, 2006). The MOVEM (standard postprocessor of WASP) was used for graphical visualization of the outputs of Tetra Tech's Savannah Model post-processor.

The Savannah Model postprocessor outputs information for the harbor's following spatial objects:

- Critical Cell – the cell with lowest D.O. concentrations during specified simulation period
- Critical Segment – an assemblage of cross section cells located at the critical cell's j-coordinate
- Zone – an assemblage of cells that is limited by specified horizontal and vertical boundaries

The postprocessor's outputs were used for comparative evaluation of water quality regime in different areas of the harbor and for different simulation scenarios by:

- Comparing critical cells' D.O. concentrations for project scenarios and existing conditions with Georgia and South Carolina existing and proposed standards for D.O.
- Comparing zones' volume-weighted D.O. concentrations for existing and project scenarios, and D.O. standards.
- Comparing the percentage of water volume with D.O. concentrations that violate the D.O. standards for each zone during the selected simulation periods.
- Comparing the percentage of water volumes with specified salinity and D.O. %iles for major parts and stations of the estuary.
- Comparing the percentage of water volumes in Upper Harbor in increments of 1° C of water temperature and 0.1 mg D.O.

- Analyzing values and their changes in longitudinal profiles of D.O. distributions along critical cells of Front, Back, Little Back, and Middle Rivers.
- Analyzing values and their changes in minimum, 5th, 50th, and 95th percentiles D.O. and salinity distributions in bottom and surface areas of the estuary.
- Analyzing dynamics of 1-, 7-, and 30-day averaged D.O. and salinity and their changes in longitudinal - vertical plane of Front River.

Figure 1 shows 26 spatial zones that delineate the major estuary's simulated areas. The zones cover the estuary areas that are or can be affected by low D.O. levels. There are 11 zones for Front River (FR), 6 zones for Middle River (MR), 3 zones for Back River (BR), 3 zones for Little Back River (LBR), 2 zones for South Channel (SH), and 1 zone for Savannah River (SR). The grid coordinates (I, J) of each zone's boundaries are presented in Table 3-1.

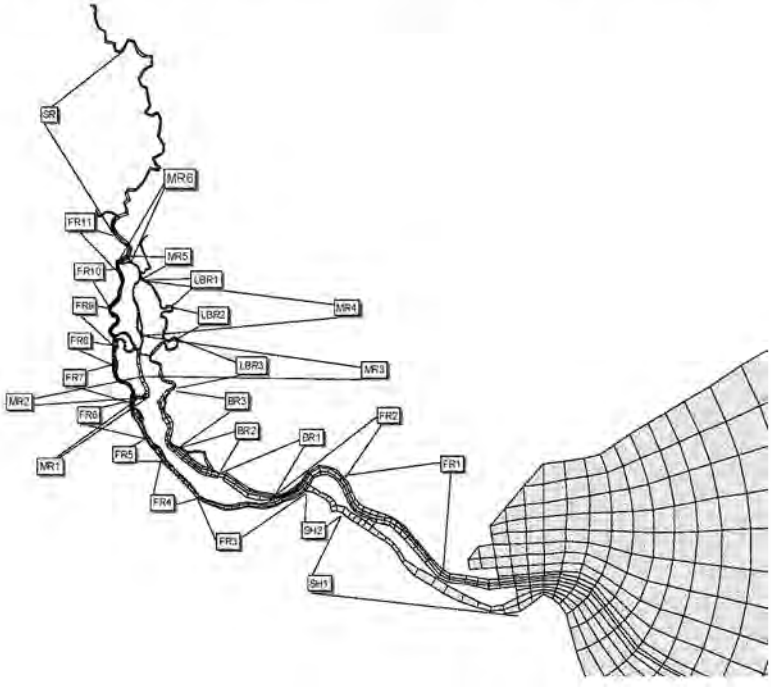


Figure 2-3 Zones' Delineation of Savannah Estuary Computational Grid

The current report is accompanied by the postprocessor's originated outputs: CSV, TXT and BMD files. These files as well as WASP MOVEM postprocessor and GIS horizontal shape files for working with BMD files are included in the attached DVD. Due to the large size of tables with water volumes in D.O. increments and water volumes corresponding to 1-, 7-, and 30-day D.O. averages, the tables were presented in electronic format and placed into folders of the postprocessor output.

Comparing corresponding tables and figures of Appendixes A, C, and D the reviewer can evaluate the effect of the harbor's point sources loads regulation on the dissolved oxygen regime of the estuary. Comparing the tables and figures of Appendixes A, and B the reviewer evaluates the effect of the drought year river flow on the dissolved oxygen regime. Comparing information of Appendixes A, A1, A2, A3, and A4, as well as Appendixes B, B1, B2, B3, and B4, the reviewer estimates effect of different scenarios of the harbor's deepening on the oxygen regime.

Table 2 Grid Coordinates and Volumes of Delineating Zones

Zone #	Zone Name	Grid Coordinates				Volume km3*1000	Relative Volume (%)
		I beg	J beg	I end	J end		
1	FR1	13	26	6	17	56.385	23.45
2	FR2	13	41	6	17	38.867	16.16
3	FR3	13	53	6	17	15.827	6.58
4	FR4	13	60	6	17	10.97	4.56
5	FR5	13	67	6	17	7.413	3.08
6	FR6	13	73	6	17	14.128	5.88
7	FR7	13	81	6	17	6.629	2.76
8	FR8	13	94	6	17	2.455	1.02
9	FR9	13	98	6	15	5.621	2.34
10	FR10	13	112	6	15	4.39	1.83
11	FR11	13	121	6	14	3.422	1.42
12	MR1	17	82	6	21	0.714	0.3
13	MR2	21	83	6	21	0.965	0.4
14	MR3	26	94	6	26	1.232	0.51
15	MR4	26	105	6	26	0.848	0.35
16	MR5	15	123	6	26	0.246	0.1
17	MR6	20	118	6	20	0.03	0.01
18	LBR1	27	123	6	38	0.347	0.14
19	LBR2	39	107	6	39	0.806	0.34
20	LBR3	30	86	6	30	2.765	1.15
21	BR1	30	59	6	34	15.089	6.28
22	BR2	30	64	6	34	4.994	2.08
23	BR3	30	71	6	32	5.572	2.32
24	SCh1	9	20	6	11	24.377	10.14
25	SCh2	7	45	6	12	4.761	1.98
26	SR	13	128	6	15	11.606	4.83

Some short conclusions from the analysis of the report's results are the following:

1. Effect of the harbor's point sources loads:

a. 2004 and 1999 loads scenarios comparisons:

- The zones most affected by the harbor's point sources' impact are FR2-FR9, and BR1-BR3. The scenario of 2004 point sources loads serves as a benchmark for comparisons with other loads scenarios.
- Table C.2 shows that 1999 loads provide 6-8 % (0.16 – 0.2 mg/l) improvement for the 1st %ile of D.O.; 2-5% (0.1-0.2 mg/l) improvement for the 50th %ile of D.O.; and 1-3% (0.02-0.15 mg/l) improvement for the 95th %ile of D.O. for critical cells of zones FR2-FR9. The D.O. deterioration is observed only for zone FR8 50 – 99 %iles. 1999 loads provide 8-11 % (0.14 – 0.16 mg/l) improvement for the 1st %ile of D.O.; 4-12% (0.14-0.32 mg/l) improvement for the 50th %ile of D.O.; and 2-9% (0.11-0.35 mg/l) improvement for the 95th %ile of D.O. for critical cells of zones BR1-BR3.
- These tendencies persist for D.O. values averaged over the volumes of zones (Table C.4) also. But deterioration of the D.O. regime for zone FR8 is not observed. Table C.5 indicates an increase in percentage of volumes with violations of existing and proposed D.O. standards for the 2004 loads scenario.
- Figures C.21 – C.23 show insignificant differences in D.O. distributions along the vertical-longitudinal plane of Upper Harbor for scenarios A and C.

b. 2004 and permitted loads scenarios comparisons:

- Table D.2 shows that 2004 loads provide 12-25 % (0.4 – 0.8 mg/l) improvement for the 1st %ile of D.O.; 6-14% (0.2-0.6 mg/l) improvement for the 50th %ile of D.O.; and 2-9% (0.1-0.6 mg/l) improvement for the 95th %ile of D.O. for critical cells of zones FR2-FR9. It shows that 2004 loads provide 21-32 % (0.41 – 0.43 mg/l) improvement for the 1st %ile of D.O.; 12-14% (0.37-0.38 mg/l) improvement for the 50th %ile of D.O.; and 5-6% (0.24-0.25 mg/l) improvement for the 95th %ile of D.O. for critical cells of zones BR1-BR3.
- These tendencies persist for D.O. values averaged over the zones' volumes (Table D.4) also. Table D.5 indicates an increase in percentage of volume with violations of existing and proposed D.O. standards for the permitted loads scenario.
- Figures D.21 – C.23 show significant differences in D.O. distributions along vertical plane of Upper Harbor for scenarios A and D

2. Effect of 1999 (drought) and 1997 (average) years hydrological and meteorological conditions :

- Table B.2 shows that the increasing of river flow strongly effects the D.O. concentrations in critical cells particularly in zones of Back, Little Back and Middle Rivers, as well as Savannah River. 1997 flow provide 10-50% increasing of the 1st D.O. %ile, 4-14% increasing of the 50th D.O. %ile, and 10-26% increasing of the 95th %ile for zones of the estuary.
- Table B.4 indicates that increases in D.O. concentrations averaged over volume of zones are up to 29 % for the 1st %ile, up to 10% for the 50th %ile, and up to 27% for the 95th %ile.
- The D.O. and salinity distributions along vertical plane of Upper Harbor for scenarios of 1997 and 1999 flows differ significantly.

3. Effect of the harbor deepening:

- Tables 2 in Appendixes A1, A2, A3, A4, and B1, B2, B3, B4 indicate the D.O. regime deterioration under the impact of the ship channel deepening mostly for critical cells of Front River zones F7, F8, and F9. For the drought year 1999 the D.O. decreases are up to 16.3% (1st and 50th %iles, zone FR7) and 18.2% (99th %ile, zone FR7) for 6 ft deepening;

and between 5.1% (1st %ile, zone FR7) and 1% (99th %ile, zone FR7) for 2 ft deepening. For the average year 1997 the D.O. decrease are 22.8% (1st %ile, zone FR9), 11.5% (50th %ile, zone FR9), and 5% (99th %ile, zone FR4) for 6 ft deepening; and between 8.3% (1st %ile, FR9), 6.6% (50th %ile, BR2), and 9.0% (99th %ile, BR2) for 2 ft deepening.

- Tables 4 in Appendixes A1, A2, A3, A4, and B1, B2, B3, B4 indicate the D.O. regime deterioration under the impact of the ship channel deepening for D.O. values averaged over volume of zones. For the drought year 1999 the D.O. decrease are up to 11.1% (1st %ile, FR9), 8.2% (50th %ile, zone FR8), and 4.9% (99th %ile, zone FR7) for 6 ft deepening; and between 4.7% (1st %ile, zone FR7) and 1.7% (99th %ile, zone FR6) for 2 ft deepening. For the average year 1997 the D.O. decrease are 9.5% (1st %ile, zone FR9), 9.3% (50th %ile, zone FR7), and 10.5% (99th %ile, zone FR4) for 6 ft deepening; and 4.0% (1st %ile, FR9), 3.2% (50th %ile, FR7), and 4.2% (99th %ile, FR3) for 2 ft deepening.
- Tables 5 in Appendixes A1, A2, A3, A4, and B1, B2, B3, B4 show that the deepening insignificantly (1-2%) increases the percentage of volume of the harbor's waters with violations of the existing D.O. standards.
- Figures 1 show the deteriorations of lowest D.O. values along critical cells of major parts of the estuary increase proportionally to projected deepening of the ship channel.
- Figures 2, 3, 6 – 8, 12-14 in Appendixes A1, A2, A3, A4, and B1, B2, B3, B4 visualize upstream shifts of lower D.O. zones in bottom and surface layers of the estuary with increasing of the harbor deepening.
- Figures 4, 5, 9 – 11, 15-17 in Appendixes A1, A2, A3, A4, and B1, B2, B3, B4 visualize an increase in salinity intrusions in bottom and surface layers of the estuary with increasing of the harbor deepening.
- Figures 18 - 23 demonstrate snapshots of animations of 1-, 7-, and 30-day averaged D.O. and salinity dynamics in vertical-longitudinal plane along the ship channel. Higher channel deepening provides increasing of salinity and D.O. stratifications particularly for zones FR7, FR8, and FR9

Appendix A

BASIC EVALUATION: EXISTING BATHYMETRY, 2004 POINT SOURCES LOADS, 1999 HYDROLOGICAL AND METEOROLOGICAL CONDITIONS

May 1 – October 30, 1999 Simulation Period

Water Quality Review Group

1. Table A.1. Dissolved oxygen percentiles distribution in Critical cells

Zone	D.O. Percentile (mg/l)								
	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	3.43	3.61	3.72	3.95	4.29	4.72	5	5.2	5.57
FR2	2.74	2.99	3.11	3.39	3.74	4.16	4.52	4.67	4.97
FR3	2.45	2.69	2.81	3.05	3.5	3.91	4.26	4.41	4.71
FR4	2.51	2.74	2.85	3.1	3.52	3.91	4.25	4.43	4.71
FR5	2.5	2.69	2.78	3.1	3.5	3.87	4.23	4.41	4.62
FR6	2.54	2.74	2.81	3.15	3.51	3.89	4.3	4.48	4.69
FR7	3.13	3.41	3.59	3.95	4.42	4.87	5.21	5.45	6.03
FR8	3.2	3.52	3.69	4.11	4.69	5.11	5.42	5.61	5.9
FR9	3.39	3.64	3.84	4.23	4.74	5.2	5.46	5.61	5.88
FR10	2.29	3.13	3.38	3.92	4.59	5.24	5.65	5.82	6.03
FR11	2.17	2.78	3.15	3.63	4.22	4.85	5.4	5.62	5.94
MR1	2.58	2.99	3.18	3.55	3.93	4.25	4.58	4.75	4.98
MR2	2.2	2.56	2.91	3.37	3.82	4.21	4.53	4.74	5
MR3	2.08	2.45	2.76	3.28	3.74	4.17	4.5	4.73	4.97
MR4	2.05	2.44	2.63	3.05	3.48	3.83	4.18	4.36	4.68
MR5	0.45	0.99	1.39	2.21	3.63	5.12	5.57	5.73	5.97
MR6	1.05	1.66	2.11	3.03	4.42	5.3	5.71	5.89	6.17
LBR1	2.67	3.29	3.5	3.96	4.31	4.6	4.92	5.1	5.43
LBR2	2.1	2.33	2.51	2.98	3.33	3.64	3.94	4.13	4.43
LBR3	1.34	1.75	2.04	2.56	3.13	3.63	3.98	4.18	4.56
BR1	2	2.23	2.41	2.78	3.21	3.63	4.01	4.22	4.48
BR2	1.37	1.61	1.83	2.2	2.78	3.19	3.57	3.78	4.15
BR3	1.69	2.03	2.22	2.56	3.06	3.47	3.79	4.05	4.39
SCH1	1.29	1.65	1.92	2.49	3.31	4.1	4.66	4.98	5.32
SCH2	3.08	3.31	3.45	3.69	4.04	4.44	4.77	4.96	5.25
SR	2.24	2.52	2.96	3.6	3.86	4.2	4.5	4.64	4.91

2. Table A.2. Dissolved oxygen percentiles distribution in Zones of Savannah Estuary

Zone Name	D.O. Concentration Percentiles (mg/l)								
	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	3.80	3.96	4.04	4.25	4.60	5.01	5.28	5.47	5.81
FR2	3.23	3.44	3.55	3.77	4.10	4.52	4.82	4.97	5.30
FR3	2.74	2.95	3.05	3.31	3.68	4.08	4.42	4.59	4.88
FR4	2.50	2.73	2.81	3.07	3.49	3.87	4.24	4.40	4.67
FR5	2.55	2.75	2.83	3.09	3.51	3.88	4.27	4.41	4.63
FR6	2.67	2.87	2.96	3.27	3.64	4.00	4.38	4.56	4.74
FR7	3.02	3.26	3.45	3.84	4.31	4.82	5.13	5.31	5.62
FR8	3.32	3.62	3.80	4.21	4.67	5.08	5.35	5.52	5.77
FR9	3.92	4.23	4.44	4.82	5.20	5.50	5.76	5.90	6.14
FR10	4.01	4.50	4.71	5.00	5.29	5.56	5.81	5.93	6.16
FR11	2.63	3.18	3.56	3.96	4.30	4.63	4.94	5.12	5.36
MR1	2.79	3.05	3.21	3.56	3.93	4.24	4.57	4.75	4.94
MR2	2.36	2.79	3.05	3.46	3.87	4.21	4.53	4.74	4.95
MR3	2.09	2.35	2.67	3.13	3.58	4.03	4.37	4.59	4.92
MR4	2.73	2.93	3.16	3.56	3.90	4.21	4.51	4.68	4.86
MR5	1.07	1.46	1.87	2.73	4.13	5.08	5.50	5.66	5.92
MR6	1.10	1.68	2.13	3.10	4.46	5.28	5.66	5.84	6.11
LBR1	2.86	3.03	3.17	3.63	3.91	4.16	4.47	4.60	4.76
LBR2	2.03	2.26	2.49	2.92	3.29	3.60	3.89	4.09	4.29
LBR3	1.76	1.90	2.00	2.52	3.05	3.33	3.66	3.81	4.16
BR1	2.41	2.55	2.66	2.95	3.36	3.77	4.15	4.34	4.60
BR2	1.95	2.17	2.30	2.61	3.07	3.50	3.88	4.08	4.34
BR3	1.92	2.10	2.24	2.58	3.06	3.43	3.81	4.03	4.30
SCh1	2.61	2.88	3.01	3.27	3.64	4.11	4.44	4.58	4.84
SCh2	3.34	3.48	3.58	3.79	4.10	4.52	4.83	5.00	5.29
SR	2.62	2.79	3.29	3.88	4.12	4.44	4.71	4.85	5.11

3. Table A.3. Percentage of water volumes with salinity in %iles within the period of May 1 – October 30, 1999

Percen-tile	Harbor / River			Stations					
	Upper Hrb %	Middle Rvr %	Back Rvr %	Houlih Brg %	Broad Str %	Pulaski Frt %	Lucknow Cnl %	USF&W Dck %	I-95 Brg %
5	19.6	5.2	4.4	4.8	4.4	4.3	4.5	3.8	88
10	23.6	9.1	8.8	9.1	8.9	8.7	9.1	8.4	88
25	35.8	20.7	22.4	22.3	22.8	22.1	26.1	21.6	88
50	57	43.1	46.6	46.5	47.1	46.1	47.1	43	88
75	79.7	69.8	72.8	72.8	73.1	72.8	74.2	69.7	88
90	91.1	87.5	89	89	89.2	89.2	89.3	87.5	89.3
95	95.6	93.6	94.4	94.5	94.6	94.6	94.1	93.7	95.3
Total Volume 100*km3:	31414.5	659.1	4809.2	22.6	39.2	136.3	10	9.5	43.6

4. Table A.4. Percentage of water volumes with D.O. in %iles within the period of May 1 – October 30, 1999

Percen-tile	Harbor / River			Stations					
	Upper Hrb %	Middle Rvr %	Back Rvr %	Houlih Brg %	Broad Str %	Pulaski Frt %	Lucknow Cnl %	USF&W Dck %	I-95 Brg %
5	5.2	4.8	4.9	5.7	5.3	4.8	5.4	5.4	5.8
10	10.4	9.6	9.8	11.1	10.5	9.6	10.3	10.5	10.9
25	26.2	24.3	24.7	27.5	25.9	24.4	25.5	25.4	26.5
50	52.1	49	49.8	53.5	51.2	49.2	50.7	50.6	51.4
75	77.4	74.2	75.1	77.8	76	74.4	75.7	75.8	75.7
90	90.7	89.6	90.1	91.3	90.5	89.8	90.2	90.3	90.4
95	95.4	94.8	95	95.7	95.3	94.9	95.1	95.3	95.2
Total Volume 100*km3:	31414.5	659.1	4809.2	22.6	39.2	136.3	10	9.5	43.6

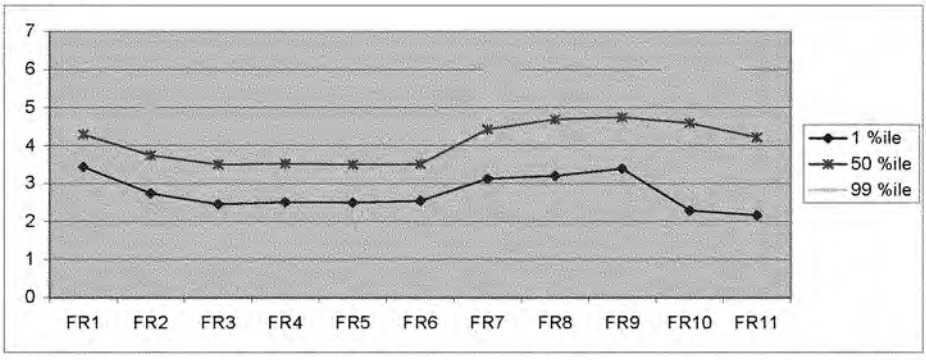
5. Table A.5. Water volumes in Upper Harbor in increments of 1° C of water temperature within the period of May 1 – October 30, 1999

Temperature C°	Total Volume %
19	0.01
20	0.7
21	3.71
22	8.89
23	14.26
24	22.76
25	33.67
26	48.48
27	59.67
28	68.63
29	77.56
30	85.3
31	89.56
32	96.42
33	99.99
34	100

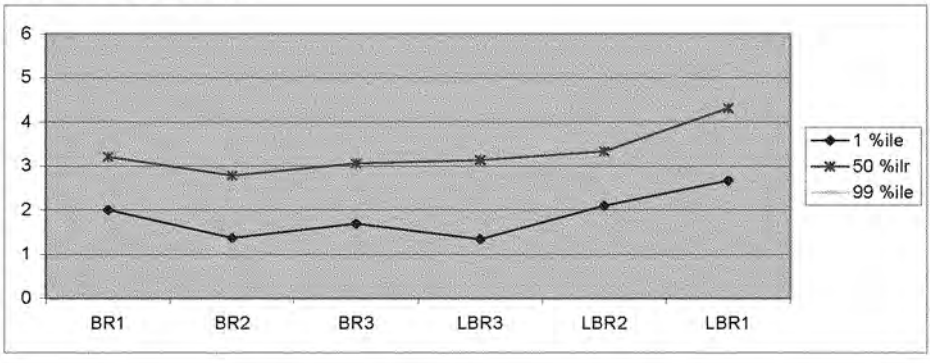
6. Table A.6. Water volumes in Upper Harbor in increments of 0.1 mg/l of D.O. within the period of May 1 – October 30, 1999
(See file: Postprocessor Output\99-B1E\99-B1E_DO Increment Volume)

7. Table A.7. Percentage of water volumes corresponding to 1-, 7-, and 30-days averages of D.O. depth-averaged concentrations in Upper Harbor within the period of May 1 – October 30, 1999
(See file: Postprocessor Output\99-B1E\99-B1E_volume DO in averages)

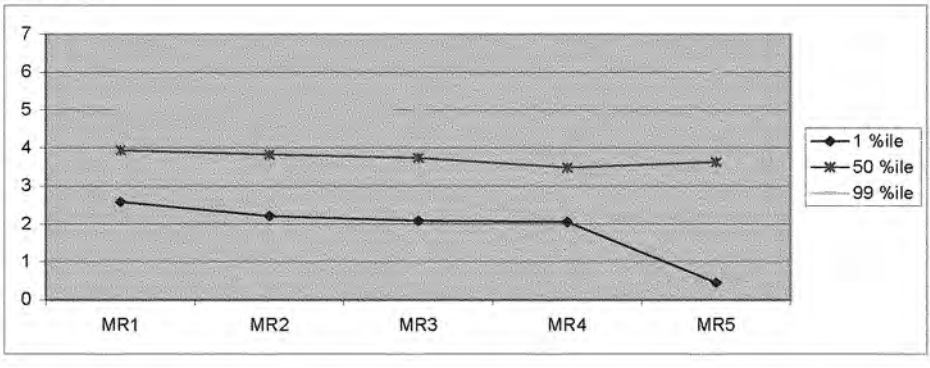
Front River



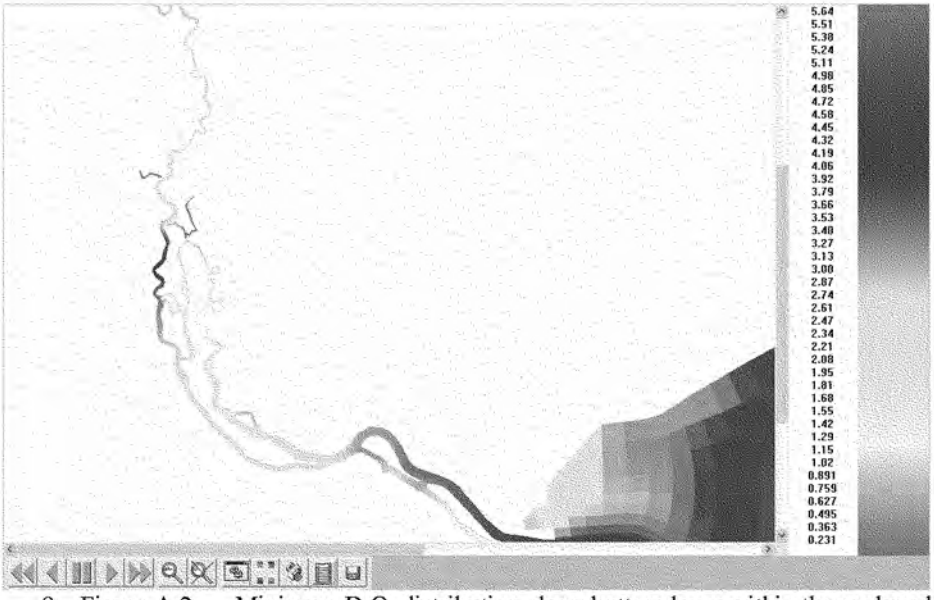
Back and Little Back Rivers



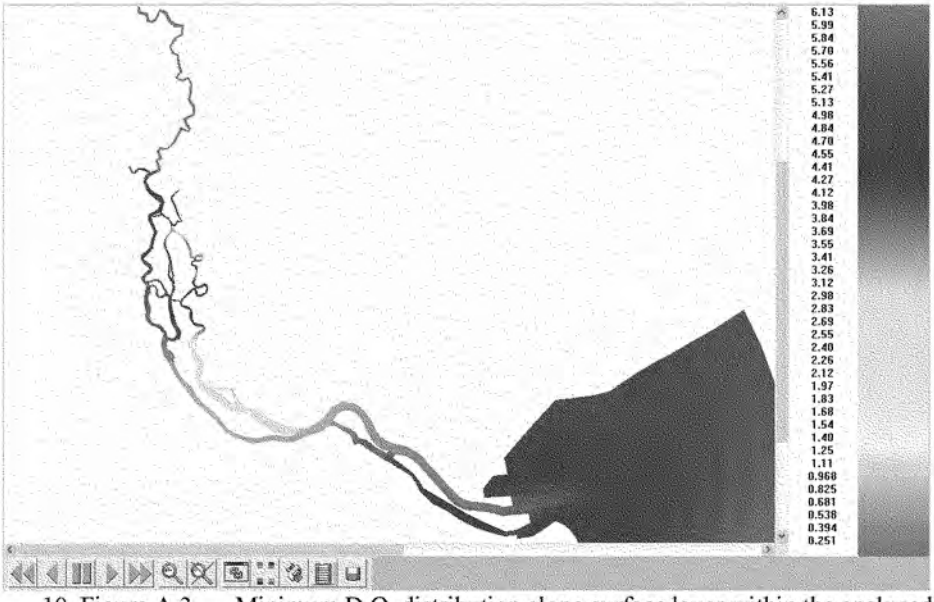
Middle River



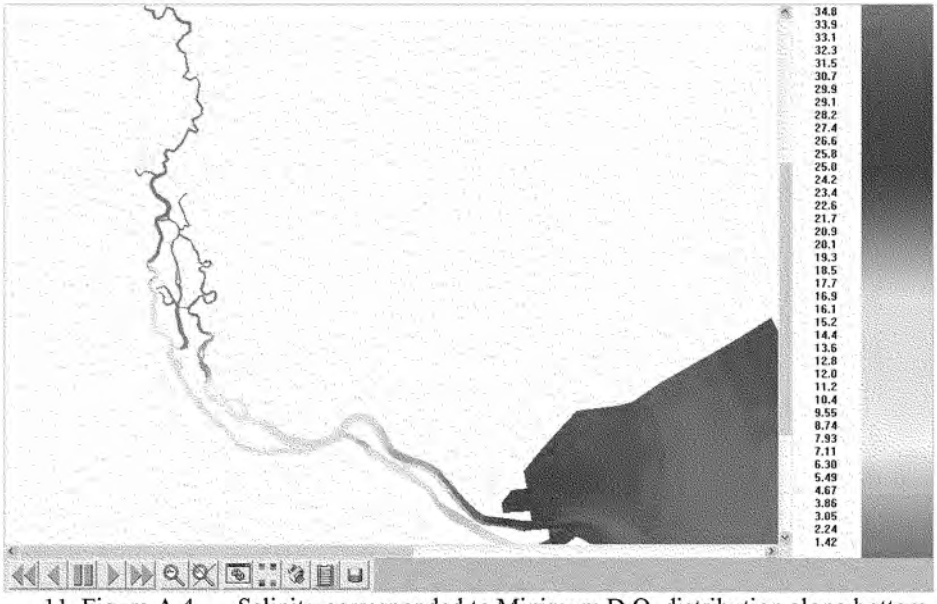
8. Figure A.1. Longitudinal profile of Dissolved Oxygen (mg/l) distribution along Critical cells of Savannah Estuary: Existing bathymetry



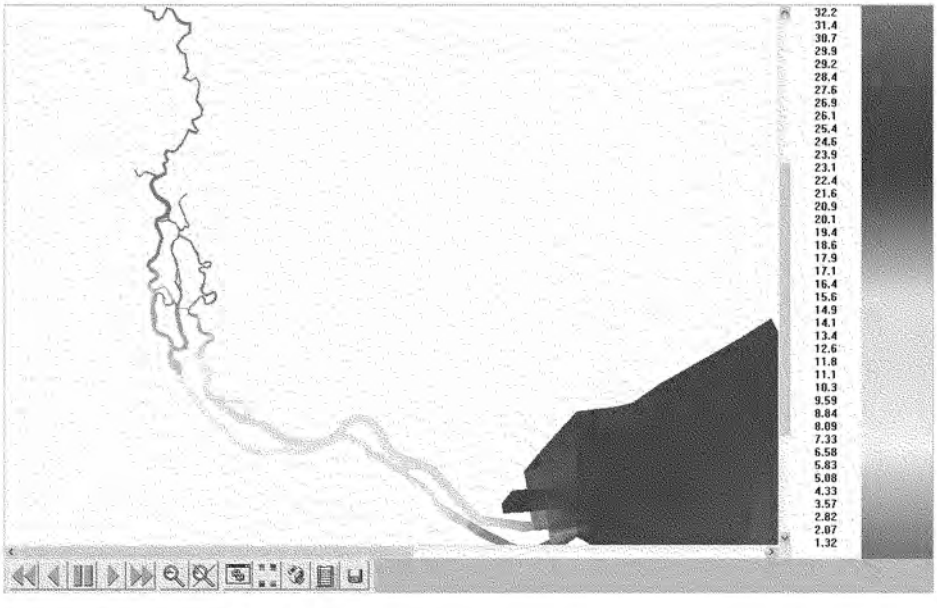
9. Figure A.2. Minimum D.O. distribution along bottom layer within the analyzed period of May 1 - October 30, 1999: Existing bathymetry



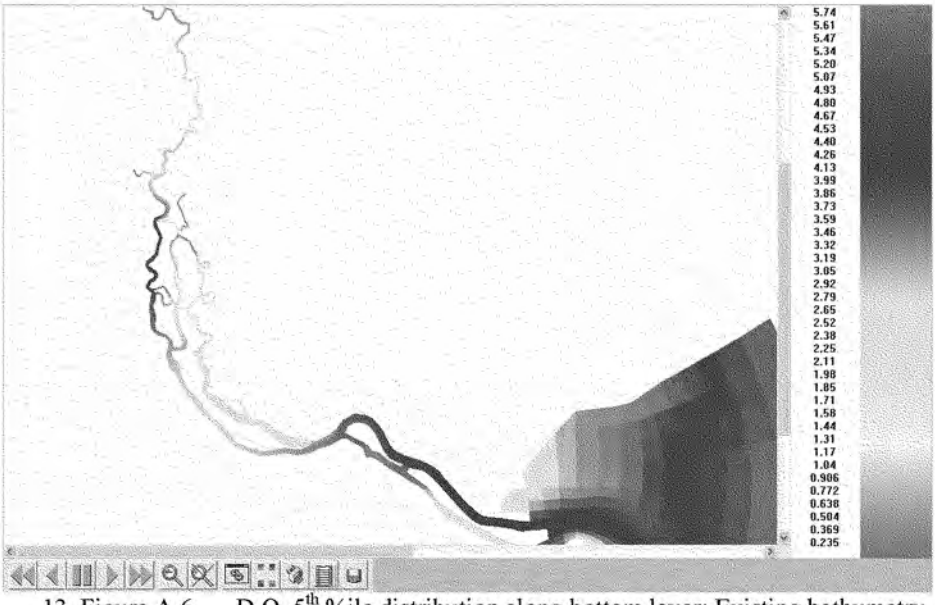
10. Figure A.3. Minimum D.O. distribution along surface layer within the analyzed period of May 1 - October 30, 1999: Existing bathymetry



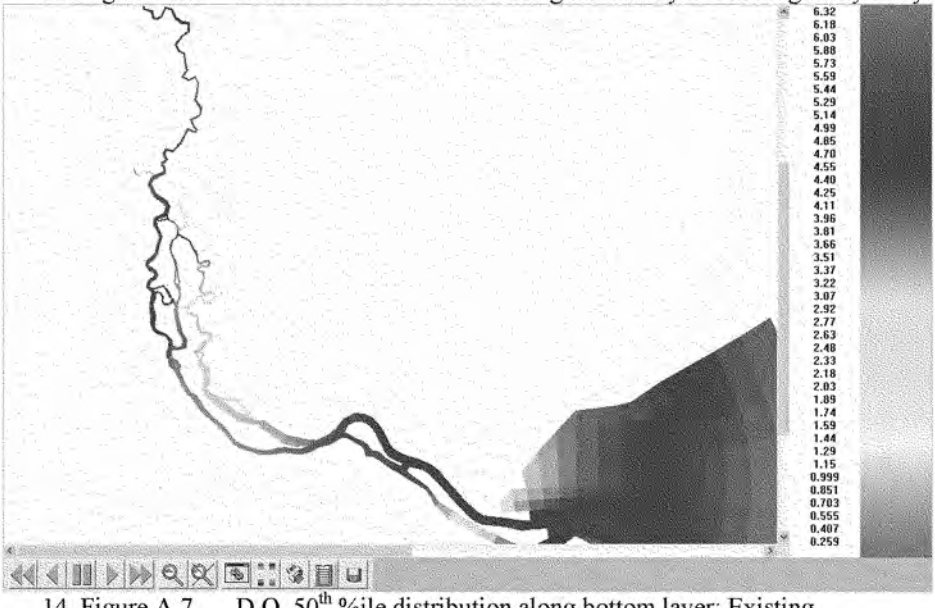
11. Figure A.4. Salinity corresponded to Minimum D.O. distribution along bottom layer within the analyzed period of May 1 - October 30, 1999: Existing bathymetry



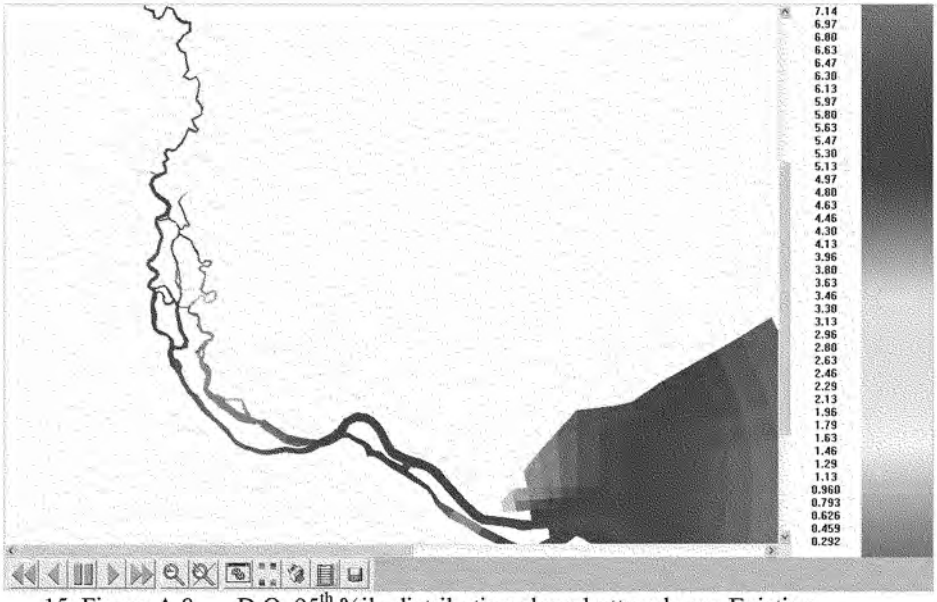
12. Figure A.5. Salinity corresponded to Minimum D.O. distribution along Surface layer within the analyzed period of May 1 - October 30, 1999: Existing bathymetry



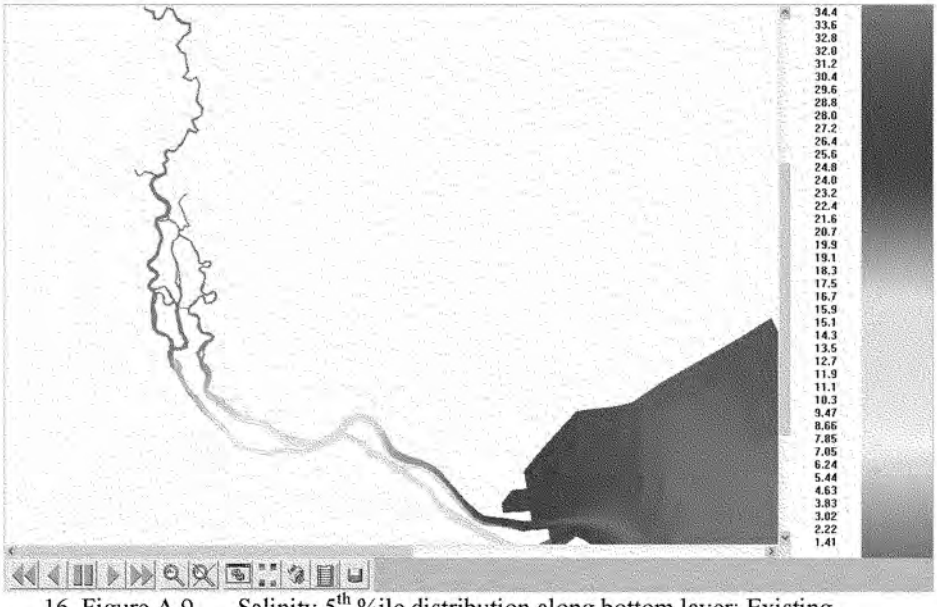
13. Figure A.6. D.O. 5th %ile distribution along bottom layer: Existing bathymetry



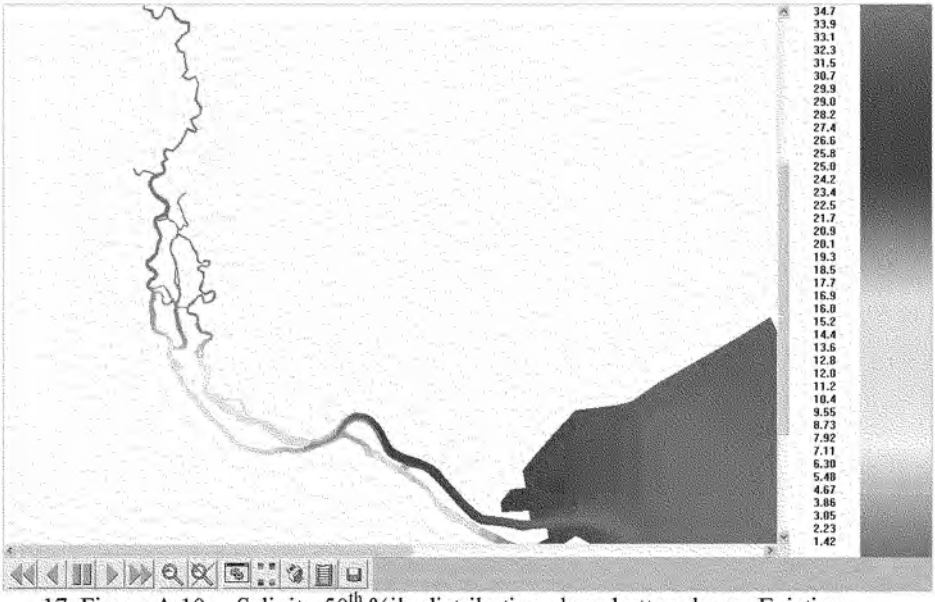
14. Figure A.7. D.O. 50th %ile distribution along bottom layer: Existing bathymetry



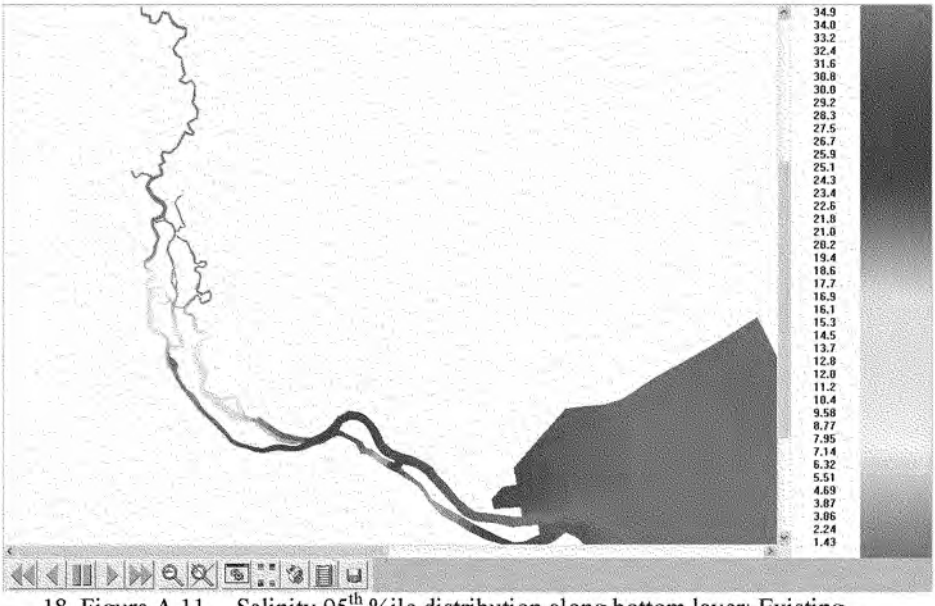
15. Figure A.8. D.O. 95th %ile distribution along bottom layer: Existing bathymetry



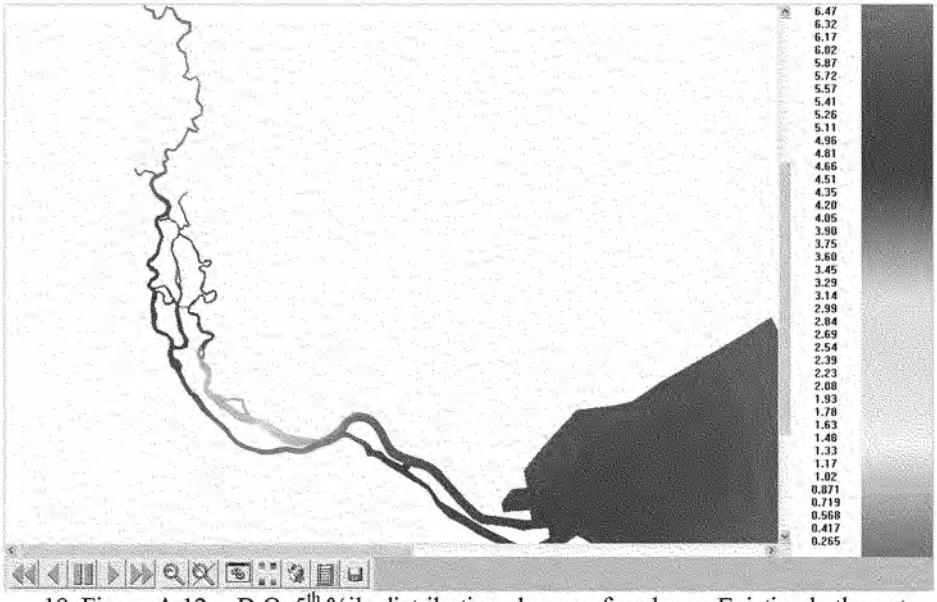
16. Figure A.9. Salinity 5th %ile distribution along bottom layer: Existing bathymetry



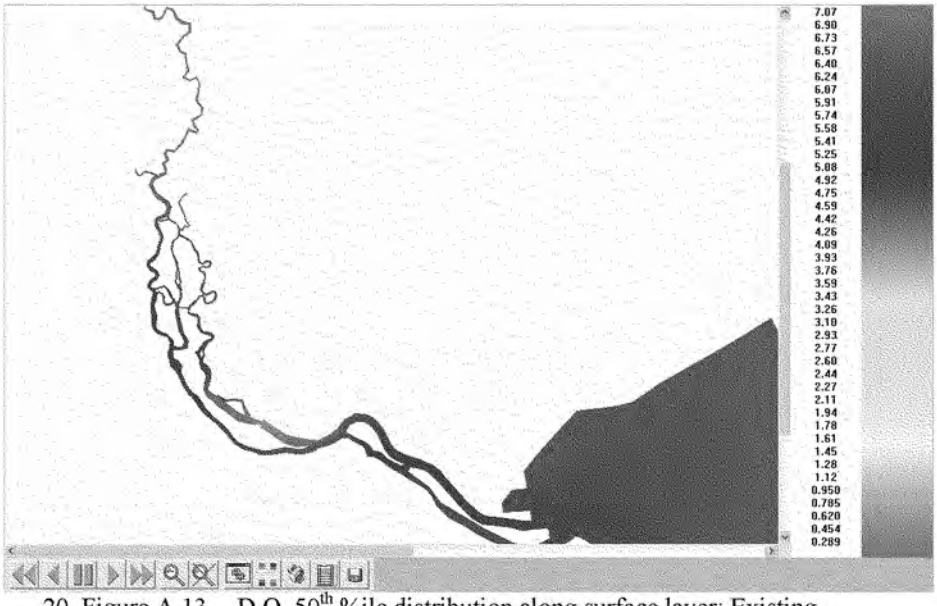
17. Figure A.10. Salinity 50th %ile distribution along bottom layer: Existing bathymetry



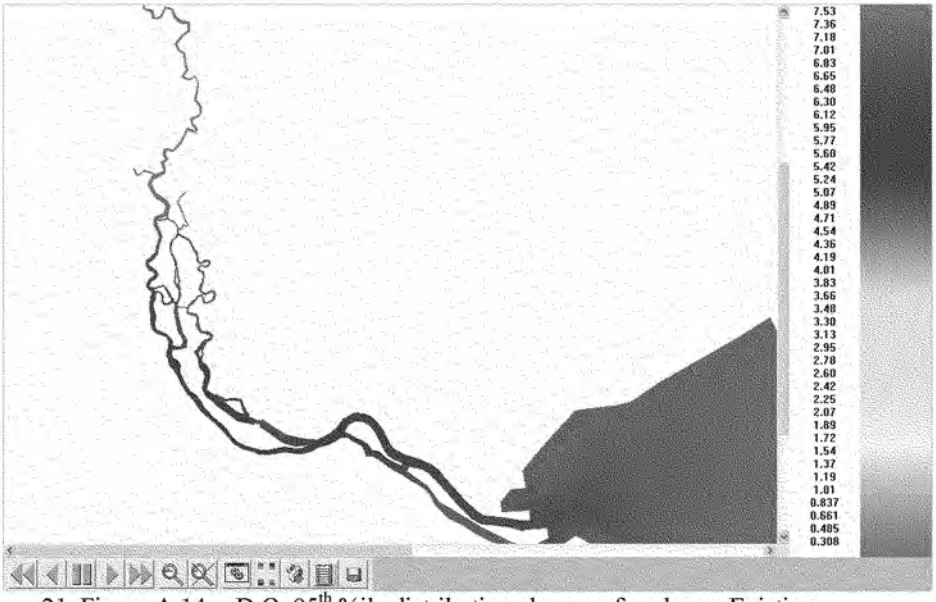
18. Figure A.11. Salinity 95th %ile distribution along bottom layer: Existing bathymetry



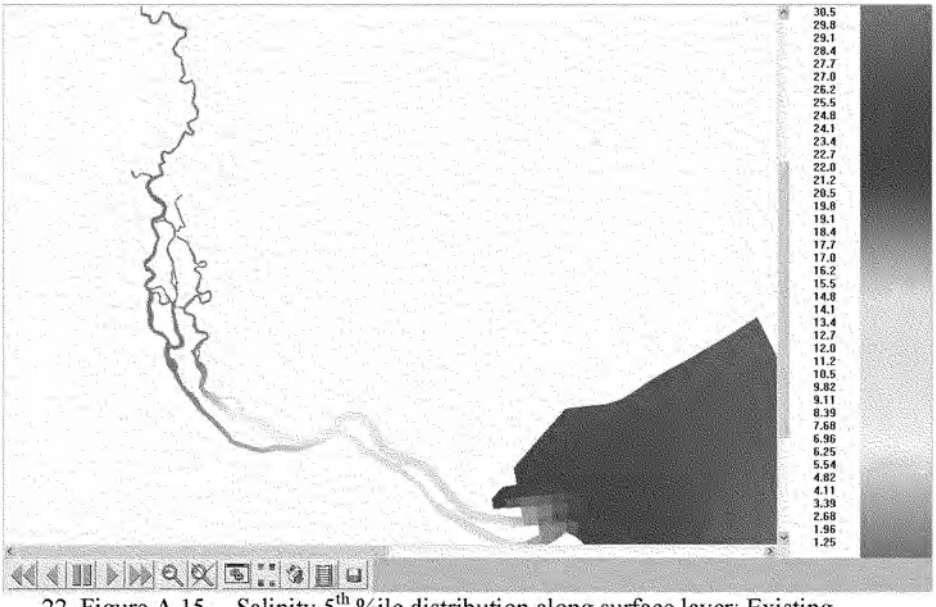
19. Figure A.12. D.O. 5th %ile distribution along surface layer: Existing bathymetry



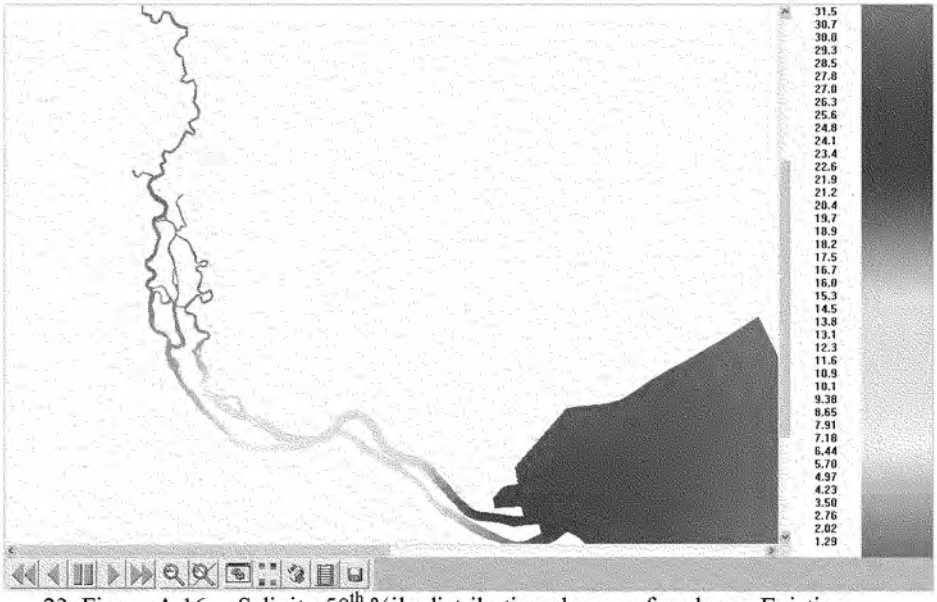
20. Figure A.13. D.O. 50th %ile distribution along surface layer: Existing bathymetry



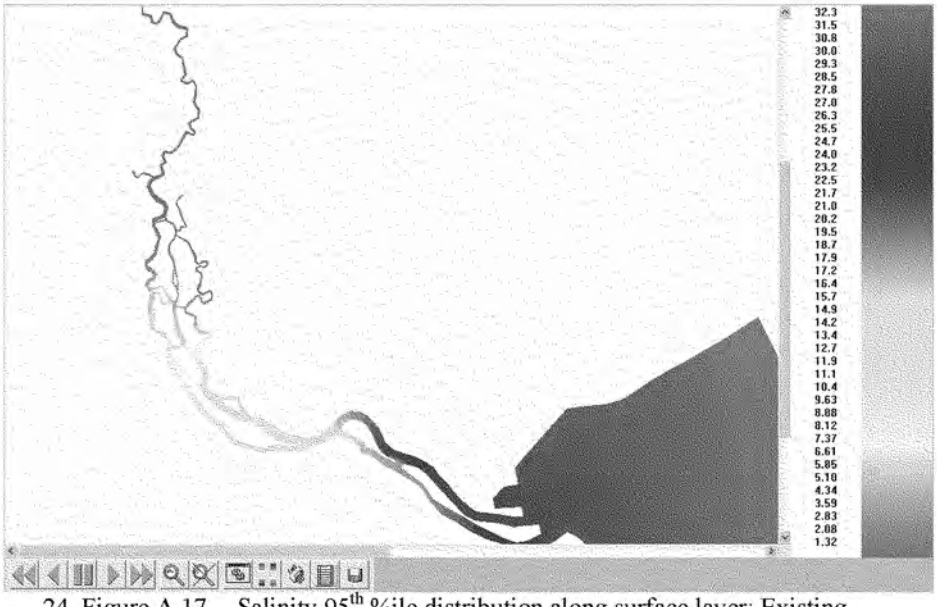
21. Figure A.14. D.O. 95th %ile distribution along surface layer: Existing bathymetry



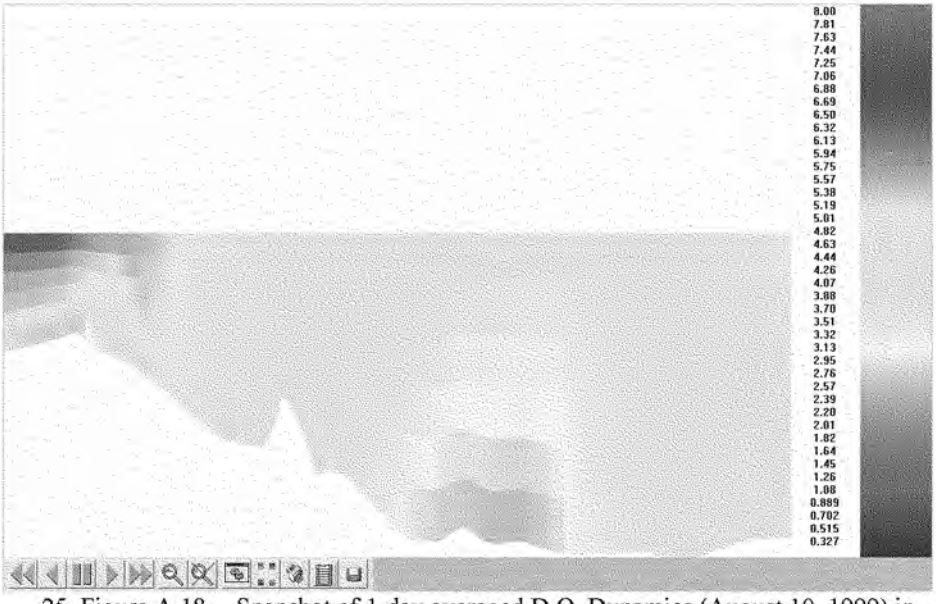
22. Figure A.15. Salinity 5th %ile distribution along surface layer: Existing bathymetry



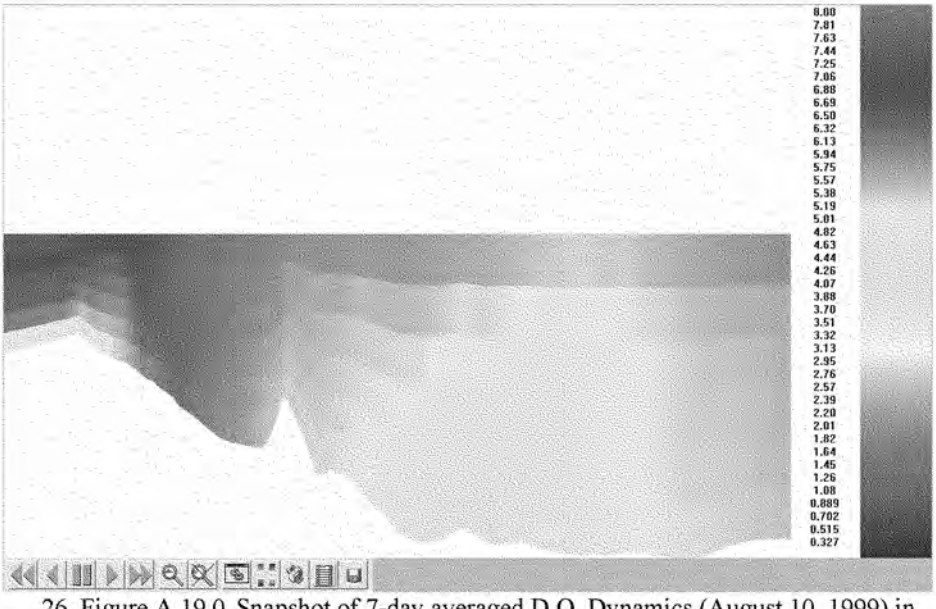
23. Figure A.16. Salinity 50th %ile distribution along surface layer: Existing bathymetry



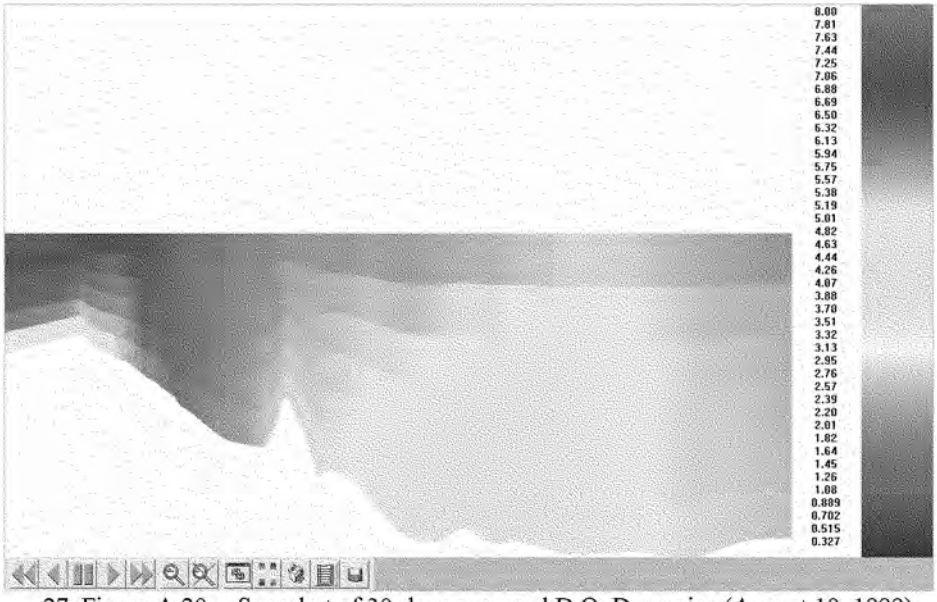
24. Figure A.17. Salinity 95th %ile distribution along surface layer: Existing bathymetry



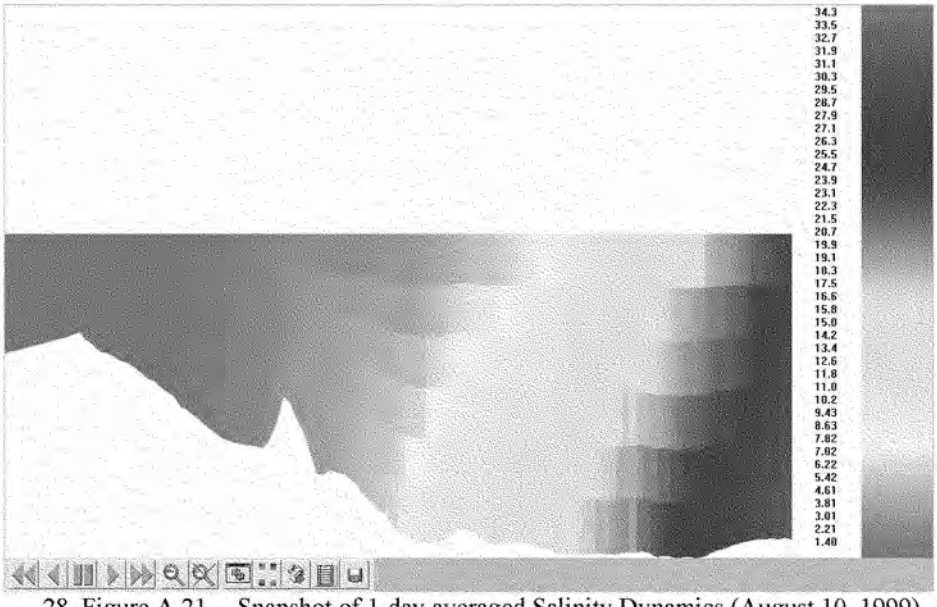
25. Figure A.18. Snapshot of 1-day averaged D.O. Dynamics (August 10, 1999) in vertical plane of Upper Harbor: Existing bathymetry



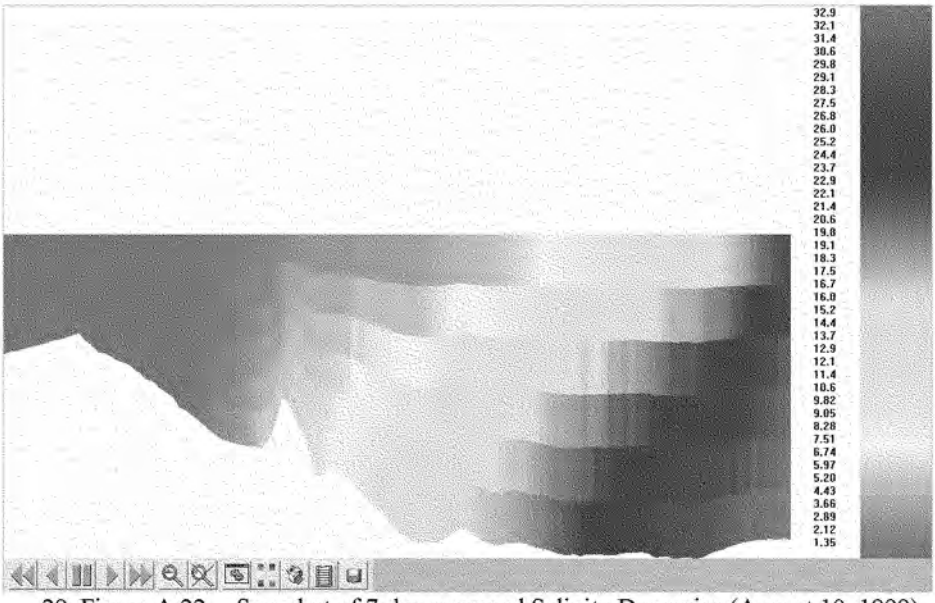
26. Figure A.19.0. Snapshot of 7-day averaged D.O. Dynamics (August 10, 1999) in vertical plane of Upper Harbor: Existing bathymetry



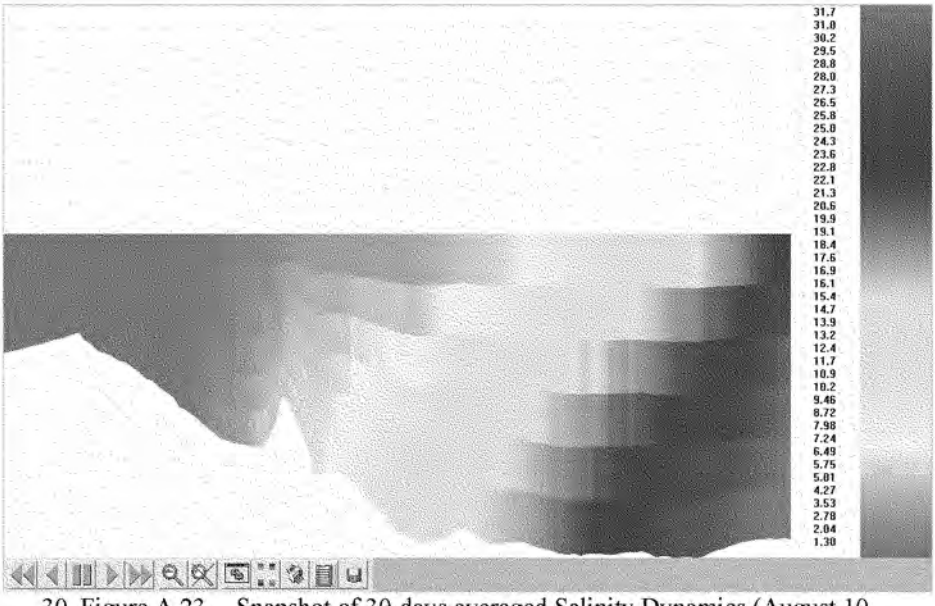
27. Figure A.20. Snapshot of 30-days averaged D.O. Dynamics (August 10, 1999) in vertical plane of Upper Harbor: Existing bathymetry



28. Figure A.21. Snapshot of 1-day averaged Salinity Dynamics (August 10, 1999) in vertical plane of Upper Harbor: Existing bathymetry



29. Figure A.22. Snapshot of 7-day averaged Salinity Dynamics (August 10, 1999) in vertical plane of Upper Harbor: Existing bathymetry



30. Figure A.23. Snapshot of 30-days averaged Salinity Dynamics (August 10, 1999) in vertical plane of Upper Harbor: Existing bathymetry

Appendix A1

BASIC EVALUATION: 6 ft DEEPENING BATHYMETRY, 2004 POINT SOURCES LOADS, 1999 HYDROLOGICAL AND METEOROLOGICAL CONDITIONS

May 1 – October 30, 1999 Simulation Period

Water Quality Review Group

1. Table A1.1. Dissolved oxygen percentiles distribution in Critical cells

Zone	D.O. Percentile (mg/l)								
	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	3.42	3.62	3.72	3.93	4.28	4.72	4.99	5.2	5.53
FR2	2.82	3.12	3.23	3.46	3.81	4.23	4.56	4.72	5
FR3	2.42	2.7	2.82	3.04	3.47	3.89	4.22	4.37	4.7
FR4	2.42	2.68	2.81	3.03	3.47	3.89	4.21	4.38	4.69
FR5	2.44	2.65	2.81	3.11	3.47	3.88	4.2	4.39	4.66
FR6	2.46	2.66	2.81	3.14	3.49	3.88	4.23	4.39	4.68
FR7	2.62	2.84	3.06	3.39	3.7	4.11	4.44	4.64	4.93
FR8	2.87	3.14	3.41	3.79	4.27	4.8	5.19	5.39	5.72
FR9	3.05	3.29	3.49	3.86	4.3	4.83	5.24	5.42	5.72
FR10	2.33	3.12	3.38	3.91	4.61	5.23	5.63	5.81	6.05
FR11	2.16	2.78	3.18	3.64	4.23	4.87	5.4	5.62	5.96
MR1	2.55	2.83	3.03	3.41	3.73	4.06	4.4	4.58	4.8
MR2	2.16	2.54	2.82	3.24	3.66	4.01	4.33	4.55	4.78
MR3	2.05	2.42	2.72	3.17	3.6	3.97	4.31	4.54	4.76
MR4	2.07	2.41	2.6	3.04	3.45	3.79	4.13	4.31	4.62
MR5	0.44	1	1.42	2.26	3.7	5.13	5.57	5.72	5.98
MR6	1.09	1.73	2.17	3.09	4.43	5.33	5.71	5.9	6.19
LBR1	2.51	3.32	3.54	4.01	4.34	4.63	4.94	5.09	5.38
LBR2	2.5	2.68	2.82	3.28	3.57	3.83	4.14	4.3	4.47
LBR3	1.56	2.15	2.36	2.8	3.32	3.75	4.08	4.31	4.66
BR1	2	2.24	2.43	2.8	3.23	3.66	4.04	4.24	4.51
BR2	1.4	1.75	2.03	2.47	2.96	3.39	3.8	4.05	4.35
BR3	1.71	2.05	2.26	2.59	3.08	3.47	3.81	4.05	4.39
SCH1	1.39	1.69	1.94	2.51	3.26	3.98	4.57	4.89	5.2
SCH2	3.05	3.26	3.41	3.65	3.99	4.41	4.75	4.93	5.25
SR	2.25	2.54	2.97	3.6	3.86	4.2	4.5	4.65	4.91

2. Table A1.2. Delta of Dissolved Oxygen percentiles distribution in Critical cells: Deepening scenario minus Existing bathymetry scenario

Zone	Delta D.O. Percentile																	
	1%		5%		10%		25%		50%		75%		90%		95%		99	
	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%
FR1	-0.01	-0.3	0.01	0.3	0	0.0	-0.02	-0.5	-0.01	-0.2	0	0.0	-0.01	-0.2	0	0.0	-0.04	-0.7
FR2	0.08	2.9	0.13	4.3	0.12	3.9	0.07	2.1	0.07	1.9	0.07	1.7	0.04	0.9	0.05	1.1	0.03	0.6
FR3	-0.03	-1.2	0.01	0.4	0.01	0.4	-0.01	-0.3	-0.03	-0.9	-0.02	-0.5	-0.04	-0.9	-0.04	-0.9	-0.01	-0.2
FR4	-0.09	-3.6	-0.06	-2.2	-0.04	-1.4	-0.07	-2.3	-0.05	-1.4	-0.02	-0.5	-0.04	-0.9	-0.05	-1.1	-0.02	-0.4
FR5	-0.06	-2.4	-0.04	-1.5	0.03	1.1	0.01	0.3	-0.03	-0.9	0.01	0.3	-0.03	-0.7	-0.02	-0.5	0.04	0.9
FR6	-0.08	-3.1	-0.08	-2.9	0	0.0	-0.01	-0.3	-0.02	-0.6	-0.01	-0.3	-0.07	-1.6	-0.09	-2.0	-0.01	-0.2
FR7	-0.51	-16.3	-0.57	-16.7	-0.53	-14.8	-0.56	-14.2	-0.72	-16.3	-0.76	-15.6	-0.77	-14.8	-0.81	-14.9	-1.1	-18.2
FR8	-0.33	-10.3	-0.38	-10.8	-0.28	-7.6	-0.32	-7.8	-0.42	-9.0	-0.31	-6.1	-0.23	-4.2	-0.22	-3.9	-0.18	-3.1
FR9	-0.34	-10.0	-0.35	-9.6	-0.35	-9.1	-0.37	-8.7	-0.44	-9.3	-0.37	-7.1	-0.22	-4.0	-0.19	-3.4	-0.16	-2.7
FR10	0.04	1.7	-0.01	-0.3	0	0.0	-0.01	-0.3	0.02	0.4	-0.01	-0.2	-0.02	-0.4	-0.01	-0.2	0.02	0.3
FR11	-0.01	-0.5	0	0.0	0.03	1.0	0.01	0.3	0.01	0.2	0.02	0.4	0	0.0	0	0.0	0.02	0.3
MR1	-0.03	-1.2	-0.16	-5.4	-0.15	-4.7	-0.14	-3.9	-0.2	-5.1	-0.19	-4.5	-0.18	-3.9	-0.17	-3.6	-0.18	-3.6
MR2	-0.04	-1.8	-0.02	-0.8	-0.09	-3.1	-0.13	-3.9	-0.16	-4.2	-0.2	-4.8	-0.2	-4.4	-0.19	-4.0	-0.22	-4.4
MR3	-0.03	-1.4	-0.03	-1.2	-0.04	-1.4	-0.11	-3.4	-0.14	-3.7	-0.2	-4.8	-0.19	-4.2	-0.19	-4.0	-0.21	-4.2
MR4	0.02	1.0	-0.03	-1.2	-0.03	-1.1	-0.01	-0.3	-0.03	-0.9	-0.04	-1.0	-0.05	-1.2	-0.05	-1.1	-0.06	-1.3
MR5	-0.01	-2.2	0.01	1.0	0.03	2.2	0.05	2.3	0.07	1.9	0.01	0.2	0	0.0	-0.01	-0.2	0.01	0.2
MR6	0.04	3.8	0.07	4.2	0.06	2.8	0.06	2.0	0.01	0.2	0.03	0.6	0	0.0	0.01	0.2	0.02	0.3
LBR1	-0.16	-6.0	0.03	0.9	0.04	1.1	0.05	1.3	0.03	0.7	0.03	0.7	0.02	0.4	-0.01	-0.2	-0.05	-0.9
LBR2	0.4	19.0	0.35	15.0	0.31	12.4	0.3	10.1	0.24	7.2	0.19	5.2	0.2	5.1	0.17	4.1	0.04	0.9
LBR3	0.22	16.4	0.4	22.9	0.32	15.7	0.24	9.4	0.19	6.1	0.12	3.3	0.1	2.5	0.13	3.1	0.1	2.2
BR1	0	0.0	0.01	0.4	0.02	0.8	0.02	0.7	0.02	0.6	0.03	0.8	0.03	0.7	0.02	0.5	0.03	0.7
BR2	0.03	2.2	0.14	8.7	0.2	10.9	0.27	12.3	0.18	6.5	0.2	6.3	0.23	6.4	0.27	7.1	0.2	4.8
BR3	0.02	1.2	0.02	1.0	0.04	1.8	0.03	1.2	0.02	0.7	0	0.0	0.02	0.5	0	0.0	0	0.0
SCH1	0.1	7.8	0.04	2.4	0.02	1.0	0.02	0.8	-0.05	-1.5	-0.12	-2.9	-0.09	-1.9	-0.09	-1.8	-0.12	-2.3
SCH2	-0.03	-1.0	-0.05	-1.5	-0.04	-1.2	-0.04	-1.1	-0.05	-1.2	-0.03	-0.7	-0.02	-0.4	-0.03	-0.6	0	0.0
SR	0.01	0.4	0.02	0.8	0.01	0.3	0	0.0	0	0.0	0	0.0	0	0.0	0.01	0.2	0	0.0

3. Table A1.3. Dissolved oxygen percentiles distribution in Zones of Savannah Estuary

Zone Name	D.O. Concentration Percentiles (mg/l)								
	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	3.82	3.96	4.04	4.25	4.62	5.03	5.29	5.48	5.76
FR2	3.24	3.48	3.58	3.79	4.14	4.56	4.86	4.99	5.31
FR3	2.79	3.05	3.15	3.37	3.73	4.16	4.48	4.64	4.93
FR4	2.47	2.74	2.90	3.14	3.52	3.94	4.27	4.47	4.73
FR5	2.44	2.67	2.82	3.09	3.47	3.88	4.20	4.40	4.67
FR6	2.54	2.74	2.84	3.13	3.51	3.88	4.23	4.37	4.65
FR7	2.75	2.99	3.22	3.57	3.97	4.42	4.80	4.98	5.34
FR8	2.96	3.25	3.49	3.86	4.29	4.77	5.09	5.27	5.59
FR9	3.49	3.83	4.03	4.40	4.86	5.30	5.59	5.75	5.99
FR10	4.00	4.46	4.66	4.93	5.22	5.48	5.73	5.86	6.09
FR11	2.63	3.19	3.56	3.96	4.30	4.63	4.94	5.13	5.39
MR1	2.65	2.88	3.05	3.44	3.73	4.06	4.40	4.58	4.79
MR2	2.31	2.71	2.92	3.33	3.69	4.02	4.35	4.54	4.76
MR3	2.08	2.33	2.64	3.08	3.50	3.91	4.23	4.47	4.77
MR4	2.73	2.94	3.17	3.58	3.91	4.20	4.50	4.66	4.87
MR5	1.08	1.51	1.91	2.76	4.15	5.09	5.51	5.67	5.94
MR6	1.11	1.75	2.19	3.15	4.48	5.30	5.66	5.85	6.10
LBR1	2.89	3.06	3.21	3.66	3.93	4.17	4.48	4.62	4.76
LBR2	2.04	2.26	2.50	2.92	3.30	3.60	3.89	4.09	4.30
LBR3	1.93	2.07	2.17	2.63	3.11	3.42	3.76	3.89	4.25
BR1	2.42	2.54	2.65	2.96	3.37	3.78	4.17	4.35	4.59
BR2	1.95	2.18	2.31	2.64	3.09	3.51	3.89	4.08	4.34
BR3	1.97	2.14	2.26	2.63	3.06	3.43	3.82	4.03	4.28
SCh1	2.67	2.89	3.01	3.27	3.65	4.13	4.43	4.57	4.86
SCh2	3.33	3.48	3.57	3.77	4.10	4.50	4.82	4.99	5.29
SR	2.62	2.80	3.29	3.89	4.12	4.44	4.71	4.85	5.11

4. Table A1.4. Delta of Dissolved Oxygen percentiles distribution in Zones of Savannah Estuary: Deepening scenario minus Existing bathymetry scenario

Zone	Project - Baseline Difference (mg/l)									Project - Baseline Relative Difference (%)								
Name	1%	5%	10%	25%	50%	75%	90%	95%	99%	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	0.02	0.01	0.00	0.00	0.02	0.03	0.01	0.01	-0.04	0.4	0.2	0.0	0.0	0.4	0.5	0.3	0.2	-0.8
FR2	0.01	0.04	0.03	0.02	0.04	0.04	0.04	0.02	0.01	0.3	1.1	0.9	0.6	0.9	0.9	0.8	0.5	0.2
FR3	0.05	0.10	0.10	0.06	0.05	0.08	0.06	0.05	0.04	1.8	3.4	3.4	1.8	1.5	2.0	1.3	1.0	0.9
FR4	-0.02	0.01	0.09	0.08	0.02	0.07	0.03	0.07	0.06	-1.0	0.5	3.3	2.5	0.7	1.8	0.7	1.6	1.4
FR5	-0.10	-0.08	-0.01	0.00	-0.04	0.00	-0.07	-0.01	0.04	-4.1	-2.9	-0.5	0.0	-1.1	0.1	-1.6	-0.3	0.9
FR6	-0.14	-0.14	-0.12	-0.14	-0.14	-0.12	-0.15	-0.19	-0.09	-5.2	-4.7	-4.1	-4.4	-3.7	-3.1	-3.4	-4.1	-1.9
FR7	-0.27	-0.27	-0.24	-0.26	-0.34	-0.40	-0.33	-0.33	-0.28	-9.0	-8.4	-6.8	-6.9	-7.9	-8.3	-6.4	-6.3	-4.9
FR8	-0.36	-0.37	-0.32	-0.34	-0.39	-0.31	-0.26	-0.25	-0.19	-11.0	-10.1	-8.3	-8.2	-8.2	-6.2	-4.8	-4.5	-3.2
FR9	-0.44	-0.41	-0.41	-0.41	-0.34	-0.19	-0.17	-0.15	-0.15	-11.1	-9.6	-9.2	-8.6	-6.5	-3.5	-2.9	-2.6	-2.4
FR10	-0.01	-0.04	-0.05	-0.07	-0.07	-0.08	-0.08	-0.07	-0.07	-0.1	-0.9	-1.0	-1.4	-1.3	-1.3	-1.3	-1.1	-1.2
FR11	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02	-0.1	0.2	0.1	0.1	0.0	0.0	0.0	0.1	0.4
MR1	-0.14	-0.16	-0.17	-0.13	-0.20	-0.18	-0.17	-0.16	-0.15	-5.0	-5.4	-5.1	-3.5	-5.1	-4.2	-3.8	-3.4	-3.0
MR2	-0.04	-0.07	-0.14	-0.13	-0.18	-0.19	-0.18	-0.20	-0.19	-1.9	-2.7	-4.4	-3.8	-4.7	-4.4	-3.9	-4.3	-3.8
MR3	-0.01	-0.02	-0.02	-0.05	-0.08	-0.12	-0.14	-0.12	-0.15	-0.5	-1.1	-0.9	-1.7	-2.2	-3.0	-3.2	-2.6	-2.9
MR4	-0.01	0.00	0.01	0.02	0.01	0.00	-0.01	-0.02	0.02	-0.2	0.2	0.3	0.6	0.2	-0.1	-0.3	-0.4	0.3
MR5	0.01	0.05	0.04	0.04	0.02	0.01	0.01	0.01	0.02	1.3	3.1	2.2	1.4	0.5	0.2	0.2	0.2	0.4
MR6	0.01	0.07	0.06	0.05	0.02	0.02	0.00	0.01	-0.01	0.6	3.9	2.9	1.6	0.4	0.4	0.1	0.1	-0.1
LBR1	0.03	0.03	0.04	0.02	0.01	0.02	0.01	0.02	0.01	0.9	1.0	1.1	0.7	0.3	0.4	0.3	0.3	0.2
LBR2	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.2	-0.1	0.3	0.1	0.2	0.0	-0.1	0.0	0.1
LBR3	0.17	0.17	0.17	0.11	0.07	0.09	0.10	0.07	0.09	9.8	8.9	8.2	4.2	2.1	2.9	2.8	1.9	2.2
BR1	0.01	0.00	0.00	0.01	0.01	0.01	0.02	0.01	0.00	0.4	-0.1	-0.2	0.4	0.4	0.3	0.4	0.1	-0.1
BR2	0.00	0.01	0.01	0.03	0.02	0.01	0.01	0.01	0.00	-0.1	0.4	0.3	1.3	0.6	0.3	0.2	0.2	0.0
BR3	0.05	0.03	0.02	0.05	0.00	0.00	0.01	0.00	-0.02	2.6	1.5	1.0	1.9	-0.1	0.0	0.3	0.0	-0.4
SCh1	0.06	0.01	0.00	0.00	0.01	0.02	-0.01	-0.02	0.02	2.3	0.5	0.2	0.0	0.2	0.5	-0.2	-0.3	0.4
SCh2	-0.01	0.01	0.00	-0.02	0.00	-0.02	-0.01	-0.01	0.00	-0.3	0.2	0.0	-0.4	0.0	-0.4	-0.2	-0.1	0.0
SR	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.2	0.1	0.0	0.1	0.0	0.0	0.1	0.0	0.0

5. Table A1.5. Percentage of the volume of waters with violation of Dissolved Oxygen standards for Zones of Savannah Estuary within the period of May 1 – October 30, 1999: Deepening (Project) and Existing bathymetry (Baseline)

Zones	D.O. STANDARDS														
	1-Day Average			7-Day Average			30-Day Average			GA MINIMUM D.O.			SC MINIMUM D.O.		
	Baseline(B)	Project(P)	Delta=P-B	Baseline(B)	Project(P)	Delta=P-B	Baseline(B)	Project(P)	Delta=P-B	Baseline(B)	Project(P)	Delta=P-B	Baseline(B)	Project(P)	Delta=P-B
FR1	0	0	0	0	0	0	0	0	0	0	0	0	7	6	-1
FR2	0	0	0	0	0	0	3	3	0	0	0	0	31	30	-1
FR3	0	0	0	2	1	-1	19	18	-1	3	2	-1	N/A	N/A	N/A
FR4	0	0	0	5	4	-1	22	23	1	6	5	-1	N/A	N/A	N/A
FR5	0	0	0	4	5	1	19	22	3	5	6	1	N/A	N/A	N/A
FR6	0	0	0	2	5	3	12	20	8	4	6	2	N/A	N/A	N/A
FR7	0	0	0	0	0	0	1	4	3	0	2	2	N/A	N/A	N/A
FR8	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
FR9	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
FR10	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
FR11	0	0	0	0	0	0	2	2	0	1	1	0	6	6	0
MR1	0	0	0	0	2	2	5	9	4	1	2	1	N/A	N/A	N/A
MR2	0	0	0	1	3	2	6	11	5	1	2	1	N/A	N/A	N/A
MR3	0	0	0	3	3	0	10	12	2	3	4	1	N/A	N/A	N/A
MR4	0	0	0	1	1	0	5	5	0	2	2	0	N/A	N/A	N/A
MR5	0	0	0	1	1	0	5	5	0	5	5	0	11	11	0
MR6	0	0	0	0	0	0	3	2	-1	3	3	0	9	8	-1
LBR1	0	0	0	1	1	0	6	6	0	1	1	0	18	18	0
LBR2	1	1	0	6	6	0	18	18	0	7	7	0	34	35	1
LBR3	3	2	-1	13	13	0	30	32	2	14	14	0	47	50	3
BR1	0	0	0	10	10	0	39	40	1	12	12	0	67	68	1
BR2	2	2	0	19	20	1	49	50	1	20	20	0	75	76	1
BR3	3	3	0	21	21	0	48	49	1	22	22	0	70	72	2
SCh1	1	1	0	4	3	-1	8	8	0	5	4	-1	N/A	N/A	N/A
SCh2	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
SR	0	0	0	1	1	0	3	3	0	1	1	0	6	6	0

26. Table A1.6. Percentage of water volumes with salinity in %iles within the period of May 1 – October 30, 1999

Percen-tile	Harbor / River			Stations					
	Upper Hrb %	Middle Rvr %	Back Rvr %	Houlih Brg %	Broad Str %	Pulaski Frt %	Lucknow Cnl %	USF&W Dck %	I-95 Brg %
5	18.1	4.3	4.3	4.4	4.4	4.3	4.4	4	82.9
10	22.1	7.8	8.7	8.9	9	8.7	9.8	8.5	82.9
25	34.7	19.4	22.2	22.5	22.9	22.1	23.4	19.5	82.9
50	56.4	41.4	46.5	46.8	47.5	46.1	46.7	42.1	82.9
75	77.8	68.8	72.7	73	73.4	72.8	72.6	69	82.9
90	90.9	87.1	88.9	89.2	89.3	89.2	88.5	87.3	89.9
95	95.3	93.4	94.4	94.6	94.6	94.6	94	93.6	96.4
Total Volume 100*km3:	33199.7	657.9	4805.5	27.3	39.2	136.3	9.9	9.5	43.6

27. Table A1.7. Percentage of water volumes with D.O. in %iles within the period of May 1 – October 30, 1999

Percen-tile	Harbor / River			Stations					
	Upper Hrb %	Middle Rvr %	Back Rvr %	Houlih Brg %	Broad Str %	Pulaski Frt %	Lucknow Cnl %	USF&W Dck %	I-95 Brg %
5	5.2	5.1	4.9	5.6	5.2	4.7	5.5	5.6	5.8
10	10.4	10	9.8	11	10.3	9.5	10.4	11.1	10.9
25	26.1	25.2	24.7	27.2	25.7	24.2	25.5	25.9	26.4
50	52	50.2	49.8	53.1	50.8	49.1	51.3	51.5	51.4
75	76.3	75	75.1	77.5	75.4	74.3	75.7	76.3	75.8
90	90.6	90	90.1	91.1	90.3	89.7	90.3	90.5	90.4
95	95.2	95	95	95.6	95.2	94.8	95.2	95.4	95.1
Total Volume 100*km3:	33199.7	657.9	4805.5	27.3	39.2	136.3	9.9	9.5	43.6

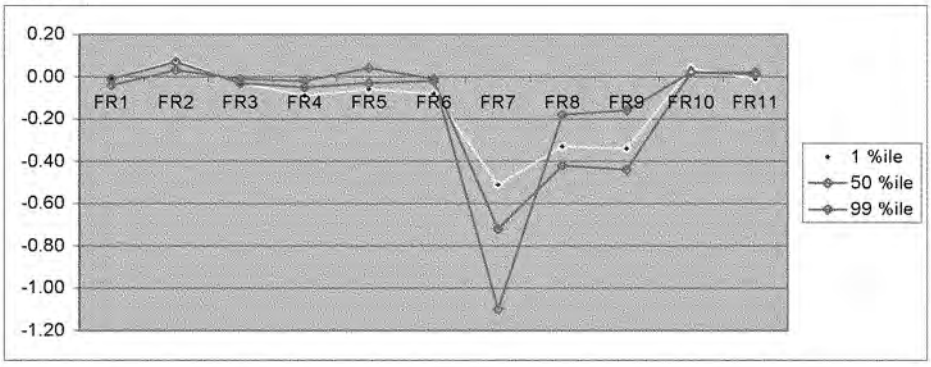
28. Table A1.8. Water volumes in Upper Harbor in increments of 1° C of water temperature within the period of May 1 – October 30, 1999

Temperature C°	Total Volume %
19	0.01
20	0.83
21	4.1
22	9.29
23	15.05
24	23.57
25	35.42
26	49.25
27	60.1
28	69.06
29	75.54
30	85.25
31	89.74
32	96.51
33	99.99
34	100

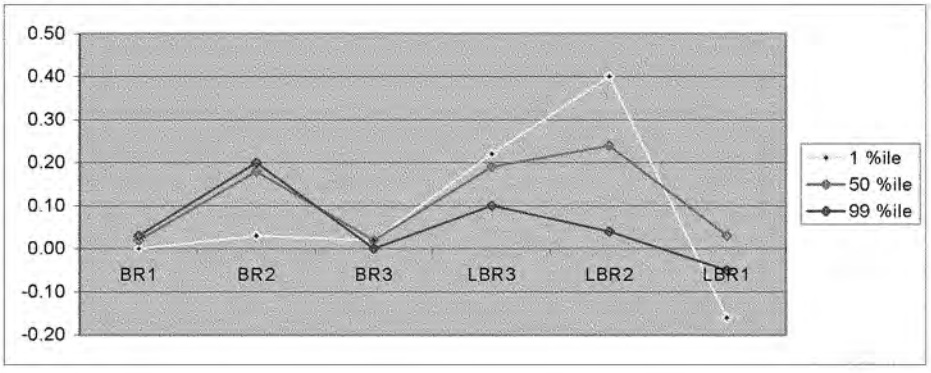
29. Table A1.9. Water volumes in Upper Harbor in increments of 0.1 mg/l of D.O. within the period of May 1 – October 30, 1999
(See file: Postprocessor Output\99-B16\99-B16_DO Increment Volume)

30. Table A1.10. Percentage of water volumes corresponding to 1-, 7-, and 30-days averages of D.O. depth-averaged concentrations in Upper Harbor within the period of May 1 – October 30, 1999
(See file: Postprocessor Output\99-B16\99-B16_volume DO in averages)

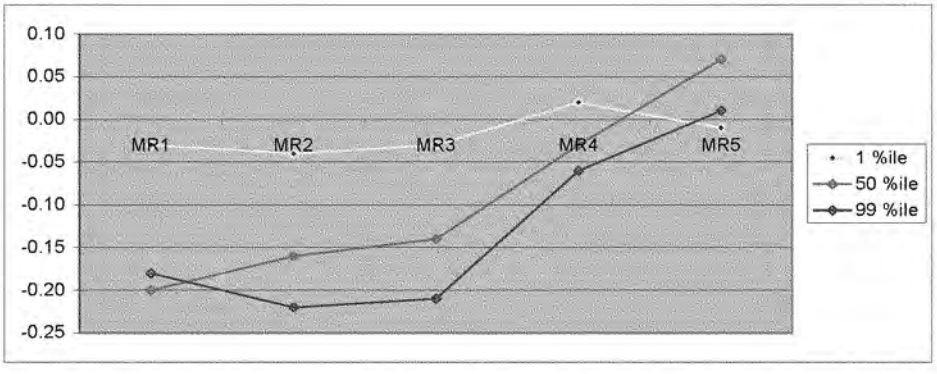
Front River



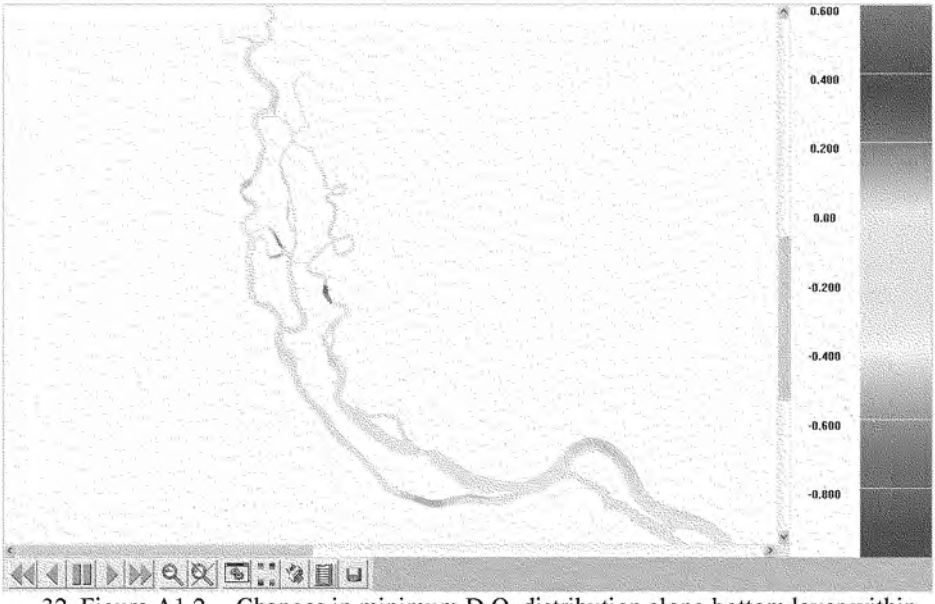
Back and Little Back Rivers



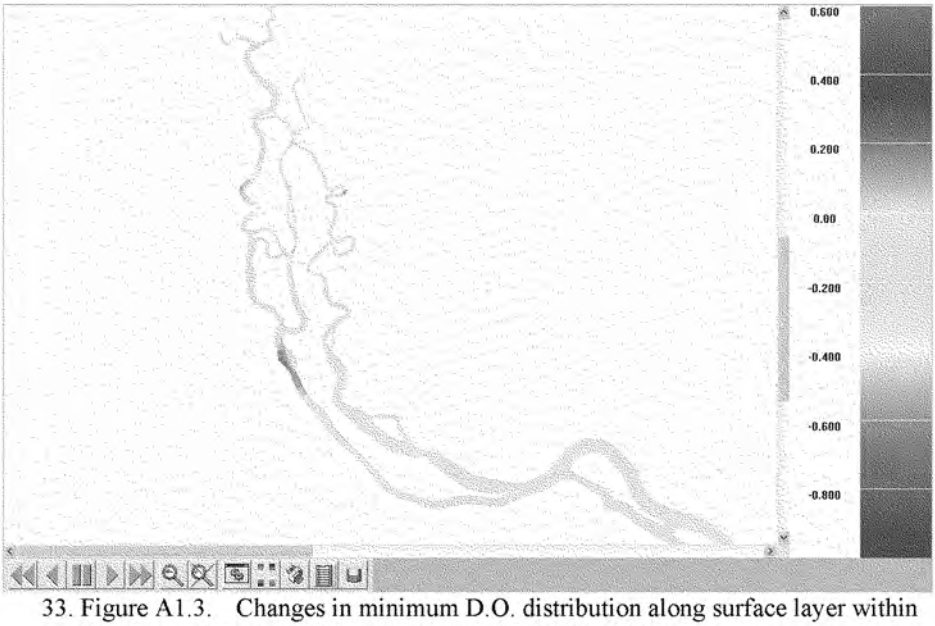
Middle River



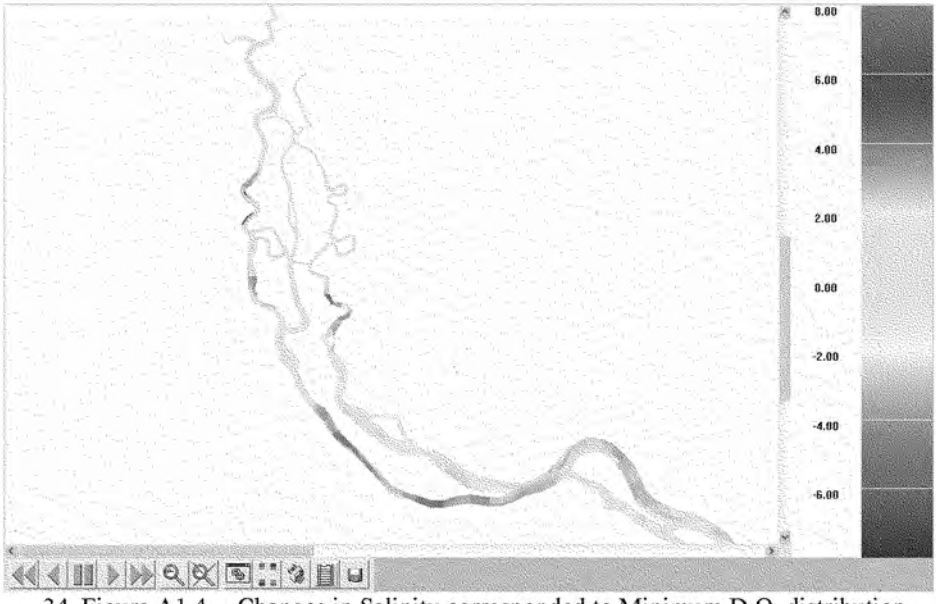
31. Figure A1.1. Changes in longitudinal profile of Dissolved Oxygen (mg/l) distribution along Critical cells of Savannah Estuary: 6 ft deepening



32. Figure A1.2. Changes in minimum D.O. distribution along bottom layer within the analyzed period of May 1 - October 30, 1999: 6 ft deepening

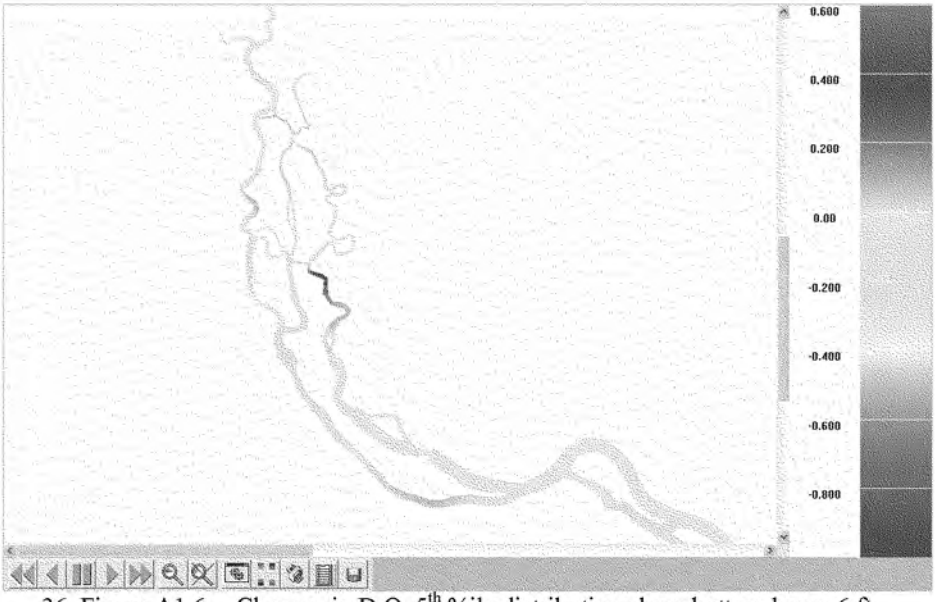


33. Figure A1.3. Changes in minimum D.O. distribution along surface layer within the analyzed period of May 1 - October 30, 1999: 6 ft deepening

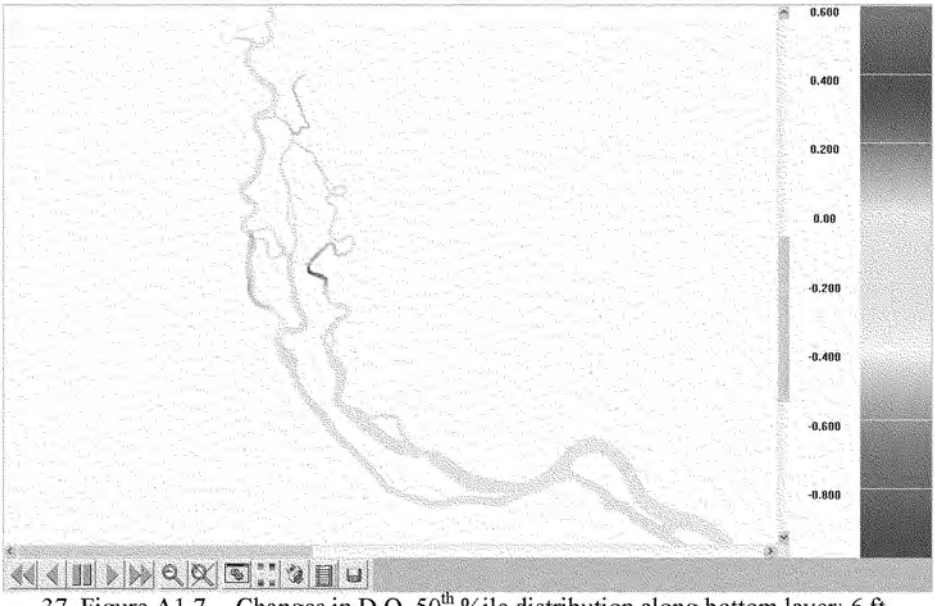


34. Figure A1.4. Changes in Salinity corresponded to Minimum D.O. distribution along bottom layer within the analyzed period of May 1 - October 30, 1999: 6 ft deepening

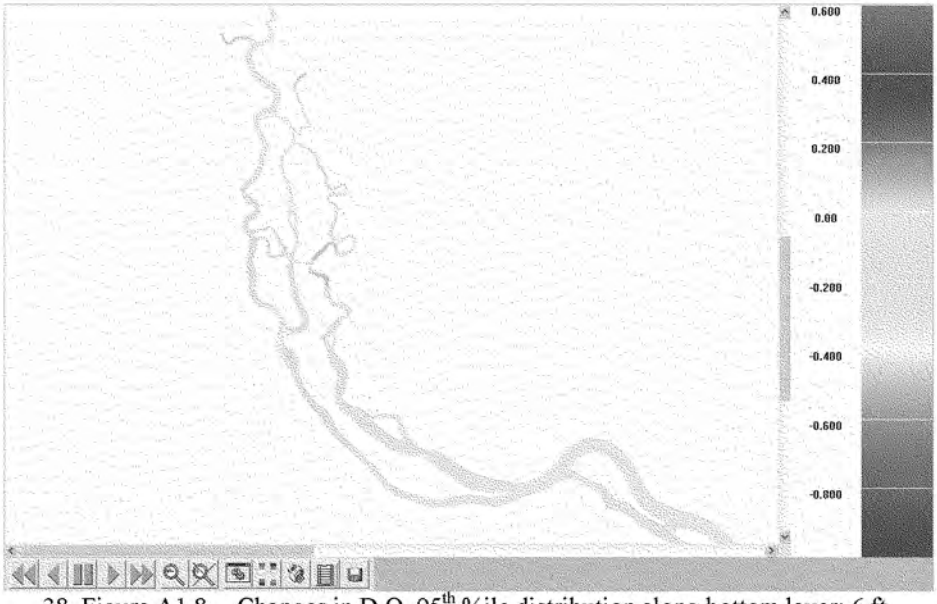
35. Figure A1.5. Changes in Salinity corresponded to Minimum D.O. distribution along Surface layer within the analyzed period of May 1 - October 30, 1999: 6 ft deepening



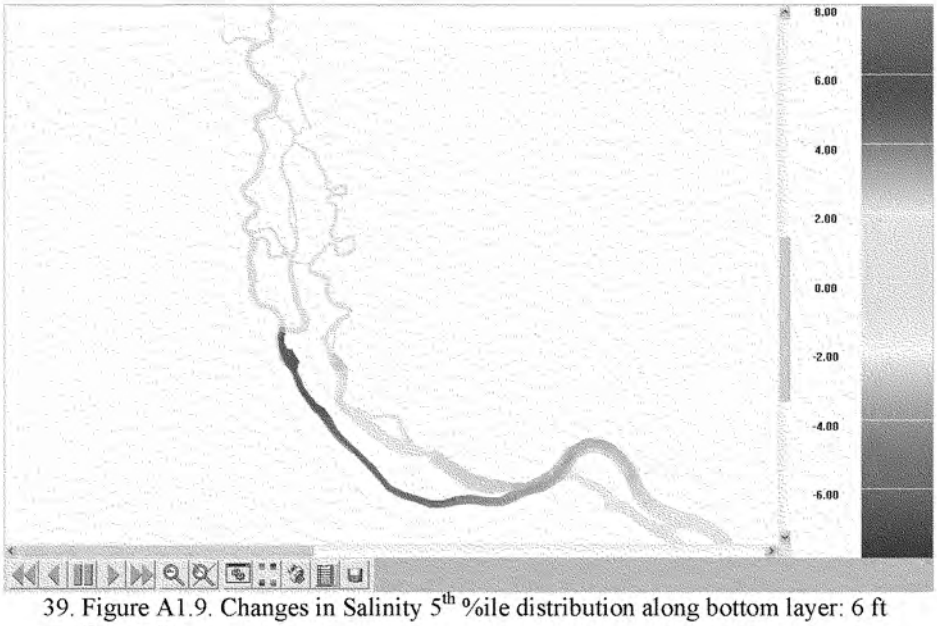
36. Figure A1.6. Changes in D.O. 5th %ile distribution along bottom layer: 6 ft deepening



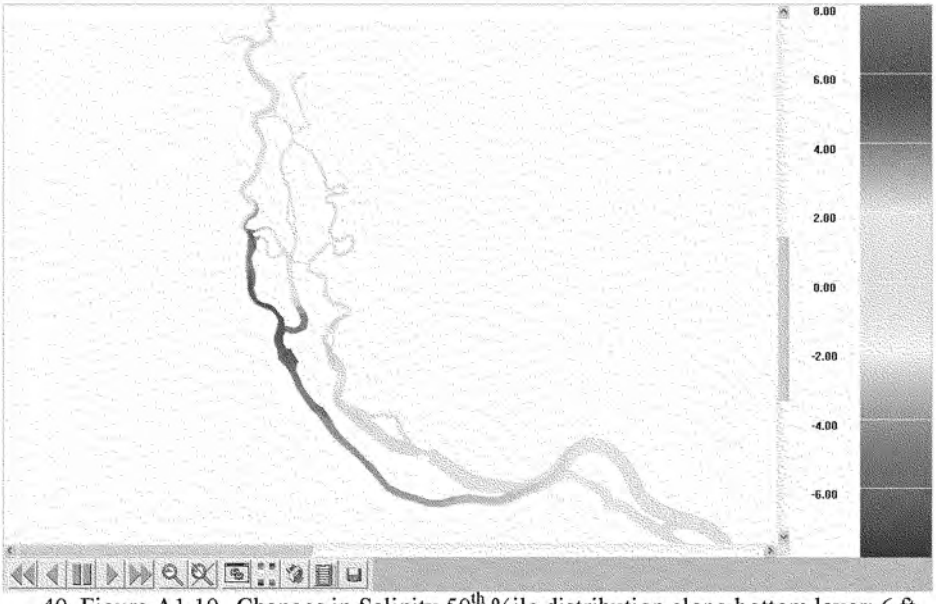
37. Figure A1.7. Changes in D.O. 50th %ile distribution along bottom layer: 6 ft deepening



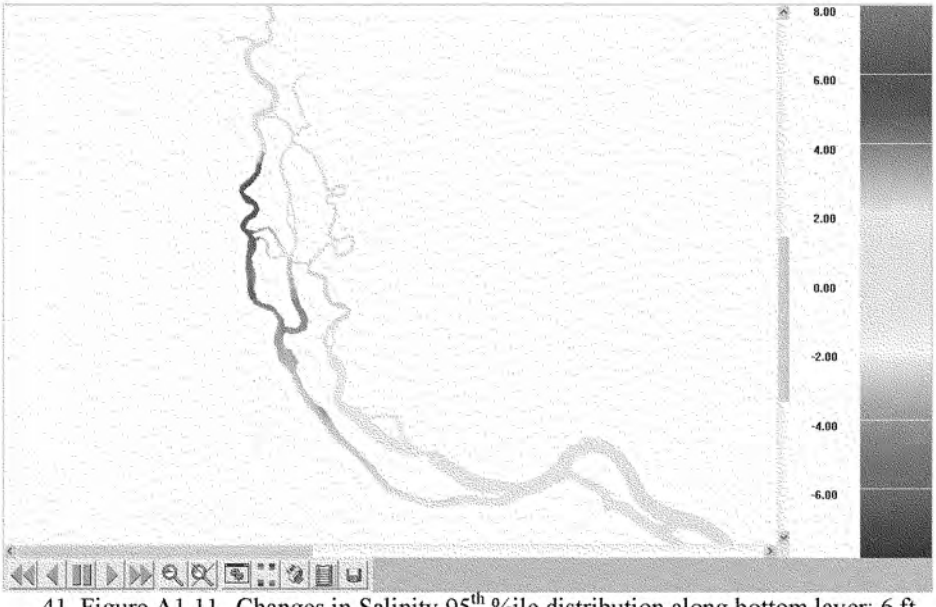
38. Figure A1.8. Changes in D.O. 95th %ile distribution along bottom layer: 6 ft deepening



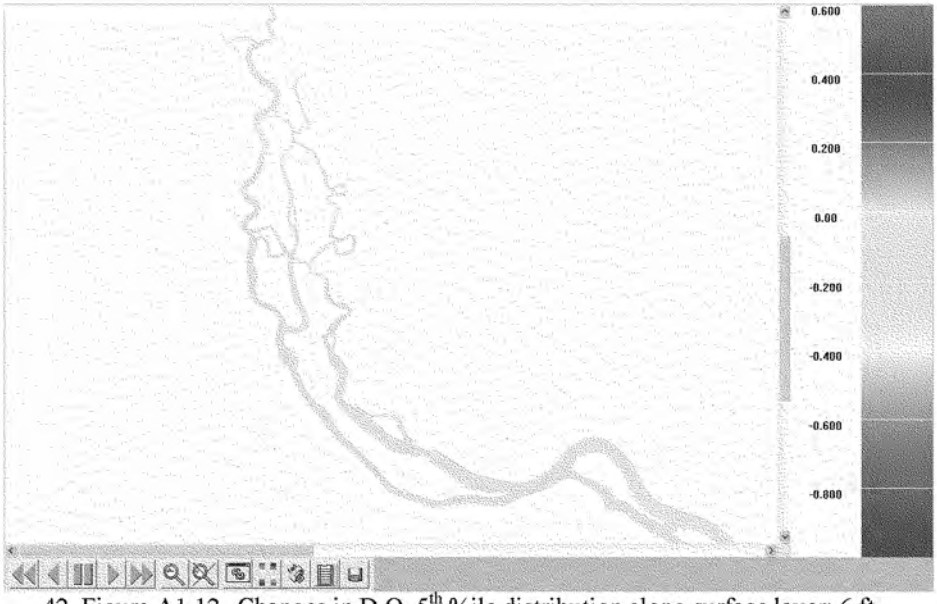
39. Figure A1.9. Changes in Salinity 5th %ile distribution along bottom layer: 6 ft deepening



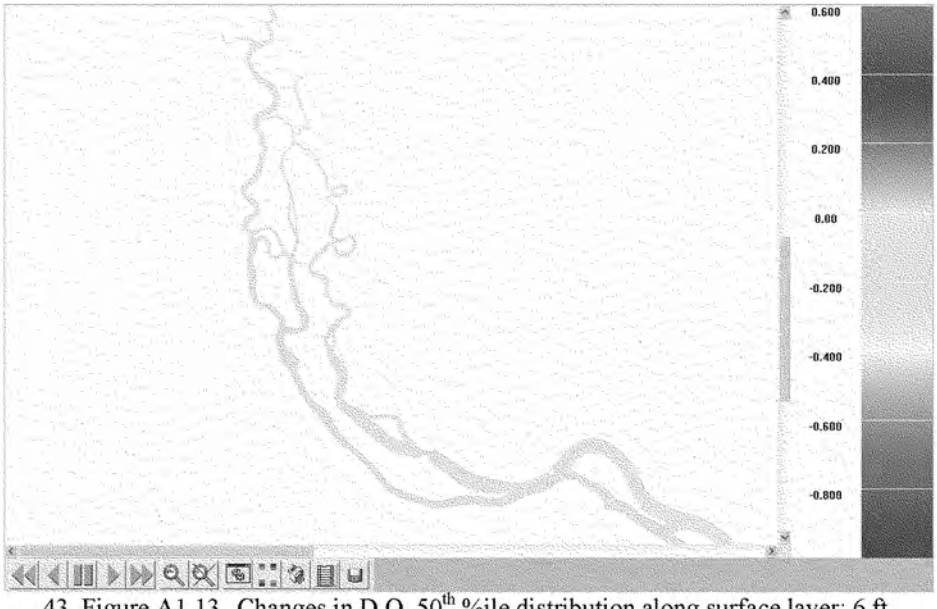
40. Figure A1.10. Changes in Salinity 50th %ile distribution along bottom layer: 6 ft deepening



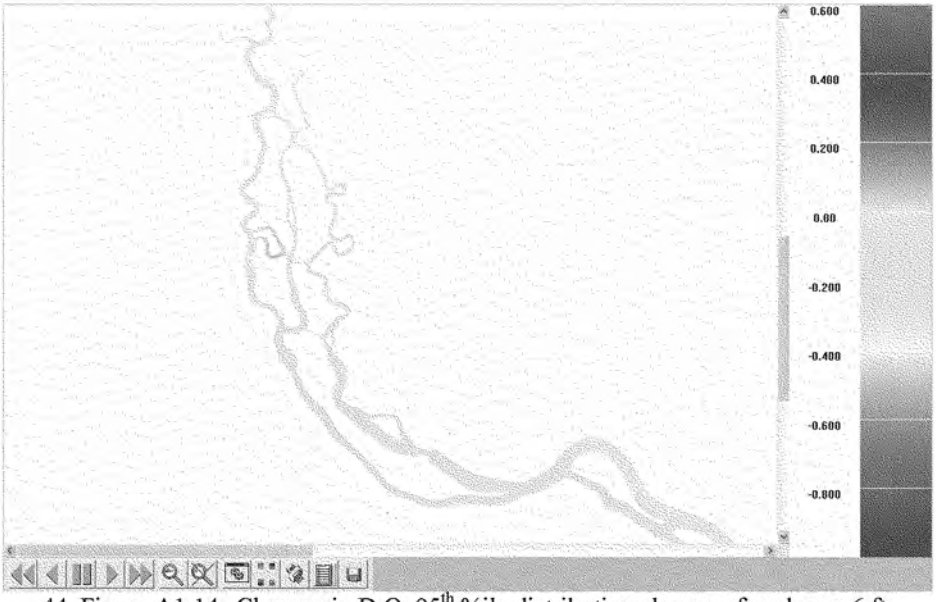
41. Figure A1.11. Changes in Salinity 95th %ile distribution along bottom layer: 6 ft deepening



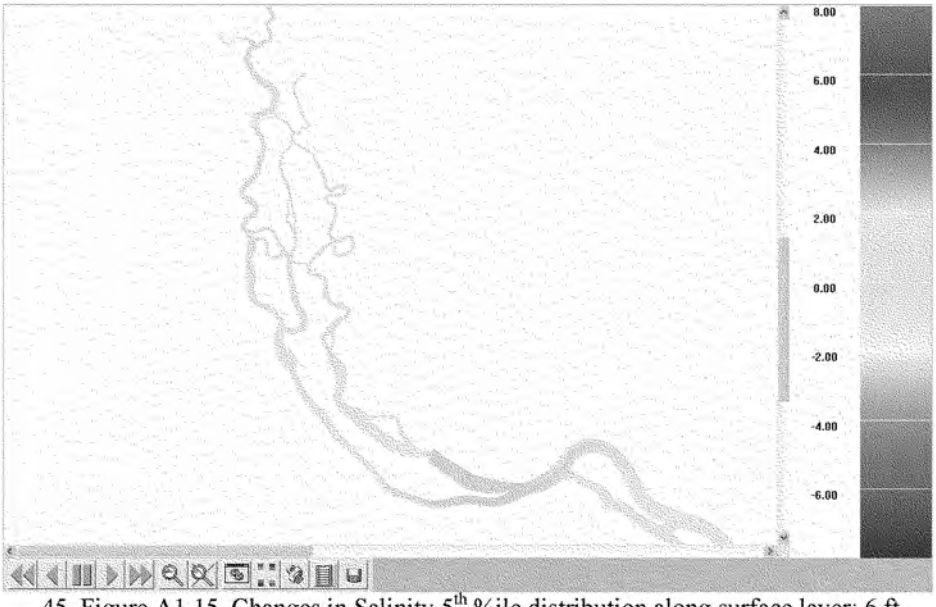
42. Figure A1.12. Changes in D.O. 5th %ile distribution along surface layer: 6 ft deepening



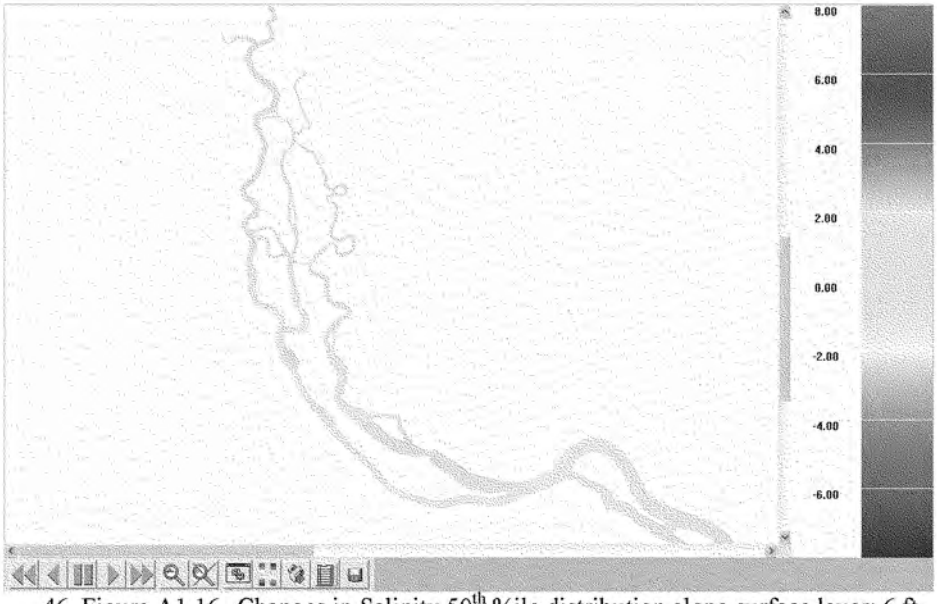
43. Figure A1.13. Changes in D.O. 50th %ile distribution along surface layer: 6 ft deepening



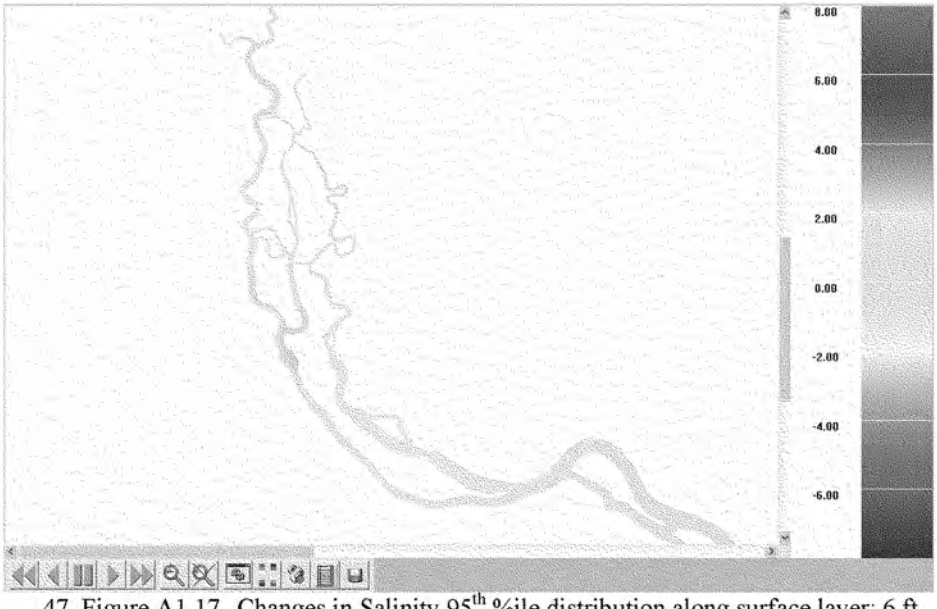
44. Figure A1.14. Changes in D.O. 95th %ile distribution along surface layer: 6 ft deepening



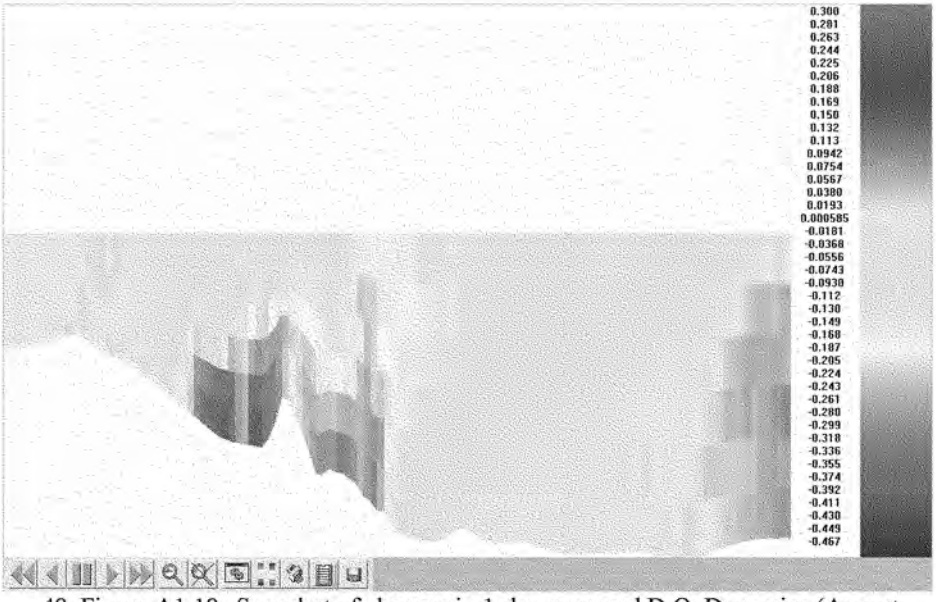
45. Figure A1.15. Changes in Salinity 5th %ile distribution along surface layer: 6 ft deepening



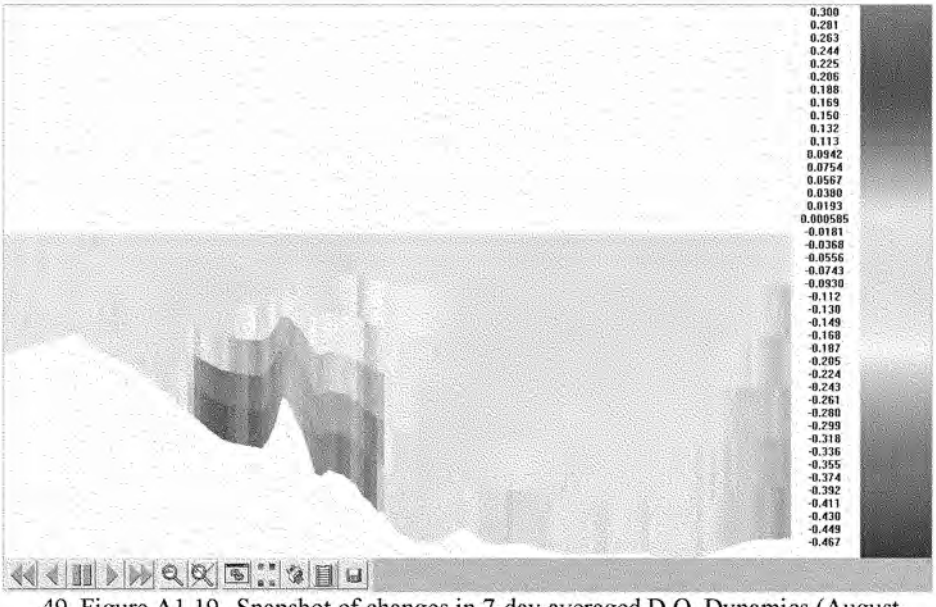
46. Figure A1.16. Changes in Salinity 50th %ile distribution along surface layer: 6 ft deepening



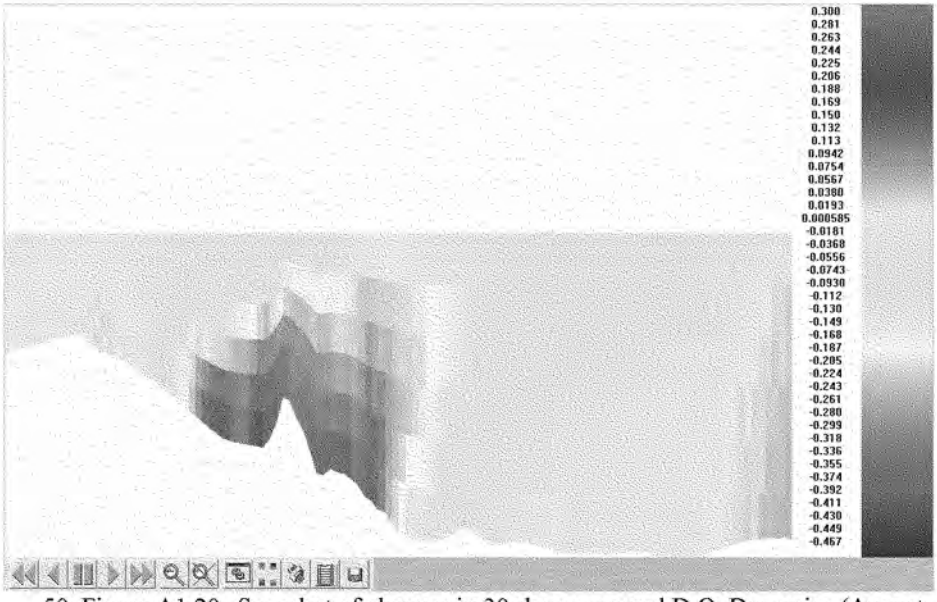
47. Figure A1.17. Changes in Salinity 95th %ile distribution along surface layer: 6 ft deepening



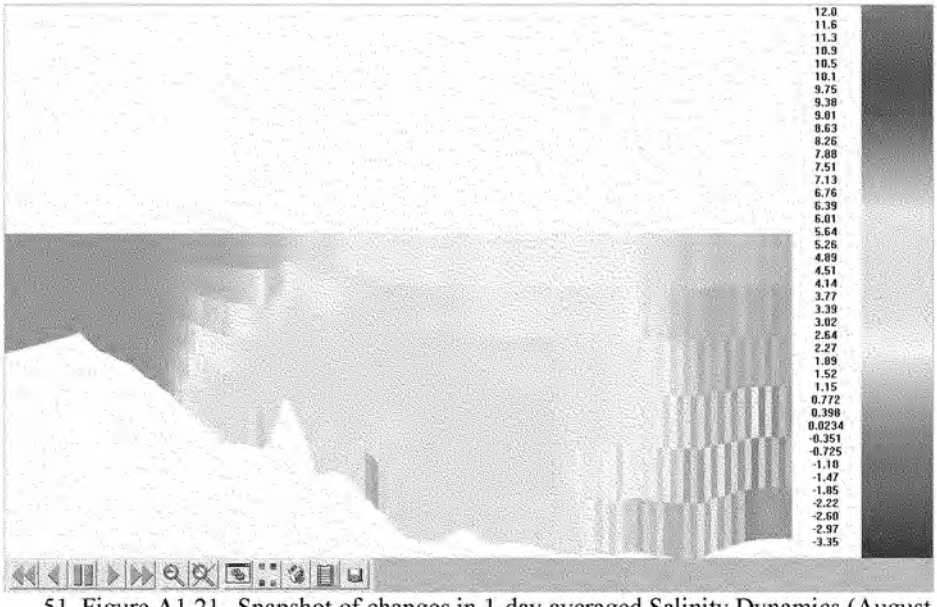
48. Figure A1.18. Snapshot of changes in 1-day averaged D.O. Dynamics (August 10, 1999) in vertical plane of Upper Harbor: 6 ft deepening



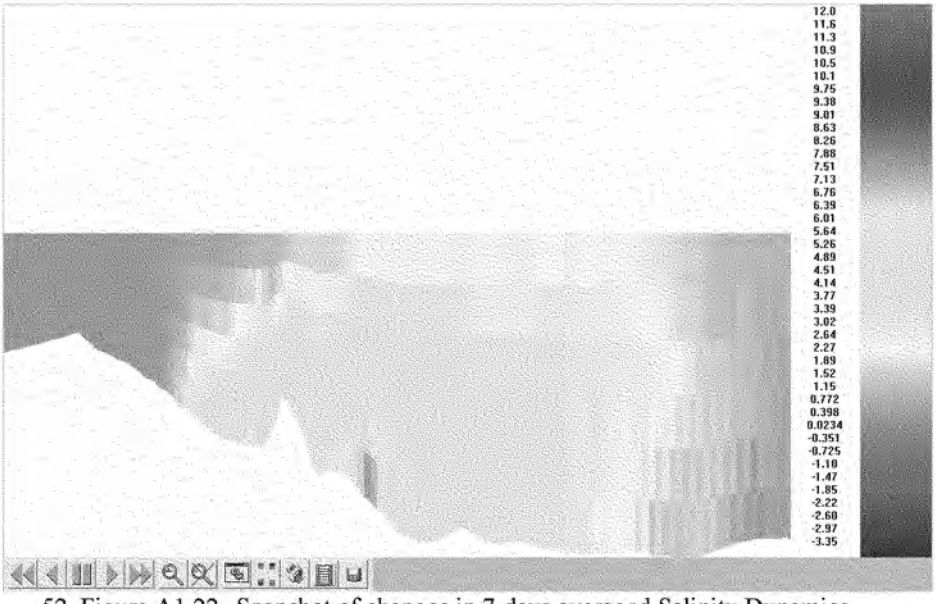
49. Figure A1.19. Snapshot of changes in 7-day averaged D.O. Dynamics (August 10, 1999) in vertical plane of Upper Harbor: 6 ft deepening



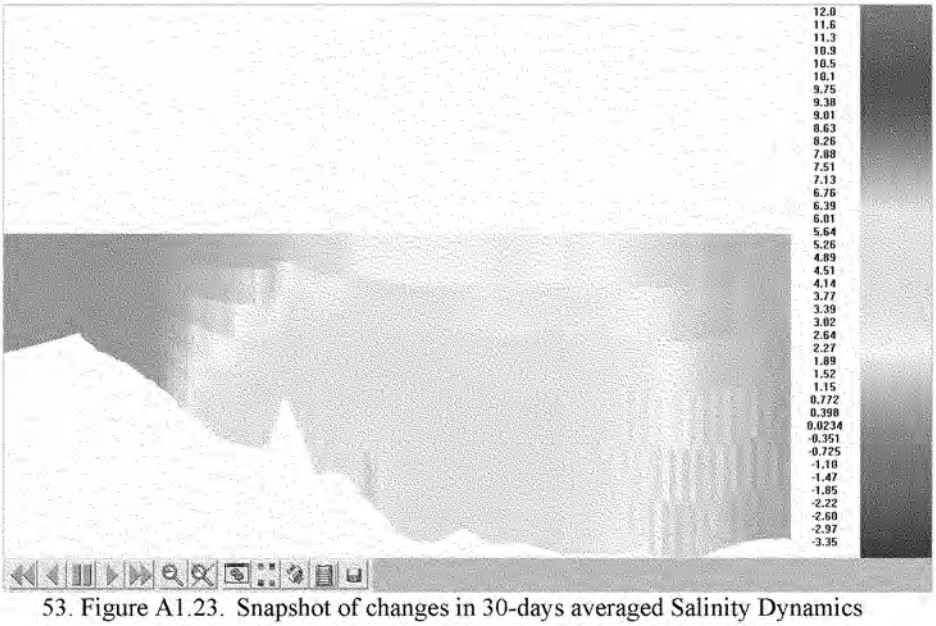
50. Figure A1.20. Snapshot of changes in 30-days averaged D.O. Dynamics (August 10, 1999) in vertical plane of Upper Harbor: 6 ft deepening



51. Figure A1.21. Snapshot of changes in 1-day averaged Salinity Dynamics (August 10, 1999) in vertical plane of Upper Harbor: 6 ft deepening



52. Figure A1.22. Snapshot of changes in 7-days averaged Salinity Dynamics (August 10, 1999) in vertical plane of Upper Harbor: 6 ft deepening



53. Figure A1.23. Snapshot of changes in 30-days averaged Salinity Dynamics (August 10, 1999) in vertical plane of Upper Harbor: 6 ft deepening

Appendix A2

BASIC EVALUATION: 4 ft DEEPENING BATHYMETRY, 2004 POINT SOURCES LOADS, 1999 HYDROLOGICAL AND METEOROLOGICAL CONDITIONS

May 1 – October 30, 1999 Simulation Period

Water Quality Review Group

1. Table A2.1. Dissolved oxygen percentiles distribution in Critical cells

Zone	D.O. Percentile (mg/l)								
	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	3.44	3.62	3.72	3.92	4.27	4.71	4.97	5.18	5.55
FR2	2.76	3.01	3.13	3.38	3.75	4.17	4.52	4.68	4.97
FR3	2.47	2.71	2.82	3.05	3.48	3.91	4.24	4.38	4.71
FR4	2.42	2.68	2.79	3.02	3.45	3.87	4.2	4.35	4.68
FR5	2.45	2.67	2.8	3.09	3.47	3.86	4.2	4.36	4.64
FR6	2.47	2.7	2.84	3.16	3.49	3.91	4.28	4.46	4.74
FR7	2.68	2.89	3.08	3.43	3.77	4.19	4.5	4.69	5.02
FR8	2.95	3.24	3.46	3.87	4.4	4.89	5.27	5.45	5.79
FR9	3.12	3.39	3.55	3.93	4.39	4.9	5.27	5.43	5.73
FR10	2.33	3.13	3.38	3.92	4.6	5.24	5.63	5.81	6.05
FR11	2.18	2.78	3.17	3.64	4.23	4.86	5.4	5.62	5.95
MR1	2.57	2.87	3.07	3.43	3.77	4.1	4.44	4.61	4.85
MR2	2.18	2.56	2.85	3.28	3.7	4.06	4.38	4.6	4.85
MR3	2.06	2.43	2.73	3.2	3.64	4.02	4.36	4.59	4.82
MR4	2.06	2.43	2.61	3.05	3.45	3.8	4.13	4.32	4.61
MR5	0.43	1	1.4	2.25	3.7	5.13	5.58	5.73	5.98
MR6	1.07	1.71	2.15	3.07	4.43	5.33	5.71	5.9	6.18
LBR1	2.58	3.31	3.53	3.99	4.33	4.63	4.93	5.1	5.38
LBR2	2.5	2.68	2.82	3.29	3.57	3.83	4.14	4.29	4.48
LBR3	1.4	1.94	2.18	2.7	3.28	3.76	4.17	4.38	4.73
BR1	2.01	2.24	2.43	2.79	3.22	3.65	4.03	4.24	4.49
BR2	1.4	1.75	2.03	2.46	2.96	3.38	3.78	4.04	4.35
BR3	1.72	2.05	2.24	2.58	3.07	3.47	3.81	4.04	4.39
SCH1	1.39	1.68	1.93	2.51	3.26	4.01	4.59	4.9	5.23
SCH2	3.06	3.28	3.43	3.66	4	4.42	4.76	4.94	5.25
SR	2.25	2.53	2.96	3.6	3.86	4.2	4.5	4.65	4.91

2. Table A2.2. Delta of Dissolved Oxygen percentiles distribution in Critical cells: Deepening scenario minus Existing bathymetry scenario

Zone	Delta D.O. Percentile																	
	1%		5%		10%		25%		50%		75%		90%		95%		99	
	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%
FR1	0.01	0.3	0.01	0.3	0	0.0	-0.03	-0.8	-0.02	-0.5	-0.01	-0.2	-0.03	-0.6	-0.02	-0.4	-0.02	-0.4
FR2	0.02	0.7	0.02	0.7	0.02	0.6	-0.01	-0.3	0.01	0.3	0.01	0.2	0	0.0	0.01	0.2	0	0.0
FR3	0.02	0.8	0.02	0.7	0.01	0.4	0	0.0	-0.02	-0.6	0	0.0	-0.02	-0.5	-0.03	-0.7	0	0.0
FR4	-0.09	-3.6	-0.06	-2.2	-0.06	-2.1	-0.08	-2.6	-0.07	-2.0	-0.04	-1.0	-0.05	-1.2	-0.08	-1.8	-0.03	-0.6
FR5	-0.05	-2.0	-0.02	-0.7	0.02	0.7	-0.01	-0.3	-0.03	-0.9	-0.01	-0.3	-0.03	-0.7	-0.05	-1.1	0.02	0.4
FR6	-0.07	-2.8	-0.04	-1.5	0.03	1.1	0.01	0.3	-0.02	-0.6	0.02	0.5	-0.02	-0.5	-0.02	-0.4	0.05	1.1
FR7	-0.45	-14.4	-0.52	-15.2	-0.51	-14.2	-0.52	-13.2	-0.65	-14.7	-0.68	-14.0	-0.71	-13.6	-0.76	-13.9	-1.01	-16.7
FR8	-0.25	-7.8	-0.28	-8.0	-0.23	-6.2	-0.24	-5.8	-0.29	-6.2	-0.22	-4.3	-0.15	-2.8	-0.16	-2.9	-0.11	-1.9
FR9	-0.27	-8.0	-0.25	-6.9	-0.29	-7.6	-0.3	-7.1	-0.35	-7.4	-0.3	-5.8	-0.19	-3.5	-0.18	-3.2	-0.15	-2.6
FR10	0.04	1.7	0	0.0	0	0.0	0	0.0	0.01	0.2	0	0.0	-0.02	-0.4	-0.01	-0.2	0.02	0.3
FR11	0.01	0.5	0	0.0	0.02	0.6	0.01	0.3	0.01	0.2	0.01	0.2	0	0.0	0	0.0	0.01	0.2
MR1	-0.01	-0.4	-0.12	-4.0	-0.11	-3.5	-0.12	-3.4	-0.16	-4.1	-0.15	-3.5	-0.14	-3.1	-0.14	-2.9	-0.13	-2.6
MR2	-0.02	-0.9	0	0.0	-0.06	-2.1	-0.09	-2.7	-0.12	-3.1	-0.15	-3.6	-0.15	-3.3	-0.14	-3.0	-0.15	-3.0
MR3	-0.02	-1.0	-0.02	-0.8	-0.03	-1.1	-0.08	-2.4	-0.1	-2.7	-0.15	-3.6	-0.14	-3.1	-0.14	-3.0	-0.15	-3.0
MR4	0.01	0.5	-0.01	-0.4	-0.02	-0.8	0	0.0	-0.03	-0.9	-0.03	-0.8	-0.05	-1.2	-0.04	-0.9	-0.07	-1.5
MR5	-0.02	-4.4	0.01	1.0	0.01	0.7	0.04	1.8	0.07	1.9	0.01	0.2	0.01	0.2	0	0.0	0.01	0.2
MR6	0.02	1.9	0.05	3.0	0.04	1.9	0.04	1.3	0.01	0.2	0.03	0.6	0	0.0	0.01	0.2	0.01	0.2
LBR1	-0.09	-3.4	0.02	0.6	0.03	0.9	0.03	0.8	0.02	0.5	0.03	0.7	0.01	0.2	0	0.0	-0.05	-0.9
LBR2	0.4	19.0	0.35	15.0	0.31	12.4	0.31	10.4	0.24	7.2	0.19	5.2	0.2	5.1	0.16	3.9	0.05	1.1
LBR3	0.06	4.5	0.19	10.9	0.14	6.9	0.14	5.5	0.15	4.8	0.13	3.6	0.19	4.8	0.2	4.8	0.17	3.7
BR1	0.01	0.5	0.01	0.4	0.02	0.8	0.01	0.4	0.01	0.3	0.02	0.6	0.02	0.5	0.02	0.5	0.01	0.2
BR2	0.03	2.2	0.14	8.7	0.2	10.9	0.26	11.8	0.18	6.5	0.19	6.0	0.21	5.9	0.26	6.9	0.2	4.8
BR3	0.03	1.8	0.02	1.0	0.02	0.9	0.02	0.8	0.01	0.3	0	0.0	0.02	0.5	-0.01	-0.2	0	0.0
SCH1	0.1	7.8	0.03	1.8	0.01	0.5	0.02	0.8	-0.05	-1.5	-0.09	-2.2	-0.07	-1.5	-0.08	-1.6	-0.09	-1.7
SCH2	-0.02	-0.6	-0.03	-0.9	-0.02	-0.6	-0.03	-0.8	-0.04	-1.0	-0.02	-0.5	-0.01	-0.2	-0.02	-0.4	0	0.0
SR	0.01	0.4	0.01	0.4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0.01	0.2	0	0.0

3. Table A2.3. Dissolved oxygen percentiles distribution in Zones of Savannah Estuary

Zone Name	D.O. Concentration Percentiles (mg/l)								
	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	3.83	3.97	4.04	4.24	4.60	5.01	5.27	5.45	5.76
FR2	3.23	3.47	3.57	3.78	4.12	4.54	4.83	4.97	5.29
FR3	2.78	3.01	3.12	3.34	3.70	4.12	4.46	4.61	4.90
FR4	2.47	2.72	2.87	3.11	3.49	3.91	4.23	4.42	4.70
FR5	2.47	2.69	2.81	3.07	3.46	3.85	4.20	4.36	4.64
FR6	2.57	2.77	2.87	3.14	3.52	3.89	4.25	4.40	4.64
FR7	2.81	3.05	3.26	3.62	4.04	4.52	4.91	5.09	5.45
FR8	3.08	3.34	3.55	3.95	4.39	4.86	5.17	5.35	5.65
FR9	3.62	3.93	4.15	4.53	4.97	5.37	5.65	5.81	6.04
FR10	4.00	4.48	4.68	4.96	5.24	5.51	5.76	5.89	6.12
FR11	2.63	3.19	3.57	3.96	4.30	4.63	4.95	5.13	5.38
MR1	2.70	2.93	3.09	3.46	3.78	4.09	4.43	4.62	4.83
MR2	2.34	2.74	2.96	3.36	3.72	4.06	4.40	4.58	4.81
MR3	2.09	2.33	2.65	3.10	3.52	3.94	4.28	4.50	4.81
MR4	2.73	2.94	3.17	3.58	3.91	4.21	4.50	4.66	4.87
MR5	1.08	1.50	1.91	2.76	4.15	5.09	5.51	5.67	5.94
MR6	1.11	1.73	2.18	3.14	4.47	5.29	5.67	5.85	6.12
LBR1	2.89	3.05	3.20	3.65	3.92	4.17	4.48	4.62	4.77
LBR2	2.05	2.27	2.50	2.92	3.30	3.61	3.89	4.09	4.31
LBR3	1.88	2.01	2.13	2.60	3.09	3.40	3.74	3.88	4.21
BR1	2.42	2.55	2.66	2.96	3.37	3.77	4.16	4.34	4.60
BR2	1.96	2.18	2.31	2.63	3.08	3.50	3.88	4.08	4.34
BR3	1.97	2.13	2.26	2.62	3.06	3.44	3.82	4.04	4.29
SCh1	2.67	2.89	3.01	3.27	3.64	4.11	4.41	4.56	4.83
SCh2	3.33	3.48	3.58	3.78	4.09	4.50	4.81	4.98	5.28
SR	2.62	2.80	3.29	3.89	4.12	4.44	4.71	4.85	5.11

4. Table A2.4. Delta of Dissolved Oxygen percentiles distribution in Zones of Savannah Estuary: Deepening scenario minus Existing bathymetry scenario

Zone	Project - Baseline Difference (mg/l)									Project - Baseline Relative Difference (%)								
Name	1%	5%	10%	25%	50%	75%	90%	95%	99%	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	0.02	0.01	0.00	-0.01	0.00	0.00	-0.01	-0.03	-0.05	0.6	0.3	0.0	-0.2	0.1	0.1	-0.2	-0.5	-0.9
FR2	0.01	0.03	0.02	0.01	0.01	0.02	0.01	0.00	-0.01	0.2	0.8	0.6	0.3	0.3	0.4	0.2	0.1	-0.2
FR3	0.04	0.06	0.07	0.04	0.03	0.05	0.04	0.03	0.02	1.4	2.2	2.4	1.1	0.7	1.1	0.8	0.6	0.4
FR4	-0.03	-0.01	0.06	0.05	-0.01	0.04	-0.01	0.03	0.04	-1.1	-0.3	2.0	1.5	-0.1	0.9	-0.2	0.6	0.8
FR5	-0.08	-0.06	-0.03	-0.02	-0.05	-0.03	-0.07	-0.05	0.01	-3.0	-2.1	-0.9	-0.8	-1.4	-0.7	-1.7	-1.1	0.2
FR6	-0.11	-0.10	-0.08	-0.13	-0.13	-0.12	-0.13	-0.16	-0.10	-4.0	-3.6	-2.8	-3.9	-3.5	-2.9	-3.0	-3.5	-2.1
FR7	-0.22	-0.21	-0.20	-0.22	-0.27	-0.29	-0.22	-0.22	-0.17	-7.1	-6.6	-5.6	-5.7	-6.2	-6.1	-4.3	-4.2	-3.0
FR8	-0.24	-0.27	-0.25	-0.26	-0.28	-0.22	-0.18	-0.17	-0.12	-7.3	-7.5	-6.6	-6.1	-6.0	-4.3	-3.3	-3.1	-2.1
FR9	-0.30	-0.31	-0.29	-0.29	-0.23	-0.13	-0.11	-0.10	-0.10	-7.7	-7.2	-6.5	-5.9	-4.4	-2.4	-1.9	-1.6	-1.6
FR10	-0.01	-0.03	-0.02	-0.04	-0.04	-0.05	-0.04	-0.04	-0.04	-0.2	-0.6	-0.5	-0.8	-0.8	-0.9	-0.7	-0.6	-0.6
FR11	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.02	0.0	0.1	0.2	0.0	0.0	0.0	0.1	0.1	0.3
MR1	-0.09	-0.12	-0.13	-0.10	-0.16	-0.15	-0.14	-0.13	-0.11	-3.4	-3.9	-4.0	-2.8	-4.0	-3.6	-3.0	-2.7	-2.3
MR2	-0.02	-0.04	-0.09	-0.10	-0.14	-0.14	-0.13	-0.16	-0.14	-0.8	-1.6	-3.0	-2.8	-3.7	-3.4	-2.9	-3.3	-2.8
MR3	0.00	-0.02	-0.01	-0.03	-0.06	-0.09	-0.09	-0.09	-0.10	-0.1	-0.9	-0.5	-1.1	-1.8	-2.3	-2.2	-1.9	-2.1
MR4	-0.01	0.01	0.01	0.02	0.01	0.00	-0.01	-0.01	0.01	-0.2	0.3	0.4	0.5	0.3	0.0	-0.3	-0.3	0.2
MR5	0.01	0.04	0.03	0.03	0.01	0.01	0.01	0.01	0.02	1.3	2.9	1.9	1.0	0.4	0.3	0.2	0.2	0.4
MR6	0.00	0.05	0.05	0.04	0.01	0.02	0.01	0.01	0.01	0.4	2.7	2.3	1.3	0.3	0.3	0.1	0.1	0.1
LBR1	0.02	0.02	0.03	0.02	0.01	0.01	0.01	0.02	0.01	0.8	0.8	1.0	0.5	0.2	0.3	0.3	0.4	0.2
LBR2	0.01	0.01	0.01	0.00	0.01	0.01	0.00	0.00	0.01	0.7	0.4	0.5	0.1	0.2	0.3	0.0	0.0	0.3
LBR3	0.12	0.11	0.13	0.08	0.05	0.07	0.07	0.07	0.05	6.7	6.0	6.3	3.1	1.6	2.1	2.0	1.8	1.2
BR1	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.3	0.0	0.0	0.2	0.2	0.0	0.1	0.0	0.0
BR2	0.01	0.01	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.7	0.5	0.3	0.8	0.4	0.1	-0.1	0.1	0.1
BR3	0.05	0.03	0.02	0.04	0.00	0.00	0.01	0.01	-0.01	2.6	1.4	1.0	1.5	0.1	0.1	0.2	0.3	-0.2
SCh1	0.06	0.01	0.00	0.00	0.00	0.00	-0.03	-0.03	-0.01	2.5	0.5	0.0	0.0	-0.1	0.0	-0.6	-0.6	-0.1
SCh2	-0.01	0.00	0.00	-0.01	-0.01	-0.02	-0.02	-0.02	-0.01	-0.2	0.1	0.0	-0.3	-0.2	-0.4	-0.4	-0.4	-0.2
SR	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.2	0.1	0.0	0.1	0.0	0.0	0.1	0.0	0.0

5. Table A2.5. Percentage of the volume of waters with violation of Dissolved Oxygen standards for Zones of Savannah Estuary within the period of May 1 – October 30, 1999: Deepening (Project) and Existing (Baseline) bathymetry

Zones	D.O. STANDARDS														
	1-Day Average			7-Day Average			30-Day Average			GA MINIMUM D.O.			SC MINIMUM D.O.		
	Baseline(B)	Project(P)	Delta=P-B	Baseline(B)	Project(P)	Delta=P-B	Baseline(B)	Project(P)	Delta=P-B	Baseline(B)	Project(P)	Delta=P-B	Baseline(B)	Project(P)	Delta=P-B
FR1	0	0	0	0	0	0	0	0	0	0	0	0	7	6	-1
FR2	0	0	0	0	0	0	3	3	0	0	0	0	31	30	-1
FR3	0	0	0	2	2	0	19	18	-1	3	3	0	N/A	N/A	N/A
FR4	0	0	0	5	5	0	22	23	1	6	5	-1	N/A	N/A	N/A
FR5	0	0	0	4	6	2	19	22	3	5	6	1	N/A	N/A	N/A
FR6	0	0	0	2	4	2	12	19	7	4	5	1	N/A	N/A	N/A
FR7	0	0	0	0	0	0	1	2	1	0	1	1	N/A	N/A	N/A
FR8	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
FR9	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
FR10	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
FR11	0	0	0	0	0	0	2	2	0	1	1	0	6	6	0
MR1	0	0	0	0	1	1	5	7	2	1	2	1	N/A	N/A	N/A
MR2	0	0	0	1	2	1	6	8	2	1	2	1	N/A	N/A	N/A
MR3	0	0	0	3	3	0	10	11	1	3	4	1	N/A	N/A	N/A
MR4	0	0	0	1	1	0	5	5	0	2	2	0	N/A	N/A	N/A
MR5	0	0	0	1	1	0	5	5	0	5	5	0	11	11	0
MR6	0	0	0	0	0	0	3	3	0	3	3	0	9	8	-1
LBR1	0	0	0	1	1	0	6	6	0	1	1	0	18	18	0
LBR2	1	1	0	6	6	0	18	18	0	7	7	0	34	35	1
LBR3	3	2	-1	13	13	0	30	31	1	14	14	0	47	49	2
BR1	0	0	0	10	10	0	39	40	1	12	12	0	67	68	1
BR2	2	2	0	19	20	1	49	50	1	20	20	0	75	75	0
BR3	3	3	0	21	21	0	48	49	1	22	22	0	70	71	1
SCh1	1	1	0	4	3	-1	8	8	0	5	4	-1	N/A	N/A	N/A
SCh2	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
SR	0	0	0	1	1	0	3	3	0	1	1	0	6	6	0

26. Table A2.6. Percentage of water volumes with salinity in %iles within the period of May 1 – October 30, 1999

Percen-tile	Harbor / River			Stations					
	Upper Hrb %	Middle Rvr %	Back Rvr %	Houlih Brg %	Broad Str %	Pulaski Frt %	Lucknow Cnl %	USF&W Dck %	I-95 Brg %
5	18.6	4.5	4.4	4.5	4.4	4.3	5.6	3.8	85.2
10	22.6	8.2	8.7	8.9	8.9	8.7	8.9	8.3	85.2
25	35	20	22.2	22.4	22.9	22.1	24.5	19.8	85.2
50	56.6	41.9	46.5	46.6	47.3	46.1	48	42.5	85.2
75	78.2	69.1	72.7	73	73.3	72.9	72.8	69.3	85.2
90	91	87.2	88.9	89.1	89.3	89.2	88.9	87.4	91.7
95	95.2	93.5	94.4	94.6	94.6	94.6	94.2	93.7	95.7
Total Volume 100*km3:	32610	658.2	4806.5	25.7	39.2	136.3	9.9	9.5	43.6

27. Table A2.7. Percentage of water volumes with D.O. in %iles within the period of May 1 – October 30, 1999

Percen-tile	Harbor / River			Stations					
	Upper Hrb %	Middle Rvr %	Back Rvr %	Houlih Brg %	Broad Str %	Pulaski Frt %	Lucknow Cnl %	USF&W Dck %	I-95 Brg %
5	5.2	5	4.9	5.6	5.2	4.7	5.4	5.5	5.7
10	10.4	9.9	9.8	11.2	10.4	9.5	10.4	11	11
25	26.1	25	24.8	27.3	25.7	24.2	25.5	25.8	26.4
50	52	49.9	49.8	53.3	51	49.1	51.2	51.2	51.3
75	76.3	74.8	75.2	77.5	75.7	74.6	75.6	76.1	75.8
90	90.5	89.9	90.1	91.2	90.3	89.7	90.2	90.4	90.3
95	95	94.9	95	95.7	95.2	94.8	95.2	95.4	95.1
Total Volume 100*km3:	32610	658.2	4806.5	25.7	39.2	136.3	9.9	9.5	43.6

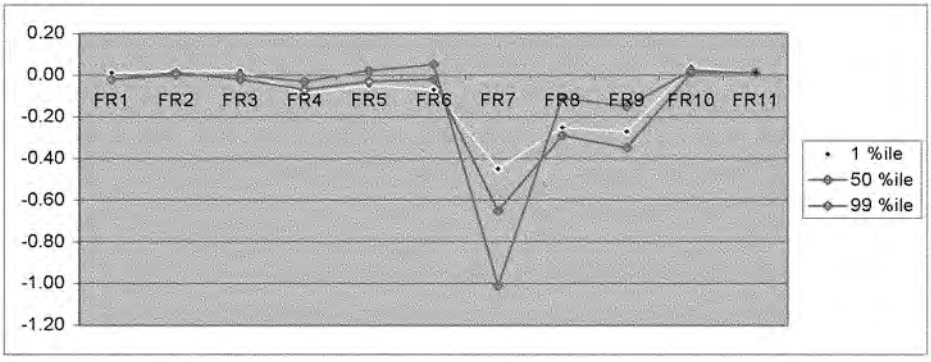
28. Table A2.8. Water volumes in Upper Harbor in increments of 1° C of water temperature within the period of May 1 – October 30, 1999

Temperature C°	Total Volume %
19	0.01
20	0.87
21	4.05
22	9.28
23	14.85
24	23.34
25	35.04
26	48.99
27	60.13
28	69.22
29	76.12
30	85.05
31	89.54
32	96.28
33	99.99
34	100

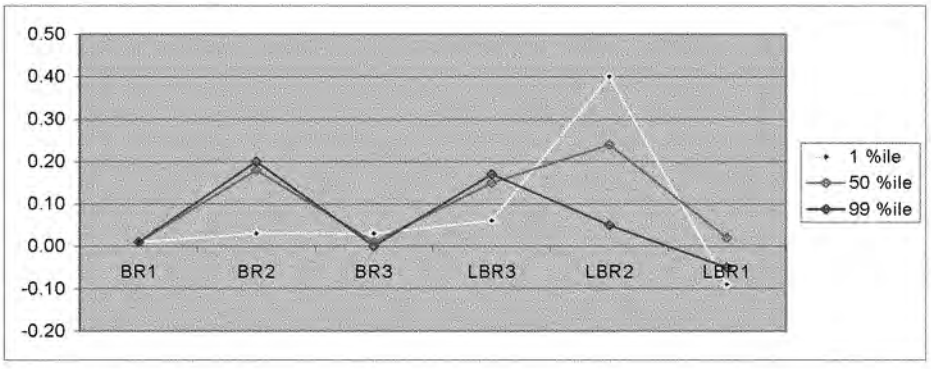
29. Table A2.9. Water volumes in Upper Harbor in increments of 0.1 mg/l of D.O. within the period of May 1 – October 30, 1999
(See file: Postprocessor Output\99-B14\99-B14_DO Increment Volume)

30. Table A2.10. Percentage of water volumes corresponding to 1-, 7-, and 30-days averages of D.O. depth-averaged concentrations in Upper Harbor within the period of May 1 – October 30, 1999
(See file: Postprocessor Output\99-B14\99-B14_volume DO in averages)

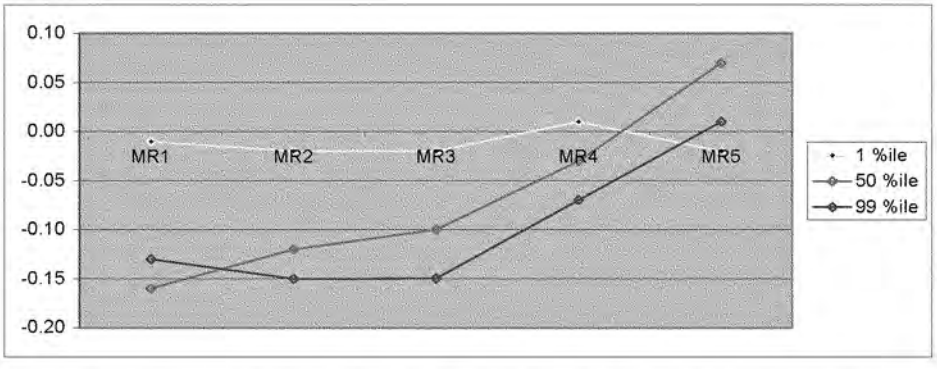
Front River



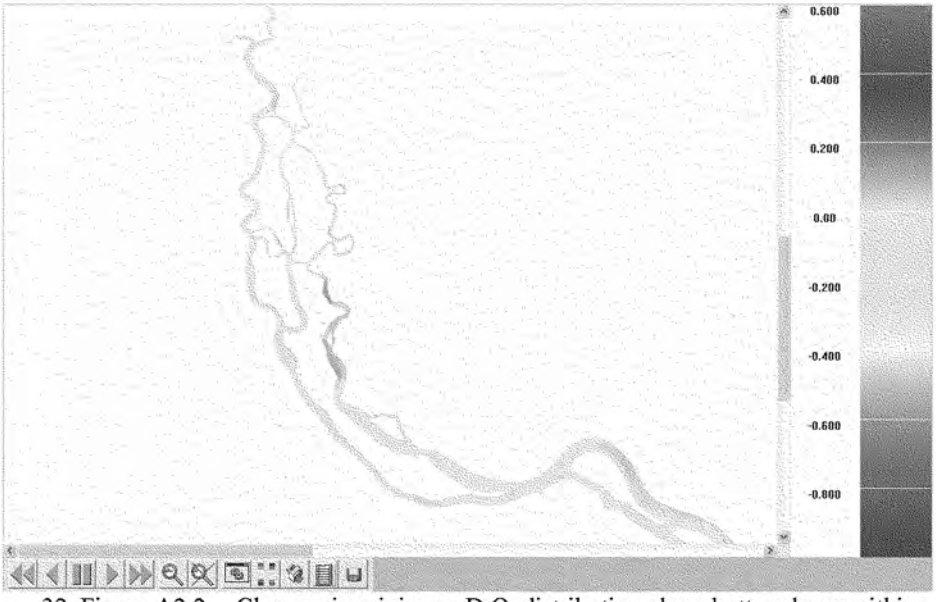
Back and Little Back Rivers



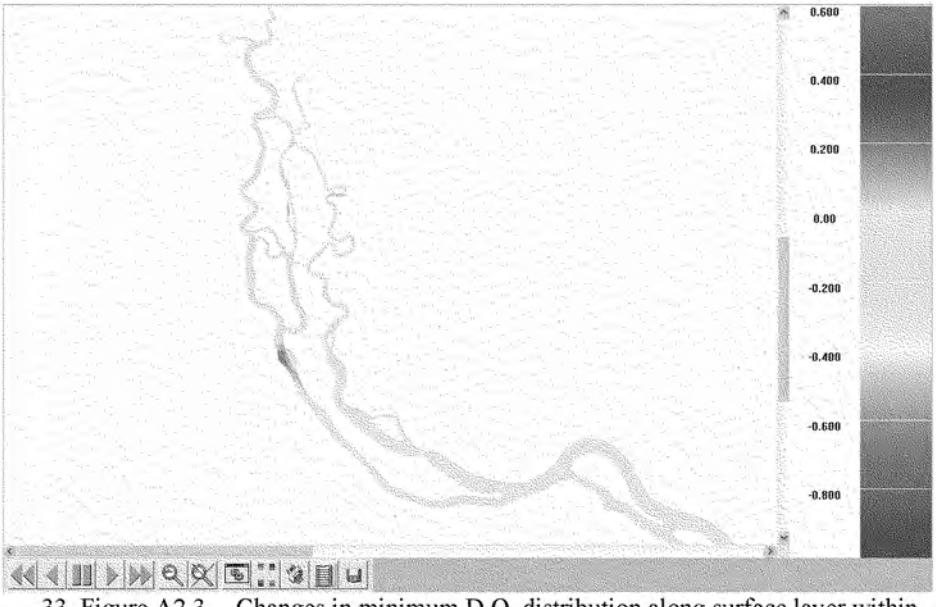
Middle River



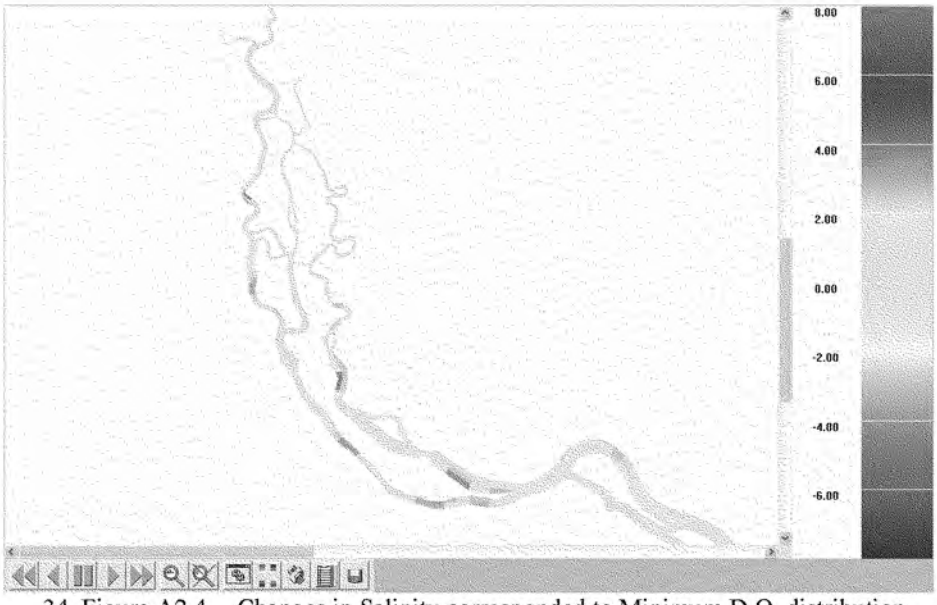
31. Figure A2.1. Changes in longitudinal profile of Dissolved Oxygen (mg/l) distribution along Critical cells of Savannah Estuary: 4 ft deepening



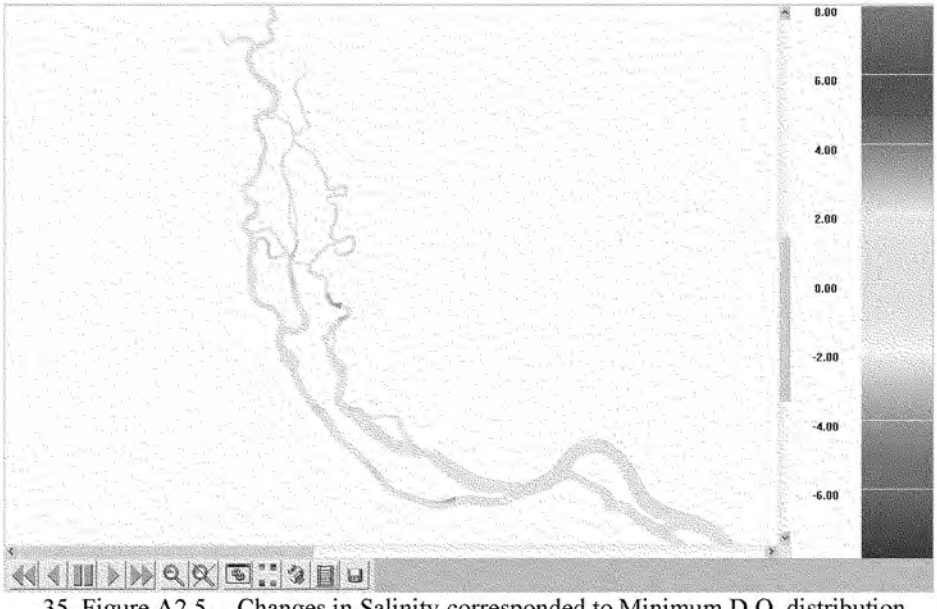
32. Figure A2.2. Changes in minimum D.O. distribution along bottom layer within the analyzed period of May 1 - October 30, 1999: 4 ft deepening



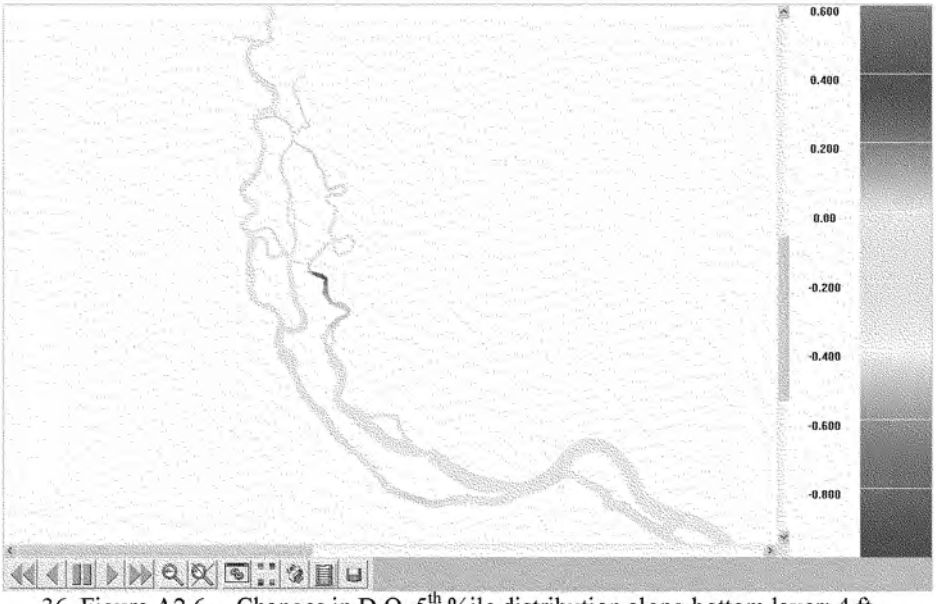
33. Figure A2.3. Changes in minimum D.O. distribution along surface layer within the analyzed period of May 1 - October 30, 1999: 4 ft deepening



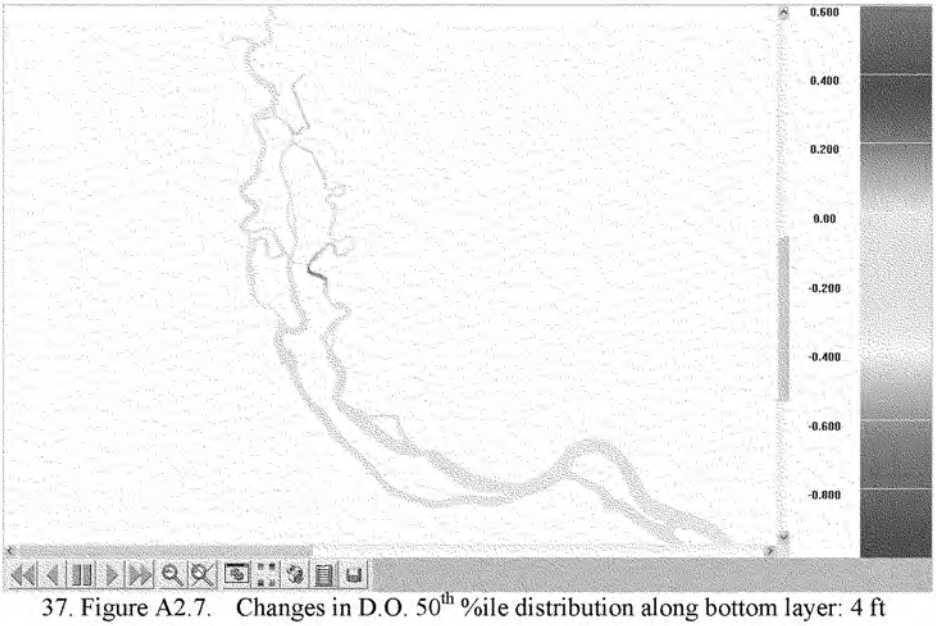
34. Figure A2.4. Changes in Salinity corresponded to Minimum D.O. distribution along bottom layer within the analyzed period of May 1 - October 30, 1999: 4 ft deepening



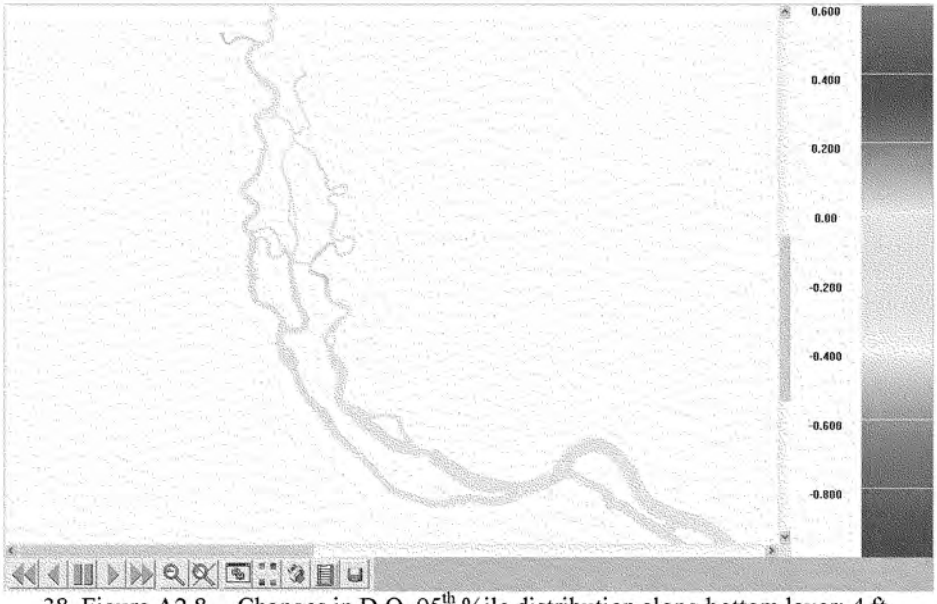
35. Figure A2.5. Changes in Salinity corresponded to Minimum D.O. distribution along Surface layer within the analyzed period of May 1 - October 30, 1999: 4 ft deepening



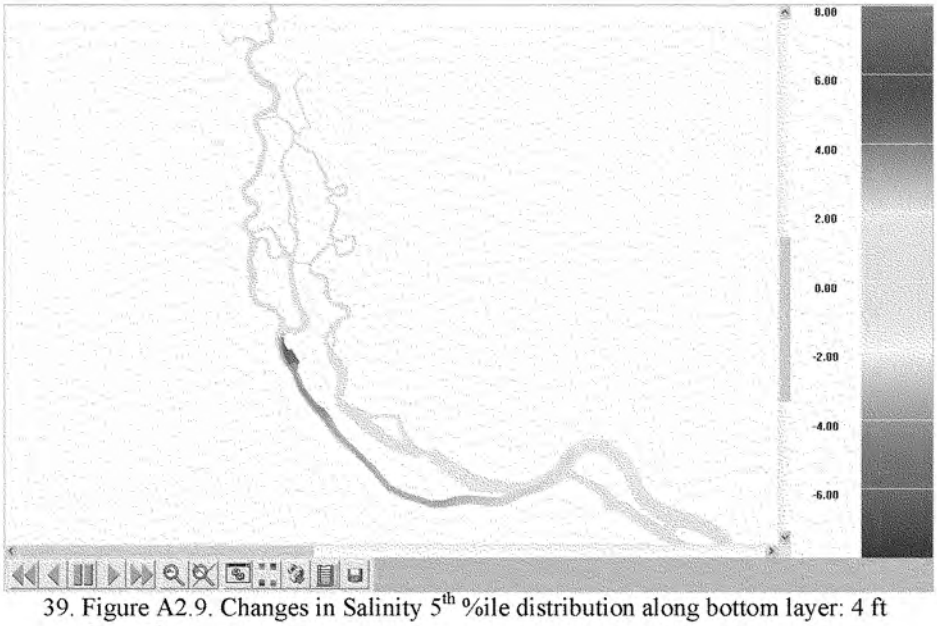
36. Figure A2.6. Changes in D.O. 5th %ile distribution along bottom layer: 4 ft deepening



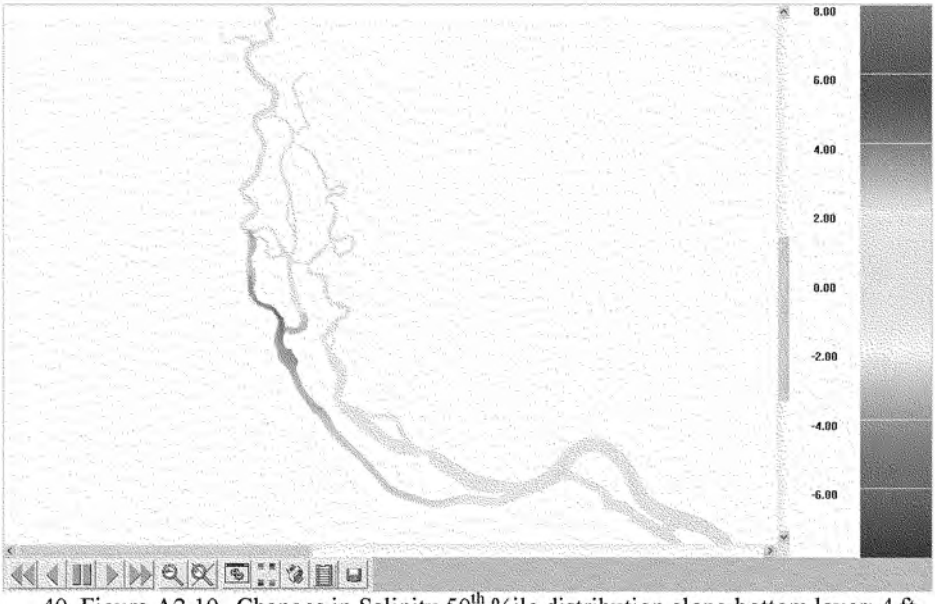
37. Figure A2.7. Changes in D.O. 50th %ile distribution along bottom layer: 4 ft deepening



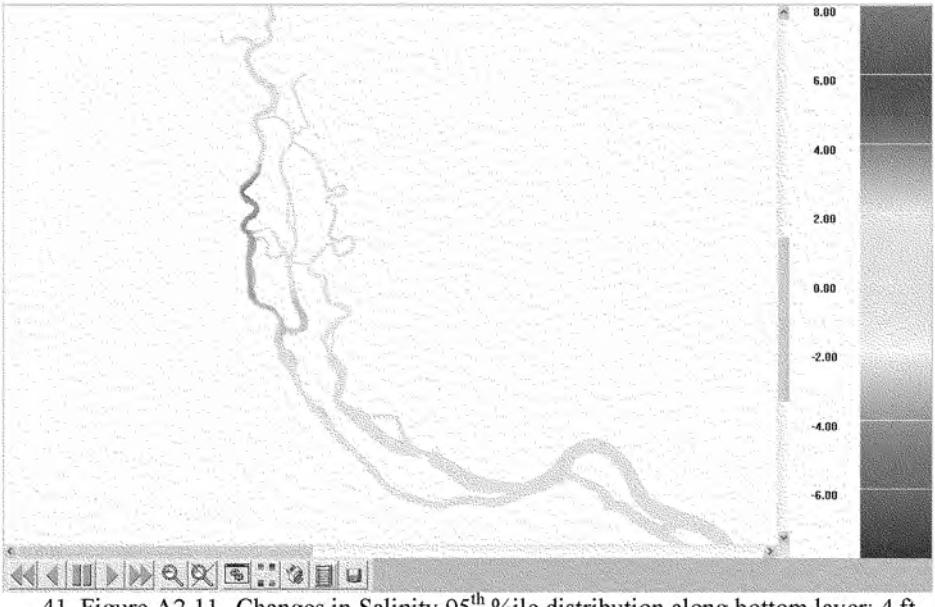
38. Figure A2.8. Changes in D.O. 95th %ile distribution along bottom layer: 4 ft deepening



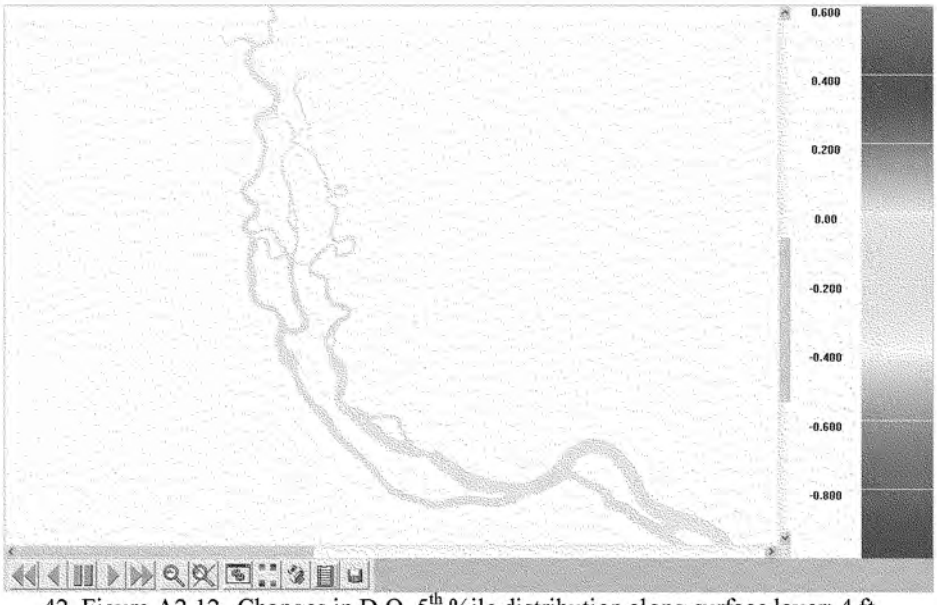
39. Figure A2.9. Changes in Salinity 5th %ile distribution along bottom layer: 4 ft deepening



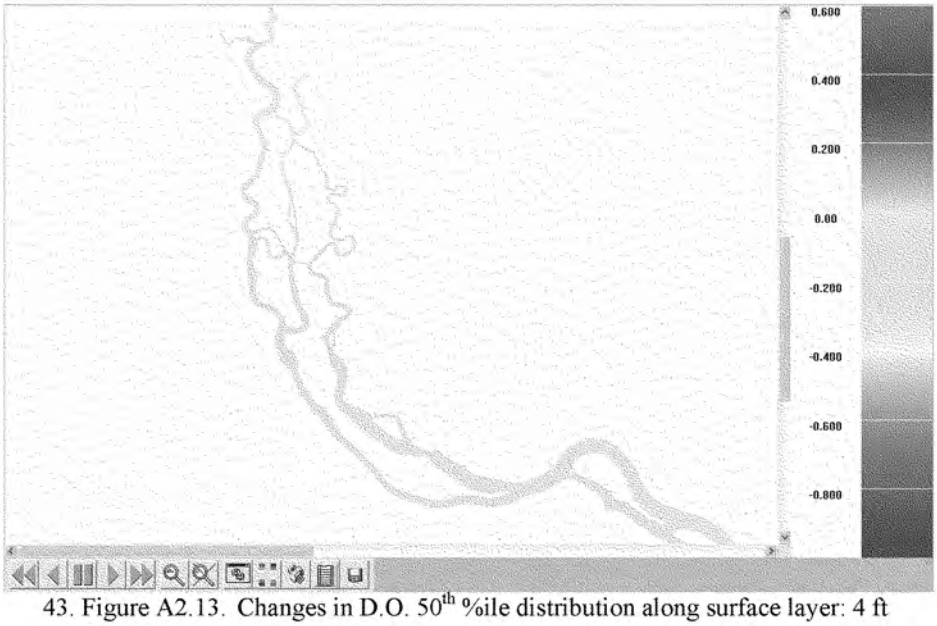
40. Figure A2.10. Changes in Salinity 50th %ile distribution along bottom layer: 4 ft deepening



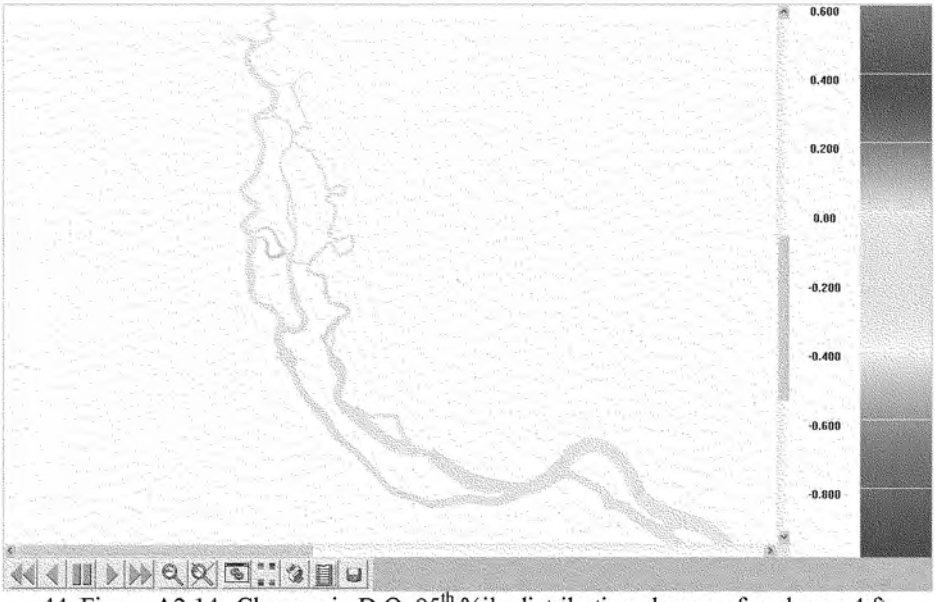
41. Figure A2.11. Changes in Salinity 95th %ile distribution along bottom layer: 4 ft deepening



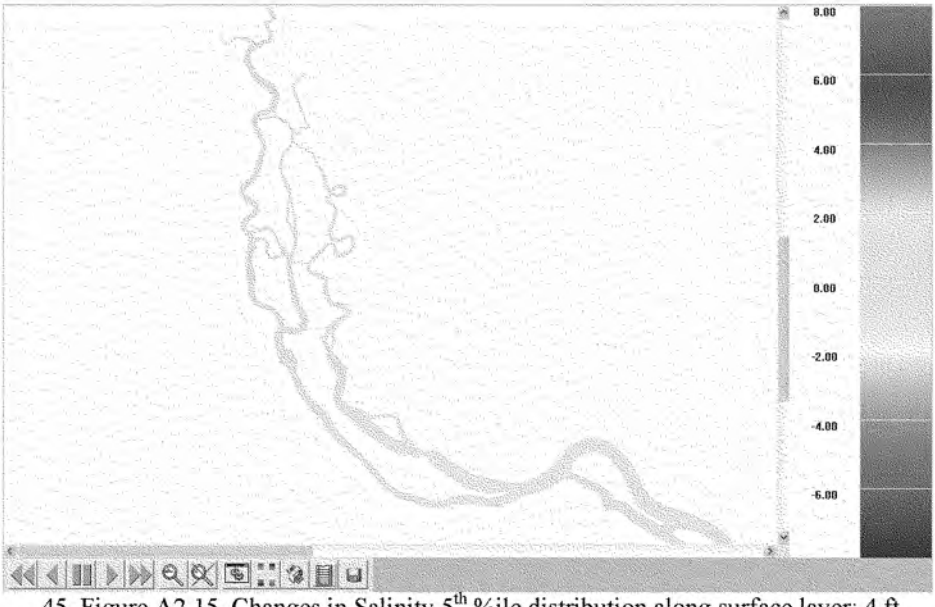
42. Figure A2.12. Changes in D.O. 5th %ile distribution along surface layer: 4 ft deepening



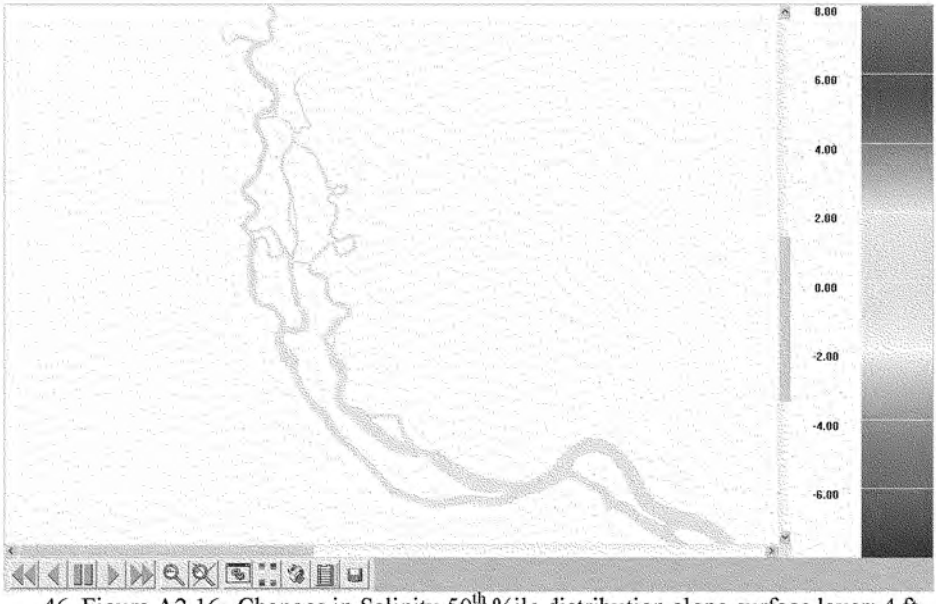
43. Figure A2.13. Changes in D.O. 50th %ile distribution along surface layer: 4 ft deepening



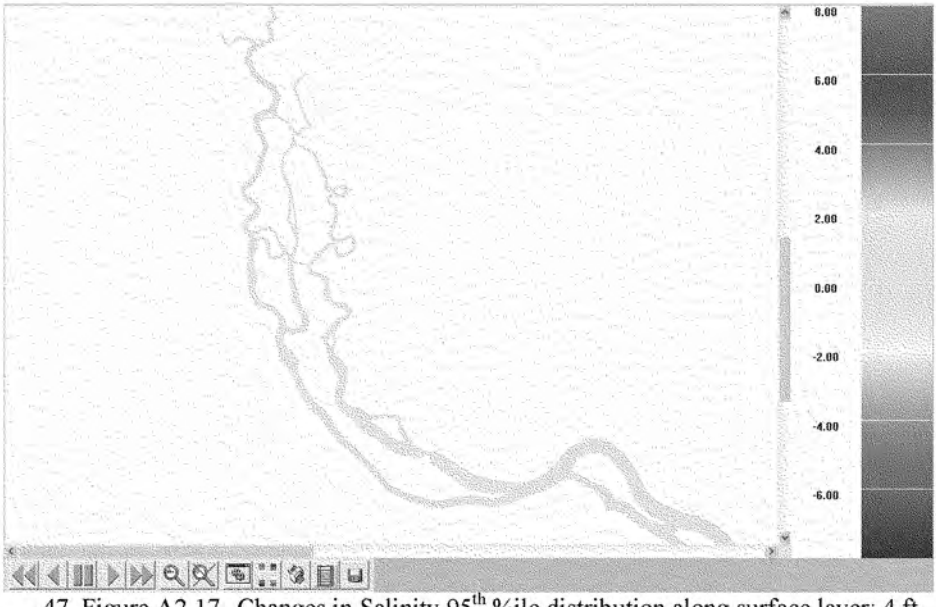
44. Figure A2.14. Changes in D.O. 95th %ile distribution along surface layer: 4 ft deepening



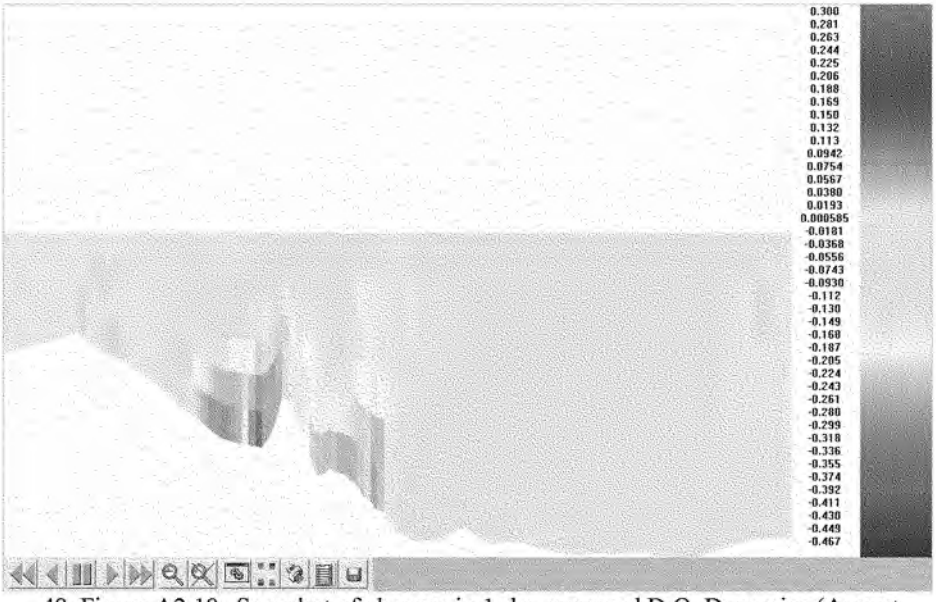
45. Figure A2.15. Changes in Salinity 5th %ile distribution along surface layer: 4 ft deepening



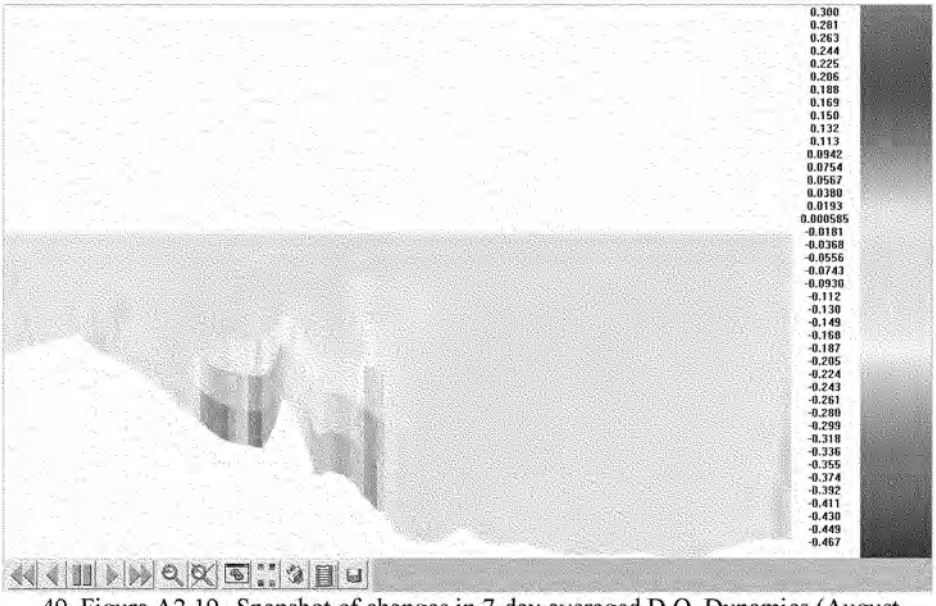
46. Figure A2.16. Changes in Salinity 50th %ile distribution along surface layer: 4 ft deepening



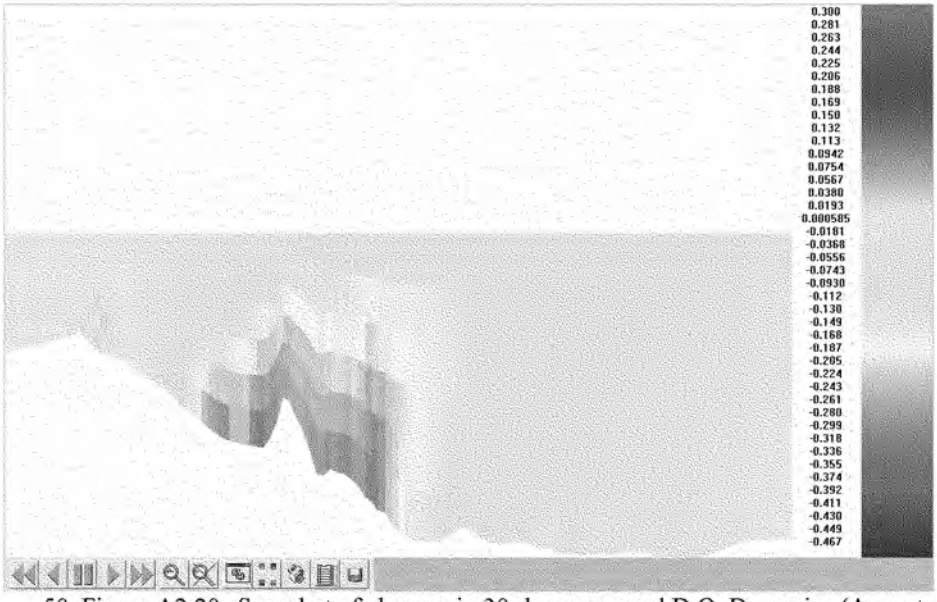
47. Figure A2.17. Changes in Salinity 95th %ile distribution along surface layer: 4 ft deepening



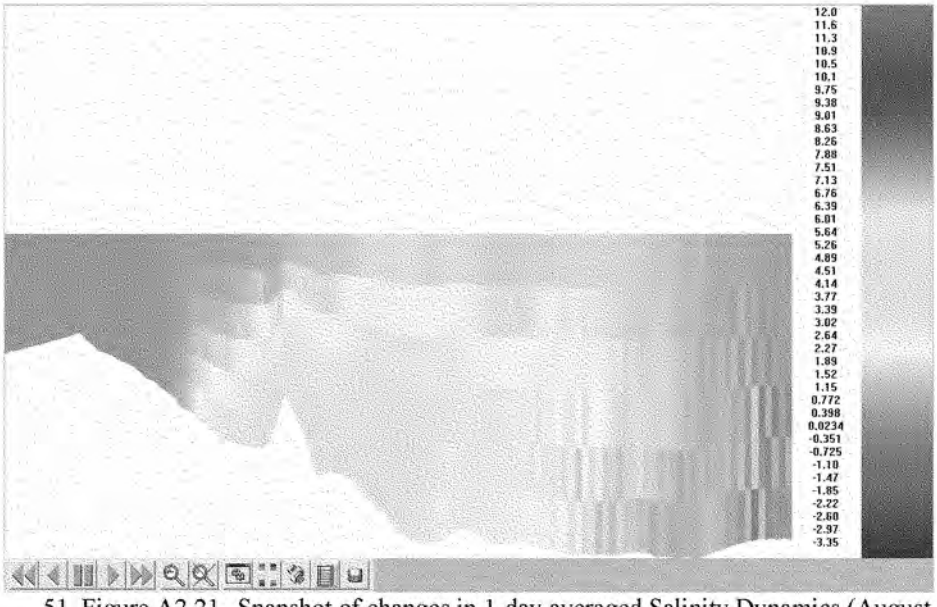
48. Figure A2.18. Snapshot of changes in 1-day averaged D.O. Dynamics (August 10, 1999) in vertical plane of Upper Harbor: 4 ft deepening



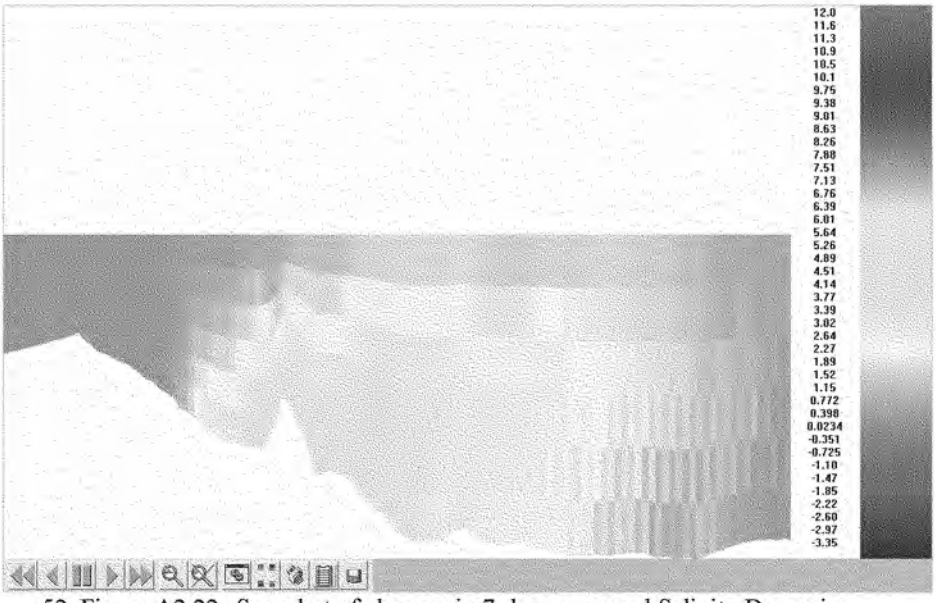
49. Figure A2.19. Snapshot of changes in 7-day averaged D.O. Dynamics (August 10, 1999) in vertical plane of Upper Harbor: 4 ft deepening



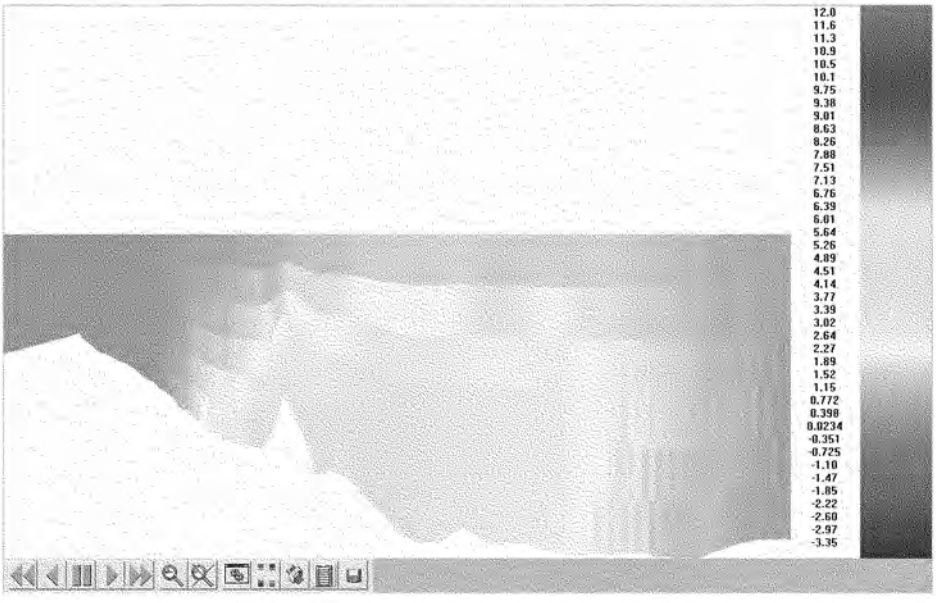
50. Figure A2.20. Snapshot of changes in 30-days averaged D.O. Dynamics (August 10, 1999) in vertical plane of Upper Harbor: 4 ft deepening



51. Figure A2.21. Snapshot of changes in 1-day averaged Salinity Dynamics (August 10, 1999) in vertical plane of Upper Harbor: 4 ft deepening



52. Figure A2.22. Snapshot of changes in 7-days averaged Salinity Dynamics (August 10, 1999) in vertical plane of Upper Harbor: 4 ft deepening



53. Figure A2.23. Snapshot of changes in 30-days averaged Salinity Dynamics (August 10, 1999) in vertical plane of Upper Harbor: 4 ft deepening

Appendix A3

BASIC EVALUATION: 3 ft DEEPENING BATHYMETRY, 2004 POINT SOURCES LOADS, 1999 HYDROLOGICAL AND METEOROLOGICAL CONDITIONS

May 1 – October 30, 1999 Simulation Period

Water Quality Review Group

1. Table A3.1. Dissolved oxygen percentiles distribution in Critical cells

Zone	D.O. Percentile (mg/l)								
	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	3.45	3.62	3.72	3.93	4.29	4.72	4.98	5.2	5.56
FR2	2.76	3.01	3.12	3.39	3.75	4.17	4.52	4.67	4.97
FR3	2.49	2.74	2.85	3.07	3.5	3.93	4.27	4.42	4.73
FR4	2.43	2.67	2.77	3	3.45	3.87	4.2	4.35	4.67
FR5	2.47	2.68	2.79	3.09	3.48	3.86	4.21	4.38	4.64
FR6	2.47	2.69	2.83	3.18	3.52	3.93	4.31	4.51	4.8
FR7	2.72	2.95	3.18	3.55	3.98	4.5	4.96	5.15	5.48
FR8	3.03	3.32	3.51	3.93	4.46	4.93	5.31	5.49	5.82
FR9	3.18	3.46	3.62	4	4.47	4.98	5.32	5.47	5.78
FR10	2.32	3.13	3.38	3.92	4.6	5.25	5.64	5.81	6.04
FR11	2.16	2.77	3.17	3.64	4.23	4.86	5.41	5.62	5.95
MR1	2.58	2.9	3.09	3.47	3.81	4.13	4.47	4.63	4.88
MR2	2.18	2.55	2.86	3.3	3.73	4.1	4.42	4.62	4.88
MR3	2.07	2.43	2.74	3.22	3.66	4.06	4.39	4.62	4.86
MR4	2.06	2.43	2.61	3.05	3.46	3.81	4.14	4.33	4.64
MR5	0.43	1.01	1.4	2.24	3.67	5.13	5.58	5.73	5.98
MR6	1.07	1.7	2.15	3.07	4.41	5.33	5.71	5.9	6.18
LBR1	2.59	3.31	3.52	3.99	4.33	4.62	4.93	5.09	5.39
LBR2	2.11	2.34	2.51	2.99	3.34	3.64	3.95	4.14	4.45
LBR3	1.4	1.98	2.19	2.69	3.25	3.71	4.04	4.26	4.62
BR1	2.01	2.24	2.42	2.8	3.22	3.65	4.02	4.22	4.49
BR2	1.38	1.65	1.85	2.22	2.81	3.2	3.59	3.79	4.17
BR3	1.71	2.05	2.25	2.58	3.07	3.47	3.8	4.05	4.4
SCH1	1.33	1.67	1.91	2.51	3.3	4.06	4.63	4.93	5.25
SCH2	3.07	3.28	3.44	3.67	4.02	4.43	4.76	4.94	5.26
SR	2.24	2.53	2.96	3.6	3.86	4.2	4.5	4.65	4.91

2. Table A3.2. Delta of Dissolved Oxygen percentiles distribution in Critical cells: Deepening scenario minus Existing bathymetry scenario

Zone	Delta D.O. Percentile																	
	1%		5%		10%		25%		50%		75%		90%		95%		99	
	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%
FR1	0.02	0.6	0.01	0.3	0	0.0	-0.02	-0.5	0	0.0	0	0.0	-0.02	-0.4	0	0.0	-0.01	-0.2
FR2	0.02	0.7	0.02	0.7	0.01	0.3	0	0.0	0.01	0.3	0.01	0.2	0	0.0	0	0.0	0	0.0
FR3	0.04	1.6	0.05	1.9	0.04	1.4	0.02	0.7	0	0.0	0.02	0.5	0.01	0.2	0.01	0.2	0.02	0.4
FR4	-0.08	-3.2	-0.07	-2.6	-0.08	-2.8	-0.1	-3.2	-0.07	-2.0	-0.04	-1.0	-0.05	-1.2	-0.08	-1.8	-0.04	-0.8
FR5	-0.03	-1.2	-0.01	-0.4	0.01	0.4	-0.01	-0.3	-0.02	-0.6	-0.01	-0.3	-0.02	-0.5	-0.03	-0.7	0.02	0.4
FR6	-0.07	-2.8	-0.05	-1.8	0.02	0.7	0.03	1.0	0.01	0.3	0.04	1.0	0.01	0.2	0.03	0.7	0.11	2.3
FR7	-0.41	-13.1	-0.46	-13.5	-0.41	-11.4	-0.4	-10.1	-0.44	-10.0	-0.37	-7.6	-0.25	-4.8	-0.3	-5.5	-0.55	-9.1
FR8	-0.17	-5.3	-0.2	-5.7	-0.18	-4.9	-0.18	-4.4	-0.23	-4.9	-0.18	-3.5	-0.11	-2.0	-0.12	-2.1	-0.08	-1.4
FR9	-0.21	-6.2	-0.18	-4.9	-0.22	-5.7	-0.23	-5.4	-0.27	-5.7	-0.22	-4.2	-0.14	-2.6	-0.14	-2.5	-0.1	-1.7
FR10	0.03	1.3	0	0.0	0	0.0	0	0.0	0.01	0.2	0.01	0.2	-0.01	-0.2	-0.01	-0.2	0.01	0.2
FR11	-0.01	-0.5	-0.01	-0.4	0.02	0.6	0.01	0.3	0.01	0.2	0.01	0.2	0.01	0.2	0	0.0	0.01	0.2
MR1	0	0.0	-0.09	-3.0	-0.09	-2.8	-0.08	-2.3	-0.12	-3.1	-0.12	-2.8	-0.11	-2.4	-0.12	-2.5	-0.1	-2.0
MR2	-0.02	-0.9	-0.01	-0.4	-0.05	-1.7	-0.07	-2.1	-0.09	-2.4	-0.11	-2.6	-0.11	-2.4	-0.12	-2.5	-0.12	-2.4
MR3	-0.01	-0.5	-0.02	-0.8	-0.02	-0.7	-0.06	-1.8	-0.08	-2.1	-0.11	-2.6	-0.11	-2.4	-0.11	-2.3	-0.11	-2.2
MR4	0.01	0.5	-0.01	-0.4	-0.02	-0.8	0	0.0	-0.02	-0.6	-0.02	-0.5	-0.04	-1.0	-0.03	-0.7	-0.04	-0.9
MR5	-0.02	-4.4	0.02	2.0	0.01	0.7	0.03	1.4	0.04	1.1	0.01	0.2	0.01	0.2	0	0.0	0.01	0.2
MR6	0.02	1.9	0.04	2.4	0.04	1.9	0.04	1.3	-0.01	-0.2	0.03	0.6	0	0.0	0.01	0.2	0.01	0.2
LBR1	-0.08	-3.0	0.02	0.6	0.02	0.6	0.03	0.8	0.02	0.5	0.02	0.4	0.01	0.2	-0.01	-0.2	-0.04	-0.7
LBR2	0.01	0.5	0.01	0.4	0	0.0	0.01	0.3	0.01	0.3	0	0.0	0.01	0.3	0.01	0.2	0.02	0.5
LBR3	0.06	4.5	0.23	13.1	0.15	7.4	0.13	5.1	0.12	3.8	0.08	2.2	0.06	1.5	0.08	1.9	0.06	1.3
BR1	0.01	0.5	0.01	0.4	0.01	0.4	0.02	0.7	0.01	0.3	0.02	0.6	0.01	0.2	0	0.0	0.01	0.2
BR2	0.01	0.7	0.04	2.5	0.02	1.1	0.02	0.9	0.03	1.1	0.01	0.3	0.02	0.6	0.01	0.3	0.02	0.5
BR3	0.02	1.2	0.02	1.0	0.03	1.4	0.02	0.8	0.01	0.3	0	0.0	0.01	0.3	0	0.0	0.01	0.2
SCH1	0.04	3.1	0.02	1.2	-0.01	-0.5	0.02	0.8	-0.01	-0.3	-0.04	-1.0	-0.03	-0.6	-0.05	-1.0	-0.07	-1.3
SCH2	-0.01	-0.3	-0.03	-0.9	-0.01	-0.3	-0.02	-0.5	-0.02	-0.5	-0.01	-0.2	-0.01	-0.2	-0.02	-0.4	0.01	0.2
SR	0	0.0	0.01	0.4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0.01	0.2	0	0.0

3. Table A3.3. Dissolved oxygen percentiles distribution in Zones of Savannah Estuary

Zone Name	D.O. Concentration Percentiles (mg/l)								
	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	3.84	3.97	4.05	4.25	4.61	5.02	5.27	5.47	5.78
FR2	3.24	3.46	3.57	3.77	4.12	4.54	4.83	4.98	5.30
FR3	2.77	2.99	3.10	3.33	3.70	4.11	4.45	4.61	4.90
FR4	2.47	2.71	2.84	3.09	3.49	3.89	4.23	4.42	4.69
FR5	2.49	2.70	2.80	3.06	3.47	3.84	4.21	4.36	4.64
FR6	2.59	2.79	2.88	3.16	3.53	3.90	4.27	4.43	4.65
FR7	2.86	3.08	3.30	3.66	4.09	4.59	4.97	5.16	5.50
FR8	3.14	3.43	3.61	4.01	4.47	4.92	5.21	5.39	5.69
FR9	3.70	4.01	4.23	4.61	5.03	5.40	5.68	5.84	6.08
FR10	4.00	4.48	4.69	4.97	5.25	5.52	5.78	5.90	6.14
FR11	2.63	3.19	3.56	3.96	4.30	4.63	4.94	5.13	5.38
MR1	2.72	2.96	3.11	3.49	3.81	4.12	4.46	4.65	4.85
MR2	2.33	2.76	2.98	3.38	3.76	4.10	4.42	4.62	4.84
MR3	2.09	2.33	2.66	3.10	3.54	3.96	4.30	4.52	4.84
MR4	2.73	2.94	3.17	3.57	3.91	4.21	4.50	4.67	4.86
MR5	1.08	1.49	1.90	2.75	4.14	5.09	5.51	5.66	5.93
MR6	1.11	1.72	2.17	3.12	4.47	5.29	5.66	5.85	6.11
LBR1	2.88	3.05	3.20	3.65	3.92	4.17	4.48	4.62	4.76
LBR2	2.04	2.26	2.50	2.92	3.30	3.60	3.89	4.09	4.30
LBR3	1.85	1.99	2.11	2.59	3.09	3.38	3.71	3.86	4.21
BR1	2.43	2.54	2.66	2.96	3.37	3.77	4.15	4.35	4.60
BR2	1.96	2.17	2.31	2.62	3.08	3.50	3.88	4.08	4.34
BR3	1.97	2.14	2.27	2.61	3.07	3.44	3.82	4.04	4.29
SCh1	2.64	2.90	3.00	3.27	3.65	4.12	4.43	4.57	4.85
SCh2	3.34	3.48	3.58	3.78	4.10	4.51	4.81	4.99	5.29
SR	2.62	2.79	3.29	3.89	4.12	4.44	4.71	4.85	5.11

4. Table A3.4. Delta (Deepening minus Existing bathymetry) of Dissolved Oxygen percentiles distribution in Zones of Savannah Estuary: Deepening scenario minus Existing bathymetry scenario

Zone	Project - Baseline Difference (mg/l)									Project - Baseline Relative Difference (%)								
Name	1%	5%	10%	25%	50%	75%	90%	95%	99%	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	0.03	0.01	0.00	0.00	0.01	0.01	-0.01	0.00	-0.03	0.8	0.3	0.0	0.0	0.2	0.2	-0.1	0.0	-0.5
FR2	0.02	0.02	0.01	0.01	0.02	0.02	0.01	0.01	0.00	0.6	0.6	0.4	0.1	0.5	0.4	0.2	0.3	0.1
FR3	0.03	0.04	0.05	0.02	0.02	0.04	0.03	0.02	0.02	1.0	1.4	1.6	0.5	0.5	0.9	0.7	0.4	0.4
FR4	-0.03	-0.02	0.03	0.03	-0.01	0.02	-0.01	0.03	0.02	-1.2	-0.6	0.9	0.9	-0.2	0.5	-0.3	0.6	0.5
FR5	-0.06	-0.05	-0.03	-0.04	-0.04	-0.03	-0.06	-0.05	0.00	-2.4	-1.9	-1.1	-1.2	-1.2	-0.8	-1.4	-1.1	0.1
FR6	-0.08	-0.08	-0.07	-0.11	-0.11	-0.11	-0.11	-0.12	-0.09	-3.0	-2.9	-2.5	-3.4	-3.1	-2.7	-2.5	-2.7	-2.0
FR7	-0.16	-0.19	-0.15	-0.18	-0.22	-0.22	-0.16	-0.16	-0.12	-5.3	-5.7	-4.3	-4.6	-5.1	-4.6	-3.1	-3.0	-2.1
FR8	-0.18	-0.19	-0.19	-0.19	-0.21	-0.17	-0.14	-0.13	-0.08	-5.5	-5.2	-5.0	-4.5	-4.4	-3.3	-2.6	-2.4	-1.4
FR9	-0.23	-0.23	-0.21	-0.21	-0.17	-0.09	-0.08	-0.07	-0.06	-5.8	-5.3	-4.8	-4.4	-3.2	-1.7	-1.3	-1.1	-0.9
FR10	0.00	-0.02	-0.01	-0.03	-0.03	-0.03	-0.03	-0.03	-0.02	0.0	-0.4	-0.3	-0.5	-0.6	-0.6	-0.5	-0.5	-0.4
FR11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	-0.2	0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.3
MR1	-0.07	-0.09	-0.10	-0.07	-0.12	-0.12	-0.11	-0.10	-0.08	-2.5	-3.0	-3.1	-2.0	-3.2	-2.8	-2.5	-2.1	-1.7
MR2	-0.03	-0.03	-0.07	-0.07	-0.11	-0.11	-0.10	-0.12	-0.11	-1.1	-1.1	-2.4	-2.1	-2.8	-2.6	-2.3	-2.6	-2.2
MR3	0.00	-0.02	-0.01	-0.02	-0.05	-0.06	-0.07	-0.07	-0.08	0.0	-0.8	-0.4	-0.8	-1.3	-1.6	-1.7	-1.5	-1.6
MR4	0.00	0.01	0.01	0.01	0.01	0.00	-0.01	-0.01	0.00	-0.1	0.3	0.3	0.4	0.3	0.1	-0.1	-0.2	0.1
MR5	0.01	0.03	0.03	0.02	0.00	0.01	0.01	0.01	0.02	0.7	2.1	1.7	0.7	0.1	0.2	0.2	0.1	0.3
MR6	0.00	0.04	0.04	0.02	0.01	0.01	0.00	0.01	0.00	0.4	2.3	1.7	0.7	0.2	0.2	0.0	0.1	0.1
LBR1	0.01	0.02	0.03	0.02	0.01	0.01	0.01	0.02	0.00	0.4	0.7	0.8	0.5	0.2	0.3	0.3	0.3	0.0
LBR2	0.00	0.00	0.01	0.00	0.01	0.01	0.00	0.00	0.01	0.1	0.0	0.5	0.1	0.3	0.2	0.1	0.0	0.2
LBR3	0.09	0.09	0.10	0.06	0.04	0.06	0.05	0.04	0.05	5.2	4.5	5.1	2.4	1.3	1.7	1.4	1.2	1.3
BR1	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.5	-0.1	-0.1	0.2	0.3	0.0	0.0	0.0	0.0
BR2	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.5	0.3	0.3	0.5	0.4	0.1	0.0	0.0	0.1
BR3	0.05	0.03	0.03	0.03	0.01	0.01	0.01	0.01	-0.01	2.7	1.7	1.5	1.3	0.3	0.2	0.3	0.3	-0.1
SCh1	0.03	0.02	0.00	0.00	0.01	0.01	-0.01	-0.01	0.02	1.2	0.7	-0.2	0.1	0.1	0.2	-0.2	-0.2	0.4
SCh2	0.00	0.01	0.00	-0.01	0.00	-0.01	-0.02	-0.01	0.00	0.1	0.3	0.0	-0.4	0.0	-0.2	-0.4	-0.1	0.1
SR	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.2	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0

5. Table A3.5. Percentage of the volume of waters with violation of Dissolved Oxygen standards for Zones of Savannah Estuary within the period of May 1 – October 30, 1999: Deepening (Project) and Existing (Baseline) bathymetry

Zones	D.O. STANDARDS														
	1-Day Average			7-Day Average			30-Day Average			GA MINIMUM D.O.			SC MINIMUM D.O.		
	Baseline(B)	Project(P)	Delta=P-B	Baseline(B)	Project(P)	Delta=P-B	Baseline(B)	Project(P)	Delta=P-B	Baseline(B)	Project(P)	Delta=P-B	Baseline(B)	Project(P)	Delta=P-B
FR1	0	0	0	0	0	0	0	0	0	0	0	0	7	6	-1
FR2	0	0	0	0	0	0	3	3	0	0	0	0	31	30	-1
FR3	0	0	0	2	2	0	19	19	0	3	3	0	N/A	N/A	N/A
FR4	0	0	0	5	5	0	22	23	1	6	6	0	N/A	N/A	N/A
FR5	0	0	0	4	5	1	19	22	3	5	6	1	N/A	N/A	N/A
FR6	0	0	0	2	4	2	12	17	5	4	5	1	N/A	N/A	N/A
FR7	0	0	0	0	0	0	1	2	1	0	1	1	N/A	N/A	N/A
FR8	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
FR9	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
FR10	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
FR11	0	0	0	0	0	0	2	2	0	1	1	0	6	6	0
MR1	0	0	0	0	1	1	5	6	1	1	2	1	N/A	N/A	N/A
MR2	0	0	0	1	2	1	6	8	2	1	2	1	N/A	N/A	N/A
MR3	0	0	0	3	3	0	10	11	1	3	4	1	N/A	N/A	N/A
MR4	0	0	0	1	1	0	5	5	0	2	2	0	N/A	N/A	N/A
MR5	0	0	0	1	1	0	5	5	0	5	5	0	11	11	0
MR6	0	0	0	0	0	0	3	3	0	3	3	0	9	9	0
LBR1	0	0	0	1	1	0	6	6	0	1	1	0	18	18	0
LBR2	1	1	0	6	6	0	18	18	0	7	7	0	34	35	1
LBR3	3	2	-1	13	13	0	30	31	1	14	14	0	47	48	1
BR1	0	0	0	10	10	0	39	39	0	12	12	0	67	67	0
BR2	2	2	0	19	19	0	49	49	0	20	20	0	75	75	0
BR3	3	3	0	21	21	0	48	48	0	22	22	0	70	71	1
SCh1	1	1	0	4	3	-1	8	8	0	5	4	-1	N/A	N/A	N/A
SCh2	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
SR	0	0	0	1	1	0	3	3	0	1	1	0	6	6	0

26. Table A3.6. Percentage of water volumes with salinity in %iles within the period of May 1 – October 30, 1999

Percen-tile	Harbor / River			Stations					
	Upper Hrb %	Middle Rvr %	Back Rvr %	Houlih Brg %	Broad Str %	Pulaski Frt %	Lucknow Cnl %	USF&W Dck %	I-95 Brg %
5	18.9	4.6	4.4	4.5	4.4	4.3	6.2	4.7	86.2
10	22.8	8.4	8.8	8.9	8.9	8.7	10.2	8.1	86.2
25	35.2	19.8	22.3	22.4	22.8	22.1	22.8	20.1	86.2
50	56.8	42.2	46.6	46.6	47.3	46.1	49.1	42.4	86.2
75	78.6	69.3	72.8	72.9	73.2	72.9	72.9	69.4	86.2
90	91.1	87.3	89	89.1	89.3	89.2	88.6	87.5	92.6
95	95.2	93.5	94.4	94.5	94.6	94.6	94.2	93.8	96.5
Total Volume 100*km3:	32284.9	658.5	4807.2	24.9	39.2	136.3	9.9	9.5	43.6

27. Table A3.7. Percentage of water volumes with D.O. in %iles within the period of May 1 – October 30, 1999

Percen-tile	Harbor / River			Stations					
	Upper Hrb %	Middle Rvr %	Back Rvr %	Houlih Brg %	Broad Str %	Pulaski Frt %	Lucknow Cnl %	USF&W Dck %	I-95 Brg %
5	5.2	5	4.9	5.6	5.2	4.7	5.2	5.5	5.7
10	10.4	9.9	9.8	11.1	10.4	9.5	10.3	10.9	11.1
25	26.1	24.9	24.8	27.4	25.8	24.1	25.5	25.7	26.5
50	52.1	49.7	49.8	53.4	51.1	49.3	50.9	51.4	51.5
75	76.5	74.7	75.2	77.6	75.8	74.5	75.7	76.1	75.8
90	90.6	89.8	90.1	91.2	90.4	89.7	90.3	90.5	90.4
95	95.1	94.9	95	95.7	95.3	94.8	95.2	95.3	95.1
Total Volume 100*km3:	32284.9	658.5	4807.2	24.9	39.2	136.3	9.9	9.5	43.6

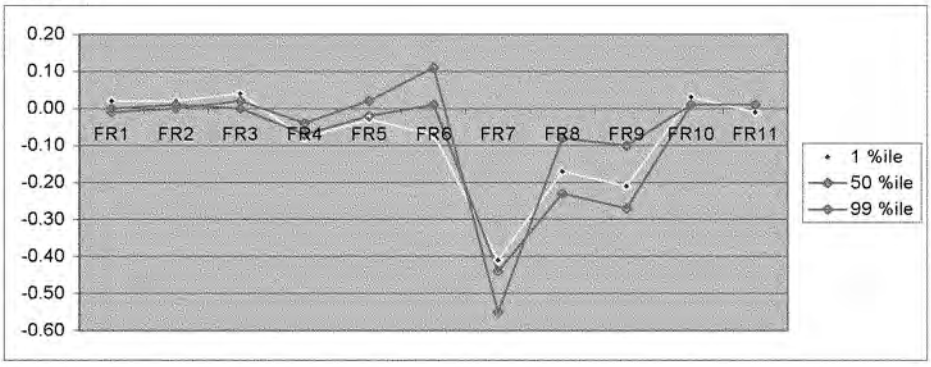
28. Table A3.8. Water volumes in Upper Harbor in increments of 1° C of water temperature within the period of May 1 – October 30, 1999

Temperature C°	Total Volume %
19	0.01
20	0.8
21	3.96
22	9.15
23	14.66
24	23.19
25	34.27
26	48.94
27	60.11
28	68.92
29	76.39
30	85.21
31	89.49
32	96.16
33	99.98
34	100

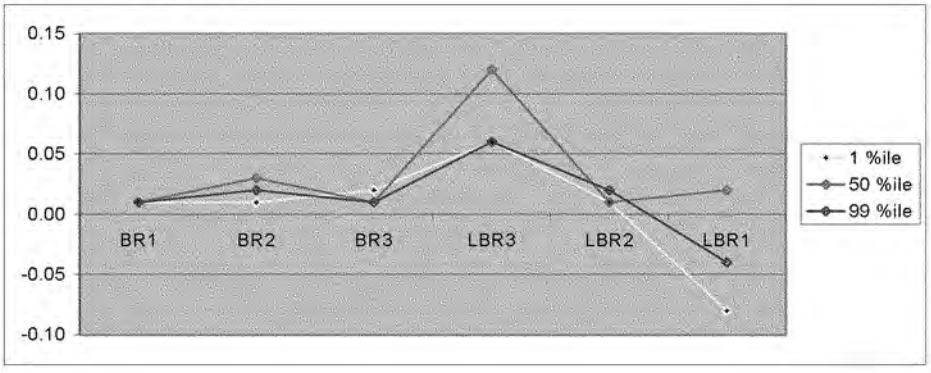
29. Table A3.9. Water volumes in Upper Harbor in increments of 0.1 mg/l of D.O. within the period of May 1 – October 30, 1999
(See file: Postprocessor Output\99-B13\99-B13_DO Increment Volume)

30. Table A3.10. Percentage of water volumes corresponding to 1-, 7-, and 30-days averages of D.O. depth-averaged concentrations in Upper Harbor within the period of May 1 – October 30, 1999
(See file: Postprocessor Output\99-B13\99-B13_volume DO in averages)

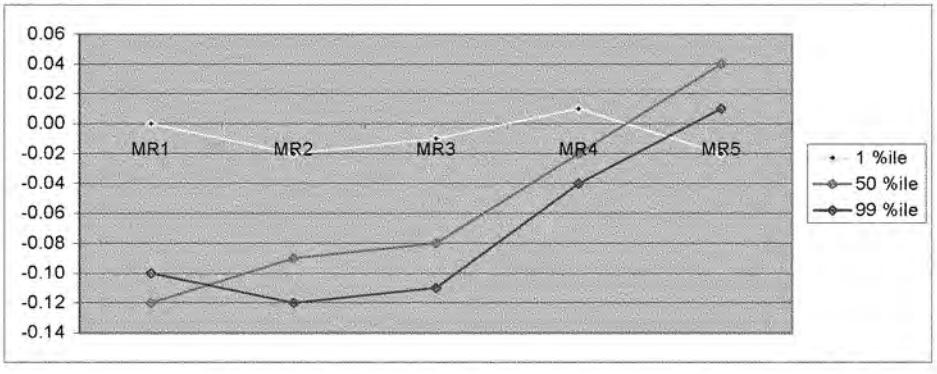
Front River



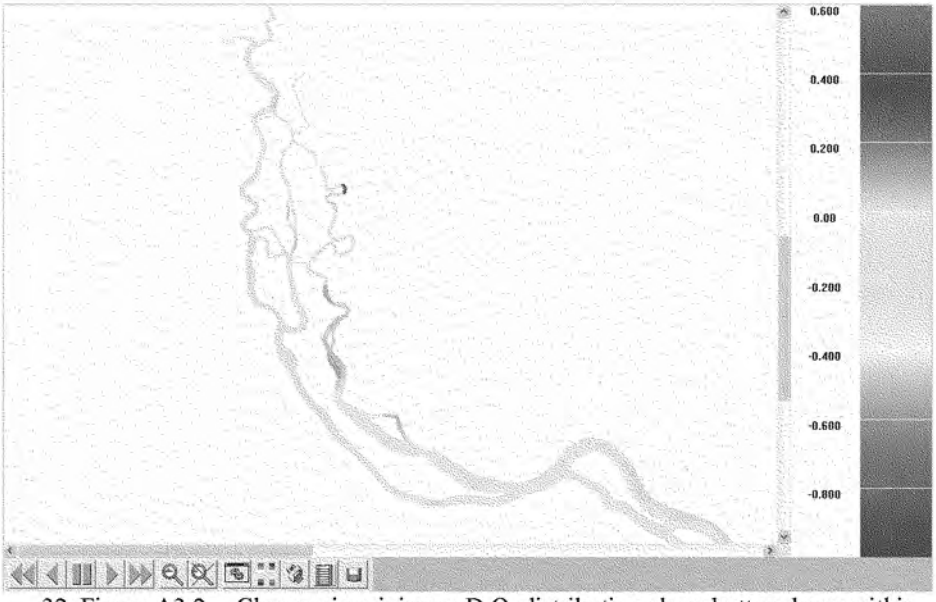
Back and Little Back Rivers



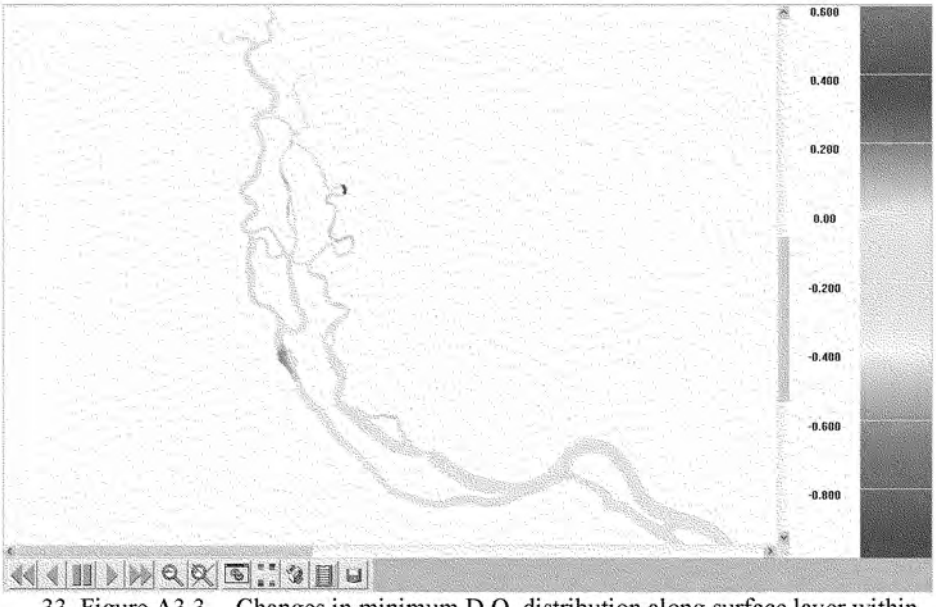
Middle River



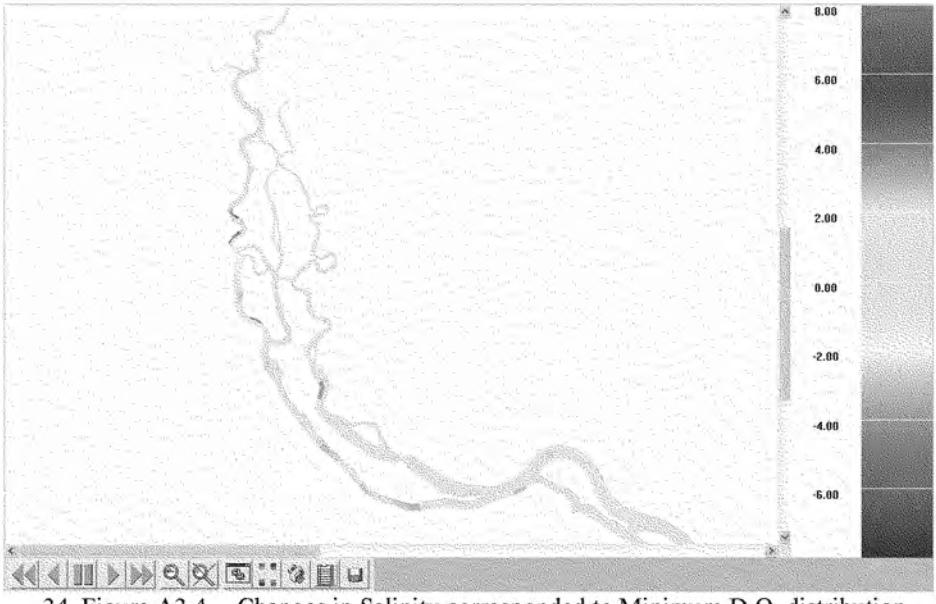
31. Figure A3.1. Changes in longitudinal profile of Dissolved Oxygen (mg/l) distribution along Critical cells of Savannah Estuary: 3 ft deepening



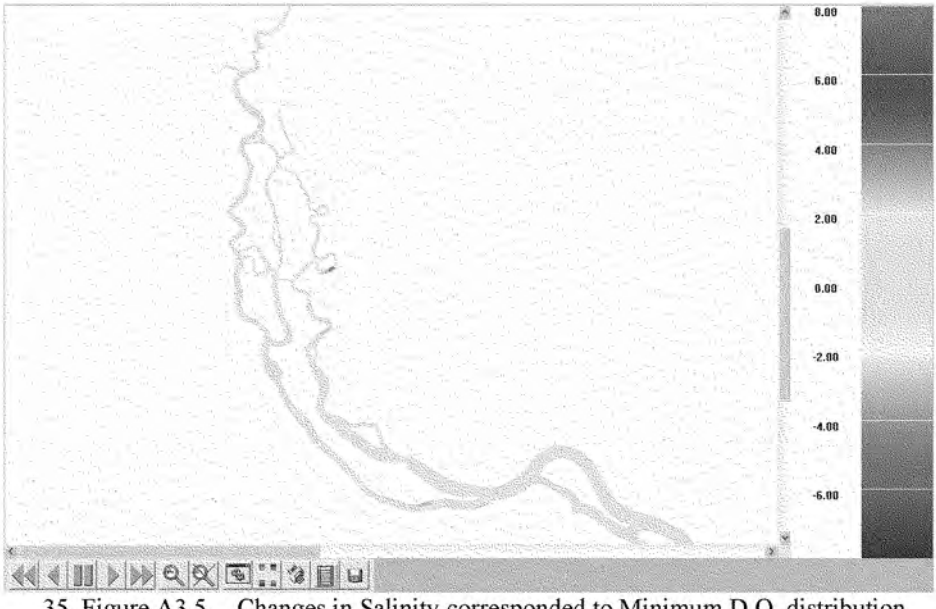
32. Figure A3.2. Changes in minimum D.O. distribution along bottom layer within the analyzed period of May 1 - October 30, 1999: 3 ft deepening



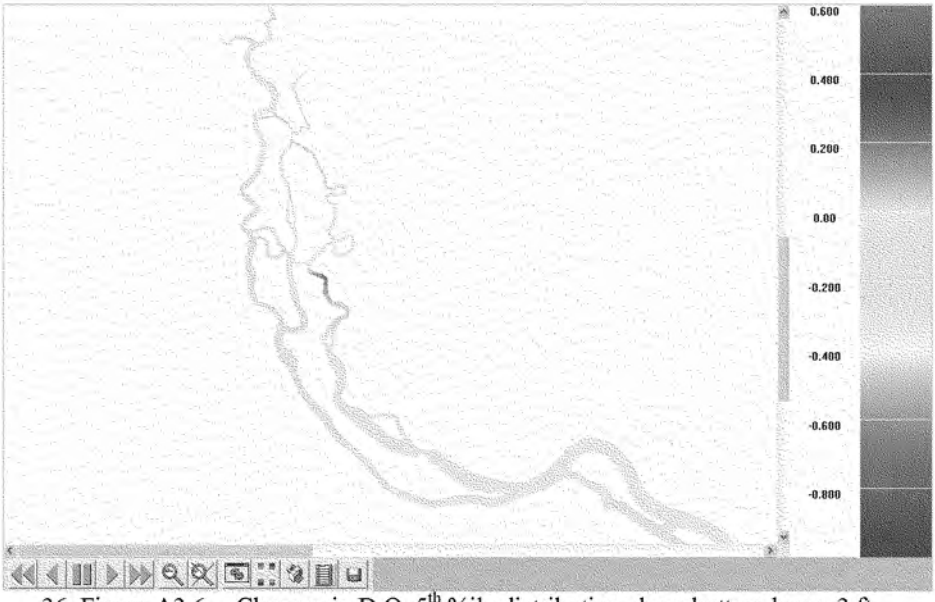
33. Figure A3.3. Changes in minimum D.O. distribution along surface layer within the analyzed period of May 1 - October 30, 1999: 3 ft deepening



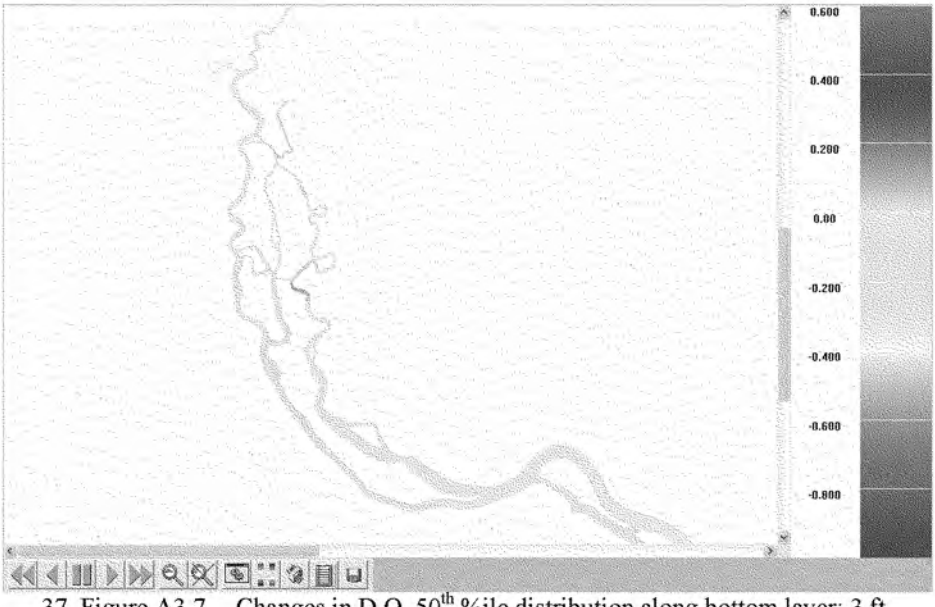
34. Figure A3.4. Changes in Salinity corresponded to Minimum D.O. distribution along bottom layer within the analyzed period of May 1 - October 30, 1999: 3 ft deepening



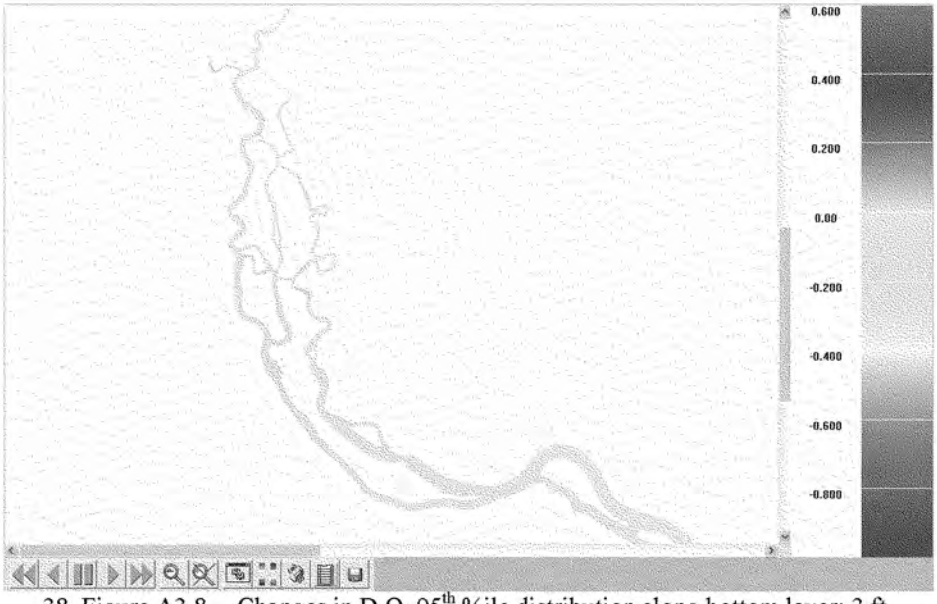
35. Figure A3.5. Changes in Salinity corresponded to Minimum D.O. distribution along Surface layer within the analyzed period of May 1 - October 30, 1999: 3 ft deepening



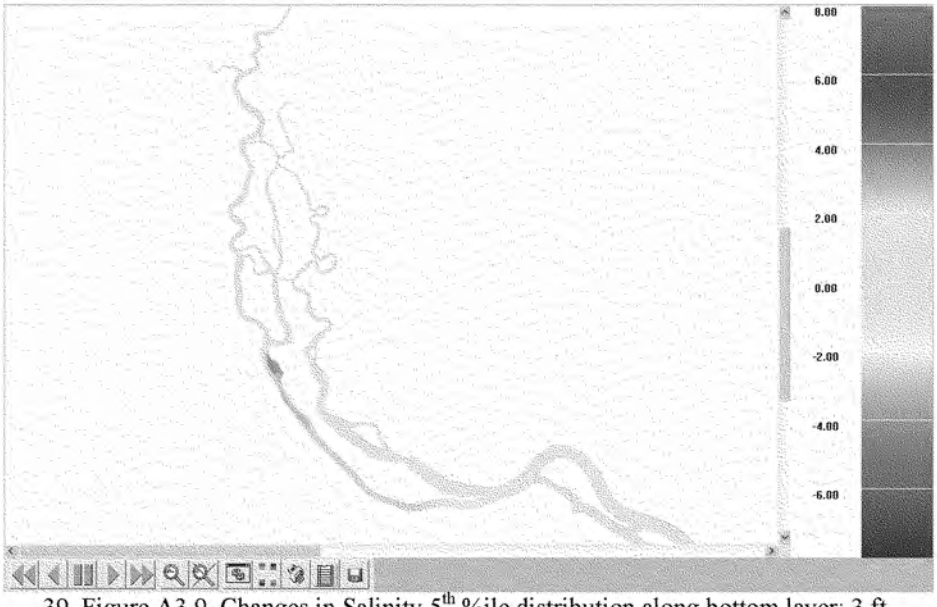
36. Figure A3.6. Changes in D.O. 5th %ile distribution along bottom layer: 3 ft deepening



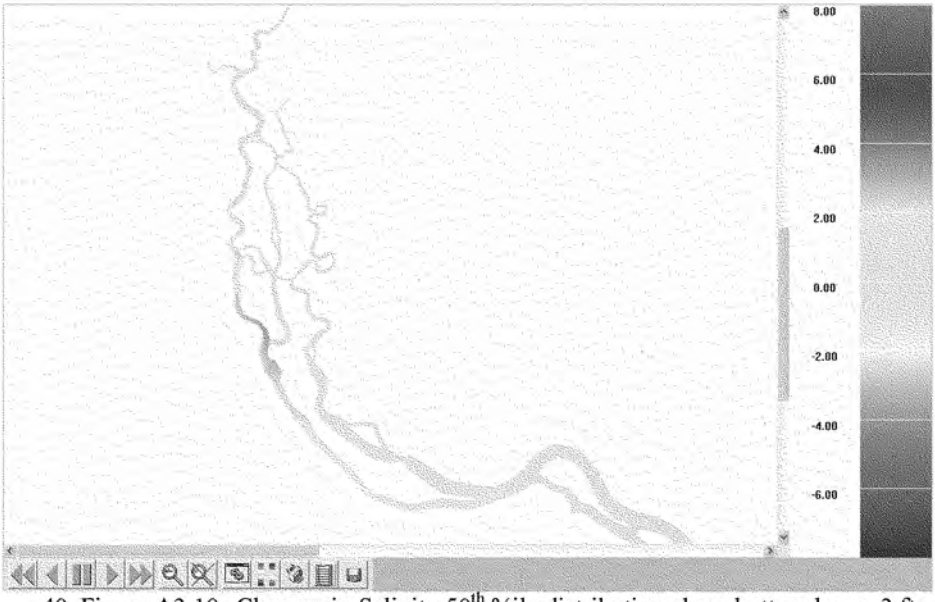
37. Figure A3.7. Changes in D.O. 50th %ile distribution along bottom layer: 3 ft deepening



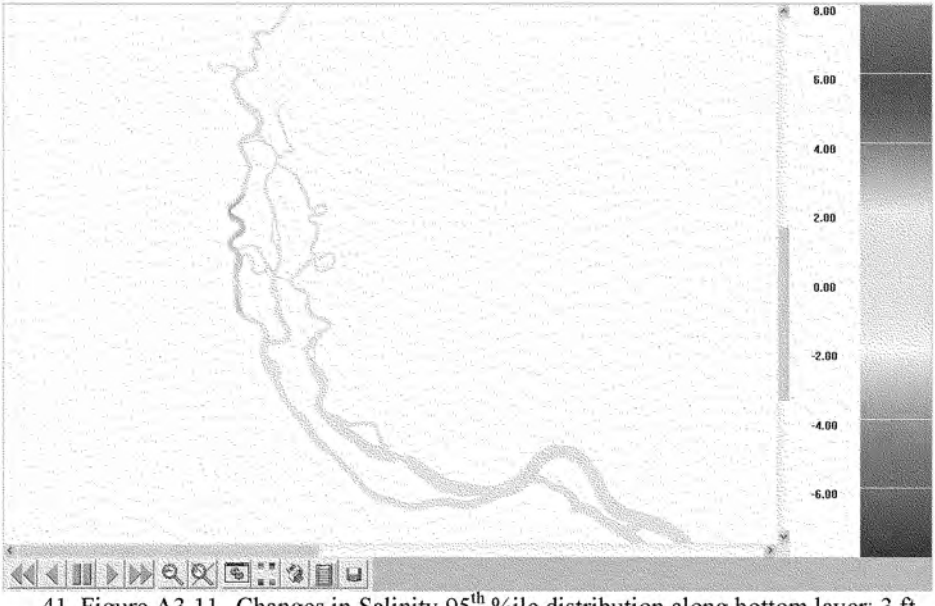
38. Figure A3.8. Changes in D.O. 95th %ile distribution along bottom layer: 3 ft deepening



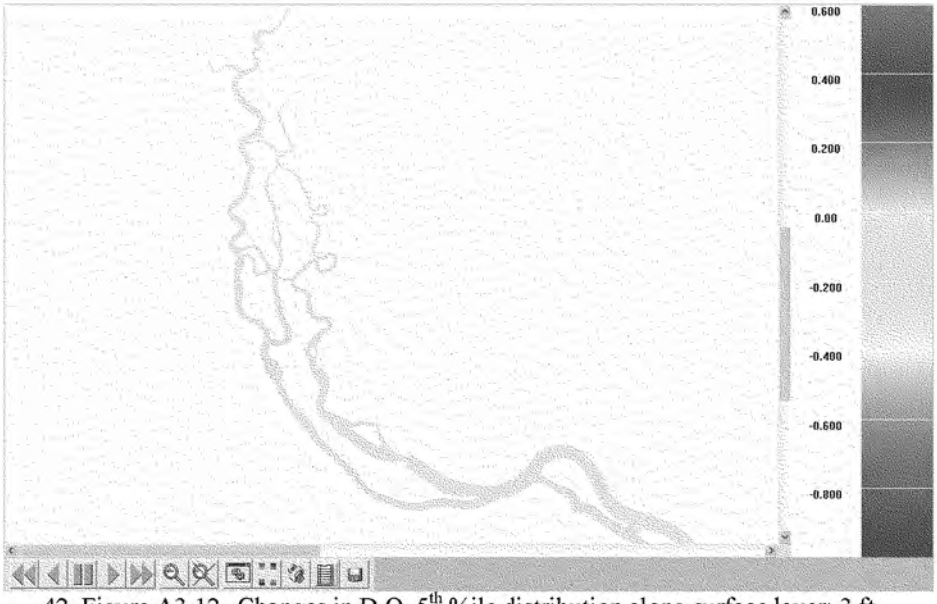
39. Figure A3.9. Changes in Salinity 5th %ile distribution along bottom layer: 3 ft deepening



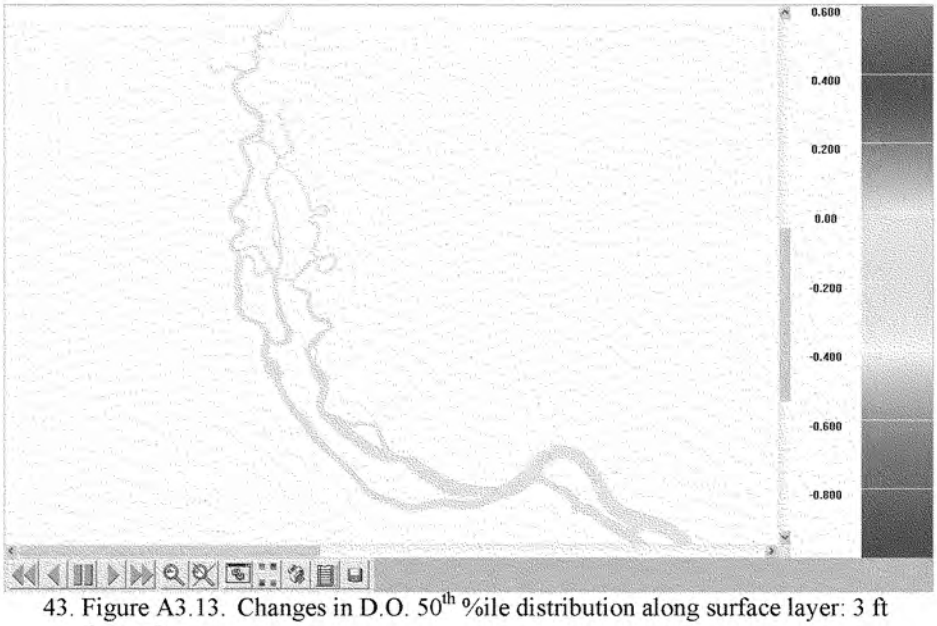
40. Figure A3.10. Changes in Salinity 50th %ile distribution along bottom layer: 3 ft deepening



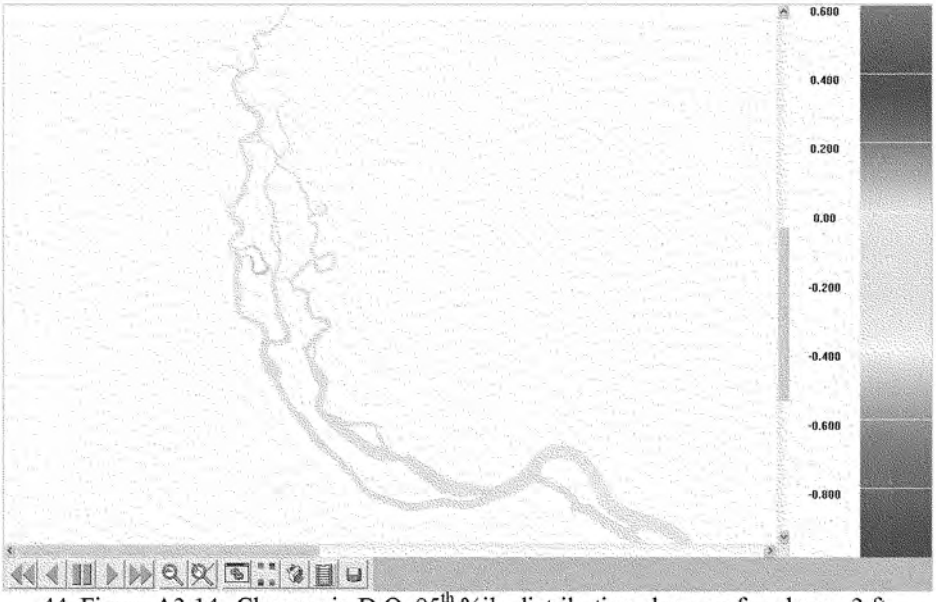
41. Figure A3.11. Changes in Salinity 95th %ile distribution along bottom layer: 3 ft deepening



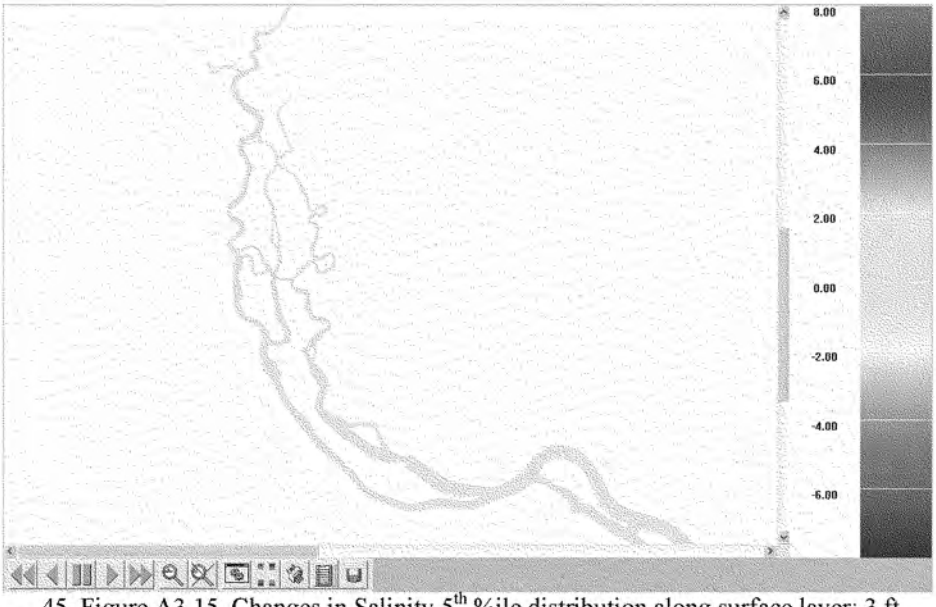
42. Figure A3.12. Changes in D.O. 5th %ile distribution along surface layer: 3 ft deepening



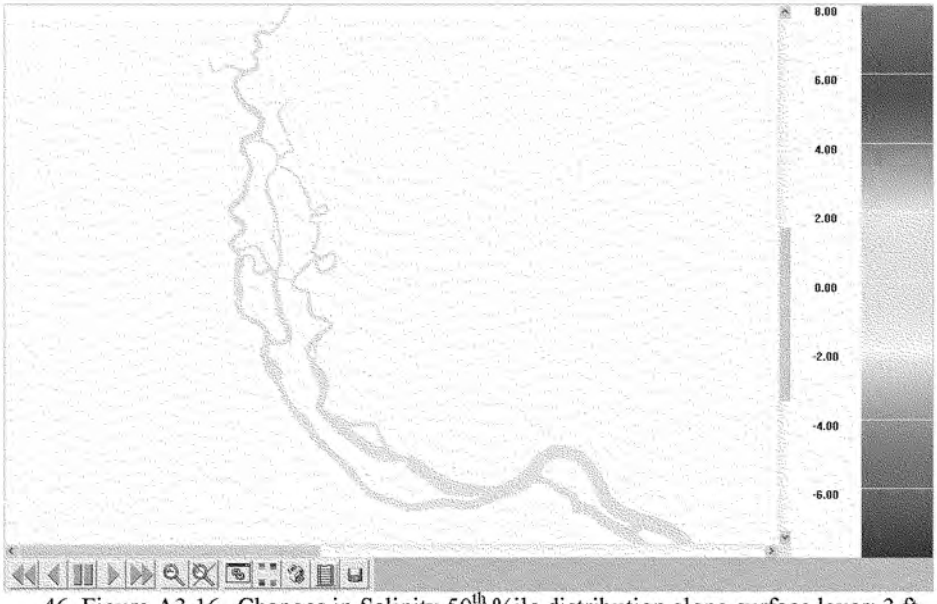
43. Figure A3.13. Changes in D.O. 50th %ile distribution along surface layer: 3 ft deepening



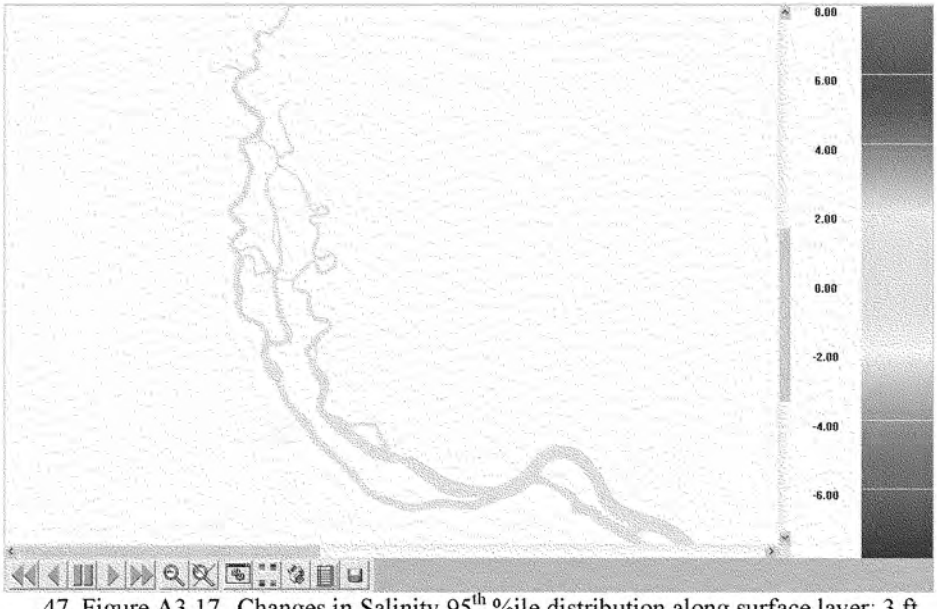
44. Figure A3.14. Changes in D.O. 95th %ile distribution along surface layer: 3 ft deepening



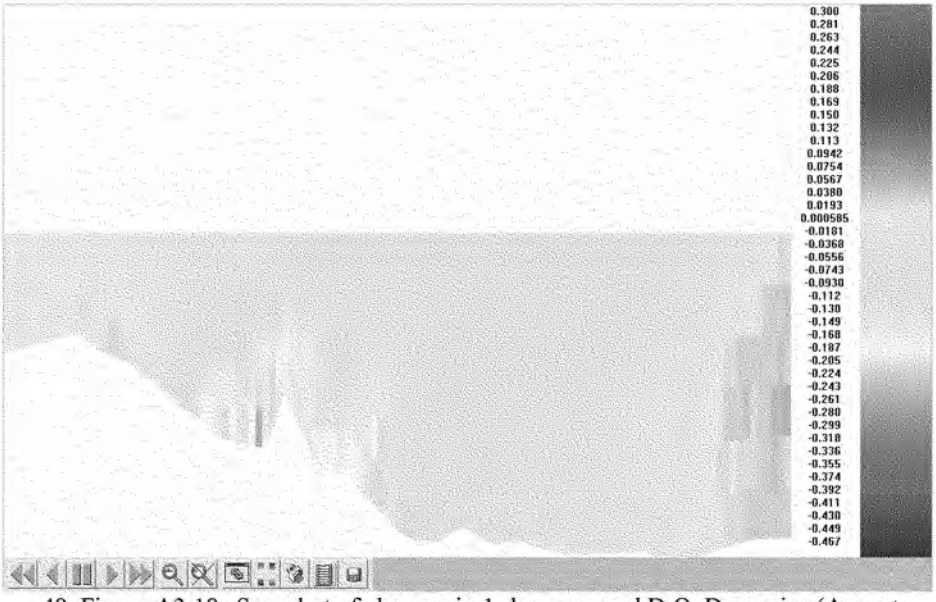
45. Figure A3.15. Changes in Salinity 5th %ile distribution along surface layer: 3 ft deepening



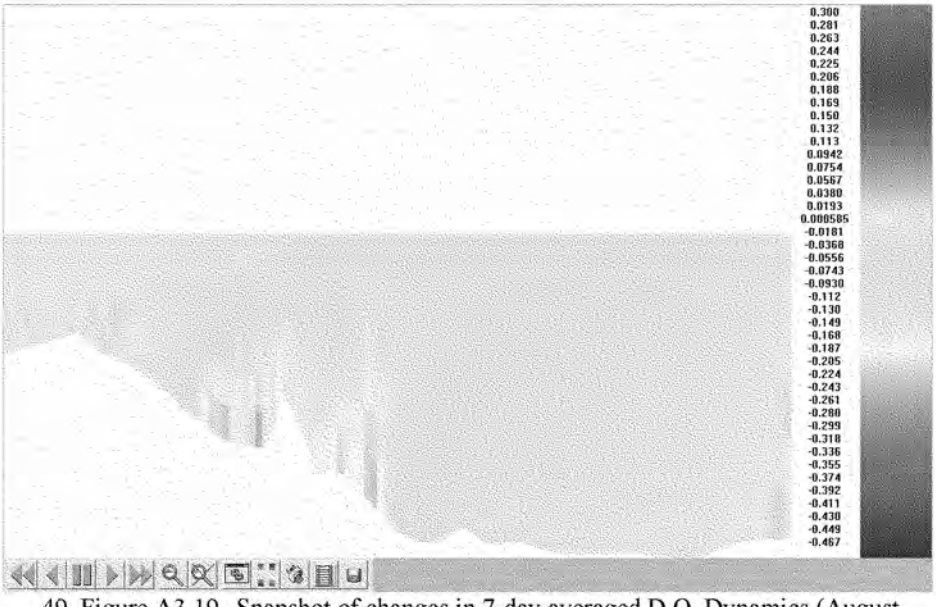
46. Figure A3.16. Changes in Salinity 50th %ile distribution along surface layer: 3 ft deepening



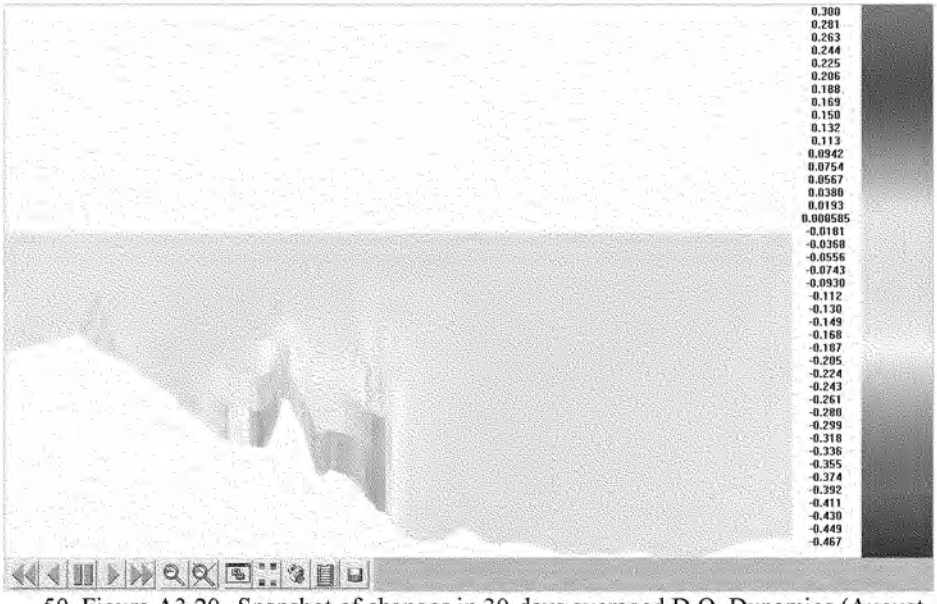
47. Figure A3.17. Changes in Salinity 95th %ile distribution along surface layer: 3 ft deepening



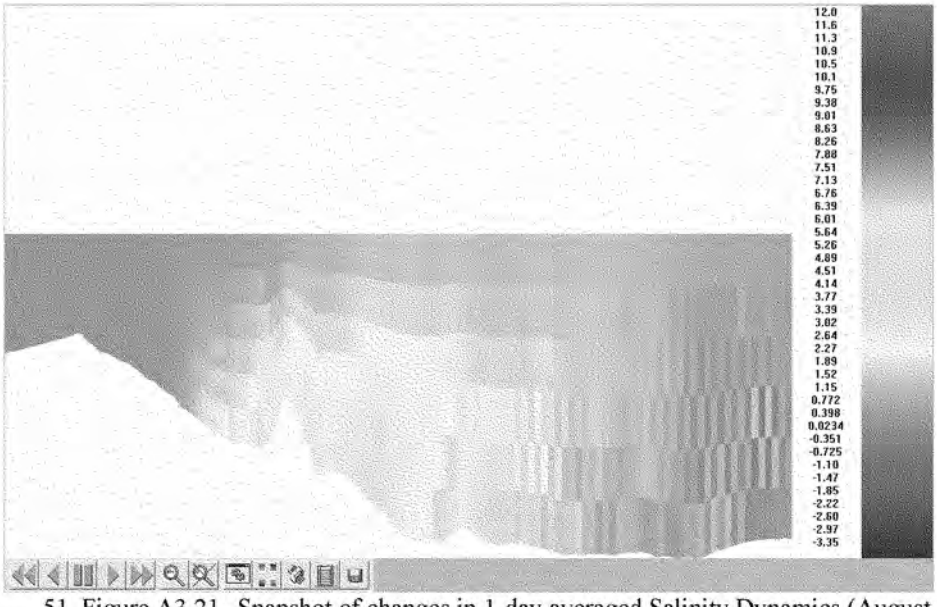
48. Figure A3.18. Snapshot of changes in 1-day averaged D.O. Dynamics (August 10, 1999) in vertical plane of Upper Harbor: 3 ft deepening



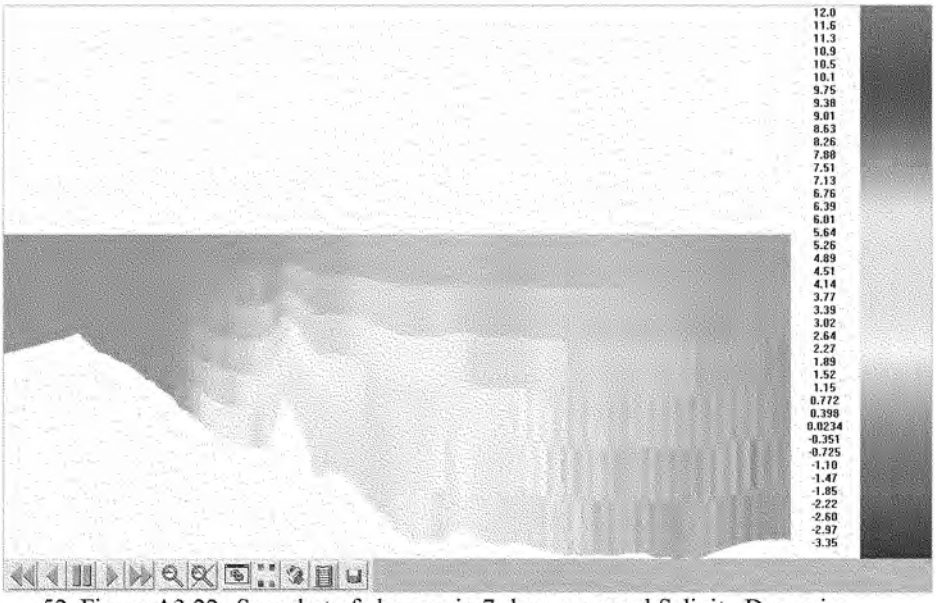
49. Figure A3.19. Snapshot of changes in 7-day averaged D.O. Dynamics (August 10, 1999) in vertical plane of Upper Harbor: 3 ft deepening



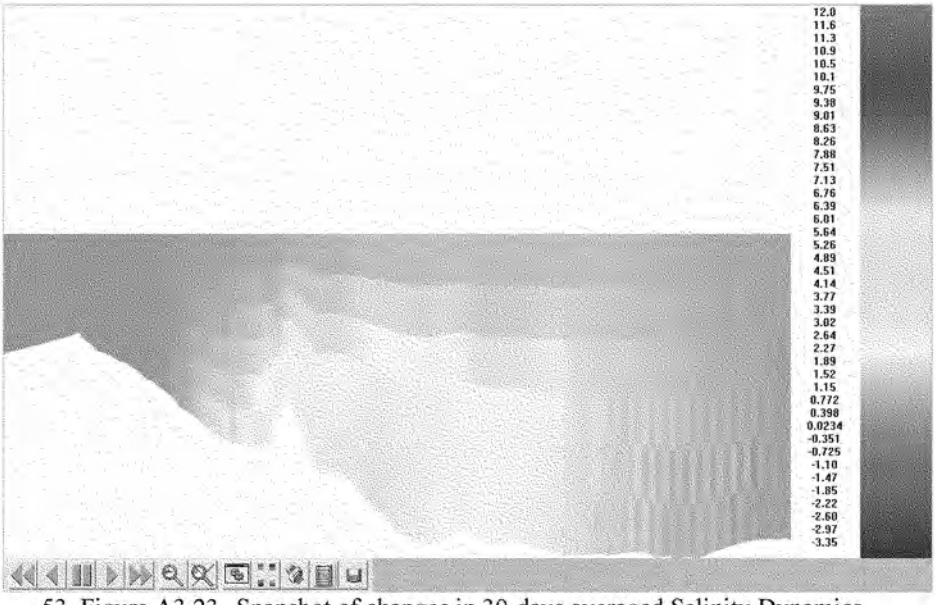
50. Figure A3.20. Snapshot of changes in 30-days averaged D.O. Dynamics (August 10, 1999) in vertical plane of Upper Harbor: 3 ft deepening



51. Figure A3.21. Snapshot of changes in 1-day averaged Salinity Dynamics (August 10, 1999) in vertical plane of Upper Harbor: 3 ft deepening



52. Figure A3.22. Snapshot of changes in 7-days averaged Salinity Dynamics (August 10, 1999) in vertical plane of Upper Harbor: 3 ft deepening



53. Figure A3.23. Snapshot of changes in 30-days averaged Salinity Dynamics (August 10, 1999) in vertical plane of Upper Harbor: 3 ft deepening

Appendix A4

BASIC EVALUATION: 2 ft DEEPENING BATHYMETRY, 2004 POINT SOURCES LOADS, 1999 HYDROLOGICAL AND METEOROLOGICAL CONDITIONS

May 1 – October 30, 1999 Simulation Period

Water Quality Review Group

1. Table A4.1. Dissolved oxygen percentiles distribution in Critical cells

Zone	D.O. Percentile (mg/l)								
	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	3.41	3.61	3.73	3.94	4.29	4.71	4.98	5.19	5.55
FR2	2.74	2.99	3.12	3.39	3.74	4.16	4.51	4.66	4.97
FR3	2.47	2.72	2.83	3.06	3.5	3.91	4.25	4.41	4.73
FR4	2.41	2.65	2.76	3	3.46	3.86	4.19	4.34	4.65
FR5	2.47	2.67	2.79	3.09	3.49	3.87	4.22	4.39	4.63
FR6	2.48	2.67	2.77	3.07	3.46	3.83	4.23	4.38	4.62
FR7	2.97	3.23	3.45	3.8	4.24	4.73	5.12	5.37	5.97
FR8	3.07	3.39	3.55	3.99	4.54	4.99	5.35	5.53	5.86
FR9	3.89	4.25	4.46	4.8	5.18	5.48	5.75	5.92	6.27
FR10	2.32	3.13	3.38	3.93	4.6	5.25	5.65	5.81	6.04
FR11	2.18	2.78	3.17	3.64	4.23	4.86	5.41	5.62	5.96
MR1	2.58	2.93	3.12	3.49	3.84	4.16	4.5	4.66	4.91
MR2	2.19	2.56	2.88	3.32	3.75	4.14	4.45	4.65	4.92
MR3	2.07	2.44	2.75	3.24	3.68	4.1	4.42	4.66	4.89
MR4	2.05	2.44	2.61	3.04	3.47	3.81	4.15	4.34	4.65
MR5	0.43	1.01	1.39	2.23	3.66	5.13	5.58	5.73	5.98
MR6	1.07	1.68	2.14	3.06	4.41	5.32	5.71	5.9	6.18
LBR1	2.59	3.3	3.52	3.98	4.33	4.62	4.93	5.1	5.39
LBR2	2.09	2.34	2.51	2.98	3.34	3.64	3.94	4.15	4.46
LBR3	1.41	1.92	2.14	2.65	3.22	3.7	4.02	4.25	4.63
BR1	2	2.23	2.42	2.79	3.22	3.64	4.02	4.22	4.48
BR2	1.37	1.64	1.84	2.21	2.8	3.2	3.58	3.79	4.16
BR3	1.69	2.04	2.23	2.57	3.06	3.47	3.8	4.04	4.4
SCH1	1.3	1.72	1.94	2.5	3.28	4.06	4.62	4.93	5.27
SCH2	3.07	3.29	3.43	3.68	4.02	4.43	4.76	4.93	5.27
SR	2.25	2.53	2.96	3.6	3.86	4.2	4.5	4.65	4.91

2. Table A4.2. Delta of Dissolved Oxygen percentiles distribution in Critical cells: Deepening scenario minus Existing bathymetry scenario

Zone	Delta D.O. Percentile																	
	1%		5%		10%		25%		50%		75%		90%		95%		99	
	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%
FR1	-0.02	-0.6	0	0.0	0.01	0.3	-0.01	-0.3	0	0.0	-0.01	-0.2	-0.02	-0.4	-0.01	-0.2	-0.02	-0.4
FR2	0	0.0	0	0.0	0.01	0.3	0	0.0	0	0.0	0	0.0	-0.01	-0.2	-0.01	-0.2	0	0.0
FR3	0.02	0.8	0.03	1.1	0.02	0.7	0.01	0.3	0	0.0	0	0.0	-0.01	-0.2	0	0.0	0.02	0.4
FR4	-0.1	-4.0	-0.09	-3.3	-0.09	-3.2	-0.1	-3.2	-0.06	-1.7	-0.05	-1.3	-0.06	-1.4	-0.09	-2.0	-0.06	-1.3
FR5	-0.03	-1.2	-0.02	-0.7	0.01	0.4	-0.01	-0.3	-0.01	-0.3	0	0.0	-0.01	-0.2	-0.02	-0.5	0.01	0.2
FR6	-0.06	-2.4	-0.07	-2.6	-0.04	-1.4	-0.08	-2.5	-0.05	-1.4	-0.06	-1.5	-0.07	-1.6	-0.1	-2.2	-0.07	-1.5
FR7	-0.16	-5.1	-0.18	-5.3	-0.14	-3.9	-0.15	-3.8	-0.18	-4.1	-0.14	-2.9	-0.09	-1.7	-0.08	-1.5	-0.06	-1.0
FR8	-0.13	-4.1	-0.13	-3.7	-0.14	-3.8	-0.12	-2.9	-0.15	-3.2	-0.12	-2.3	-0.07	-1.3	-0.08	-1.4	-0.04	-0.7
FR9	0.5	14.7	0.61	16.8	0.62	16.1	0.57	13.5	0.44	9.3	0.28	5.4	0.29	5.3	0.31	5.5	0.39	6.6
FR10	0.03	1.3	0	0.0	0	0.0	0.01	0.3	0.01	0.2	0.01	0.2	0	0.0	-0.01	-0.2	0.01	0.2
FR11	0.01	0.5	0	0.0	0.02	0.6	0.01	0.3	0.01	0.2	0.01	0.2	0.01	0.2	0	0.0	0.02	0.3
MR1	0	0.0	-0.06	-2.0	-0.06	-1.9	-0.06	-1.7	-0.09	-2.3	-0.09	-2.1	-0.08	-1.7	-0.09	-1.9	-0.07	-1.4
MR2	-0.01	-0.5	0	0.0	-0.03	-1.0	-0.05	-1.5	-0.07	-1.8	-0.07	-1.7	-0.08	-1.8	-0.09	-1.9	-0.08	-1.6
MR3	-0.01	-0.5	-0.01	-0.4	-0.01	-0.4	-0.04	-1.2	-0.06	-1.6	-0.07	-1.7	-0.08	-1.8	-0.07	-1.5	-0.08	-1.6
MR4	0	0.0	0	0.0	-0.02	-0.8	-0.01	-0.3	-0.01	-0.3	-0.02	-0.5	-0.03	-0.7	-0.02	-0.5	-0.03	-0.6
MR5	-0.02	-4.4	0.02	2.0	0	0.0	0.02	0.9	0.03	0.8	0.01	0.2	0.01	0.2	0	0.0	0.01	0.2
MR6	0.02	1.9	0.02	1.2	0.03	1.4	0.03	1.0	-0.01	-0.2	0.02	0.4	0	0.0	0.01	0.2	0.01	0.2
LBR1	-0.08	-3.0	0.01	0.3	0.02	0.6	0.02	0.5	0.02	0.5	0.02	0.4	0.01	0.2	0	0.0	-0.04	-0.7
LBR2	-0.01	-0.5	0.01	0.4	0	0.0	0	0.0	0.01	0.3	0	0.0	0	0.0	0.02	0.5	0.03	0.7
LBR3	0.07	5.2	0.17	9.7	0.1	4.9	0.09	3.5	0.09	2.9	0.07	1.9	0.04	1.0	0.07	1.7	0.07	1.5
BR1	0	0.0	0	0.0	0.01	0.4	0.01	0.4	0.01	0.3	0.01	0.3	0.01	0.2	0	0.0	0	0.0
BR2	0	0.0	0.03	1.9	0.01	0.5	0.01	0.5	0.02	0.7	0.01	0.3	0.01	0.3	0.01	0.3	0.01	0.2
BR3	0	0.0	0.01	0.5	0.01	0.5	0.01	0.4	0	0.0	0	0.0	0.01	0.3	-0.01	-0.2	0.01	0.2
SCH1	0.01	0.8	0.07	4.2	0.02	1.0	0.01	0.4	-0.03	-0.9	-0.04	-1.0	-0.04	-0.9	-0.05	-1.0	-0.05	-0.9
SCH2	-0.01	-0.3	-0.02	-0.6	-0.02	-0.6	-0.01	-0.3	-0.02	-0.5	-0.01	-0.2	-0.01	-0.2	-0.03	-0.6	0.02	0.4
SR	0.01	0.4	0.01	0.4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0.01	0.2	0	0.0

3. Table A4.3. Dissolved oxygen percentiles distribution in Zones of Savannah Estuary

Zone Name	D.O. Concentration Percentiles (mg/l)								
	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	3.79	3.96	4.05	4.25	4.61	5.00	5.26	5.46	5.80
FR2	3.21	3.45	3.56	3.78	4.12	4.52	4.82	4.97	5.30
FR3	2.75	2.98	3.07	3.32	3.69	4.09	4.43	4.60	4.89
FR4	2.45	2.69	2.82	3.08	3.49	3.87	4.22	4.40	4.68
FR5	2.48	2.70	2.80	3.05	3.47	3.84	4.21	4.37	4.63
FR6	2.60	2.80	2.90	3.18	3.55	3.91	4.29	4.46	4.66
FR7	2.88	3.12	3.35	3.70	4.15	4.67	5.02	5.20	5.53
FR8	3.18	3.49	3.65	4.07	4.53	4.97	5.25	5.43	5.73
FR9	3.79	4.07	4.30	4.67	5.09	5.43	5.70	5.86	6.10
FR10	4.01	4.49	4.70	4.98	5.26	5.54	5.79	5.91	6.14
FR11	2.63	3.18	3.56	3.96	4.30	4.63	4.94	5.13	5.37
MR1	2.74	2.99	3.14	3.51	3.84	4.15	4.50	4.67	4.87
MR2	2.34	2.77	3.00	3.40	3.79	4.13	4.46	4.65	4.86
MR3	2.09	2.34	2.65	3.11	3.55	3.98	4.32	4.54	4.86
MR4	2.73	2.94	3.17	3.57	3.91	4.21	4.51	4.67	4.86
MR5	1.08	1.49	1.90	2.74	4.13	5.09	5.51	5.67	5.94
MR6	1.10	1.71	2.16	3.11	4.47	5.28	5.66	5.85	6.12
LBR1	2.87	3.04	3.19	3.65	3.92	4.17	4.48	4.61	4.75
LBR2	2.03	2.26	2.50	2.91	3.30	3.60	3.90	4.09	4.31
LBR3	1.81	1.96	2.08	2.56	3.07	3.37	3.70	3.85	4.20
BR1	2.41	2.54	2.65	2.95	3.36	3.77	4.15	4.34	4.60
BR2	1.95	2.17	2.30	2.62	3.07	3.50	3.88	4.07	4.34
BR3	1.95	2.13	2.25	2.60	3.06	3.44	3.82	4.02	4.29
SCh1	2.59	2.90	3.01	3.28	3.64	4.10	4.42	4.57	4.85
SCh2	3.33	3.47	3.58	3.79	4.10	4.51	4.82	4.99	5.30
SR	2.62	2.80	3.29	3.89	4.12	4.44	4.71	4.85	5.11

4. Table A4.4. Delta of Dissolved Oxygen percentiles distribution in Zones of Savannah Estuary: Deepening scenario minus Existing bathymetry scenario

Zone	Project - Baseline Difference (mg/l)									Project - Baseline Relative Difference (%)								
Name	1%	5%	10%	25%	50%	75%	90%	95%	99%	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	-0.01	0.00	0.00	0.00	0.01	-0.01	-0.02	-0.01	-0.01	-0.3	0.1	0.0	0.1	0.2	-0.2	-0.3	-0.2	-0.2
FR2	-0.01	0.01	0.00	0.01	0.01	0.00	0.01	0.00	0.00	-0.3	0.4	0.1	0.2	0.3	0.0	0.1	0.1	-0.1
FR3	0.01	0.03	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.3	0.9	0.9	0.3	0.3	0.3	0.3	0.2	0.1
FR4	-0.04	-0.03	0.01	0.01	-0.01	-0.01	-0.02	0.00	0.01	-1.8	-1.1	0.2	0.3	-0.3	-0.2	-0.4	0.1	0.3
FR5	-0.06	-0.05	-0.03	-0.04	-0.04	-0.04	-0.05	-0.04	0.00	-2.5	-1.8	-1.1	-1.2	-1.0	-1.0	-1.3	-0.8	0.0
FR6	-0.07	-0.07	-0.06	-0.09	-0.09	-0.09	-0.09	-0.10	-0.08	-2.7	-2.5	-2.0	-2.6	-2.5	-2.3	-2.0	-2.2	-1.7
FR7	-0.14	-0.14	-0.11	-0.13	-0.16	-0.15	-0.11	-0.11	-0.09	-4.7	-4.3	-3.1	-3.5	-3.8	-3.2	-2.1	-2.1	-1.6
FR8	-0.14	-0.13	-0.15	-0.13	-0.14	-0.11	-0.10	-0.09	-0.04	-4.2	-3.5	-3.9	-3.2	-3.0	-2.2	-1.9	-1.6	-0.7
FR9	-0.14	-0.16	-0.14	-0.14	-0.11	-0.07	-0.05	-0.04	-0.04	-3.5	-3.8	-3.1	-3.0	-2.1	-1.2	-0.9	-0.7	-0.6
FR10	0.00	-0.02	-0.01	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	0.0	-0.4	-0.1	-0.4	-0.4	-0.3	-0.4	-0.3	-0.3
FR11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	-0.2	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.2
MR1	-0.05	-0.06	-0.08	-0.05	-0.09	-0.09	-0.08	-0.08	-0.07	-1.9	-1.9	-2.4	-1.4	-2.3	-2.1	-1.6	-1.6	-1.3
MR2	-0.02	-0.02	-0.05	-0.05	-0.07	-0.07	-0.07	-0.09	-0.09	-0.8	-0.8	-1.5	-1.5	-1.9	-1.7	-1.6	-1.9	-1.8
MR3	0.00	-0.01	-0.01	-0.02	-0.03	-0.05	-0.05	-0.05	-0.06	0.0	-0.6	-0.5	-0.6	-0.9	-1.1	-1.1	-1.0	-1.1
MR4	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	-0.1	0.3	0.3	0.3	0.2	0.1	-0.1	-0.1	0.1
MR5	0.00	0.03	0.02	0.02	0.00	0.01	0.00	0.01	0.02	0.5	1.8	1.2	0.6	0.0	0.2	0.1	0.1	0.3
MR6	0.00	0.03	0.03	0.01	0.01	0.01	0.00	0.01	0.01	0.0	1.5	1.4	0.5	0.2	0.1	0.0	0.1	0.1
LBR1	0.01	0.01	0.02	0.01	0.00	0.01	0.01	0.01	0.00	0.2	0.5	0.5	0.4	0.1	0.2	0.3	0.2	-0.1
LBR2	0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.00	0.02	-0.1	0.2	0.3	0.0	0.2	0.2	0.2	0.1	0.5
LBR3	0.06	0.06	0.08	0.04	0.03	0.04	0.04	0.03	0.04	3.1	3.1	3.9	1.5	0.9	1.4	1.1	0.8	1.1
BR1	-0.01	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	-0.4	-0.1	-0.4	0.0	0.1	-0.1	0.0	-0.1	-0.1
BR2	0.00	0.00	0.00	0.01	0.01	0.00	-0.01	0.00	0.00	0.0	0.1	0.0	0.4	0.2	0.0	-0.2	0.0	0.1
BR3	0.03	0.02	0.01	0.02	0.00	0.01	0.01	0.00	0.00	1.6	1.0	0.5	0.8	0.0	0.2	0.3	-0.1	-0.1
SCh1	-0.02	0.02	0.00	0.01	0.00	-0.01	-0.02	-0.01	0.02	-0.6	0.9	0.2	0.3	-0.1	-0.2	-0.5	-0.2	0.4
SCh2	-0.01	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	0.01	-0.2	0.0	0.0	-0.1	0.0	-0.2	-0.2	-0.2	0.2
SR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0

5. Table A4.5. Percentage of the volume of waters with violation of Dissolved Oxygen standards for Zones of Savannah Estuary within the period of May 1 – October 30, 1999: Deepening (Project) and Existing (Baseline) bathymetry

Zones	1-Day Average			7-Day Average			30-Day Average			GA MINIMUM D.O.			SC MINIMUM D.O.		
	Baseline(B)	Project(P)	Delta=P-B	Baseline(B)	Project(P)	Delta=P-B	Baseline(B)	Project(P)	Delta=P-B	Baseline(B)	Project(P)	Delta=P-B	Baseline(B)	Project(P)	Delta=P-B
FR1	0	0	0	0	0	0	0	0	0	0	0	0	7	7	0
FR2	0	0	0	0	0	0	3	3	0	0	1	1	31	31	0
FR3	0	0	0	2	2	0	19	19	0	3	3	0	N/A	N/A	N/A
FR4	0	0	0	5	6	1	22	23	1	6	6	0	N/A	N/A	N/A
FR5	0	0	0	4	5	1	19	21	2	5	6	1	N/A	N/A	N/A
FR6	0	0	0	2	3	1	12	16	4	4	5	1	N/A	N/A	N/A
FR7	0	0	0	0	0	0	1	1	0	0	1	1	N/A	N/A	N/A
FR8	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
FR9	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
FR10	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
FR11	0	0	0	0	0	0	2	2	0	1	1	0	6	6	0
MR1	0	0	0	0	1	1	5	6	1	1	1	0	N/A	N/A	N/A
MR2	0	0	0	1	1	0	6	7	1	1	2	1	N/A	N/A	N/A
MR3	0	0	0	3	3	0	10	11	1	3	4	1	N/A	N/A	N/A
MR4	0	0	0	1	1	0	5	5	0	2	2	0	N/A	N/A	N/A
MR5	0	0	0	1	1	0	5	5	0	5	5	0	11	11	0
MR6	0	0	0	0	0	0	3	3	0	3	3	0	9	9	0
LBR1	0	0	0	1	1	0	6	6	0	1	1	0	18	18	0
LBR2	1	1	0	6	6	0	18	18	0	7	7	0	34	34	0
LBR3	3	3	0	13	13	0	30	30	0	14	14	0	47	48	1
BR1	0	0	0	10	10	0	39	39	0	12	12	0	67	67	0
BR2	2	2	0	19	20	1	49	49	0	20	20	0	75	75	0
BR3	3	3	0	21	21	0	48	48	0	22	22	0	70	71	1
SCh1	1	1	0	4	3	-1	8	8	0	5	5	0	N/A	N/A	N/A
SCh2	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
SR	0	0	0	1	1	0	3	3	0	1	1	0	6	6	0

26. Table A4.6. Percentage of water volumes with salinity in %iles within the period of May 1 – October 30, 1999

Percen-tile	Harbor / River			Stations					
	Upper Hrb %	Middle Rvr %	Back Rvr %	Houlih Brg %	Broad Str %	Pulaski Frt %	Lucknow Cnl %	USF&W Dck %	I-95 Brg %
5	19.1	4.8	4.4	4.5	4.4	4.3	7	3.8	86.9
10	23.1	8.6	8.8	8.9	8.9	8.7	11.2	9.5	86.9
25	35.4	20.1	22.3	22.4	22.8	22.1	25.2	19.9	86.9
50	56.9	42.3	46.6	46.6	47.2	46.2	49.5	42.7	86.9
75	79.1	69.4	72.8	72.9	73.1	72.9	73.5	69.3	86.9
90	91.2	87.3	89	89.1	89.2	89.1	88.8	87.5	93.4
95	95.4	93.6	94.4	94.5	94.6	94.6	94.2	93.7	96.9
Total Volume 100*km3:	31984.3	658.7	4807.8	24.1	39.2	136.3	9.9	9.5	43.6

27. Table A4.7. Percentage of water volumes with D.O. in %iles within the period of May 1 – October 30, 1999

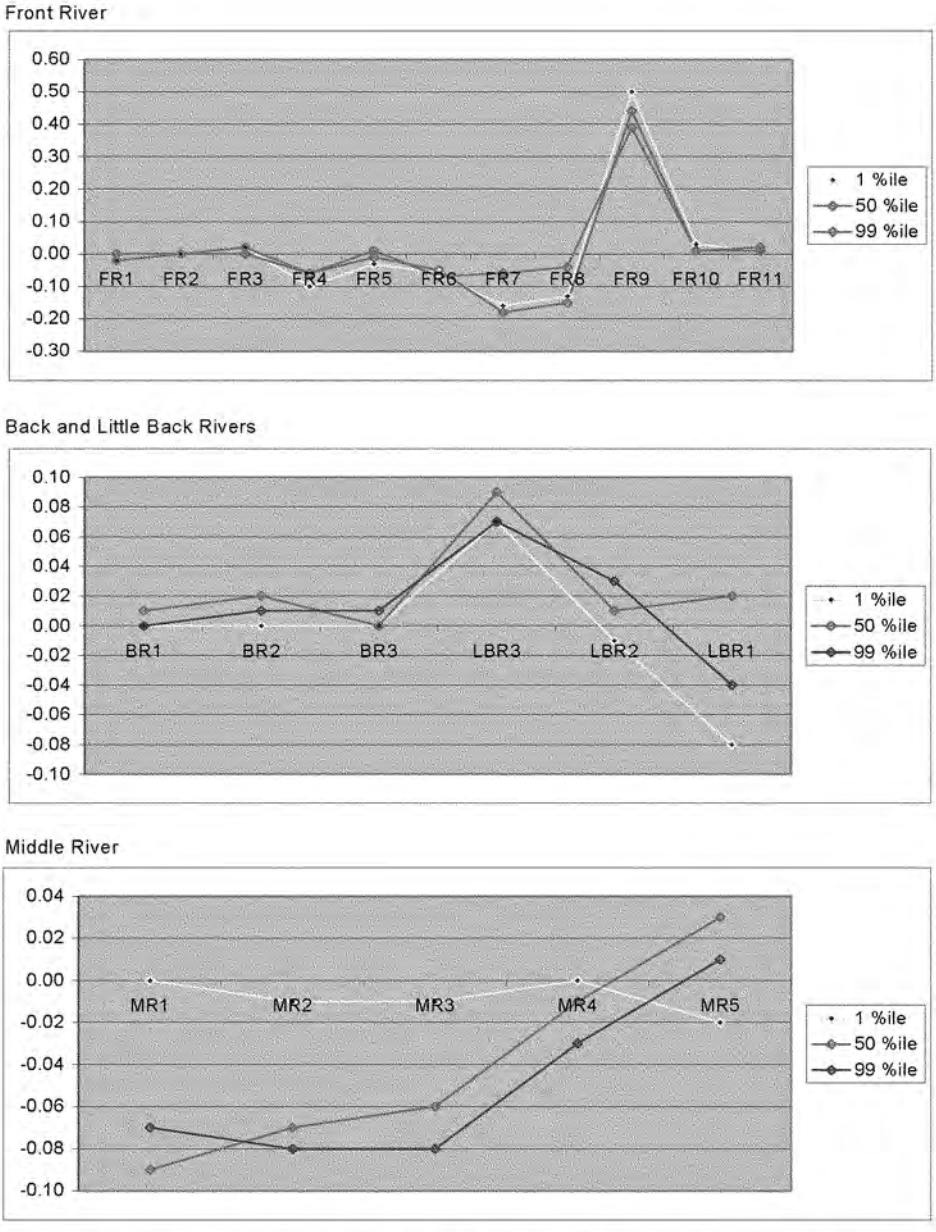
Percen-tile	Harbor / River			Stations					
	Upper Hrb %	Middle Rvr %	Back Rvr %	Houlih Brg %	Broad Str %	Pulaski Frt %	Lucknow Cnl %	USF&W Dck %	I-95 Brg %
5	5.2	4.9	4.9	5.5	5.3	4.8	5.3	5.6	5.7
10	10.4	9.8	9.8	11.3	10.4	9.6	10.2	10.7	11.1
25	26.1	24.7	24.8	27.5	26.1	24.2	25.5	25.7	26.4
50	52.1	49.5	49.9	53.3	51.1	49.3	50.6	51.1	51.6
75	76.9	74.6	75.1	77.5	76	74.5	75.5	76	75.8
90	90.7	89.8	90.1	91.2	90.4	89.9	90.3	90.4	90.5
95	95.3	94.9	95	95.7	95.3	94.8	95.1	95.3	95.1
Total Volume 100*km3:	31984.3	658.7	4807.8	24.1	39.2	136.3	9.9	9.5	43.6

28. Table A4.8. Water volumes in Upper Harbor in increments of 1° C of water temperature within the period of May 1 – October 30, 1999

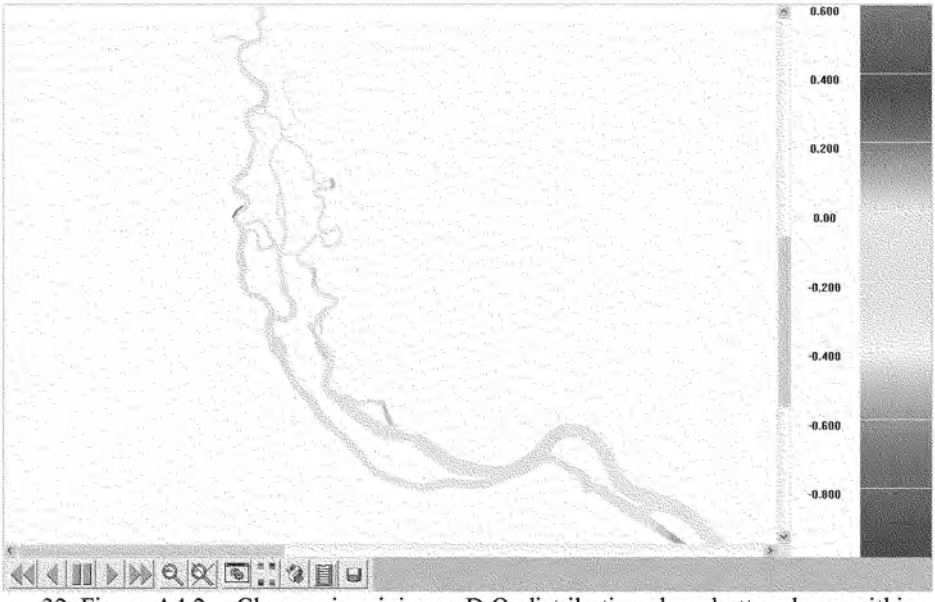
Temperature C°	Total Volume %
19	0.01
20	0.8
21	3.88
22	9.01
23	14.43
24	22.87
25	34.03
26	48.57
27	59.8
28	68.4
29	76.72
30	85.33
31	89.34
32	95.97
33	99.99
34	100

29. Table A4.9. Water volumes in Upper Harbor in increments of 0.1 mg/l of D.O. within the period of May 1 – October 30, 1999
(See file: Postprocessor Output\99-B12\99-B12_DO Increment Volume)

30. Table A4.10. Percentage of water volumes corresponding to 1-, 7-, and 30-days averages of D.O. depth-averaged concentrations in Upper Harbor within the period of May 1 – October 30, 1999
(See file: Postprocessor Output\99-B12\99-B12_volume DO in averages)

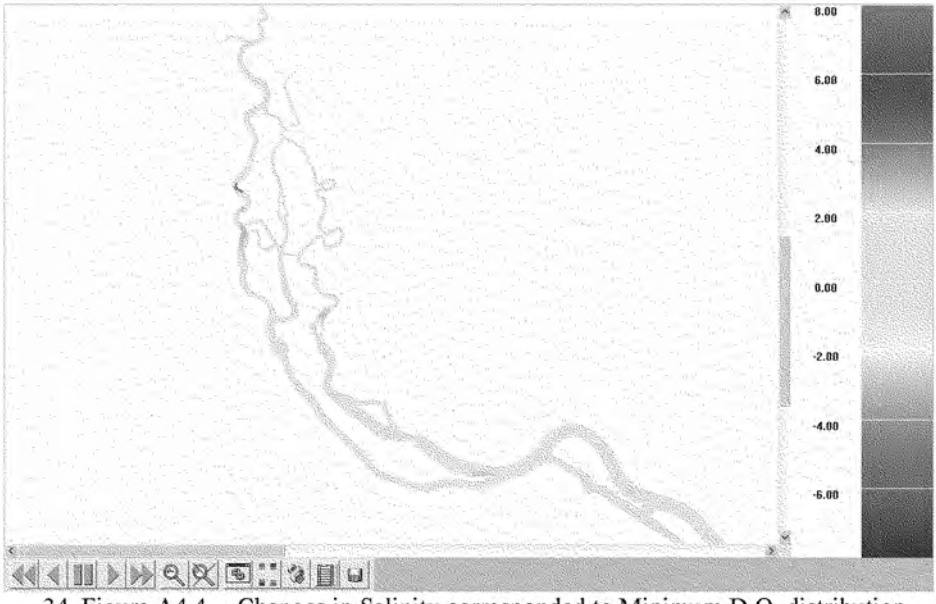


31. Figure A4.1. Changes in longitudinal profile of Dissolved Oxygen (mg/l) distribution along Critical cells of Savannah Estuary: 2 ft deepening

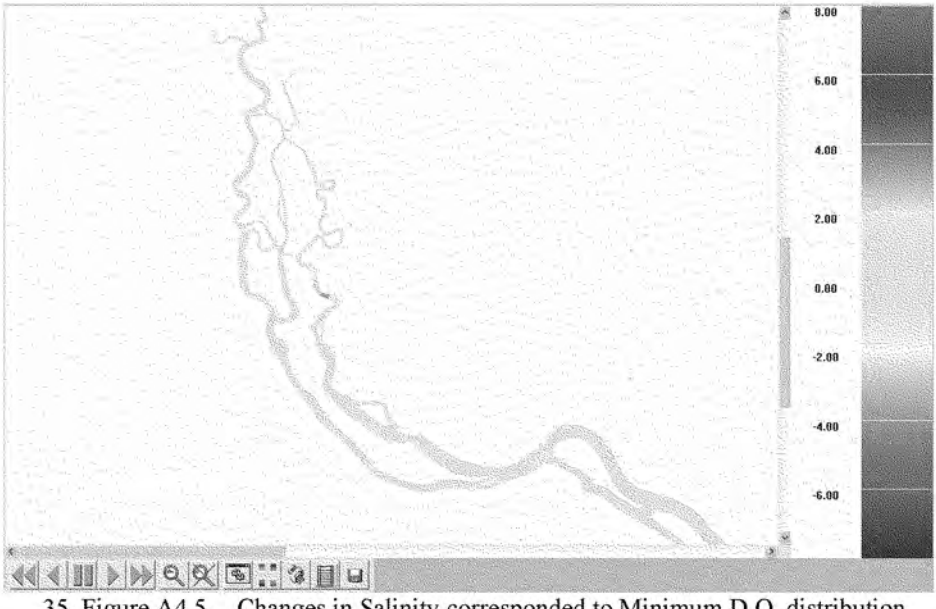


32. Figure A4.2. Changes in minimum D.O. distribution along bottom layer within the analyzed period of May 1 - October 30, 1999: 2 ft deepening

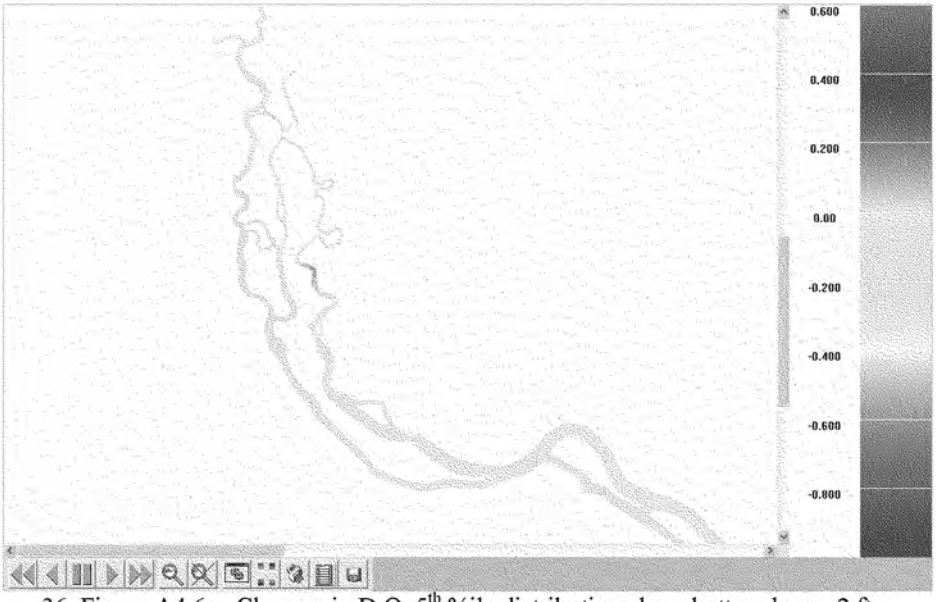
33. Figure A4.3. Changes in minimum D.O. distribution along surface layer within the analyzed period of May 1 - October 30, 1999: 2 ft deepening



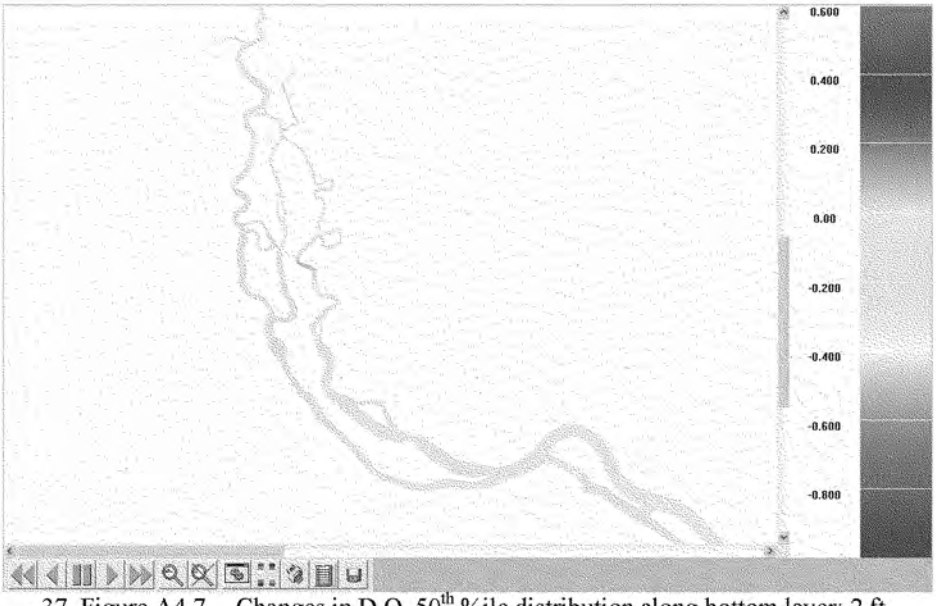
34. Figure A4.4. Changes in Salinity corresponded to Minimum D.O. distribution along bottom layer within the analyzed period of May 1 - October 30, 1999: 2 ft deepening



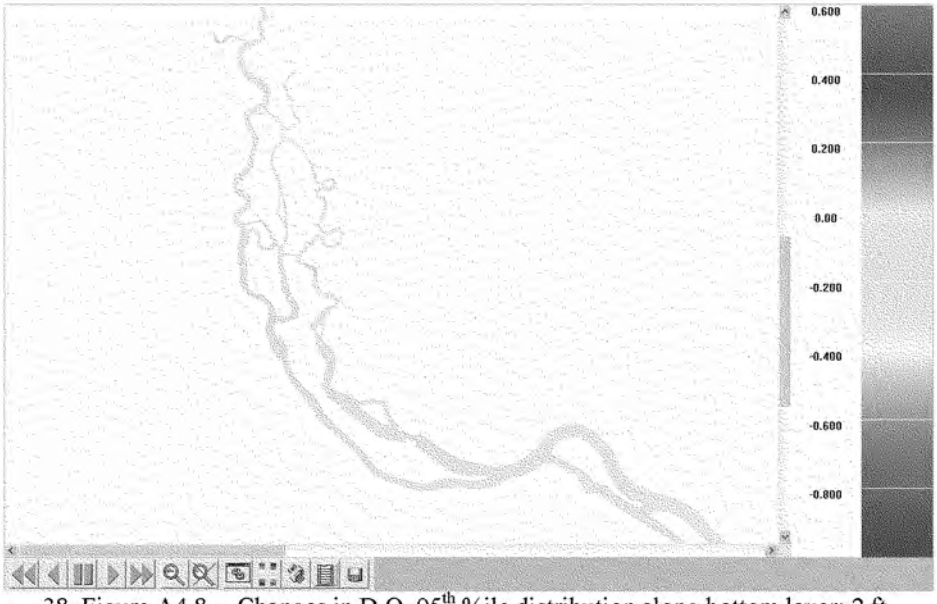
35. Figure A4.5. Changes in Salinity corresponded to Minimum D.O. distribution along Surface layer within the analyzed period of May 1 - October 30, 1999: 2 ft deepening



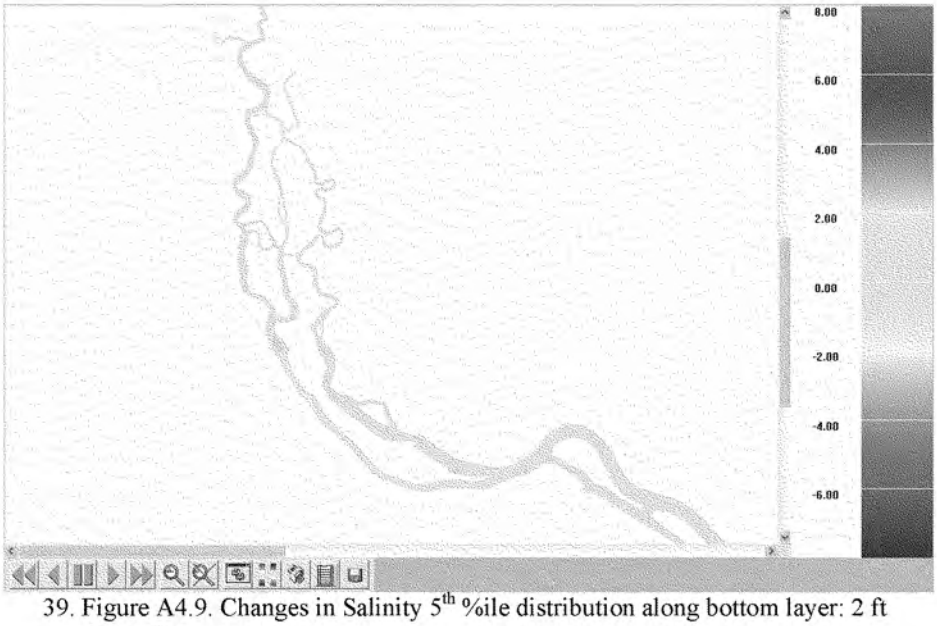
36. Figure A4.6. Changes in D.O. 5th %ile distribution along bottom layer: 2 ft deepening



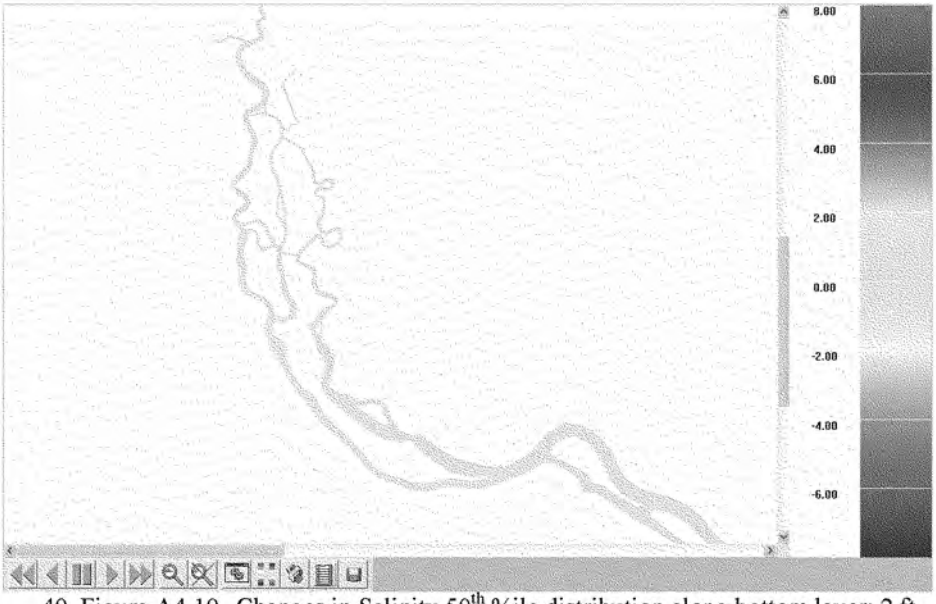
37. Figure A4.7. Changes in D.O. 50th %ile distribution along bottom layer: 2 ft deepening



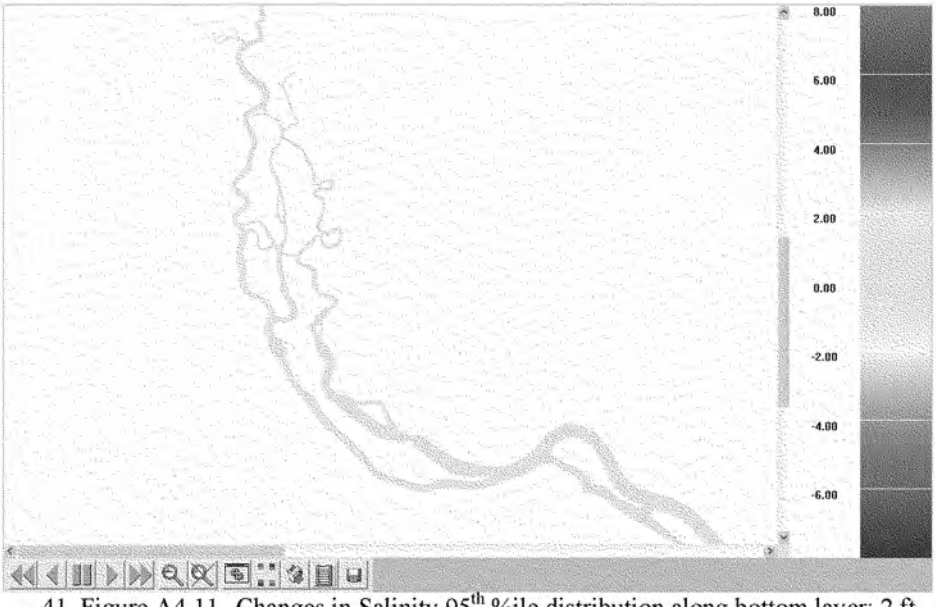
38. Figure A4.8. Changes in D.O. 95th %ile distribution along bottom layer: 2 ft deepening



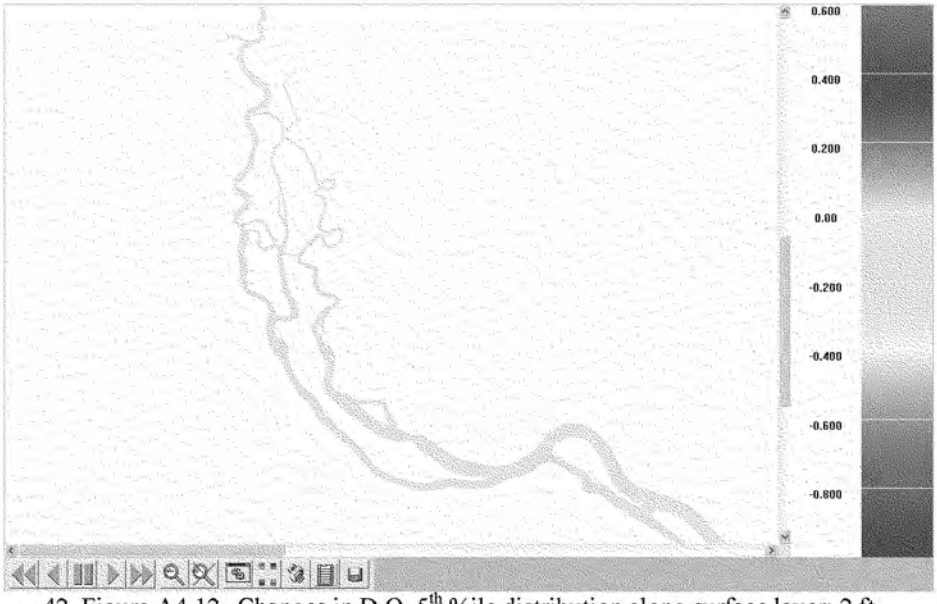
39. Figure A4.9. Changes in Salinity 5th %ile distribution along bottom layer: 2 ft deepening



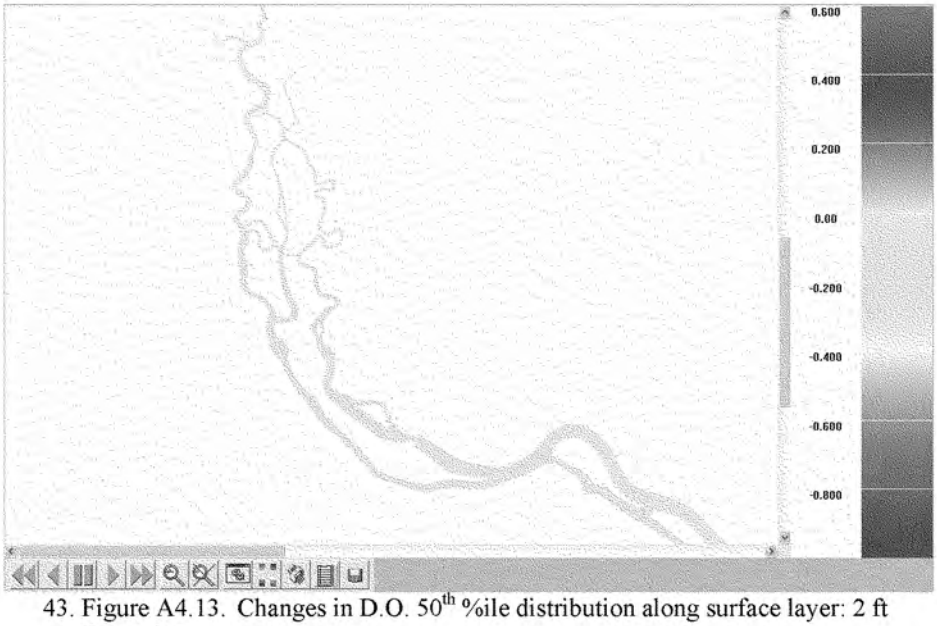
40. Figure A4.10. Changes in Salinity 50th %ile distribution along bottom layer: 2 ft deepening



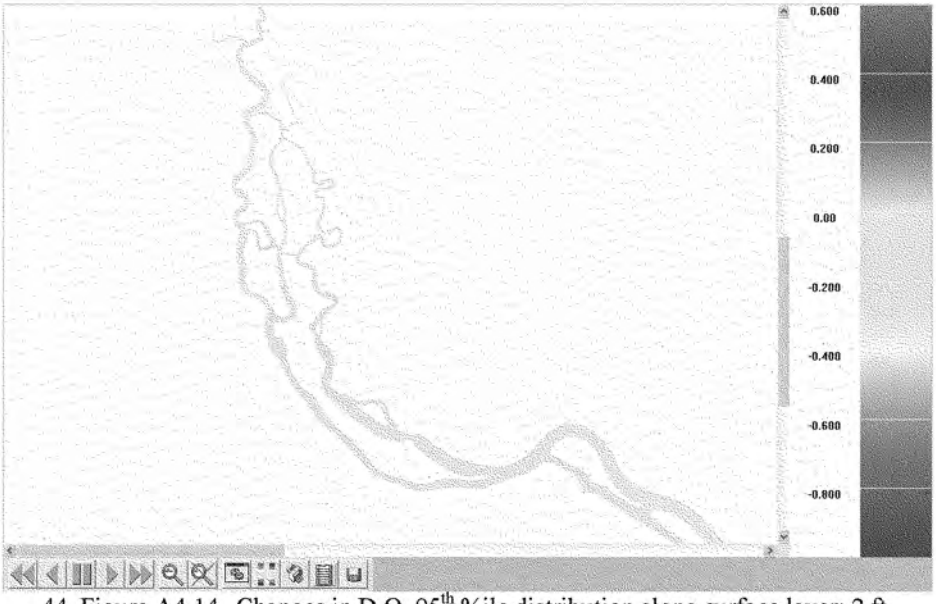
41. Figure A4.11. Changes in Salinity 95th %ile distribution along bottom layer: 2 ft deepening



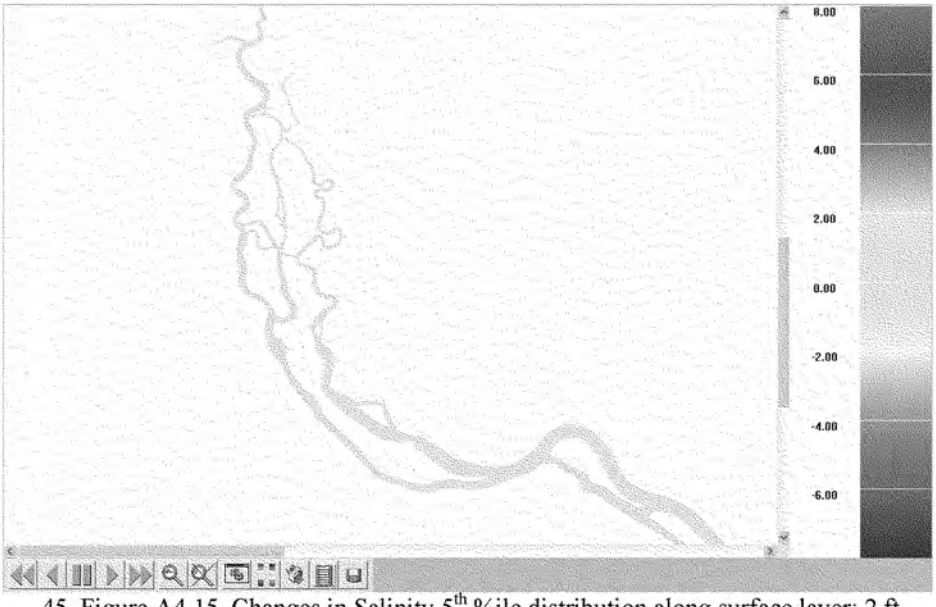
42. Figure A4.12. Changes in D.O. 5th %ile distribution along surface layer: 2 ft deepening



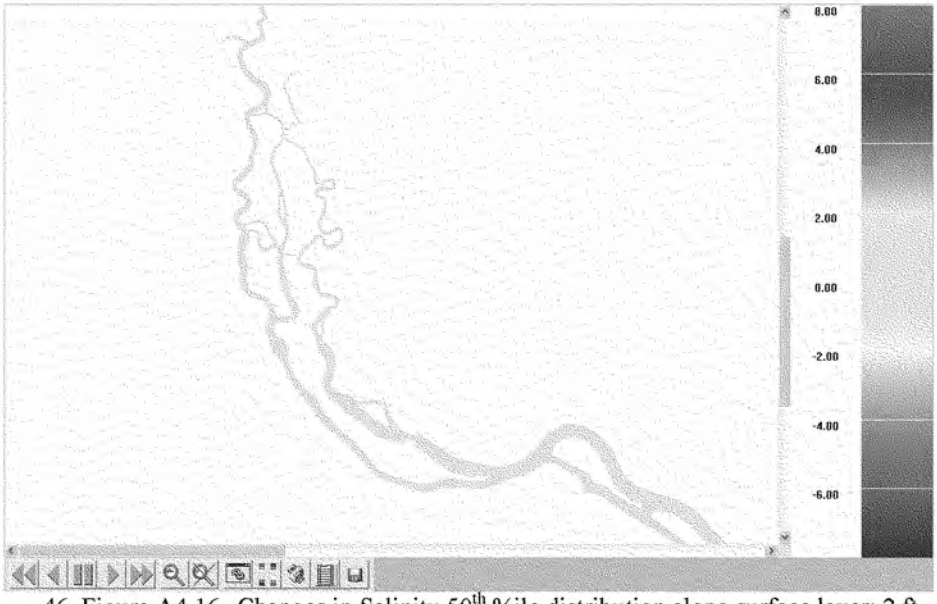
43. Figure A4.13. Changes in D.O. 50th %ile distribution along surface layer: 2 ft deepening



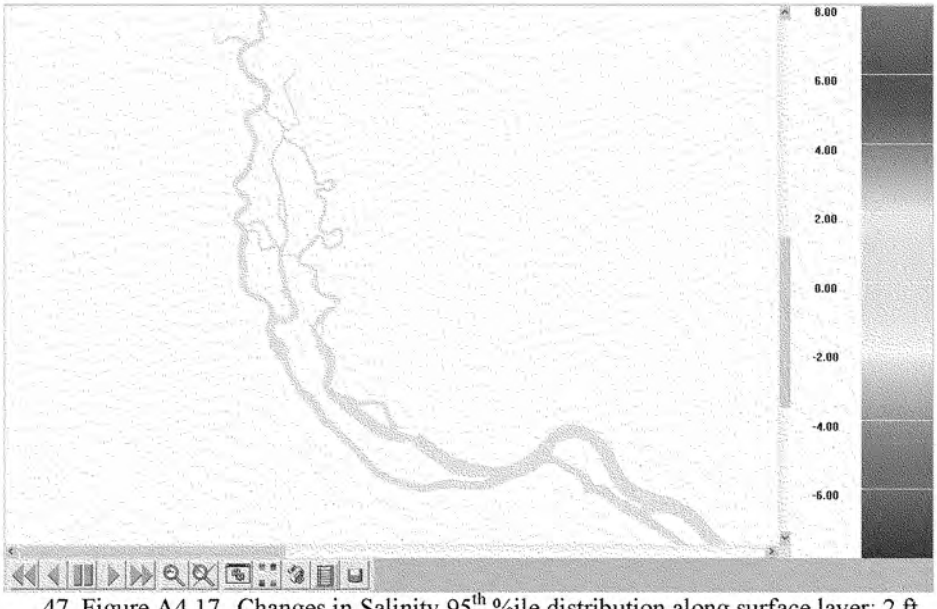
44. Figure A4.14. Changes in D.O. 95th %ile distribution along surface layer: 2 ft deepening



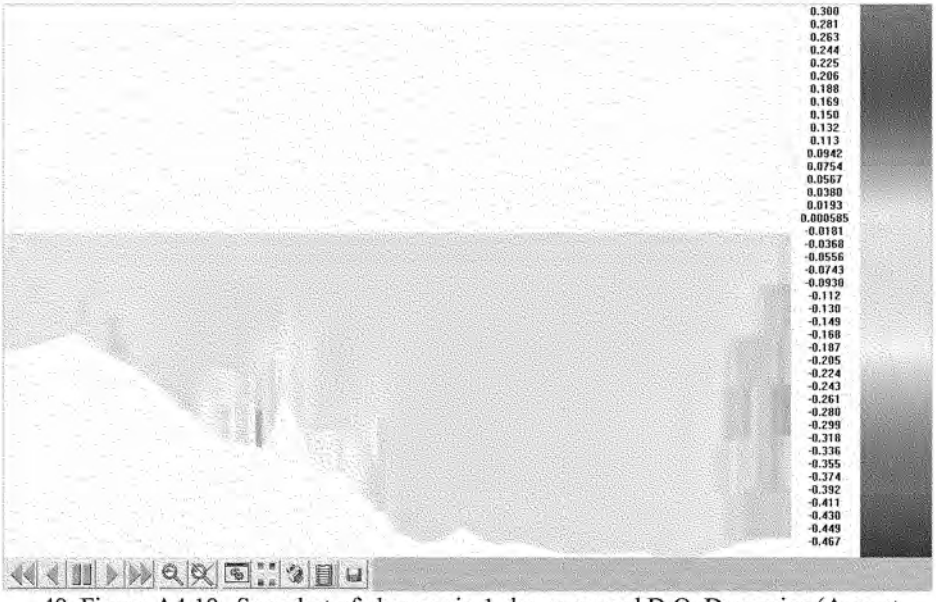
45. Figure A4.15. Changes in Salinity 5th %ile distribution along surface layer: 2 ft deepening



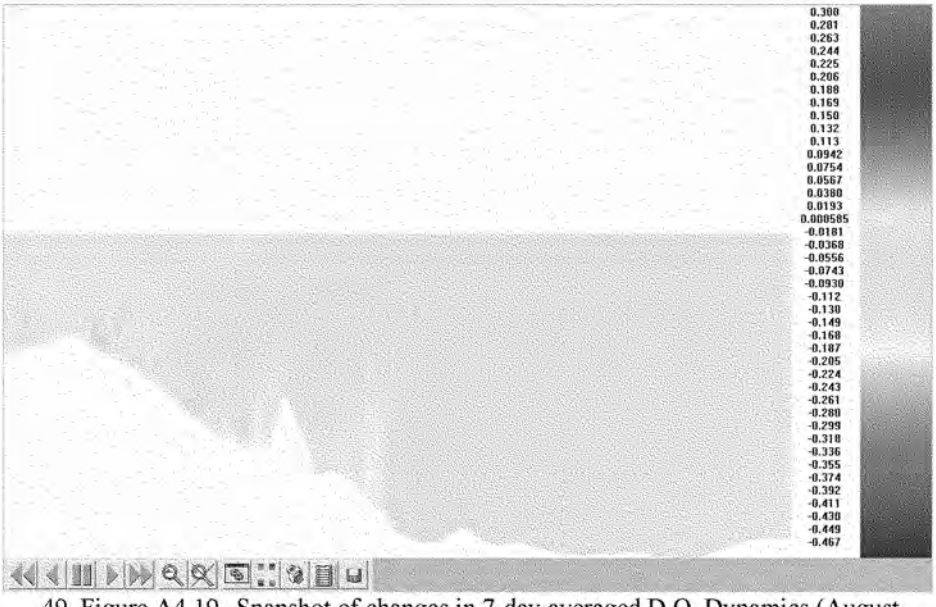
46. Figure A4.16. Changes in Salinity 50th %ile distribution along surface layer: 2 ft deepening



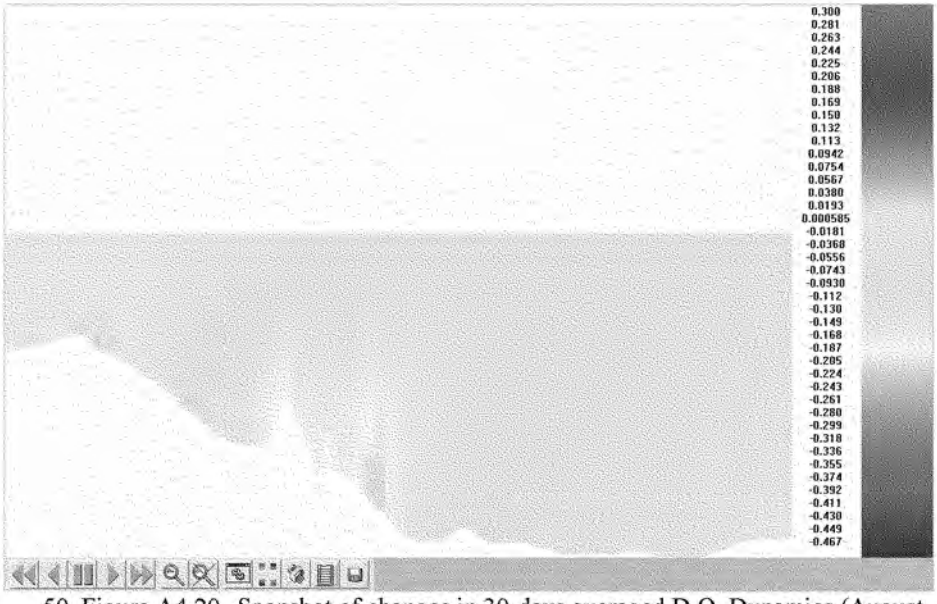
47. Figure A4.17. Changes in Salinity 95th %ile distribution along surface layer: 2 ft deepening



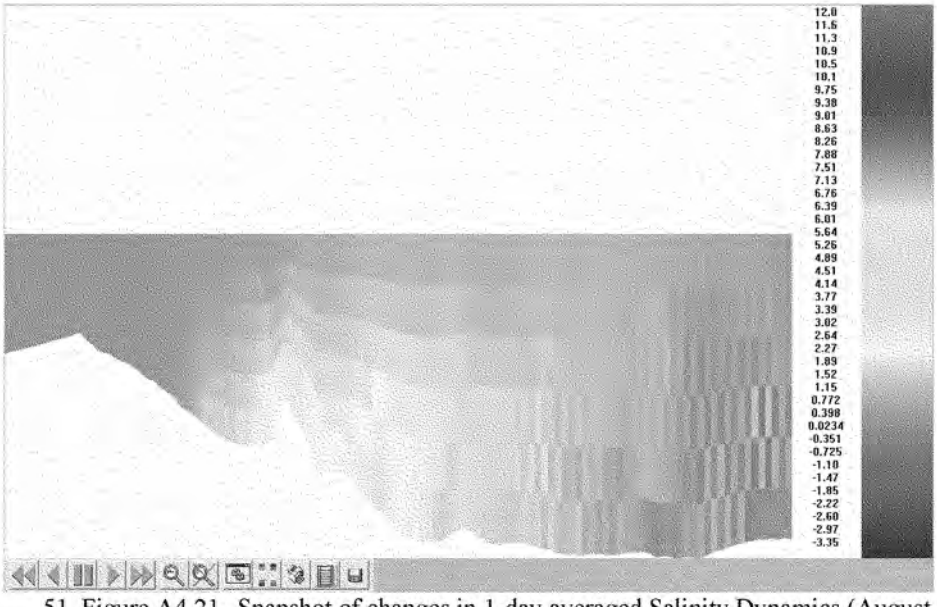
48. Figure A4.18. Snapshot of changes in 1-day averaged D.O. Dynamics (August 10, 1999) in vertical plane of Upper Harbor: 2 ft deepening



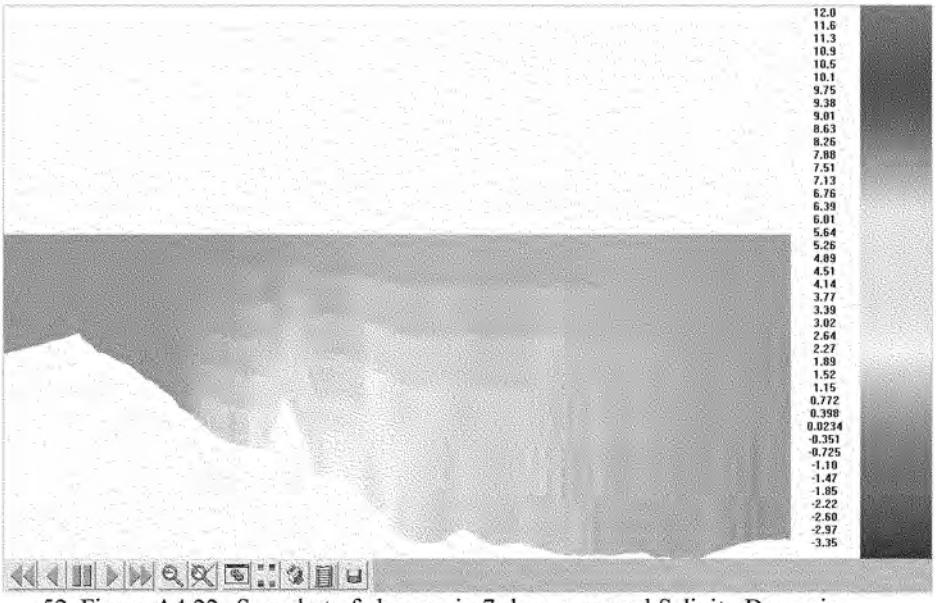
49. Figure A4.19. Snapshot of changes in 7-day averaged D.O. Dynamics (August 10, 1999) in vertical plane of Upper Harbor: 2 ft deepening



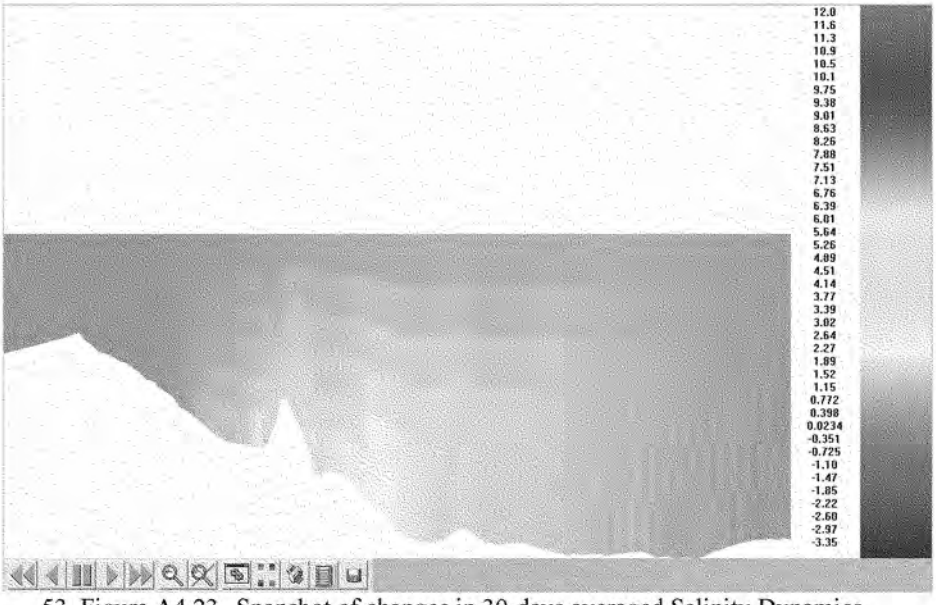
50. Figure A4.20. Snapshot of changes in 30-days averaged D.O. Dynamics (August 10, 1999) in vertical plane of Upper Harbor: 2 ft deepening



51. Figure A4.21. Snapshot of changes in 1-day averaged Salinity Dynamics (August 10, 1999) in vertical plane of Upper Harbor: 2 ft deepening



52. Figure A4.22. Snapshot of changes in 7-days averaged Salinity Dynamics (August 10, 1999) in vertical plane of Upper Harbor: 2 ft deepening



53. Figure A4.23. Snapshot of changes in 30-days averaged Salinity Dynamics (August 10, 1999) in vertical plane of Upper Harbor: 2 ft deepening

Appendix B

SENSITIVITY ANALYSIS #1: EXISTING BATHYMETRY, 2004 POINT SOURCES LOADS, 1997 HYDROLOGICAL AND METEOROLOGICAL CONDITIONS

May 1 – October 30, 1997 Simulation Period

Water Quality Review Group

1. Table B.1. Dissolved oxygen percentiles distribution in Critical cells

Zone	D.O. Percentile (mg/l)								
	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	3.41	3.74	3.91	4.13	4.46	4.93	5.36	5.5	5.66
FR2	3.03	3.3	3.4	3.65	4.01	4.45	4.99	5.28	5.77
FR3	2.84	3.15	3.25	3.44	3.84	4.28	4.86	5.33	6.18
FR4	2.82	3.09	3.22	3.44	3.85	4.31	4.83	5.48	6.22
FR5	2.91	3.12	3.26	3.53	3.94	4.42	4.87	5.8	6.23
FR6	3.01	3.21	3.36	3.65	4.1	4.69	5.22	6.16	6.31
FR7	3.45	3.8	4.01	4.44	4.93	5.35	5.9	6.4	6.55
FR8	3.47	3.86	4.12	4.68	5.14	5.51	6.04	6.39	6.53
FR9	4.35	4.77	5	5.27	5.48	5.83	6.28	6.49	6.59
FR10	3.17	3.5	3.74	4.29	4.89	5.42	5.81	5.96	6.15
FR11	2.87	3.35	3.59	4.06	4.53	5.17	5.69	5.89	5.99
MR1	3.28	3.46	3.61	3.91	4.31	4.8	5.17	5.72	6.32
MR2	2.84	3.13	3.3	3.68	4.18	4.71	5.09	5.37	6.24
MR3	2.68	2.92	3.08	3.46	3.95	4.52	4.93	5.17	5.93
MR4	2.75	3	3.14	3.39	3.7	4.15	4.69	5.05	5.27
MR5	0.9	1.52	1.86	2.49	4.14	5.21	5.67	5.88	6.04
MR6	1.42	2.03	2.39	3.12	4.63	5.43	5.87	6.1	6.72
LBR1	2.88	3.61	3.96	4.17	4.45	4.89	5.33	5.61	5.87
LBR2	3.12	3.26	3.34	3.47	3.68	4.14	4.52	4.97	5.18
LBR3	2.1	2.38	2.55	2.88	3.3	3.81	4.31	4.45	4.81
BR1	2.45	2.68	2.82	3.08	3.47	3.98	4.51	4.78	5.13
BR2	1.84	2.19	2.39	2.79	3.19	3.72	4.23	4.56	5
BR3	2.11	2.43	2.61	2.9	3.23	3.77	4.35	4.51	4.74
SCH1	1.71	2.18	2.39	2.8	3.63	4.39	4.91	5.26	5.64
SCH2	3.14	3.42	3.63	3.95	4.23	4.68	5.11	5.32	5.56
SR	3.38	3.46	3.56	3.9	4.22	4.69	5.37	5.85	5.89

2. Table B.2. Delta of Dissolved Oxygen percentiles distribution in Critical cells: 1999 minus 1997 Existing bathymetry scenarios

Zone	Delta D.O. Percentile																	
	1%		5%		10%		25%		50%		75%		90%		95%		99	
	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%
FR1	0.02	0.6	-0.13	-3.5	-0.19	-4.9	-0.18	-4.4	-0.17	-3.8	-0.21	-4.3	-0.36	-6.7	-0.3	-5.5	-0.09	-1.6
FR2	-0.29	-9.6	-0.31	-9.4	-0.29	-8.5	-0.26	-7.1	-0.27	-6.7	-0.29	-6.5	-0.47	-9.4	-0.61	-11.6	-0.8	-13.9
FR3	-0.39	-13.7	-0.46	-14.6	-0.44	-13.5	-0.39	-11.3	-0.34	-8.9	-0.37	-8.6	-0.6	-12.3	-0.92	-17.3	-1.47	-23.8
FR4	-0.31	-11.0	-0.35	-11.3	-0.37	-11.5	-0.34	-9.9	-0.33	-8.6	-0.4	-9.3	-0.58	-12.0	-1.05	-19.2	-1.51	-24.3
FR5	-0.41	-14.1	-0.43	-13.8	-0.48	-14.7	-0.43	-12.2	-0.44	-11.2	-0.55	-12.4	-0.64	-13.1	-1.39	-24.0	-1.61	-25.8
FR6	-0.47	-15.6	-0.47	-14.6	-0.55	-16.4	-0.5	-13.7	-0.59	-14.4	-0.8	-17.1	-0.92	-17.6	-1.68	-27.3	-1.62	-25.7
FR7	-0.32	-9.3	-0.39	-10.3	-0.42	-10.5	-0.49	-11.0	-0.51	-10.3	-0.48	-9.0	-0.69	-11.7	-0.95	-14.8	-0.52	-7.9
FR8	-0.27	-7.8	-0.34	-8.8	-0.43	-10.4	-0.57	-12.2	-0.45	-8.8	-0.4	-7.3	-0.62	-10.3	-0.78	-12.2	-0.63	-9.6
FR9	-0.96	-22.1	-1.13	-23.7	-1.16	-23.2	-1.04	-19.7	-0.74	-13.5	-0.63	-10.8	-0.82	-13.1	-0.88	-13.6	-0.71	-10.8
FR10	-0.88	-27.8	-0.37	-10.6	-0.36	-9.6	-0.37	-8.6	-0.3	-6.1	-0.18	-3.3	-0.16	-2.8	-0.14	-2.3	-0.12	-2.0
FR11	-0.7	-24.4	-0.57	-17.0	-0.44	-12.3	-0.43	-10.6	-0.31	-6.8	-0.32	-6.2	-0.29	-5.1	-0.27	-4.6	-0.05	-0.8
MR1	-0.7	-21.3	-0.47	-13.6	-0.43	-11.9	-0.36	-9.2	-0.38	-8.8	-0.55	-11.5	-0.59	-11.4	-0.97	-17.0	-1.34	-21.2
MR2	-0.64	-22.5	-0.57	-18.2	-0.39	-11.8	-0.31	-8.4	-0.36	-8.6	-0.5	-10.6	-0.56	-11.0	-0.63	-11.7	-1.24	-19.9
MR3	-0.6	-22.4	-0.47	-16.1	-0.32	-10.4	-0.18	-5.2	-0.21	-5.3	-0.35	-7.7	-0.43	-8.7	-0.44	-8.5	-0.96	-16.2
MR4	-0.7	-25.5	-0.56	-18.7	-0.51	-16.2	-0.34	-10.0	-0.22	-5.9	-0.32	-7.7	-0.51	-10.9	-0.69	-13.7	-0.59	-11.2
MR5	-0.45	-50.0	-0.53	-34.9	-0.47	-25.3	-0.28	-11.2	-0.51	-12.3	-0.09	-1.7	-0.1	-1.8	-0.15	-2.6	-0.07	-1.2
MR6	-0.37	-26.1	-0.37	-18.2	-0.28	-11.7	-0.09	-2.9	-0.21	-4.5	-0.13	-2.4	-0.16	-2.7	-0.21	-3.4	-0.55	-8.2
LBR1	-0.21	-7.3	-0.32	-8.9	-0.46	-11.6	-0.21	-5.0	-0.14	-3.1	-0.29	-5.9	-0.41	-7.7	-0.51	-9.1	-0.44	-7.5
LBR2	-1.02	-32.7	-0.93	-28.5	-0.83	-24.9	-0.49	-14.1	-0.35	-9.5	-0.5	-12.1	-0.58	-12.8	-0.84	-16.9	-0.75	-14.5
LBR3	-0.76	-36.2	-0.63	-26.5	-0.51	-20.0	-0.32	-11.1	-0.17	-5.2	-0.18	-4.7	-0.33	-7.7	-0.27	-6.1	-0.25	-5.2
BR1	-0.45	-18.4	-0.45	-16.8	-0.41	-14.5	-0.3	-9.7	-0.26	-7.5	-0.35	-8.8	-0.5	-11.1	-0.56	-11.7	-0.65	-12.7
BR2	-0.47	-25.5	-0.58	-26.5	-0.56	-23.4	-0.59	-21.1	-0.41	-12.9	-0.53	-14.2	-0.66	-15.6	-0.78	-17.1	-0.85	-17.0
BR3	-0.42	-19.9	-0.4	-16.5	-0.39	-14.9	-0.34	-11.7	-0.17	-5.3	-0.3	-8.0	-0.56	-12.9	-0.46	-10.2	-0.35	-7.4
SCH1	-0.42	-24.6	-0.53	-24.3	-0.47	-19.7	-0.31	-11.1	-0.32	-8.8	-0.29	-6.6	-0.25	-5.1	-0.28	-5.3	-0.32	-5.7
SCH2	-0.06	-1.9	-0.11	-3.2	-0.18	-5.0	-0.26	-6.6	-0.19	-4.5	-0.24	-5.1	-0.34	-6.7	-0.36	-6.8	-0.31	-5.6
SR	-1.14	-33.7	-0.94	-27.2	-0.6	-16.9	-0.3	-7.7	-0.36	-8.5	-0.49	-10.4	-0.87	-16.2	-1.21	-20.7	-0.98	-16.6

3. Table B.3. Dissolved oxygen percentiles distribution in Zones of Savannah Estuary

Zone Name	D.O. Concentration Percentiles (mg/l)								
	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	3.75	4.07	4.22	4.41	4.70	5.19	5.57	5.68	5.79
FR2	3.35	3.58	3.76	4.00	4.31	4.77	5.25	5.44	5.59
FR3	3.01	3.28	3.40	3.61	3.98	4.40	4.98	5.28	6.04
FR4	2.89	3.16	3.28	3.46	3.88	4.31	4.86	5.39	6.26
FR5	2.97	3.17	3.31	3.54	3.94	4.42	4.87	5.74	6.29
FR6	3.12	3.23	3.44	3.68	4.11	4.65	5.07	6.07	6.34
FR7	3.33	3.67	3.86	4.30	4.89	5.29	5.77	6.35	6.45
FR8	3.60	3.99	4.25	4.71	5.16	5.52	5.97	6.39	6.53
FR9	4.19	4.64	4.91	5.25	5.49	5.85	6.26	6.47	6.60
FR10	4.68	4.88	4.99	5.20	5.44	5.81	6.16	6.30	6.46
FR11	3.63	3.83	4.01	4.26	4.59	5.00	5.54	5.92	6.00
MR1	3.34	3.54	3.70	3.95	4.34	4.80	5.19	5.79	6.32
MR2	3.04	3.30	3.45	3.79	4.24	4.71	5.12	5.45	6.27
MR3	2.77	2.95	3.10	3.43	3.90	4.45	4.91	5.14	5.83
MR4	3.40	3.52	3.62	3.81	4.07	4.49	4.93	5.27	5.49
MR5	1.44	1.98	2.28	2.91	4.47	5.16	5.61	5.85	5.99
MR6	1.46	2.07	2.40	3.17	4.68	5.39	5.81	6.03	6.60
LBR1	3.47	3.61	3.67	3.82	4.01	4.48	4.83	5.30	5.45
LBR2	2.70	2.90	3.01	3.20	3.47	3.93	4.33	4.78	5.03
LBR3	2.48	2.60	2.71	2.88	3.12	3.63	4.16	4.39	4.55
BR1	2.77	2.96	3.04	3.26	3.62	4.12	4.61	4.97	5.29
BR2	2.37	2.63	2.74	2.95	3.27	3.79	4.38	4.57	4.91
BR3	2.43	2.63	2.73	2.92	3.17	3.75	4.29	4.40	4.53
SCh1	2.76	3.07	3.35	3.58	3.85	4.38	4.93	5.09	5.25
SCh2	3.28	3.51	3.78	4.03	4.30	4.77	5.19	5.38	5.54
SR	3.70	3.75	3.81	4.14	4.44	4.90	5.54	5.97	5.99

4. Table B.4. Delta of Dissolved Oxygen percentiles distribution in Zones: 1997 minus 1999 Existing bathymetry scenarios

Zone	Project - Baseline Difference (mg/l)									Project - Baseline Relative Difference (%)								
Name	1%	5%	10%	25%	50%	75%	90%	95%	99%	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	0.05	-0.11	-0.17	-0.17	-0.10	-0.18	-0.29	-0.21	0.02	1.4	-2.7	-4.1	-3.8	-2.2	-3.5	-5.2	-3.7	0.4
FR2	-0.13	-0.14	-0.21	-0.23	-0.20	-0.25	-0.43	-0.47	-0.30	-3.8	-4.0	-5.5	-5.7	-4.7	-5.3	-8.1	-8.7	-5.3
FR3	-0.27	-0.33	-0.36	-0.30	-0.30	-0.32	-0.56	-0.69	-1.16	-9.0	-9.9	-10.4	-8.4	-7.6	-7.3	-11.2	-13.0	-19.1
FR4	-0.39	-0.44	-0.47	-0.39	-0.38	-0.44	-0.62	-1.00	-1.59	-13.5	-13.9	-14.2	-11.4	-9.9	-10.2	-12.7	-18.5	-25.4
FR5	-0.43	-0.42	-0.48	-0.45	-0.43	-0.55	-0.60	-1.34	-1.66	-14.3	-13.4	-14.4	-12.6	-10.9	-12.3	-12.4	-23.3	-26.4
FR6	-0.45	-0.36	-0.48	-0.41	-0.47	-0.65	-0.69	-1.51	-1.60	-14.4	-11.2	-14.0	-11.2	-11.4	-14.0	-13.5	-24.9	-25.2
FR7	-0.30	-0.41	-0.40	-0.46	-0.58	-0.47	-0.64	-1.04	-0.83	-9.1	-11.2	-10.5	-10.8	-11.8	-8.9	-11.0	-16.3	-12.8
FR8	-0.28	-0.37	-0.45	-0.51	-0.49	-0.43	-0.62	-0.87	-0.76	-7.8	-9.2	-10.5	-10.7	-9.5	-7.9	-10.4	-13.6	-11.6
FR9	-0.27	-0.41	-0.48	-0.44	-0.29	-0.35	-0.50	-0.57	-0.47	-6.4	-8.8	-9.7	-8.3	-5.3	-6.0	-8.0	-8.8	-7.0
FR10	-0.68	-0.38	-0.28	-0.21	-0.16	-0.25	-0.35	-0.38	-0.30	-14.4	-7.7	-5.6	-3.9	-2.9	-4.3	-5.7	-6.0	-4.7
FR11	-0.99	-0.65	-0.45	-0.30	-0.29	-0.37	-0.60	-0.79	-0.64	-27.4	-17.0	-11.3	-7.0	-6.3	-7.4	-10.9	-13.4	-10.7
MR1	-0.55	-0.50	-0.49	-0.39	-0.41	-0.56	-0.61	-1.05	-1.38	-16.4	-14.0	-13.1	-9.8	-9.5	-11.7	-11.8	-18.1	-21.9
MR2	-0.68	-0.51	-0.40	-0.34	-0.38	-0.51	-0.59	-0.71	-1.32	-22.4	-15.5	-11.5	-8.9	-8.9	-10.8	-11.6	-13.0	-21.0
MR3	-0.68	-0.59	-0.43	-0.30	-0.32	-0.42	-0.53	-0.56	-0.91	-24.5	-20.2	-13.9	-8.7	-8.2	-9.4	-10.9	-10.8	-15.7
MR4	-0.67	-0.59	-0.47	-0.25	-0.16	-0.28	-0.42	-0.60	-0.63	-19.6	-16.7	-12.8	-6.5	-4.0	-6.3	-8.6	-11.3	-11.5
MR5	-0.37	-0.51	-0.41	-0.19	-0.34	-0.08	-0.11	-0.19	-0.07	-25.7	-26.0	-17.9	-6.4	-7.6	-1.5	-2.0	-3.3	-1.1
MR6	-0.36	-0.38	-0.27	-0.08	-0.22	-0.11	-0.15	-0.19	-0.49	-24.7	-18.5	-11.4	-2.4	-4.7	-2.0	-2.6	-3.1	-7.4
LBR1	-0.60	-0.58	-0.50	-0.19	-0.10	-0.33	-0.37	-0.70	-0.69	-17.4	-16.1	-13.7	-4.9	-2.4	-7.3	-7.6	-13.1	-12.7
LBR2	-0.67	-0.64	-0.52	-0.28	-0.18	-0.33	-0.44	-0.69	-0.74	-24.8	-22.1	-17.2	-8.8	-5.2	-8.4	-10.2	-14.5	-14.7
LBR3	-0.72	-0.70	-0.71	-0.36	-0.07	-0.30	-0.50	-0.58	-0.39	-29.0	-26.8	-26.1	-12.4	-2.4	-8.4	-12.0	-13.1	-8.6
BR1	-0.35	-0.41	-0.38	-0.31	-0.26	-0.34	-0.46	-0.62	-0.69	-12.8	-13.9	-12.6	-9.4	-7.3	-8.3	-10.0	-12.6	-13.1
BR2	-0.43	-0.46	-0.44	-0.34	-0.20	-0.30	-0.49	-0.50	-0.57	-17.9	-17.6	-16.0	-11.6	-6.1	-7.8	-11.3	-10.9	-11.7
BR3	-0.52	-0.52	-0.49	-0.34	-0.11	-0.32	-0.48	-0.38	-0.23	-21.2	-19.9	-18.0	-11.6	-3.6	-8.6	-11.2	-8.5	-5.1
SCh1	-0.16	-0.19	-0.34	-0.31	-0.21	-0.27	-0.49	-0.51	-0.41	-5.6	-6.3	-10.3	-8.7	-5.3	-6.1	-10.0	-10.0	-7.8
SCh2	0.05	-0.03	-0.20	-0.24	-0.20	-0.25	-0.36	-0.39	-0.25	1.6	-1.0	-5.3	-5.9	-4.7	-5.3	-7.0	-7.2	-4.6
SR	-1.08	-0.96	-0.52	-0.26	-0.32	-0.46	-0.83	-1.11	-0.89	-29.2	-25.6	-13.6	-6.3	-7.2	-9.4	-15.1	-18.7	-14.8

5. Table B.5. Percentage of water volumes with salinity in %iles within the period of May 1 – October 30, 1997

Percen-tile	Harbor / River			Stations					
	Upper Hrb %	Middle Rvr %	Back Rvr %	Houlih Brg %	Broad Str %	Pulaski Frt %	Lucknow Cnl %	USF&W Dck %	I-95 Brg %
5	21.9	8.2	5	7.1	4.5	4.3	14.4	7.3	96.3
10	25.8	11.7	9.4	10.9	9	8.7	14.4	14.3	96.3
25	37.7	24	23.2	23.3	23	22	31.1	24.1	96.3
50	58.1	45.5	47.1	47	47.5	46.1	52	45	96.3
75	80.2	70.3	72.8	72.7	73.1	72.8	75.2	70	96.3
90	91.2	87.5	88.9	88.9	89	89.1	89.3	87.6	96.3
95	95.7	93.6	94.4	94.5	94.5	94.6	94.7	93.7	96.3
Total Volume 100*km3:	31709.1	653.9	4772.9	22.5	39	135.5	9.9	9.4	43.7

6. Table B.6. Percentage of water volumes with D.O. in %iles within the period of May 1 – October 30, 1997

Percen-tile	Harbor / River			Stations					
	Upper Hrb %	Middle Rvr %	Back Rvr %	Houlih Brg %	Broad Str %	Pulaski Frt %	Lucknow Cnl %	USF&W Dck %	I-95 Brg %
5	5.4	5	4.9	5.7	5.5	4.7	5.6	5.5	5.9
10	10.6	9.9	9.9	11.2	10.9	9.5	10.9	10.9	11.3
25	26.2	24.1	24.9	27.4	26.4	24.4	26.4	26.2	26.3
50	52	48.8	50.1	53.1	51.8	49.7	50.4	50.7	51
75	77.2	74.4	75.4	77	76.1	74.9	75.7	75.7	75.8
90	90.4	89.8	90.2	90.3	90.3	89.9	90.1	90.3	90
95	95.4	94.6	95	95.5	95.3	94.9	95.1	95.3	95.2
Total Volume 100*km3:	31709.1	653.9	4772.9	22.5	39	135.5	9.9	9.4	43.7

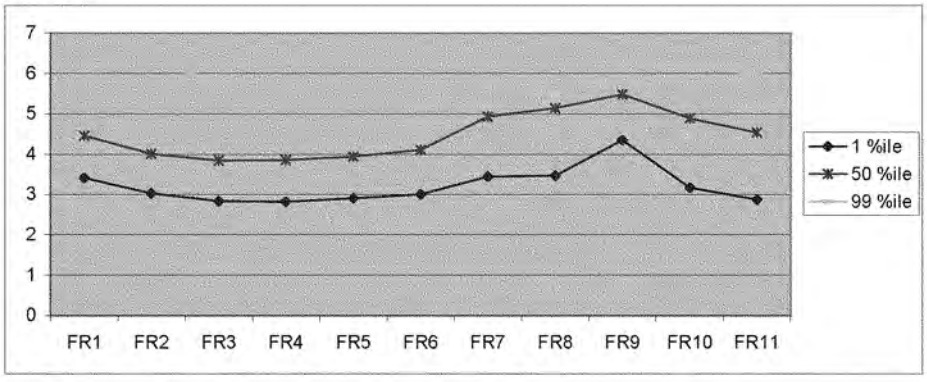
7. Table B.7. Water volumes in Upper Harbor in increments of 1° C of water temperature within the period of May 1 – October 30, 1997

Temperature C°	Total Volume %
17	0.12
18	0.47
19	1.31
20	4.22
21	12.79
22	17.62
23	22.2
24	32.41
25	42.87
26	50.8
27	61.7
28	81.94
29	93.58
30	99.8
31	100

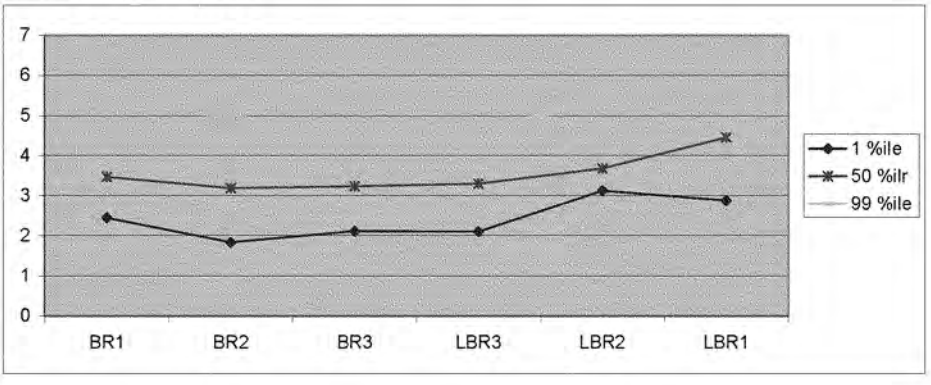
8. Table B.8. Water volumes in Upper Harbor in increments of 0.1 mg/l of D.O. within the period of May 1 – October 30, 1997
(See file: Postprocessor Output\97-S1E\97-S1E_DO Increment Volume)

9. Table B.7. Percentage of water volumes corresponding to 1-, 7-, and 30-days averages of D.O. depth-averaged concentrations in Upper Harbor within the period of May 1 – October 30, 1997
(See file: Postprocessor Output\97-S1E\97-S1E_volume DO in averages)

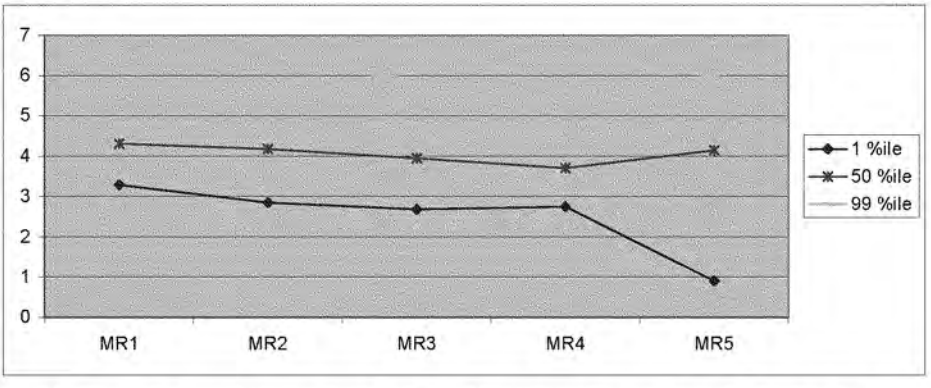
Front River



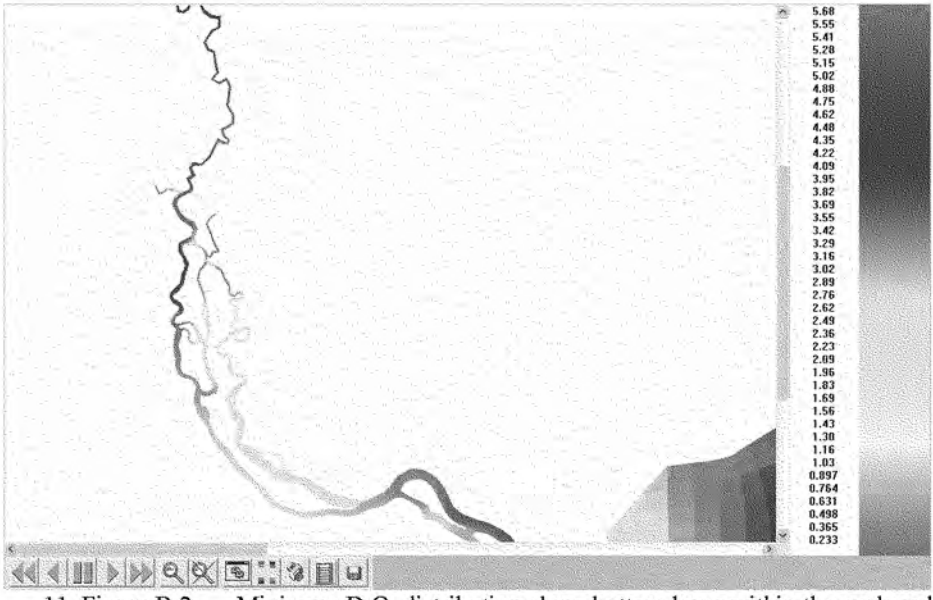
Back and Little Back Rivers



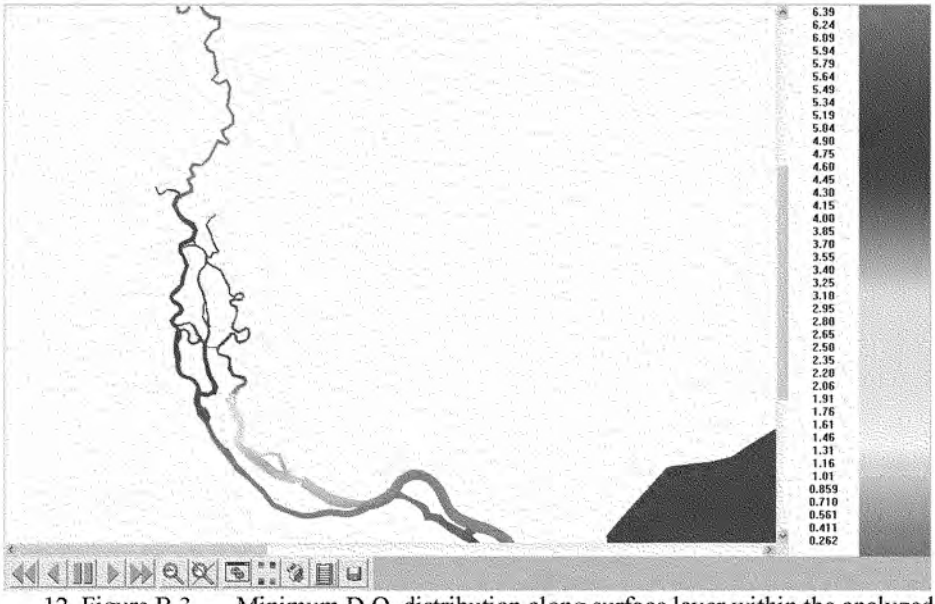
Middle River



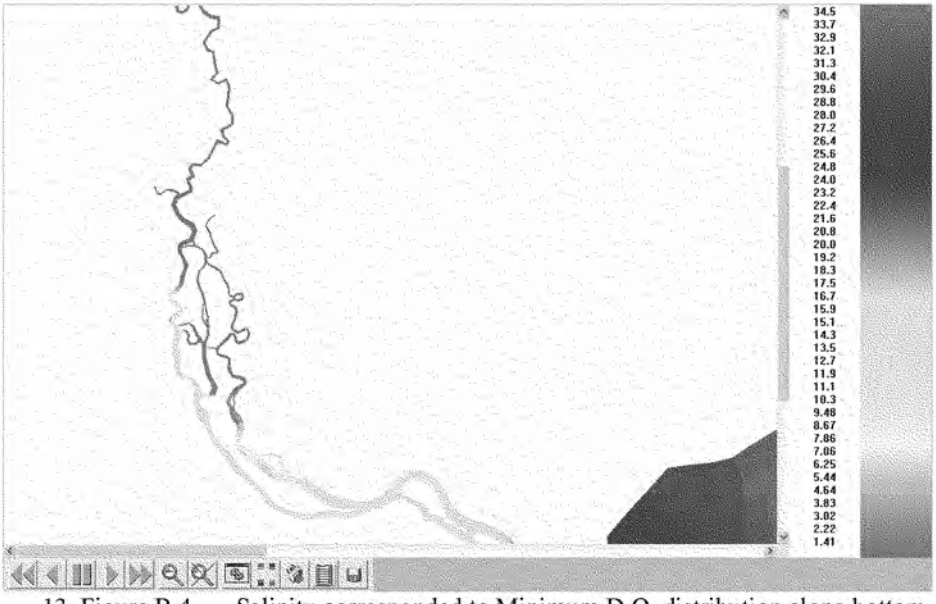
10. Figure B.1. Longitudinal profile of Dissolved Oxygen (mg/l) distribution along Critical cells of Savannah Estuary: Existing bathymetry



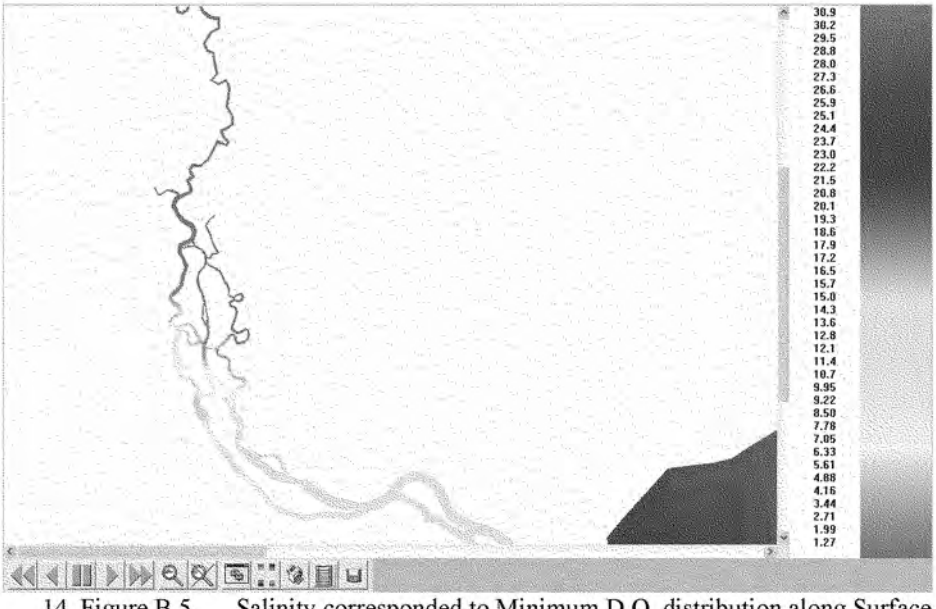
11. Figure B.2. Minimum D.O. distribution along bottom layer within the analyzed period of May 1 - October 30, 1997: Existing bathymetry



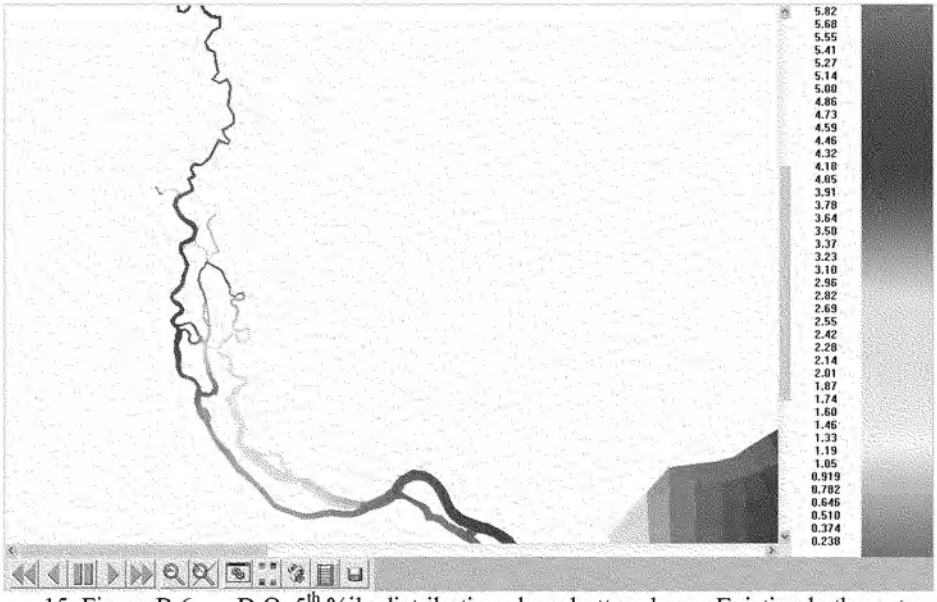
12. Figure B.3. Minimum D.O. distribution along surface layer within the analyzed period of May 1 - October 30, 1997: Existing bathymetry



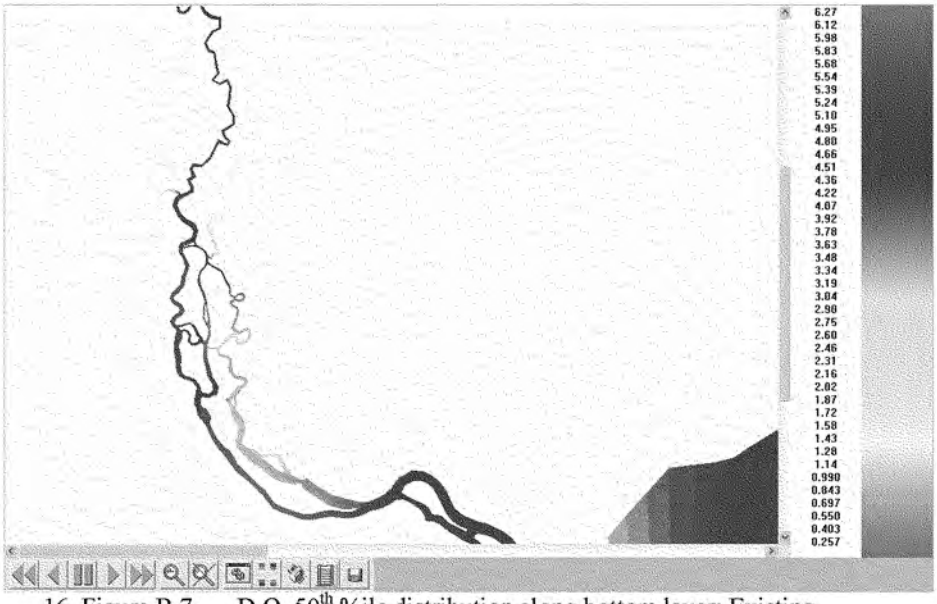
13. Figure B.4. Salinity corresponded to Minimum D.O. distribution along bottom layer within the analyzed period of May 1 - October 30, 1997: Existing bathymetry



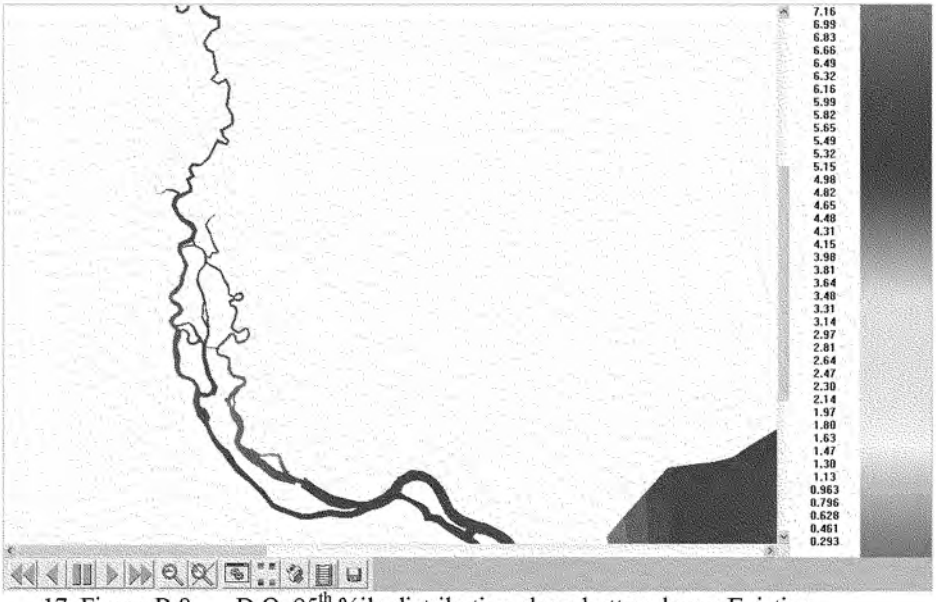
14. Figure B.5. Salinity corresponded to Minimum D.O. distribution along Surface layer within the analyzed period of May 1 - October 30, 1997: Existing bathymetry



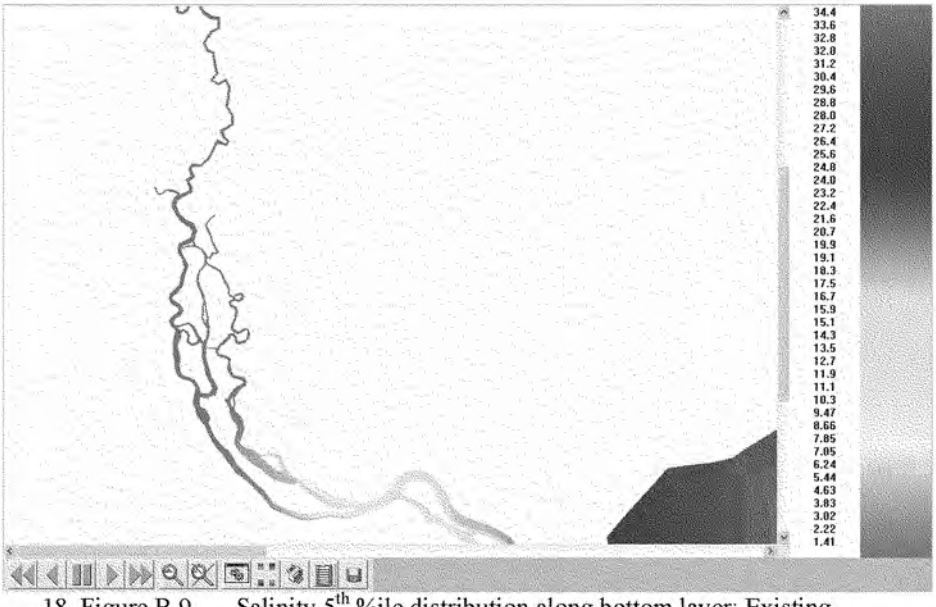
15. Figure B.6. D.O. 5th %ile distribution along bottom layer: Existing bathymetry



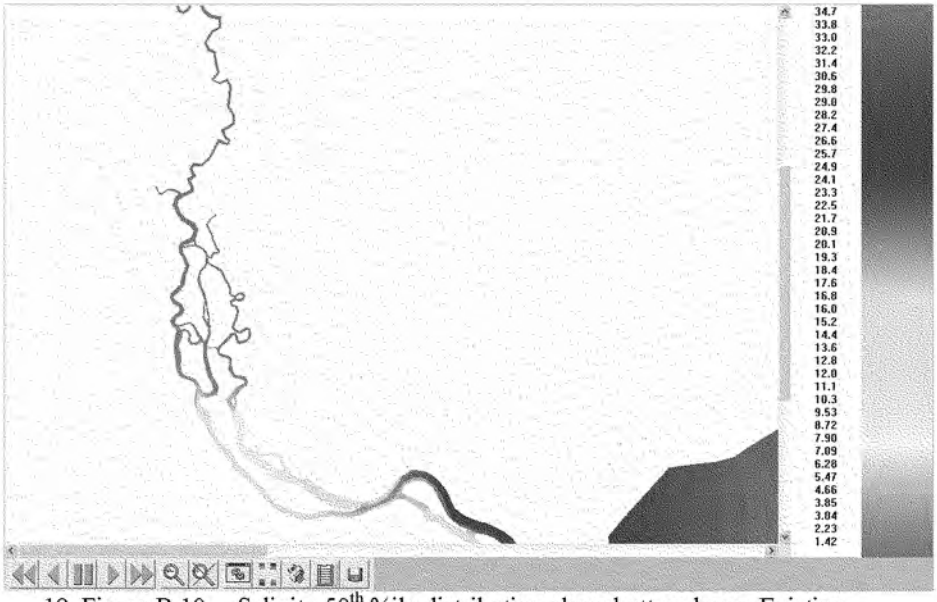
16. Figure B.7. D.O. 50th %ile distribution along bottom layer: Existing bathymetry



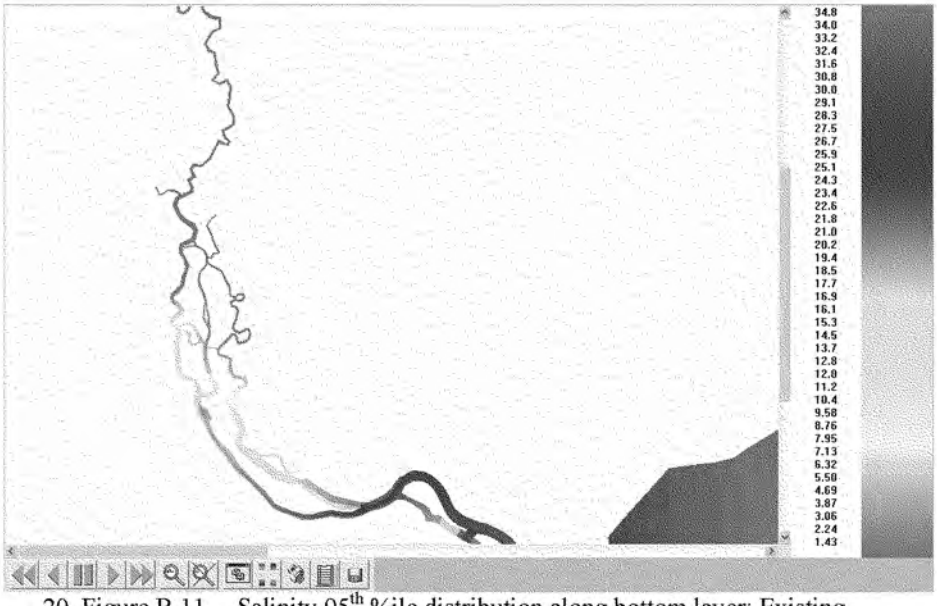
17. Figure B.8. D.O. 95th %ile distribution along bottom layer: Existing bathymetry



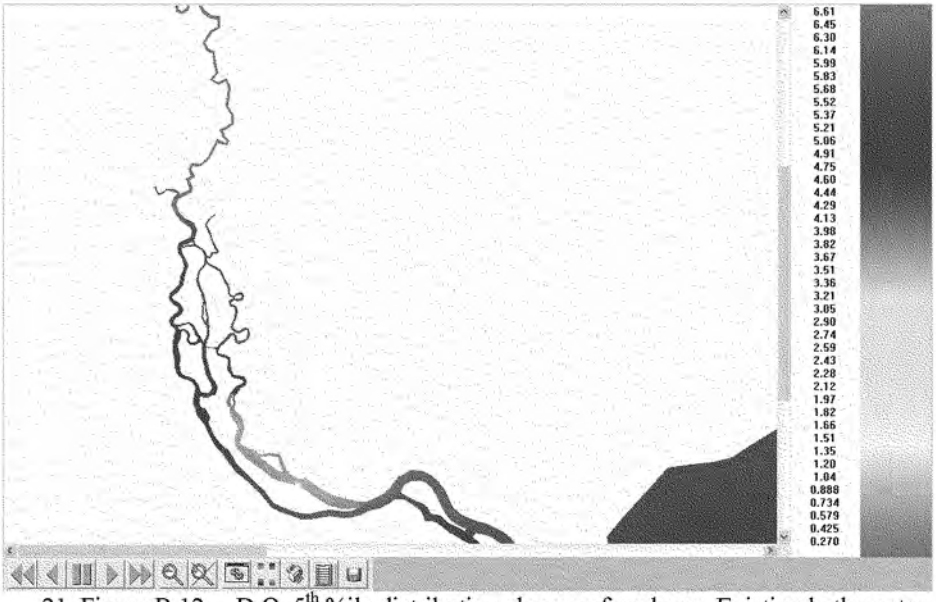
18. Figure B.9. Salinity 5th %ile distribution along bottom layer: Existing bathymetry



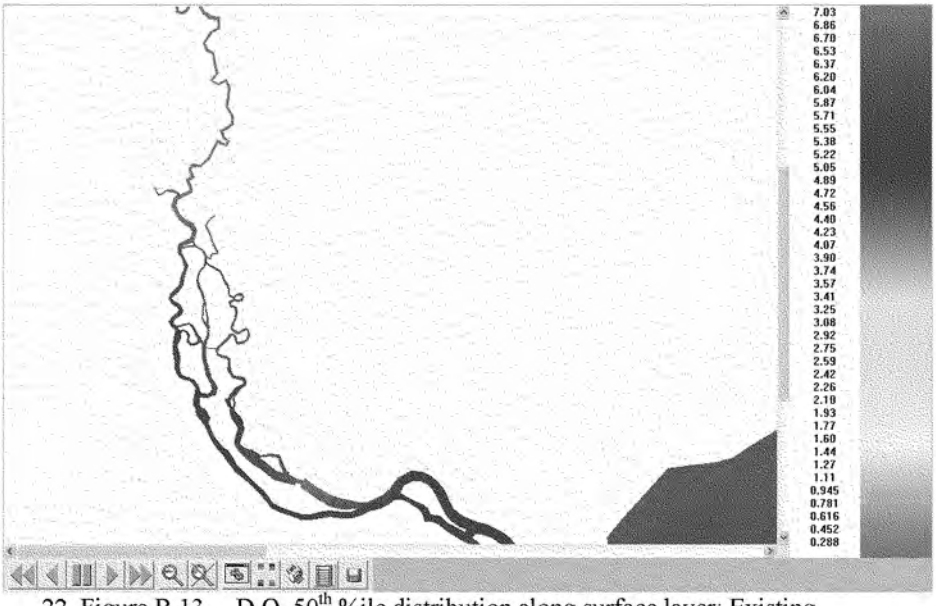
19. Figure B.10. Salinity 50th %ile distribution along bottom layer: Existing bathymetry



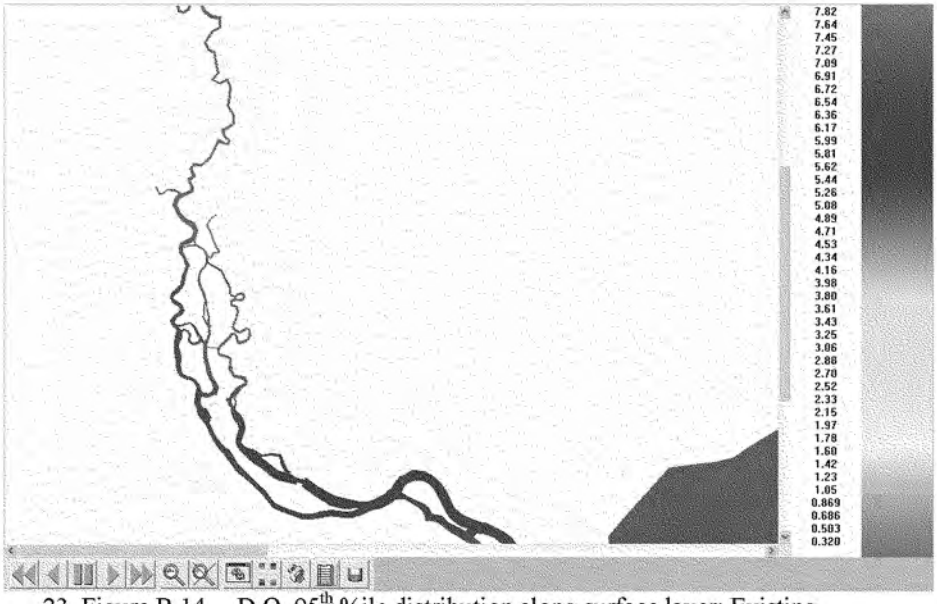
20. Figure B.11. Salinity 95th %ile distribution along bottom layer: Existing bathymetry



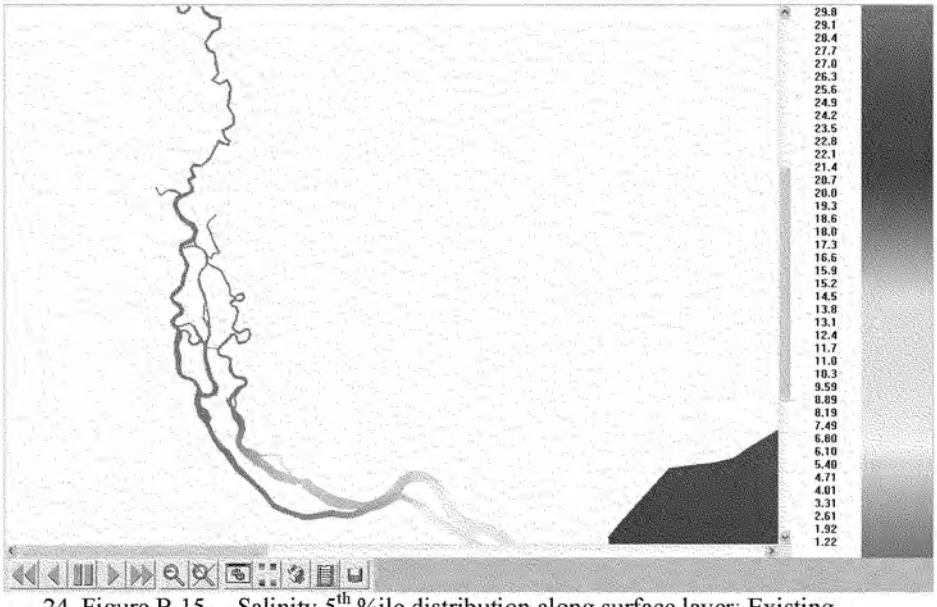
21. Figure B.12. D.O. 5th %ile distribution along surface layer: Existing bathymetry



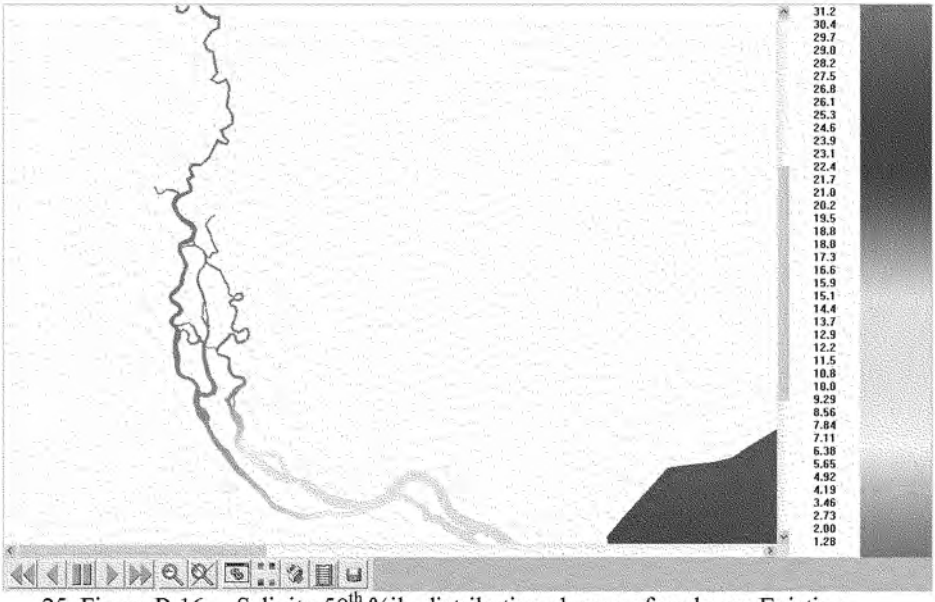
22. Figure B.13. D.O. 50th %ile distribution along surface layer: Existing bathymetry



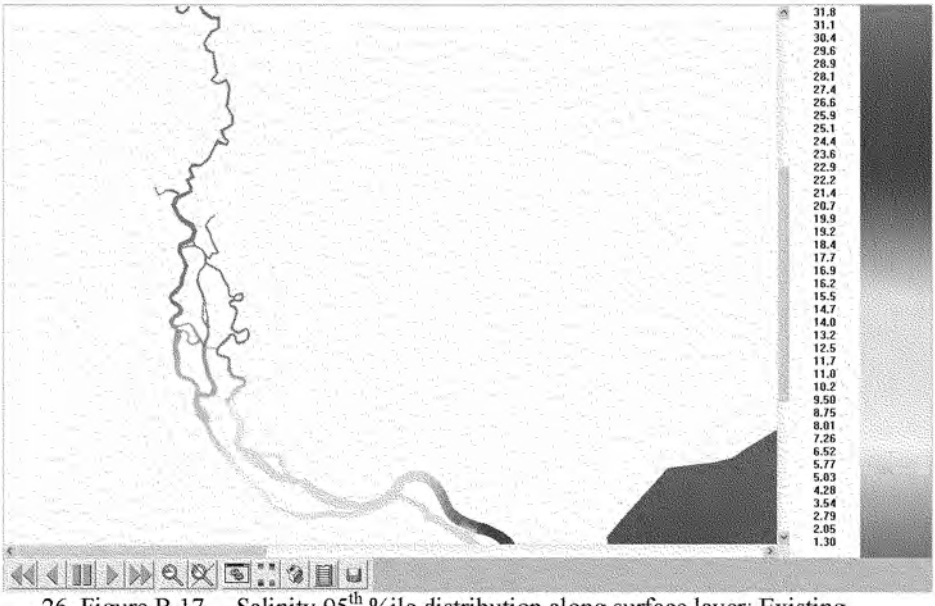
23. Figure B.14. D.O. 95th %ile distribution along surface layer: Existing bathymetry



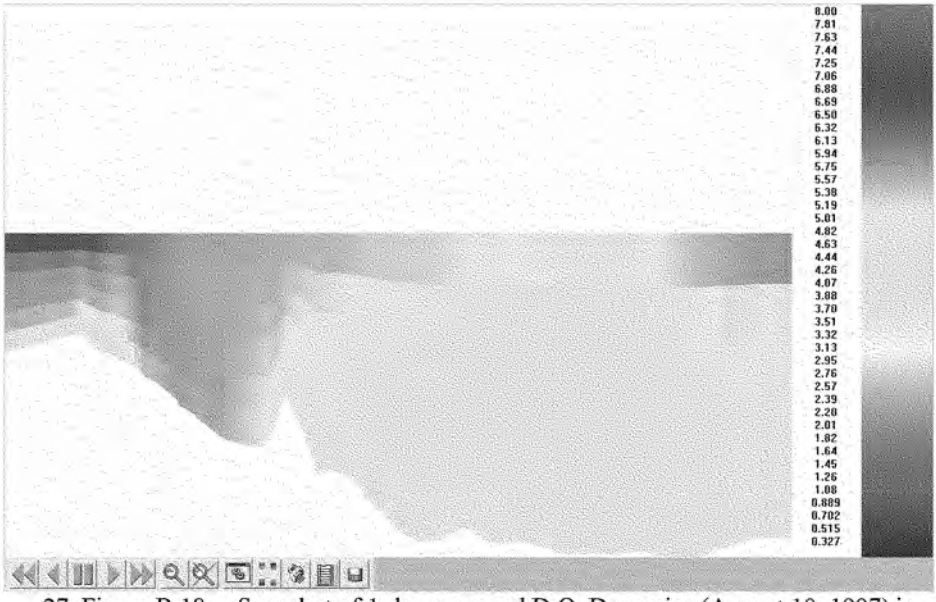
24. Figure B.15. Salinity 5th %ile distribution along surface layer: Existing bathymetry



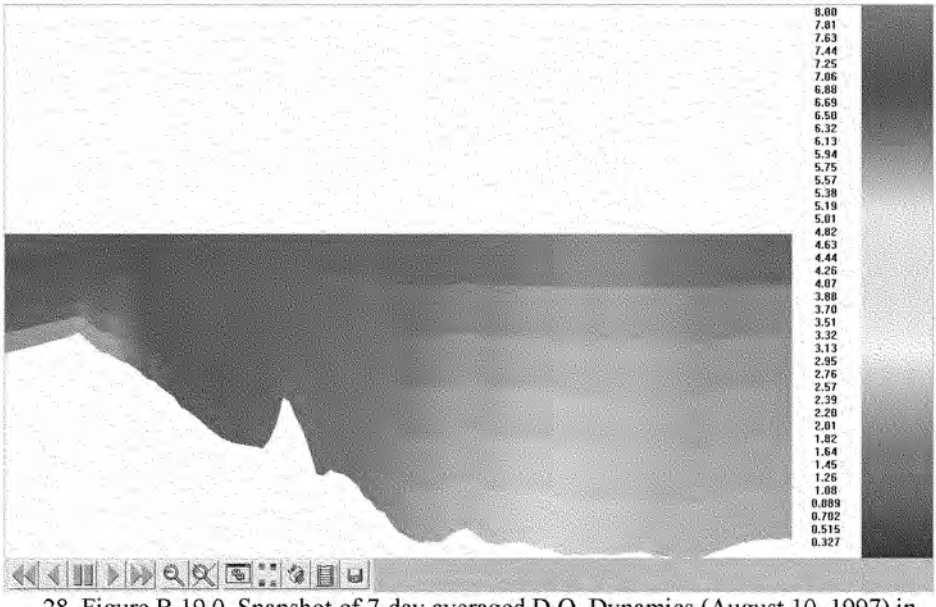
25. Figure B.16. Salinity 50th %ile distribution along surface layer: Existing bathymetry



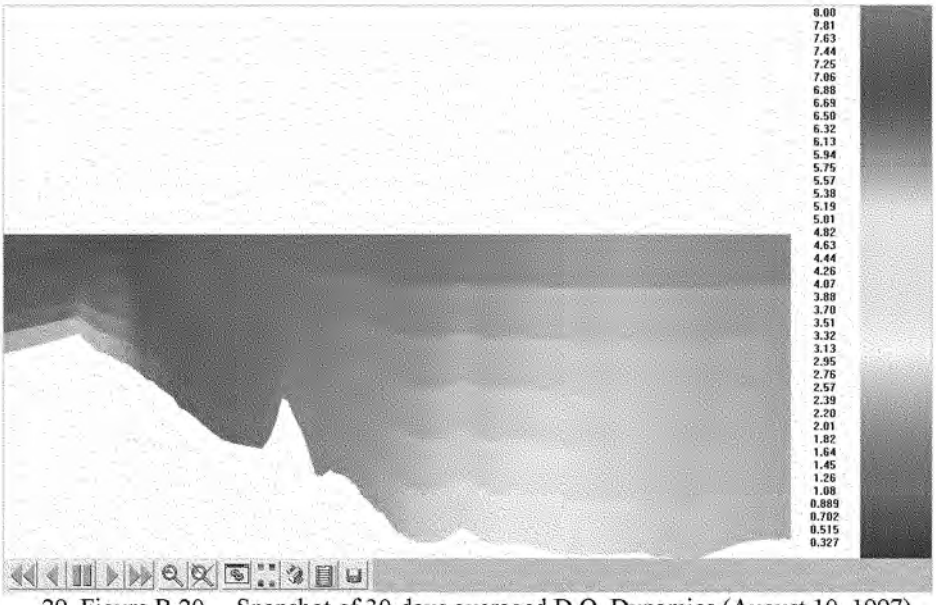
26. Figure B.17. Salinity 95th %ile distribution along surface layer: Existing bathymetry



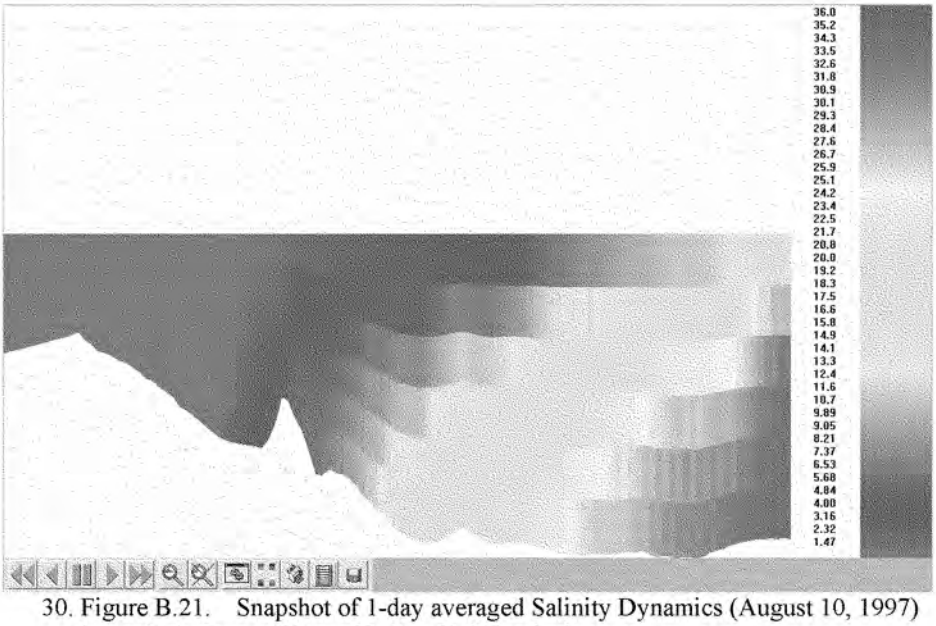
27. Figure B.18. Snapshot of 1-day averaged D.O. Dynamics (August 10, 1997) in vertical plane of Upper Harbor: Existing bathymetry



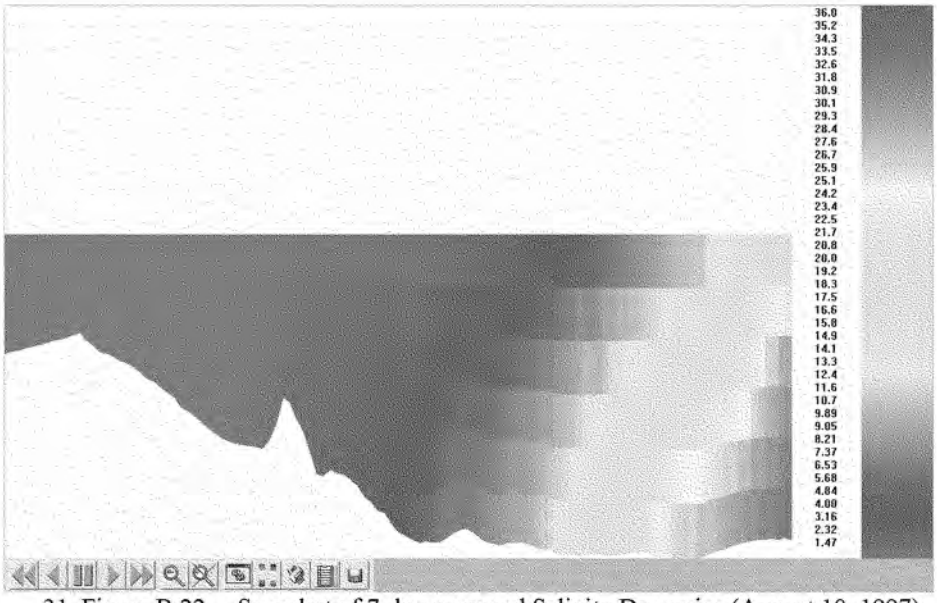
28. Figure B.19.0. Snapshot of 7-day averaged D.O. Dynamics (August 10, 1997) in vertical plane of Upper Harbor: Existing bathymetry



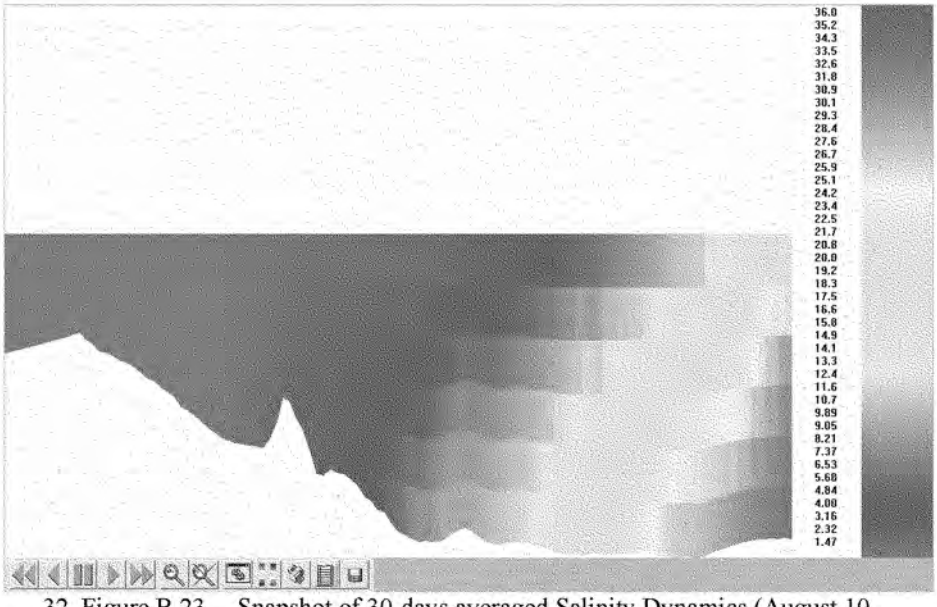
29. Figure B.20. Snapshot of 30-days averaged D.O. Dynamics (August 10, 1997) in vertical plane of Upper Harbor: Existing bathymetry



30. Figure B.21. Snapshot of 1-day averaged Salinity Dynamics (August 10, 1997) in vertical plane of Upper Harbor: Existing bathymetry



31. Figure B.22. Snapshot of 7-day averaged Salinity Dynamics (August 10, 1997) in vertical plane of Upper Harbor: Existing bathymetry



32. Figure B.23. Snapshot of 30-days averaged Salinity Dynamics (August 10, 1997) in vertical plane of Upper Harbor: Existing bathymetry

Appendix B1

SENSITIVITY ANALYSIS #1: 6 ft DEEPENING BATHYMETRY, 2004 POINT SOURCES LOADS, 1997 HYDROLOGICAL AND METEOROLOGICAL CONDITIONS

May 1 – October 30, 1997 Simulation Period

Water Quality Review Group

1. Table B1.1. Dissolved oxygen percentiles distribution in Critical cells

Zone	D.O. Percentile (mg/l)								
	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	3.44	3.74	3.91	4.12	4.43	4.92	5.37	5.5	5.65
FR2	2.99	3.28	3.42	3.65	3.98	4.47	5.02	5.22	5.42
FR3	2.86	3.09	3.24	3.46	3.8	4.26	4.89	5.14	5.84
FR4	2.83	3.07	3.21	3.4	3.77	4.23	4.84	5.25	5.91
FR5	2.89	3.11	3.23	3.42	3.8	4.2	4.89	5.22	5.98
FR6	2.98	3.16	3.23	3.43	3.8	4.22	4.84	5.37	6.22
FR7	3.35	3.58	3.74	4.07	4.57	5.09	5.75	6.26	6.51
FR8	3.37	3.73	3.91	4.32	4.81	5.3	5.85	6.3	6.52
FR9	3.36	3.71	3.87	4.26	4.85	5.38	5.88	6.43	6.58
FR10	3.18	3.5	3.74	4.29	4.9	5.43	5.82	5.97	6.18
FR11	2.94	3.37	3.61	4.06	4.54	5.18	5.69	5.89	6.01
MR1	3.21	3.37	3.51	3.74	4.11	4.53	5.04	5.57	6.18
MR2	2.82	3.08	3.25	3.58	4	4.48	4.92	5.22	6.15
MR3	2.64	2.81	2.94	3.21	3.64	4.29	4.84	5.08	5.89
MR4	2.77	3	3.12	3.37	3.68	4.14	4.68	5.02	5.28
MR5	0.85	1.49	1.85	2.51	4.16	5.23	5.68	5.89	6.05
MR6	1.45	2.09	2.46	3.16	4.64	5.45	5.88	6.12	6.72
LBR1	2.82	3.58	3.99	4.21	4.49	4.92	5.34	5.63	5.88
LBR2	3.11	3.26	3.35	3.49	3.71	4.16	4.51	4.98	5.21
LBR3	2.1	2.38	2.53	2.84	3.41	4.14	4.52	4.83	5.22
BR1	2.46	2.7	2.83	3.09	3.47	3.99	4.54	4.79	5.12
BR2	1.87	2.2	2.42	2.8	3.2	3.74	4.28	4.58	4.97
BR3	2.15	2.48	2.64	2.93	3.24	3.78	4.38	4.54	4.76
SCH1	1.81	2.15	2.39	2.8	3.54	4.28	4.82	5.17	5.59
SCH2	3.07	3.37	3.57	3.88	4.18	4.64	5.07	5.26	5.5
SR	3.38	3.47	3.56	3.9	4.22	4.7	5.37	5.85	5.89

2. Table B1.2. Delta of Dissolved Oxygen percentiles distribution in Critical cells: Deepening scenario minus Existing bathymetry scenario

Zone	Delta D.O. Percentile																	
	1%		5%		10%		25%		50%		75%		90%		95%		99	
	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%
FR1	0.03	0.9	0	0.0	0	0.0	-0.01	-0.2	-0.03	-0.7	-0.01	-0.2	0.01	0.2	0	0.0	-0.01	-0.2
FR2	-0.04	-1.3	-0.02	-0.6	0.02	0.6	0	0.0	-0.03	-0.7	0.02	0.4	0.03	0.6	-0.06	-1.1	-0.35	-6.1
FR3	0.02	0.7	-0.06	-1.9	-0.01	-0.3	0.02	0.6	-0.04	-1.0	-0.02	-0.5	0.03	0.6	-0.19	-3.6	-0.34	-5.5
FR4	0.01	0.4	-0.02	-0.6	-0.01	-0.3	-0.04	-1.2	-0.08	-2.1	-0.08	-1.9	0.01	0.2	-0.23	-4.2	-0.31	-5.0
FR5	-0.02	-0.7	-0.01	-0.3	-0.03	-0.9	-0.11	-3.1	-0.14	-3.6	-0.22	-5.0	0.02	0.4	-0.58	-10.0	-0.25	-4.0
FR6	-0.03	-1.0	-0.05	-1.6	-0.13	-3.9	-0.22	-6.0	-0.3	-7.3	-0.47	-10.0	-0.38	-7.3	-0.79	-12.8	-0.09	-1.4
FR7	-0.1	-2.9	-0.22	-5.8	-0.27	-6.7	-0.37	-8.3	-0.36	-7.3	-0.26	-4.9	-0.15	-2.5	-0.14	-2.2	-0.04	-0.6
FR8	-0.1	-2.9	-0.13	-3.4	-0.21	-5.1	-0.36	-7.7	-0.33	-6.4	-0.21	-3.8	-0.19	-3.1	-0.09	-1.4	-0.01	-0.2
FR9	-0.99	-22.8	-1.06	-22.2	-1.13	-22.6	-1.01	-19.2	-0.63	-11.5	-0.45	-7.7	-0.4	-6.4	-0.06	-0.9	-0.01	-0.2
FR10	0.01	0.3	0	0.0	0	0.0	0	0.0	0.01	0.2	0.01	0.2	0.01	0.2	0.01	0.2	0.03	0.5
FR11	0.07	2.4	0.02	0.6	0.02	0.6	0	0.0	0.01	0.2	0.01	0.2	0	0.0	0	0.0	0.02	0.3
MR1	-0.07	-2.1	-0.09	-2.6	-0.1	-2.8	-0.17	-4.3	-0.2	-4.6	-0.27	-5.6	-0.13	-2.5	-0.15	-2.6	-0.14	-2.2
MR2	-0.02	-0.7	-0.05	-1.6	-0.05	-1.5	-0.1	-2.7	-0.18	-4.3	-0.23	-4.9	-0.17	-3.3	-0.15	-2.8	-0.09	-1.4
MR3	-0.04	-1.5	-0.11	-3.8	-0.14	-4.5	-0.25	-7.2	-0.31	-7.8	-0.23	-5.1	-0.09	-1.8	-0.09	-1.7	-0.04	-0.7
MR4	0.02	0.7	0	0.0	-0.02	-0.6	-0.02	-0.6	-0.02	-0.5	-0.01	-0.2	-0.01	-0.2	-0.03	-0.6	0.01	0.2
MR5	-0.05	-5.6	-0.03	-2.0	-0.01	-0.5	0.02	0.8	0.02	0.5	0.02	0.4	0.01	0.2	0.01	0.2	0.01	0.2
MR6	0.03	2.1	0.06	3.0	0.07	2.9	0.04	1.3	0.01	0.2	0.02	0.4	0.01	0.2	0.02	0.3	0	0.0
LBR1	-0.06	-2.1	-0.03	-0.8	0.03	0.8	0.04	1.0	0.04	0.9	0.03	0.6	0.01	0.2	0.02	0.4	0.01	0.2
LBR2	-0.01	-0.3	0	0.0	0.01	0.3	0.02	0.6	0.03	0.8	0.02	0.5	-0.01	-0.2	0.01	0.2	0.03	0.6
LBR3	0	0.0	0	0.0	-0.02	-0.8	-0.04	-1.4	0.11	3.3	0.33	8.7	0.21	4.9	0.38	8.5	0.41	8.5
BR1	0.01	0.4	0.02	0.7	0.01	0.4	0.01	0.3	0	0.0	0.01	0.3	0.03	0.7	0.01	0.2	-0.01	-0.2
BR2	0.03	1.6	0.01	0.5	0.03	1.3	0.01	0.4	0.01	0.3	0.02	0.5	0.05	1.2	0.02	0.4	-0.03	-0.6
BR3	0.04	1.9	0.05	2.1	0.03	1.1	0.03	1.0	0.01	0.3	0.01	0.3	0.03	0.7	0.03	0.7	0.02	0.4
SCH1	0.1	5.8	-0.03	-1.4	0	0.0	0	0.0	-0.09	-2.5	-0.11	-2.5	-0.09	-1.8	-0.09	-1.7	-0.05	-0.9
SCH2	-0.07	-2.2	-0.05	-1.5	-0.06	-1.7	-0.07	-1.8	-0.05	-1.2	-0.04	-0.9	-0.04	-0.8	-0.06	-1.1	-0.06	-1.1
SR	0	0.0	0.01	0.3	0	0.0	0	0.0	0	0.0	0.01	0.2	0	0.0	0	0.0	0	0.0

3. Table B1.3. Dissolved oxygen percentiles distribution in Zones of Savannah Estuary

Zone Name	D.O. Concentration Percentiles (mg/l)								
	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	3.80	4.08	4.21	4.40	4.69	5.20	5.60	5.71	5.83
FR2	3.37	3.61	3.79	4.01	4.31	4.79	5.28	5.42	5.57
FR3	3.03	3.25	3.44	3.66	3.97	4.45	5.05	5.24	5.41
FR4	2.89	3.11	3.26	3.47	3.82	4.25	4.93	5.18	5.78
FR5	2.94	3.16	3.26	3.45	3.83	4.21	4.88	5.30	6.08
FR6	3.10	3.21	3.32	3.51	3.88	4.30	4.84	5.47	6.22
FR7	3.28	3.48	3.63	3.94	4.43	4.98	5.53	6.19	6.43
FR8	3.40	3.72	3.89	4.29	4.81	5.27	5.78	6.36	6.52
FR9	3.79	4.18	4.45	4.88	5.33	5.68	6.17	6.44	6.59
FR10	4.66	4.84	4.96	5.16	5.42	5.78	6.13	6.30	6.46
FR11	3.63	3.83	4.01	4.26	4.59	5.00	5.54	5.92	6.01
MR1	3.29	3.43	3.55	3.76	4.12	4.51	5.05	5.61	6.18
MR2	2.98	3.22	3.37	3.66	4.02	4.49	4.95	5.40	6.14
MR3	2.79	2.95	3.09	3.38	3.80	4.32	4.81	5.06	5.80
MR4	3.43	3.54	3.64	3.83	4.09	4.51	4.94	5.26	5.49
MR5	1.46	2.01	2.34	2.98	4.48	5.17	5.62	5.85	6.00
MR6	1.51	2.12	2.48	3.23	4.69	5.41	5.83	6.04	6.61
LBR1	3.47	3.62	3.70	3.85	4.04	4.50	4.83	5.32	5.47
LBR2	2.69	2.90	3.01	3.21	3.49	3.93	4.33	4.80	5.04
LBR3	2.60	2.72	2.82	2.99	3.21	3.72	4.23	4.39	4.58
BR1	2.77	2.96	3.04	3.25	3.59	4.12	4.64	4.93	5.21
BR2	2.40	2.64	2.76	2.96	3.28	3.82	4.41	4.60	4.90
BR3	2.50	2.68	2.77	2.95	3.20	3.76	4.33	4.46	4.61
SCh1	2.82	3.09	3.31	3.56	3.85	4.39	4.92	5.09	5.27
SCh2	3.31	3.51	3.76	4.00	4.28	4.76	5.19	5.37	5.54
SR	3.70	3.76	3.81	4.14	4.44	4.90	5.54	5.97	6.00

4. Table B1.4. Delta of Dissolved Oxygen percentiles distribution in Zones of Savannah Estuary: Deepening scenario minus Existing bathymetry scenario

Zone	Project - Baseline Difference (mg/l)									Project - Baseline Relative Difference (%)								
Name	1%	5%	10%	25%	50%	75%	90%	95%	99%	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	0.05	0.02	0.00	-0.01	-0.01	0.02	0.03	0.03	0.05	1.4	0.4	0.0	-0.2	-0.2	0.3	0.5	0.6	0.8
FR2	0.01	0.03	0.03	0.01	0.00	0.02	0.04	-0.02	-0.03	0.4	0.8	0.9	0.4	0.1	0.4	0.7	-0.3	-0.5
FR3	0.02	-0.03	0.04	0.05	-0.01	0.06	0.07	-0.03	-0.63	0.7	-0.8	1.2	1.3	-0.3	1.3	1.4	-0.6	-10.5
FR4	0.00	-0.06	-0.01	0.01	-0.06	-0.06	0.07	-0.21	-0.48	0.1	-1.7	-0.5	0.2	-1.5	-1.5	1.5	-3.9	-7.6
FR5	-0.03	-0.02	-0.05	-0.09	-0.11	-0.21	0.01	-0.45	-0.21	-1.0	-0.5	-1.4	-2.5	-2.9	-4.7	0.3	-7.8	-3.4
FR6	-0.03	-0.03	-0.12	-0.17	-0.23	-0.35	-0.22	-0.61	-0.12	-0.9	-0.8	-3.4	-4.7	-5.6	-7.5	-4.4	-10.0	-1.9
FR7	-0.04	-0.20	-0.23	-0.36	-0.45	-0.31	-0.24	-0.16	-0.01	-1.3	-5.4	-6.0	-8.4	-9.3	-5.9	-4.1	-2.4	-0.2
FR8	-0.21	-0.26	-0.36	-0.42	-0.36	-0.25	-0.19	-0.03	-0.01	-5.7	-6.6	-8.5	-8.8	-6.9	-4.6	-3.2	-0.5	-0.2
FR9	-0.40	-0.46	-0.47	-0.37	-0.16	-0.16	-0.09	-0.03	-0.01	-9.5	-9.9	-9.5	-7.0	-2.9	-2.8	-1.4	-0.5	-0.1
FR10	-0.03	-0.03	-0.03	-0.04	-0.02	-0.03	-0.03	0.00	0.00	-0.5	-0.7	-0.6	-0.8	-0.3	-0.4	-0.5	0.0	0.0
FR11	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.1	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MR1	-0.05	-0.12	-0.15	-0.19	-0.22	-0.29	-0.14	-0.19	-0.14	-1.5	-3.2	-4.1	-4.8	-5.0	-6.1	-2.6	-3.2	-2.2
MR2	-0.06	-0.07	-0.08	-0.13	-0.22	-0.23	-0.17	-0.05	-0.13	-1.9	-2.2	-2.2	-3.5	-5.2	-4.8	-3.3	-0.9	-2.0
MR3	0.02	0.01	-0.01	-0.05	-0.10	-0.12	-0.10	-0.08	-0.03	0.7	0.3	-0.3	-1.4	-2.5	-2.7	-2.0	-1.5	-0.4
MR4	0.03	0.02	0.02	0.02	0.02	0.02	0.01	-0.01	0.00	0.9	0.6	0.6	0.5	0.5	0.4	0.1	-0.2	0.1
MR5	0.02	0.04	0.05	0.06	0.01	0.01	0.00	0.00	0.02	1.3	1.8	2.4	2.1	0.1	0.2	0.1	0.0	0.3
MR6	0.04	0.05	0.08	0.06	0.00	0.02	0.02	0.01	0.02	2.8	2.4	3.3	1.8	0.1	0.4	0.3	0.1	0.3
LBR1	0.01	0.01	0.02	0.03	0.03	0.02	0.00	0.02	0.02	0.2	0.3	0.6	0.9	0.8	0.4	0.0	0.3	0.5
LBR2	-0.02	0.00	0.00	0.01	0.02	0.00	-0.01	0.02	0.01	-0.6	-0.1	0.0	0.3	0.5	0.0	-0.1	0.3	0.2
LBR3	0.12	0.13	0.11	0.11	0.09	0.09	0.07	0.00	0.03	4.9	4.9	4.0	3.7	2.9	2.5	1.6	0.1	0.6
BR1	0.00	0.00	0.00	0.00	-0.03	0.00	0.02	-0.04	-0.08	0.1	0.1	0.1	-0.1	-0.8	0.1	0.5	-0.7	-1.5
BR2	0.03	0.01	0.01	0.01	0.01	0.03	0.03	0.03	-0.02	1.2	0.4	0.4	0.4	0.4	0.7	0.7	0.6	-0.3
BR3	0.06	0.05	0.03	0.03	0.03	0.00	0.05	0.05	0.08	2.6	1.8	1.3	1.1	0.8	0.1	1.1	1.2	1.8
SCh1	0.05	0.02	-0.04	-0.02	0.00	0.01	-0.01	0.00	0.02	1.8	0.6	-1.2	-0.5	-0.1	0.3	-0.2	0.0	0.4
SCh2	0.03	0.00	-0.02	-0.02	-0.02	-0.01	0.00	-0.01	-0.01	0.9	-0.1	-0.4	-0.6	-0.3	-0.2	-0.1	-0.2	-0.1
SR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0

5. Table B1.5. Percentage of the volume of waters with violation of Dissolved Oxygen standards for Zones of Savannah Estuary within the period of May 1 – October 30, 1997: Deepening (Project) and Existing (Baseline) bathymetry

Zones	D.O. STANDARDS														
	1-Day Average			7-Day Average			30-Day Average			GA MINIMUM D.O.			SC MINIMUM D.O.		
	Baseline(B)	Project(P)	Delta=P-B	Baseline(B)	Project(P)	Delta=P-B	Baseline(B)	Project(P)	Delta=P-B	Baseline(B)	Project(P)	Delta=P-B	Baseline(B)	Project(P)	Delta=P-B
FR1	0	0	0	0	0	0	0	0	0	0	0	0	4	4	0
FR2	0	0	0	0	0	0	0	0	0	0	0	0	17	17	0
FR3	0	0	0	0	0	0	3	3	0	0	0	0	N/A	N/A	N/A
FR4	0	0	0	0	0	0	5	7	2	0	0	0	N/A	N/A	N/A
FR5	0	0	0	0	0	0	3	7	4	0	0	0	N/A	N/A	N/A
FR6	0	0	0	0	0	0	1	5	4	0	0	0	N/A	N/A	N/A
FR7	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
FR8	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
FR9	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
FR10	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
FR11	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0
MR1	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
MR2	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
MR3	0	0	0	0	0	0	3	5	2	1	1	0	N/A	N/A	N/A
MR4	0	0	0	0	0	0	1	1	0	0	0	0	N/A	N/A	N/A
MR5	0	0	0	0	0	0	2	1	-1	4	4	0	9	9	0
MR6	0	0	0	0	0	0	0	0	0	2	2	0	7	7	0
LBR1	0	0	0	0	0	0	1	1	0	0	0	0	11	11	0
LBR2	0	0	0	2	1	-1	11	11	0	3	3	0	25	25	0
LBR3	0	0	0	6	5	-1	21	22	1	8	7	-1	36	38	2
BR1	0	0	0	1	2	1	18	20	2	2	2	0	50	51	1
BR2	0	0	0	6	6	0	36	37	1	7	7	0	60	61	1
BR3	0	0	0	9	8	-1	35	36	1	11	10	-1	57	59	2
SCh1	0	0	0	2	2	0	6	5	-1	3	3	0	N/A	N/A	N/A
SCh2	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
SR	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0

26. Table B1.6. Percentage of water volumes with salinity in %iles within the period of May 1 – October 30, 1997

Percen-tile	Harbor / River			Stations					
	Upper Hrb %	Middle Rvr %	Back Rvr %	Houlih Brg %	Broad Str %	Pulaski Frt %	Lucknow Cnl %	USF&W Dck %	I-95 Brg %
5	20.4	6.5	4.6	5	4.5	4.3	8.1	7	94.2
10	24.3	10.1	9.1	9.5	9.1	8.6	18.7	10.4	94.2
25	36.5	21.6	22.8	23	23.3	22.1	26.6	20.7	94.2
50	57.4	43	46.9	47.1	47.9	46	51.2	43.3	94.2
75	78.4	69.2	72.8	73	73.5	72.9	72.5	69.3	94.2
90	91.1	87.1	88.9	89.1	89.3	89.2	89.1	87.4	94.2
95	95.4	93.5	94.4	94.5	94.6	94.6	94.3	93.6	94.7
Total Volume 100*km3:	33480.8	652.5	4769	27.2	39	135.5	9.9	9.4	43.6

27. Table B1.7. Percentage of water volumes with D.O. in %iles within the period of May 1 – October 30, 1997

Percen-tile	Harbor / River			Stations					
	Upper Hrb %	Middle Rvr %	Back Rvr %	Houlih Brg %	Broad Str %	Pulaski Frt %	Lucknow Cnl %	USF&W Dck %	I-95 Brg %
5	5.3	5.2	5	5.6	5.5	4.8	5.6	5.5	5.9
10	10.5	10.3	9.9	11.2	10.6	9.6	10.9	11.1	11.3
25	26.2	24.9	25	27.2	26.1	24.2	26.4	26.8	26.6
50	51.9	49.6	50.1	52.9	51.3	49.6	50.5	51	51.3
75	76.2	74.8	75.4	76.7	75.7	74.8	75.7	76.1	76
90	90.4	89.9	90.2	90.4	90.2	89.9	90.1	90.4	90.2
95	95.2	94.7	95	95.5	95.3	94.9	95.2	95.3	95.2
Total Volume 100*km3:	33480.8	652.5	4769	27.2	39	135.5	9.9	9.4	43.6

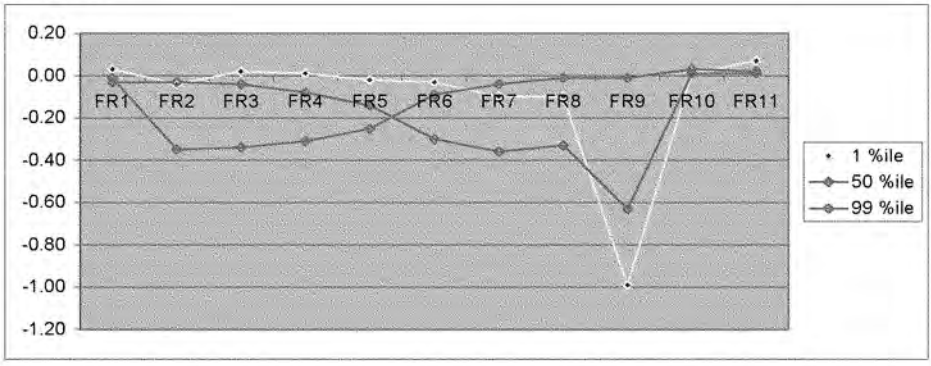
28. Table B1.8. Water volumes in Upper Harbor in increments of 1° C of water temperature within the period of May 1 – October 30, 1997

Temperature C°	Total Volume %
17	0.11
18	0.44
19	1.23
20	4.51
21	13.25
22	17.88
23	22.86
24	33.11
25	43.4
26	51.04
27	62.56
28	82.77
29	94.38
30	99.87
31	100

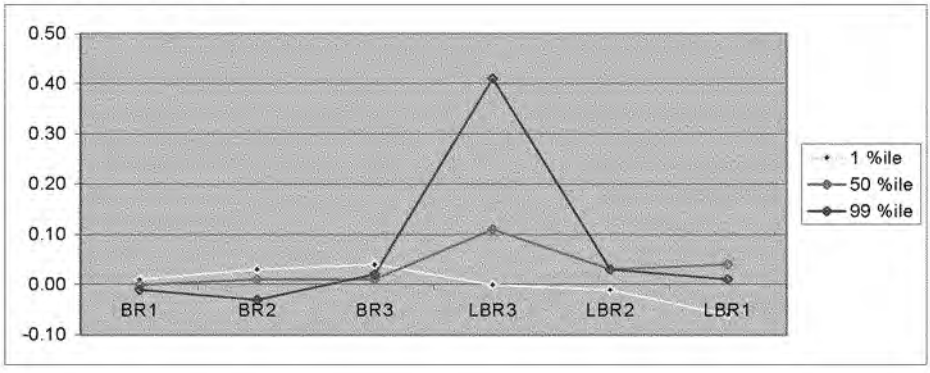
29. Table B1.9. Water volumes in Upper Harbor in increments of 0.1 mg/l of D.O. within the period of May 1 – October 30, 1997
(See file: Postprocessor Output\S16\97-S16_DO Increment Volume)

30. Table B1.10. Percentage of water volumes corresponding to 1-, 7-, and 30-days averages of D.O. depth-averaged concentrations in Upper Harbor within the period of May 1 – October 30, 1997
(See file: Postprocessor Output\S16\97-S16_volume DO in averages)

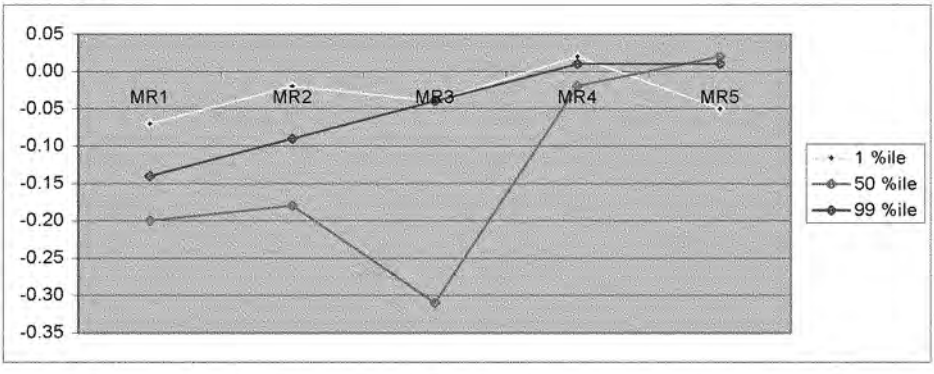
Front River



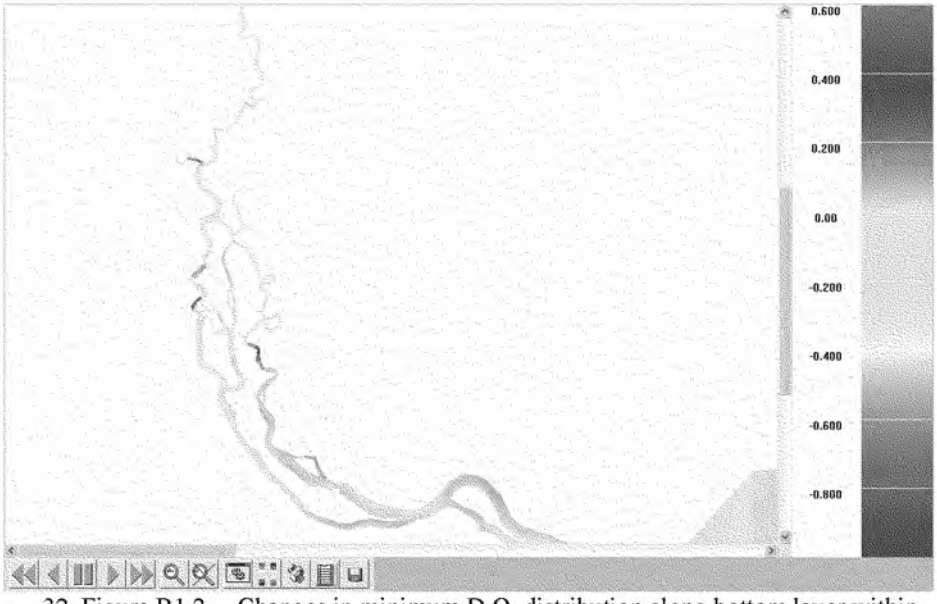
Back and Little Back Rivers



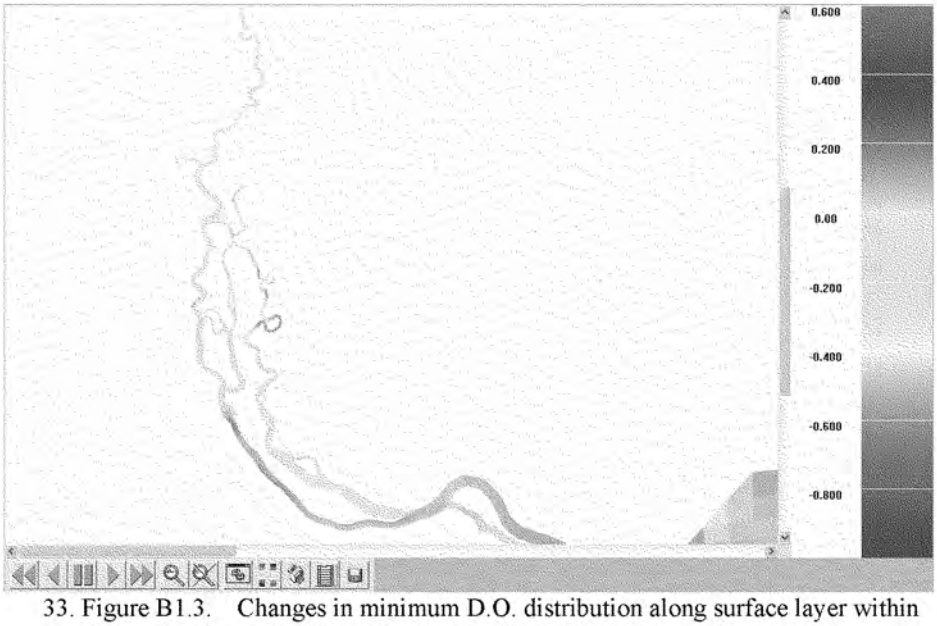
Middle River



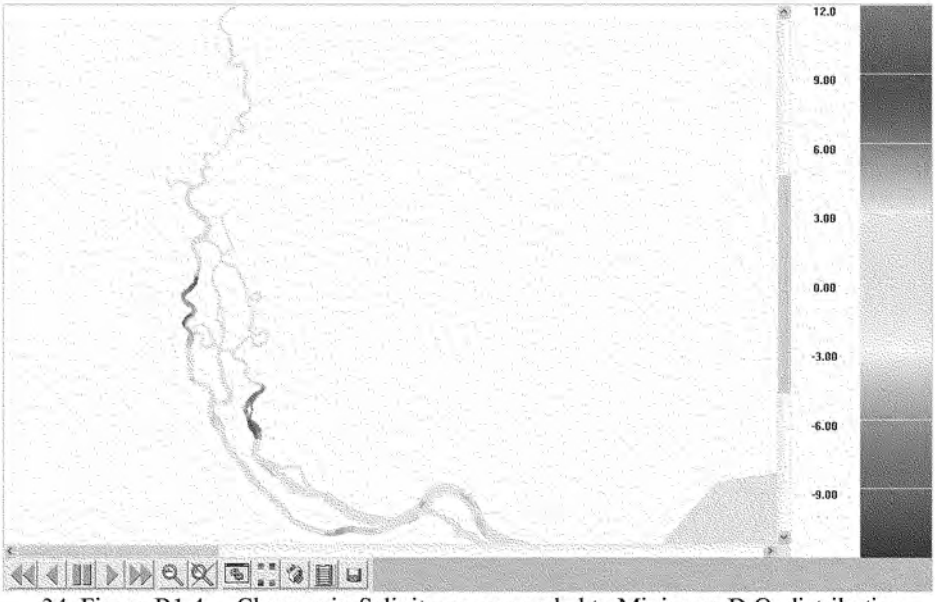
31. Figure B1.1. Changes in longitudinal profile of Dissolved Oxygen (mg/l) distribution along Critical cells of Savannah Estuary: 6 ft deepening



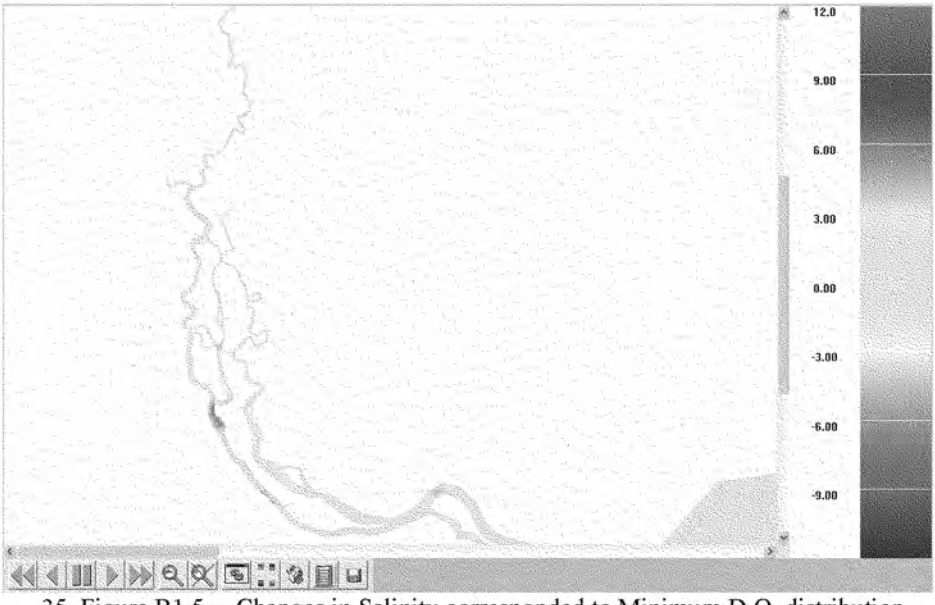
32. Figure B1.2. Changes in minimum D.O. distribution along bottom layer within the analyzed period of May 1 - October 30, 1997: 6 ft deepening



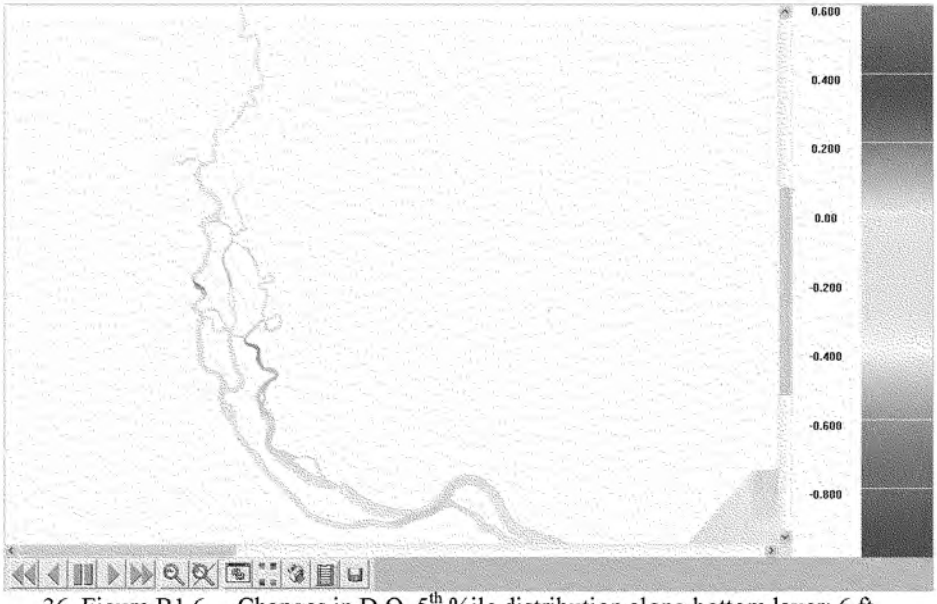
33. Figure B1.3. Changes in minimum D.O. distribution along surface layer within the analyzed period of May 1 - October 30, 1997: 6 ft deepening



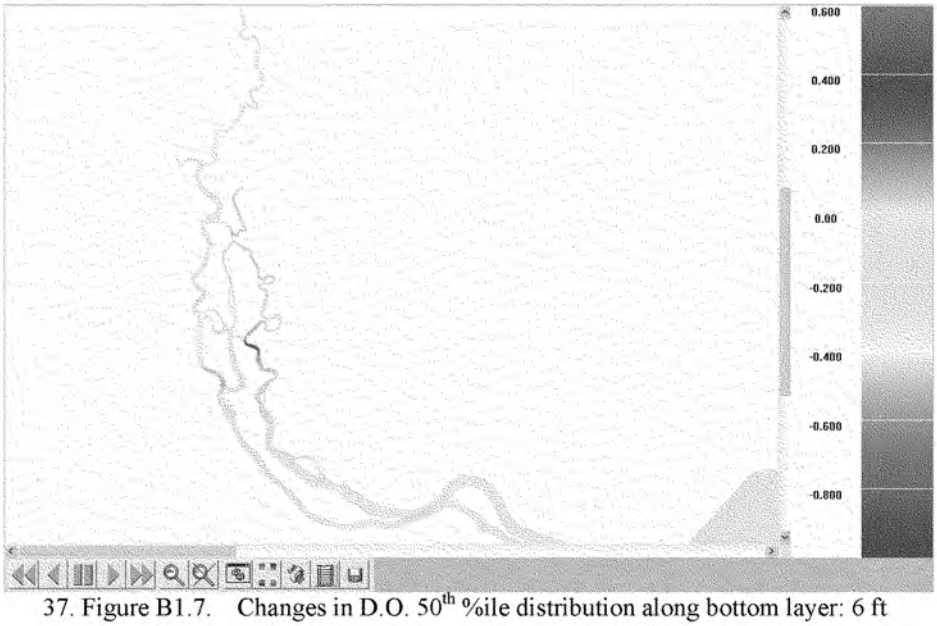
34. Figure B1.4. Changes in Salinity corresponded to Minimum D.O. distribution along bottom layer within the analyzed period of May 1 - October 30, 1997: 6 ft deepening



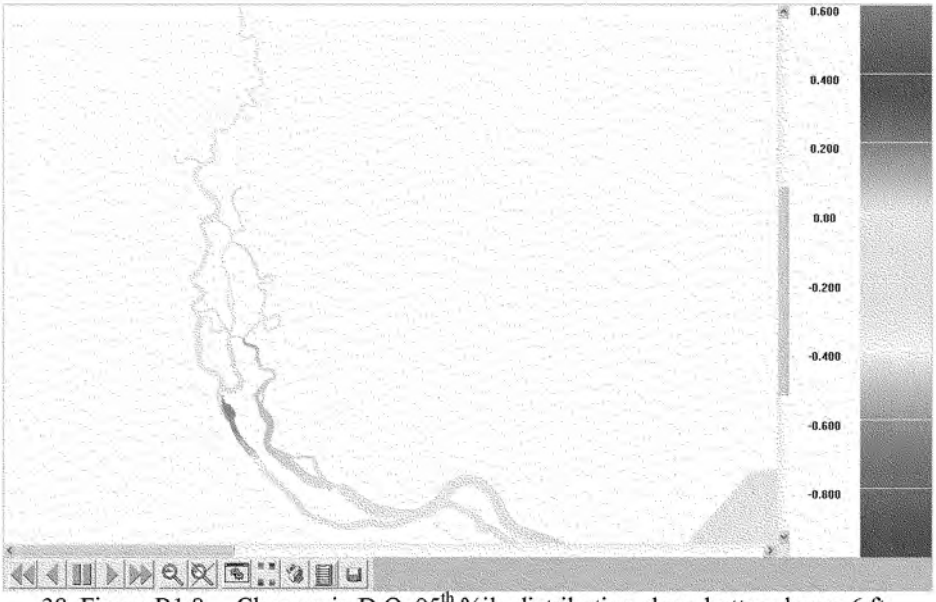
35. Figure B1.5. Changes in Salinity corresponded to Minimum D.O. distribution along Surface layer within the analyzed period of May 1 - October 30, 1997: 6 ft deepening



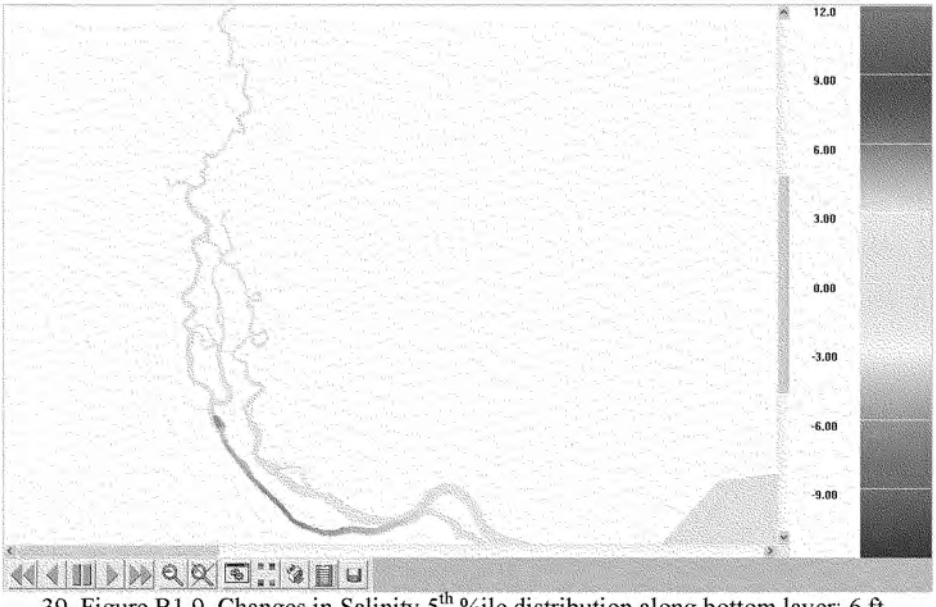
36. Figure B1.6. Changes in D.O. 5th %ile distribution along bottom layer: 6 ft deepening



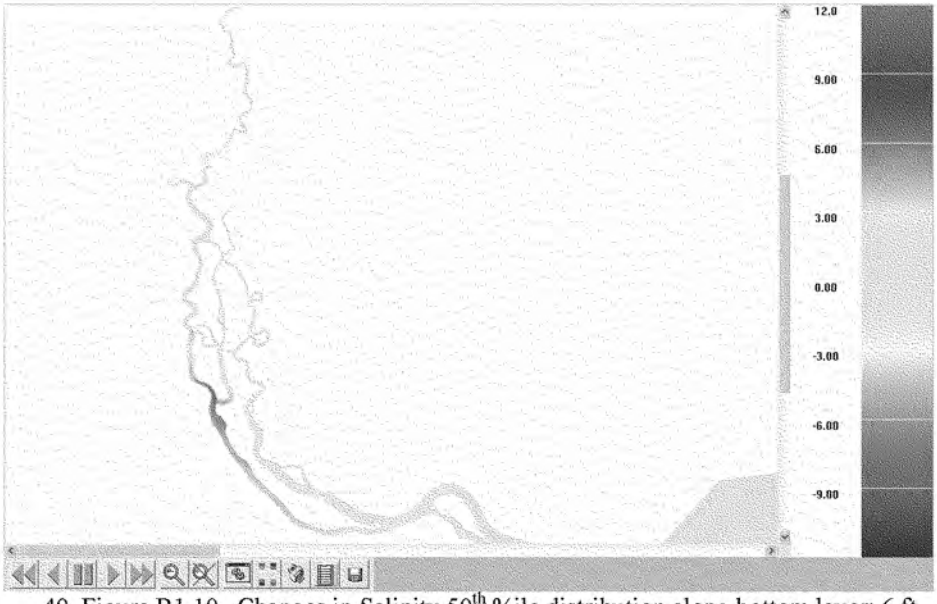
37. Figure B1.7. Changes in D.O. 50th %ile distribution along bottom layer: 6 ft deepening



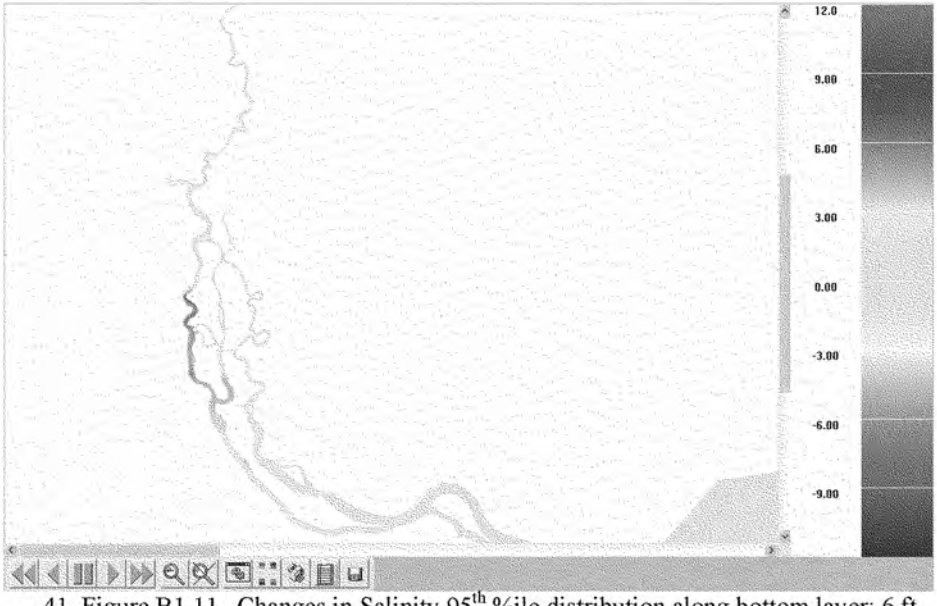
38. Figure B1.8. Changes in D.O. 95th %ile distribution along bottom layer: 6 ft deepening



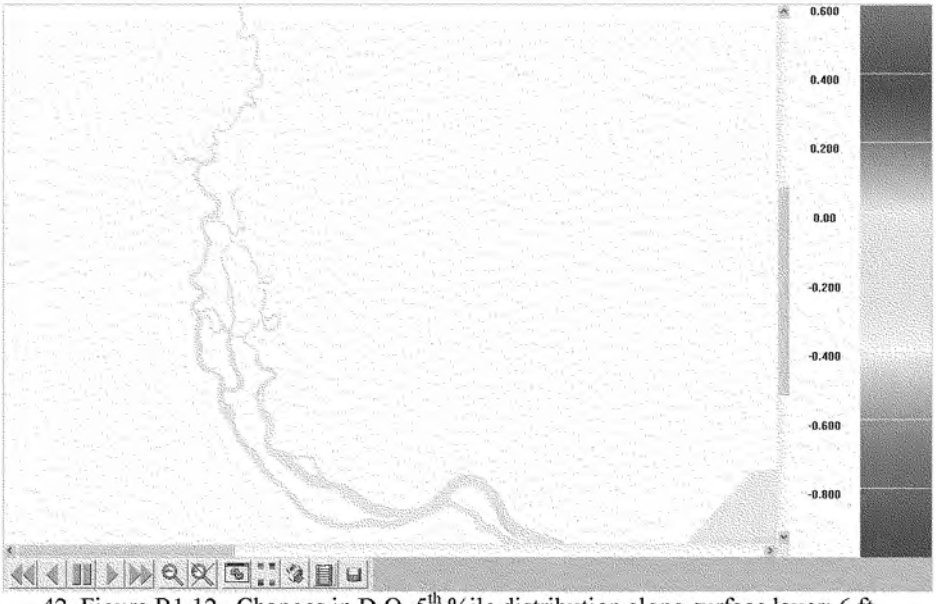
39. Figure B1.9. Changes in Salinity 5th %ile distribution along bottom layer: 6 ft deepening



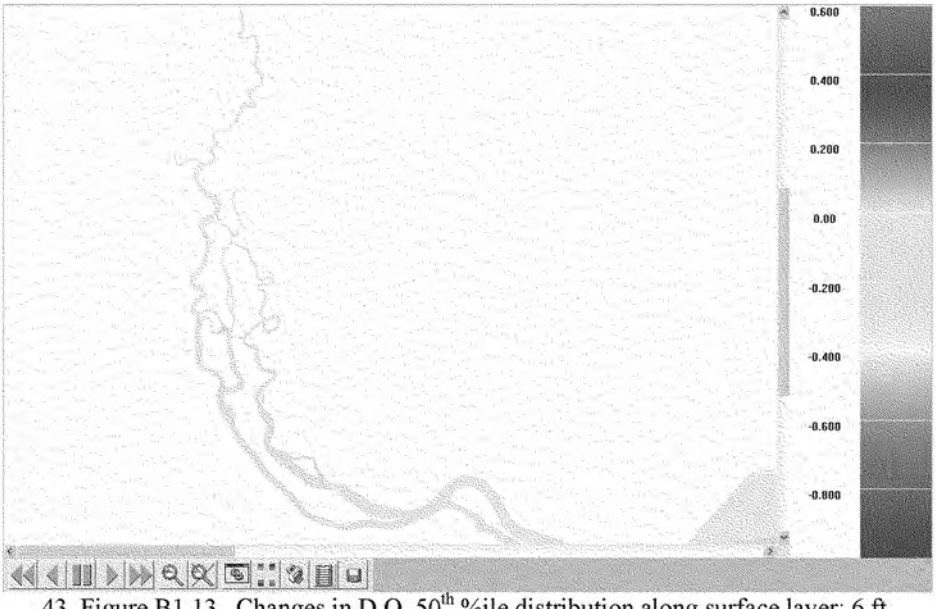
40. Figure B1.10. Changes in Salinity 50th %ile distribution along bottom layer: 6 ft deepening



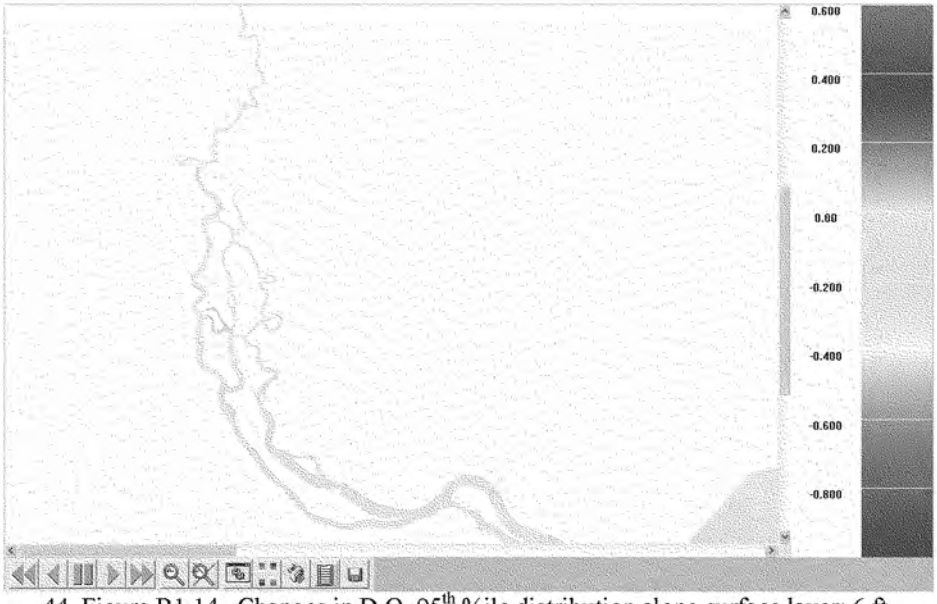
41. Figure B1.11. Changes in Salinity 95th %ile distribution along bottom layer: 6 ft deepening



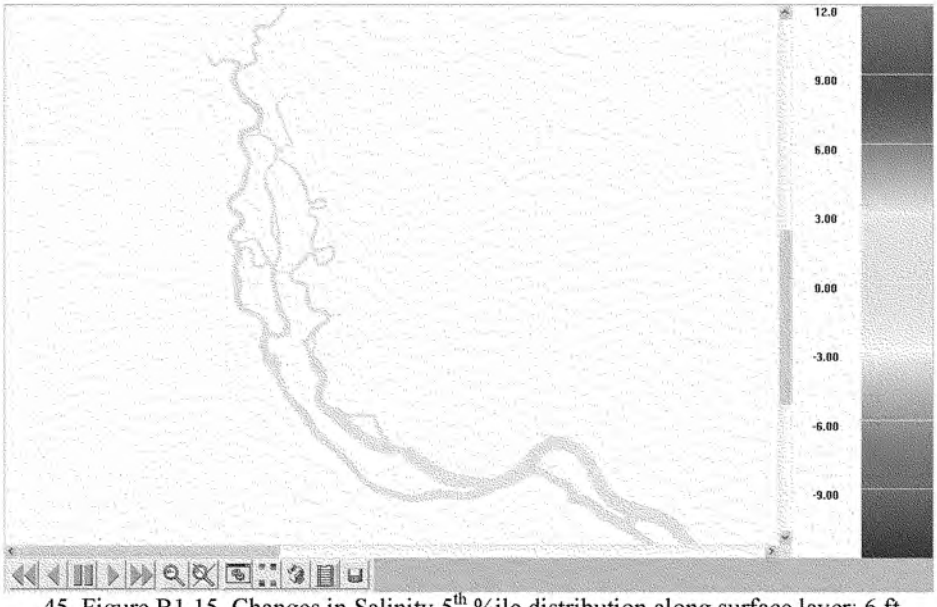
42. Figure B1.12. Changes in D.O. 5th %ile distribution along surface layer: 6 ft deepening



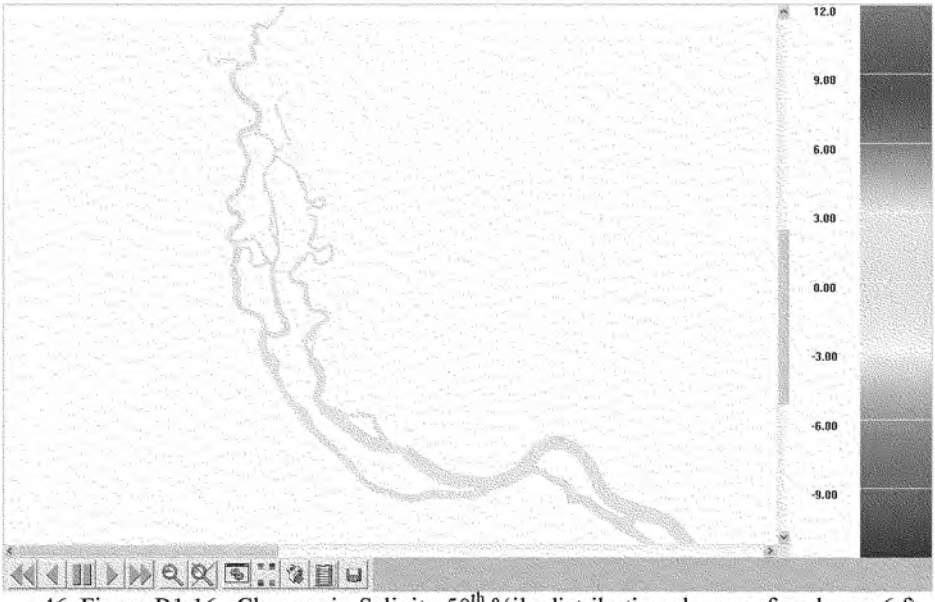
43. Figure B1.13. Changes in D.O. 50th %ile distribution along surface layer: 6 ft deepening



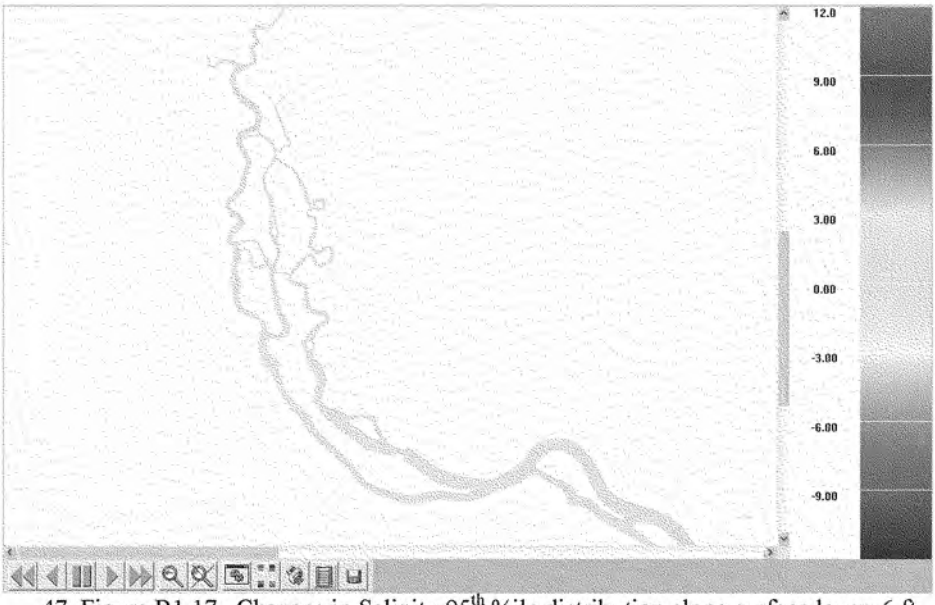
44. Figure B1.14. Changes in D.O. 95th %ile distribution along surface layer: 6 ft deepening



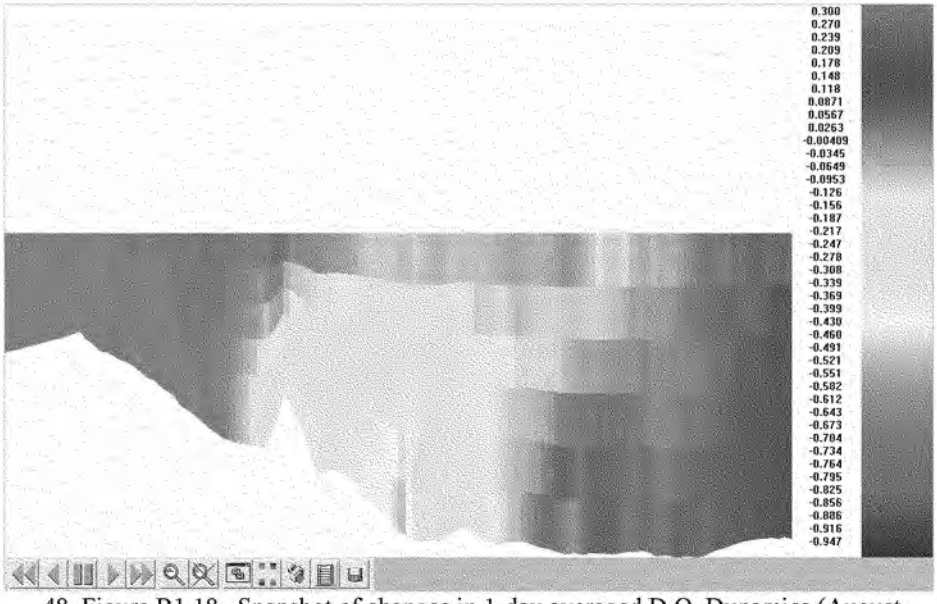
45. Figure B1.15. Changes in Salinity 5th %ile distribution along surface layer: 6 ft deepening



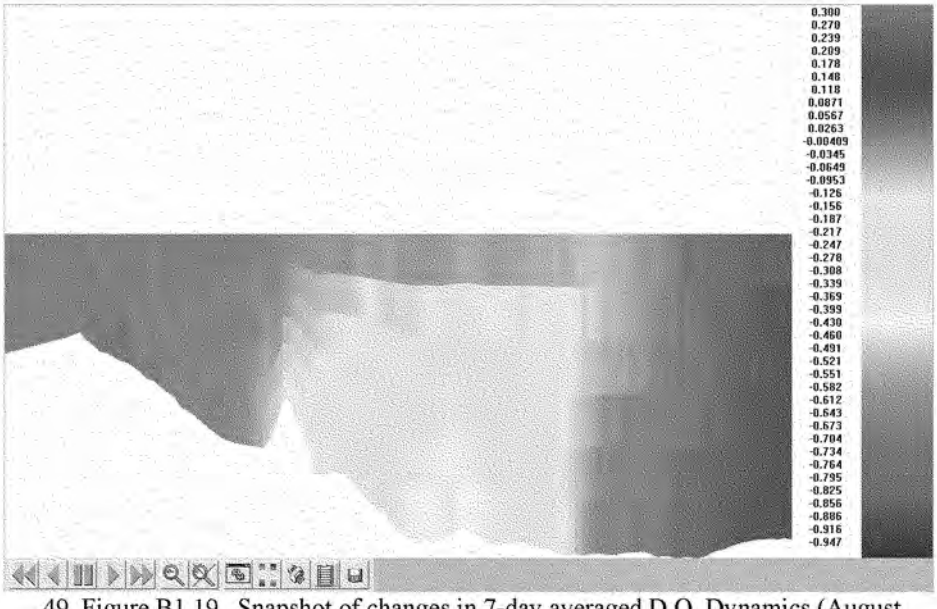
46. Figure B1.16. Changes in Salinity 50th %ile distribution along surface layer: 6 ft deepening



47. Figure B1.17. Changes in Salinity 95th %ile distribution along surface layer: 6 ft deepening

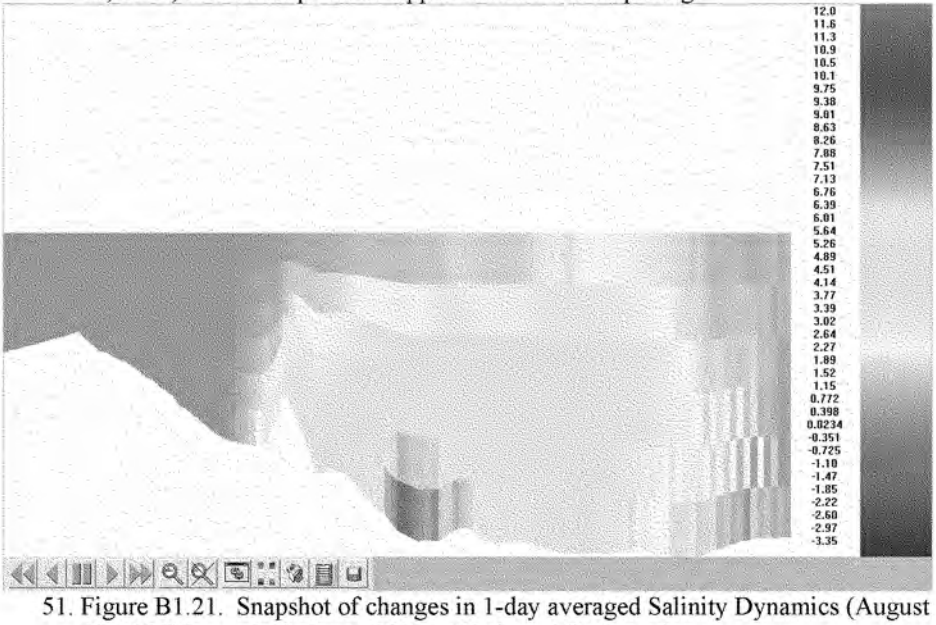


48. Figure B1.18. Snapshot of changes in 1-day averaged D.O. Dynamics (August 10, 1997) in vertical plane of Upper Harbor: 6 ft deepening

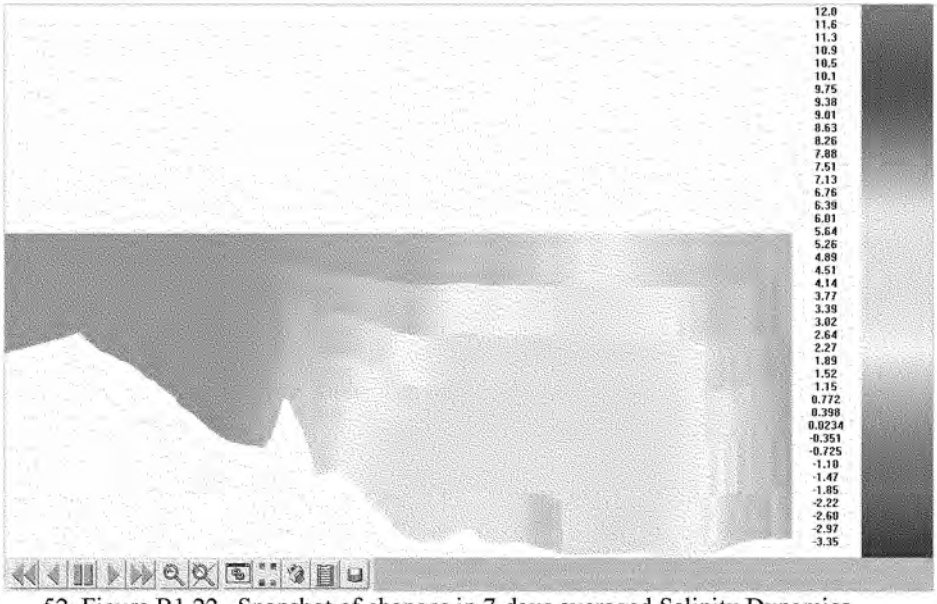


49. Figure B1.19. Snapshot of changes in 7-day averaged D.O. Dynamics (August 10, 1997) in vertical plane of Upper Harbor: 6 ft deepening

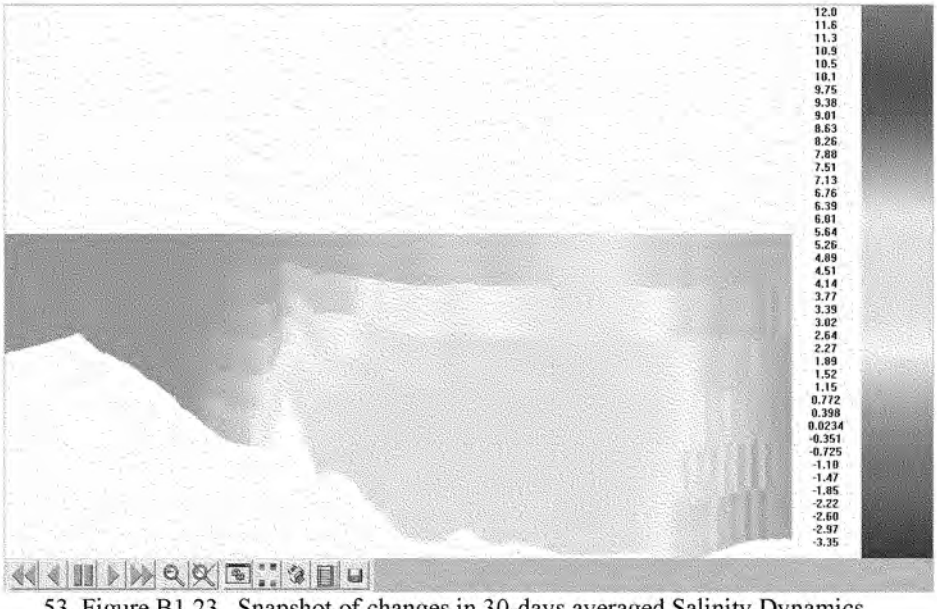
50. Figure B1.20. Snapshot of changes in 30-days averaged D.O. Dynamics (August 10, 1997) in vertical plane of Upper Harbor: 6 ft deepening



51. Figure B1.21. Snapshot of changes in 1-day averaged Salinity Dynamics (August 10, 1997) in vertical plane of Upper Harbor: 6 ft deepening



52. Figure B1.22. Snapshot of changes in 7-days averaged Salinity Dynamics (August 10, 1997) in vertical plane of Upper Harbor: 6 ft deepening



53. Figure B1.23. Snapshot of changes in 30-days averaged Salinity Dynamics (August 10, 1997) in vertical plane of Upper Harbor: 6 ft deepening

Appendix B2

SENSITIVITY ANALYSIS #1: 4 ft DEEPENING BATHYMETRY, 2004 POINT SOURCES LOADS, 1997 HYDROLOGICAL AND METEOROLOGICAL CONDITIONS

May 1 – October 30, 1997 Simulation Period

Water Quality Review Group

1. Table B2.1. Dissolved oxygen percentiles distribution in Critical cells

Zone	D.O. Percentile (mg/l)								
	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	3.44	3.76	3.91	4.11	4.44	4.92	5.36	5.48	5.64
FR2	3	3.28	3.41	3.64	3.98	4.45	5.01	5.23	5.46
FR3	2.84	3.1	3.23	3.44	3.81	4.26	4.86	5.18	5.92
FR4	2.84	3.1	3.22	3.41	3.82	4.28	4.83	5.39	6.11
FR5	2.91	3.15	3.25	3.46	3.85	4.27	4.87	5.47	6.19
FR6	2.98	3.15	3.24	3.45	3.83	4.28	4.83	5.51	6.3
FR7	3.32	3.63	3.78	4.16	4.67	5.15	5.87	6.35	6.52
FR8	3.38	3.73	3.93	4.41	4.96	5.42	5.94	6.37	6.54
FR9	3.41	3.78	3.96	4.39	4.99	5.47	5.95	6.45	6.58
FR10	3.18	3.5	3.75	4.29	4.89	5.42	5.82	5.96	6.18
FR11	2.92	3.37	3.6	4.06	4.54	5.18	5.69	5.88	6.01
MR1	3.21	3.39	3.53	3.78	4.16	4.61	5.06	5.63	6.29
MR2	2.84	3.09	3.25	3.6	4.05	4.56	4.97	5.25	6.2
MR3	2.65	2.82	2.95	3.23	3.68	4.35	4.86	5.12	5.87
MR4	2.76	3	3.13	3.37	3.68	4.14	4.67	5.01	5.28
MR5	0.87	1.49	1.84	2.5	4.14	5.22	5.68	5.89	6.05
MR6	1.44	2.08	2.44	3.16	4.65	5.45	5.88	6.11	6.72
LBR1	2.81	3.6	3.99	4.2	4.48	4.92	5.34	5.63	5.87
LBR2	3.12	3.26	3.35	3.49	3.71	4.16	4.52	4.99	5.21
LBR3	2.22	2.51	2.68	3.04	3.46	3.93	4.36	4.52	4.85
BR1	2.46	2.69	2.83	3.09	3.46	3.98	4.52	4.77	5.11
BR2	1.88	2.21	2.41	2.79	3.2	3.73	4.27	4.57	4.97
BR3	2.14	2.47	2.63	2.92	3.24	3.77	4.36	4.53	4.76
SCH1	1.78	2.14	2.39	2.79	3.57	4.32	4.84	5.19	5.59
SCH2	3.11	3.39	3.59	3.9	4.19	4.65	5.08	5.28	5.5
SR	3.38	3.47	3.56	3.9	4.22	4.7	5.37	5.85	5.89

2. Table B2.2. Delta of Dissolved Oxygen percentiles distribution in Critical cells: Deepening scenario minus Existing bathymetry scenario

Zone	Delta D.O. Percentile																	
	1%		5%		10%		25%		50%		75%		90%		95%		99	
	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%
FR1	0.03	0.9	0.02	0.5	0	0.0	-0.02	-0.5	-0.02	-0.4	-0.01	-0.2	0	0.0	-0.02	-0.4	-0.02	-0.4
FR2	-0.03	-1.0	-0.02	-0.6	0.01	0.3	-0.01	-0.3	-0.03	-0.7	0	0.0	0.02	0.4	-0.05	-0.9	-0.31	-5.4
FR3	0	0.0	-0.05	-1.6	-0.02	-0.6	0	0.0	-0.03	-0.8	-0.02	-0.5	0	0.0	-0.15	-2.8	-0.26	-4.2
FR4	0.02	0.7	0.01	0.3	0	0.0	-0.03	-0.9	-0.03	-0.8	-0.03	-0.7	0	0.0	-0.09	-1.6	-0.11	-1.8
FR5	0	0.0	0.03	1.0	-0.01	-0.3	-0.07	-2.0	-0.09	-2.3	-0.15	-3.4	0	0.0	-0.33	-5.7	-0.04	-0.6
FR6	-0.03	-1.0	-0.06	-1.9	-0.12	-3.6	-0.2	-5.5	-0.27	-6.6	-0.41	-8.7	-0.39	-7.5	-0.65	-10.6	-0.01	-0.2
FR7	-0.13	-3.8	-0.17	-4.5	-0.23	-5.7	-0.28	-6.3	-0.26	-5.3	-0.2	-3.7	-0.03	-0.5	-0.05	-0.8	-0.03	-0.5
FR8	-0.09	-2.6	-0.13	-3.4	-0.19	-4.6	-0.27	-5.8	-0.18	-3.5	-0.09	-1.6	-0.1	-1.7	-0.02	-0.3	0.01	0.2
FR9	-0.94	-21.6	-0.99	-20.8	-1.04	-20.8	-0.88	-16.7	-0.49	-8.9	-0.36	-6.2	-0.33	-5.3	-0.04	-0.6	-0.01	-0.2
FR10	0.01	0.3	0	0.0	0.01	0.3	0	0.0	0	0.0	0	0.0	0.01	0.2	0	0.0	0.03	0.5
FR11	0.05	1.7	0.02	0.6	0.01	0.3	0	0.0	0.01	0.2	0.01	0.2	0	0.0	-0.01	-0.2	0.02	0.3
MR1	-0.07	-2.1	-0.07	-2.0	-0.08	-2.2	-0.13	-3.3	-0.15	-3.5	-0.19	-4.0	-0.11	-2.1	-0.09	-1.6	-0.03	-0.5
MR2	0	0.0	-0.04	-1.3	-0.05	-1.5	-0.08	-2.2	-0.13	-3.1	-0.15	-3.2	-0.12	-2.4	-0.12	-2.2	-0.04	-0.6
MR3	-0.03	-1.1	-0.1	-3.4	-0.13	-4.2	-0.23	-6.6	-0.27	-6.8	-0.17	-3.8	-0.07	-1.4	-0.05	-1.0	-0.06	-1.0
MR4	0.01	0.4	0	0.0	-0.01	-0.3	-0.02	-0.6	-0.02	-0.5	-0.01	-0.2	-0.02	-0.4	-0.04	-0.8	0.01	0.2
MR5	-0.03	-3.3	-0.03	-2.0	-0.02	-1.1	0.01	0.4	0	0.0	0.01	0.2	0.01	0.2	0.01	0.2	0.01	0.2
MR6	0.02	1.4	0.05	2.5	0.05	2.1	0.04	1.3	0.02	0.4	0.02	0.4	0.01	0.2	0.01	0.2	0	0.0
LBR1	-0.07	-2.4	-0.01	-0.3	0.03	0.8	0.03	0.7	0.03	0.7	0.03	0.6	0.01	0.2	0.02	0.4	0	0.0
LBR2	0	0.0	0	0.0	0.01	0.3	0.02	0.6	0.03	0.8	0.02	0.5	0	0.0	0.02	0.4	0.03	0.6
LBR3	0.12	5.7	0.13	5.5	0.13	5.1	0.16	5.6	0.16	4.8	0.12	3.1	0.05	1.2	0.07	1.6	0.04	0.8
BR1	0.01	0.4	0.01	0.4	0.01	0.4	0.01	0.3	-0.01	-0.3	0	0.0	0.01	0.2	-0.01	-0.2	-0.02	-0.4
BR2	0.04	2.2	0.02	0.9	0.02	0.8	0	0.0	0.01	0.3	0.01	0.3	0.04	0.9	0.01	0.2	-0.03	-0.6
BR3	0.03	1.4	0.04	1.6	0.02	0.8	0.02	0.7	0.01	0.3	0	0.0	0.01	0.2	0.02	0.4	0.02	0.4
SCH1	0.07	4.1	-0.04	-1.8	0	0.0	-0.01	-0.4	-0.06	-1.7	-0.07	-1.6	-0.07	-1.4	-0.07	-1.3	-0.05	-0.9
SCH2	-0.03	-1.0	-0.03	-0.9	-0.04	-1.1	-0.05	-1.3	-0.04	-0.9	-0.03	-0.6	-0.03	-0.6	-0.04	-0.8	-0.06	-1.1
SR	0	0.0	0.01	0.3	0	0.0	0	0.0	0	0.0	0.01	0.2	0	0.0	0	0.0	0	0.0

3. Table B2.3. Dissolved oxygen percentiles distribution in Zones of Savannah Estuary

Zone	D.O. Concentration Percentiles (mg/l)								
Name	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	3.80	4.08	4.22	4.40	4.69	5.19	5.59	5.69	5.81
FR2	3.37	3.61	3.78	4.00	4.31	4.78	5.27	5.41	5.55
FR3	3.02	3.24	3.42	3.64	3.96	4.43	5.02	5.24	5.51
FR4	2.88	3.13	3.25	3.45	3.83	4.23	4.89	5.22	6.11
FR5	2.95	3.17	3.26	3.45	3.84	4.24	4.85	5.37	6.24
FR6	3.11	3.20	3.35	3.55	3.94	4.37	4.83	5.62	6.31
FR7	3.27	3.53	3.69	4.02	4.57	5.09	5.61	6.30	6.44
FR8	3.44	3.78	3.98	4.41	4.93	5.34	5.84	6.38	6.53
FR9	3.90	4.31	4.59	5.02	5.39	5.75	6.21	6.46	6.60
FR10	4.67	4.86	4.97	5.18	5.43	5.80	6.13	6.30	6.47
FR11	3.63	3.83	4.01	4.27	4.59	5.00	5.55	5.91	6.01
MR1	3.29	3.46	3.58	3.81	4.18	4.60	5.08	5.67	6.28
MR2	3.00	3.24	3.38	3.70	4.09	4.54	4.99	5.42	6.21
MR3	2.78	2.94	3.08	3.39	3.83	4.36	4.83	5.08	5.81
MR4	3.42	3.53	3.64	3.83	4.08	4.51	4.93	5.26	5.49
MR5	1.45	2.00	2.32	2.96	4.48	5.17	5.62	5.85	6.00
MR6	1.49	2.11	2.47	3.21	4.68	5.40	5.83	6.04	6.60
LBR1	3.48	3.62	3.69	3.84	4.03	4.50	4.84	5.31	5.48
LBR2	2.70	2.90	3.01	3.21	3.49	3.94	4.33	4.79	5.04
LBR3	2.56	2.69	2.79	2.96	3.19	3.71	4.21	4.39	4.56
BR1	2.78	2.96	3.04	3.25	3.60	4.11	4.62	4.94	5.23
BR2	2.39	2.64	2.75	2.96	3.28	3.81	4.39	4.59	4.90
BR3	2.48	2.67	2.76	2.94	3.19	3.75	4.32	4.43	4.58
SCh1	2.81	3.09	3.32	3.56	3.85	4.38	4.94	5.10	5.25
SCh2	3.31	3.51	3.76	4.00	4.28	4.76	5.19	5.36	5.53
SR	3.70	3.76	3.81	4.14	4.44	4.90	5.54	5.97	6.00

4. Table B2.4. Delta of Dissolved Oxygen percentiles distribution in Zones of Savannah Estuary: Deepening scenario minus Existing bathymetry scenario

Zone	Project - Baseline Difference (mg/l)									Project - Baseline Relative Difference (%)								
Name	1%	5%	10%	25%	50%	75%	90%	95%	99%	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	0.05	0.02	0.00	-0.01	-0.01	0.01	0.02	0.01	0.02	1.3	0.4	0.0	-0.2	-0.2	0.1	0.3	0.1	0.4
FR2	0.01	0.03	0.02	0.00	0.01	0.01	0.03	-0.03	-0.04	0.4	0.8	0.5	0.1	0.2	0.2	0.6	-0.6	-0.8
FR3	0.01	-0.03	0.02	0.03	-0.02	0.03	0.04	-0.04	-0.52	0.4	-1.0	0.5	0.8	-0.5	0.7	0.8	-0.7	-8.7
FR4	-0.01	-0.03	-0.02	-0.01	-0.05	-0.08	0.04	-0.17	-0.15	-0.3	-0.9	-0.8	-0.3	-1.3	-1.9	0.7	-3.2	-2.3
FR5	-0.02	0.00	-0.05	-0.09	-0.10	-0.18	-0.02	-0.37	-0.05	-0.6	0.0	-1.5	-2.5	-2.6	-4.1	-0.4	-6.5	-0.9
FR6	-0.02	-0.03	-0.09	-0.13	-0.17	-0.29	-0.23	-0.46	-0.02	-0.6	-1.0	-2.7	-3.6	-4.2	-6.1	-4.6	-7.5	-0.4
FR7	-0.05	-0.15	-0.17	-0.28	-0.32	-0.20	-0.16	-0.05	0.00	-1.6	-4.0	-4.3	-6.5	-6.6	-3.9	-2.7	-0.7	0.0
FR8	-0.17	-0.21	-0.27	-0.30	-0.24	-0.18	-0.13	-0.01	0.00	-4.6	-5.2	-6.4	-6.4	-4.6	-3.2	-2.1	-0.2	0.0
FR9	-0.29	-0.33	-0.32	-0.23	-0.10	-0.10	-0.05	-0.01	0.00	-6.9	-7.1	-6.5	-4.3	-1.8	-1.7	-0.8	-0.2	-0.1
FR10	-0.02	-0.01	-0.01	-0.03	-0.01	-0.01	-0.02	0.00	0.00	-0.3	-0.3	-0.3	-0.5	-0.2	-0.1	-0.3	0.0	0.1
FR11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.1	0.0	-0.1	0.1	0.0	0.0	0.1	0.0	0.0
MR1	-0.05	-0.08	-0.12	-0.14	-0.16	-0.20	-0.10	-0.13	-0.04	-1.5	-2.3	-3.2	-3.5	-3.8	-4.2	-2.0	-2.2	-0.6
MR2	-0.04	-0.06	-0.06	-0.10	-0.15	-0.17	-0.13	-0.03	-0.06	-1.4	-1.7	-1.9	-2.6	-3.7	-3.6	-2.6	-0.6	-1.0
MR3	0.01	0.00	-0.01	-0.04	-0.07	-0.08	-0.07	-0.06	-0.01	0.3	-0.1	-0.4	-1.2	-1.7	-1.8	-1.5	-1.2	-0.3
MR4	0.02	0.01	0.01	0.02	0.01	0.02	0.00	-0.01	0.00	0.5	0.4	0.4	0.4	0.3	0.4	0.1	-0.2	0.1
MR5	0.01	0.02	0.04	0.04	0.01	0.01	0.00	0.00	0.01	1.0	1.2	1.8	1.5	0.1	0.1	0.1	0.1	0.2
MR6	0.03	0.04	0.06	0.03	0.00	0.01	0.01	0.00	0.00	2.0	1.9	2.7	1.1	0.0	0.3	0.2	0.1	0.0
LBR1	0.01	0.01	0.02	0.02	0.03	0.02	0.00	0.02	0.03	0.2	0.3	0.5	0.6	0.6	0.4	0.1	0.3	0.5
LBR2	0.00	0.00	0.00	0.01	0.02	0.01	-0.01	0.01	0.01	-0.1	-0.1	0.1	0.3	0.5	0.2	-0.2	0.3	0.2
LBR3	0.08	0.09	0.08	0.08	0.07	0.08	0.05	0.00	0.01	3.4	3.5	2.9	2.7	2.2	2.1	1.3	0.1	0.3
BR1	0.02	0.00	0.00	0.00	-0.02	-0.01	0.01	-0.03	-0.07	0.6	0.1	0.0	-0.1	-0.6	-0.2	0.2	-0.7	-1.3
BR2	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.01	-0.02	0.9	0.4	0.3	0.3	0.2	0.4	0.4	0.3	-0.3
BR3	0.04	0.04	0.03	0.03	0.02	0.00	0.03	0.03	0.05	1.8	1.7	1.1	0.9	0.7	0.0	0.7	0.7	1.2
SCh1	0.04	0.02	-0.03	-0.02	0.00	0.00	0.01	0.00	0.01	1.5	0.7	-0.9	-0.5	-0.1	0.1	0.2	0.1	0.1
SCh2	0.03	0.00	-0.02	-0.02	-0.02	-0.01	0.00	-0.03	-0.01	0.8	0.1	-0.4	-0.5	-0.4	-0.2	-0.1	-0.5	-0.3
SR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0

5. Table B2.5. Percentage of the volume of waters with violation of Dissolved Oxygen standards for Zones of Savannah Estuary within the period of May 1 – October 30, 1997: Deepening (Project) and Existing (Baseline) bathymetry

Zones	D.O. STANDARDS														
	1-Day Average			7-Day Average			30-Day Average			GA MINIMUM D.O.			SC MINIMUM D.O.		
	Baseline(B)	Project(P)	Delta=P-B	Baseline(B)	Project(P)	Delta=P-B	Baseline(B)	Project(P)	Delta=P-B	Baseline(B)	Project(P)	Delta=P-B	Baseline(B)	Project(P)	Delta=P-B
FR1	0	0	0	0	0	0	0	0	0	0	0	0	4	4	0
FR2	0	0	0	0	0	0	0	0	0	0	0	0	17	17	0
FR3	0	0	0	0	0	0	3	4	1	0	0	0	N/A	N/A	N/A
FR4	0	0	0	0	0	0	5	7	2	0	0	0	N/A	N/A	N/A
FR5	0	0	0	0	0	0	3	6	3	0	0	0	N/A	N/A	N/A
FR6	0	0	0	0	0	0	1	3	2	0	0	0	N/A	N/A	N/A
FR7	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
FR8	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
FR9	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
FR10	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
FR11	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0
MR1	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
MR2	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
MR3	0	0	0	0	0	0	3	5	2	1	1	0	N/A	N/A	N/A
MR4	0	0	0	0	0	0	1	1	0	0	0	0	N/A	N/A	N/A
MR5	0	0	0	0	0	0	2	1	-1	4	4	0	9	9	0
MR6	0	0	0	0	0	0	0	0	0	2	2	0	7	7	0
LBR1	0	0	0	0	0	0	1	1	0	0	0	0	11	11	0
LBR2	0	0	0	2	1	-1	11	11	0	3	3	0	25	25	0
LBR3	0	0	0	6	5	-1	21	22	1	8	7	-1	36	37	1
BR1	0	0	0	1	2	1	18	20	2	2	2	0	50	51	1
BR2	0	0	0	6	6	0	36	37	1	7	7	0	60	61	1
BR3	0	0	0	9	8	-1	35	36	1	11	10	-1	57	59	2
SCh1	0	0	0	2	2	0	6	6	0	3	3	0	N/A	N/A	N/A
SCh2	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
SR	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0

26. Table B2.6. Percentage of water volumes with salinity in %iles within the period of May 1 – October 30, 1997

Percen-tile	Harbor / River			Stations					
	Upper Hrb %	Middle Rvr %	Back Rvr %	Houlih Brg %	Broad Str %	Pulaski Frt %	Lucknow Cnl %	USF&W Dck %	I-95 Brg %
5	20.8	6.9	4.7	4.8	4.5	4.3	8.8	4.9	95.1
10	24.8	10.6	9.2	9.8	9.1	8.6	21.9	9	95.1
25	36.8	22.1	22.9	23	23.2	22.1	30.5	21.5	95.1
50	57.6	43.7	47	47.1	47.8	46.1	51.7	43	95.1
75	79	69.4	72.8	72.9	73.4	72.9	73.9	69.7	95.1
90	91.2	87.2	88.9	89.1	89.2	89.2	88.9	87.5	95.1
95	95.3	93.5	94.4	94.5	94.5	94.6	94.4	93.7	95.1
Total Volume 100*km3:	32890.1	653	4770.2	25.6	39	135.5	9.9	9.4	43.6

27. Table B2.7. Percentage of water volumes with D.O. in %iles within the period of May 1 – October 30, 1997

Percen-tile	Harbor / River			Stations					
	Upper Hrb %	Middle Rvr %	Back Rvr %	Houlih Brg %	Broad Str %	Pulaski Frt %	Lucknow Cnl %	USF&W Dck %	I-95 Brg %
5	5.3	5.2	5	5.6	5.6	4.7	5.7	5.5	5.8
10	10.5	10.2	10	11.1	10.6	9.6	11	11	11.2
25	26.2	24.7	25	27.3	26.1	24.3	26.4	26.4	26.5
50	51.9	49.4	50.1	53.1	51.4	49.6	50.7	51	51.1
75	76.2	74.7	75.4	76.8	75.9	74.8	75.7	75.9	75.9
90	90.4	89.9	90.2	90.4	90.2	89.9	90.2	90.4	90.1
95	95	94.7	95	95.4	95.3	94.9	95.1	95.2	95.2
Total Volume 100*km3:	32890.1	653	4770.2	25.6	39	135.5	9.9	9.4	43.6

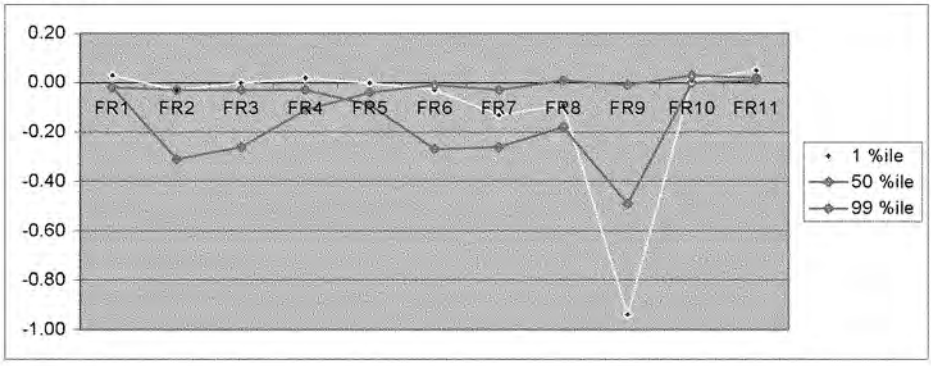
28. Table B2.8. Water volumes in Upper Harbor in increments of 1° C of water temperature within the period of May 1 – October 30, 1997

Temperature C°	Total Volume %
17	0.11
18	0.45
19	1.26
20	4.35
21	13.01
22	17.74
23	22.47
24	32.71
25	43.06
26	50.83
27	62.16
28	81.77
29	93.96
30	99.84
31	100

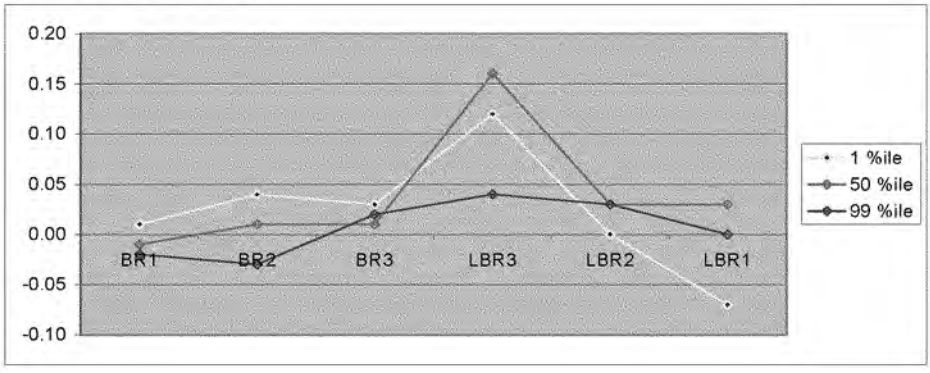
29. Table B2.9. Water volumes in Upper Harbor in increments of 0.1 mg/l of D.O. within the period of May 1 – October 30, 1997
(See file: Postprocessor Output\S14\97-S14_DO Increment Volume)

30. Table B2.10. Percentage of water volumes corresponding to 1-, 7-, and 30-days averages of D.O. depth-averaged concentrations in Upper Harbor within the period of May 1 – October 30, 1997
(See file: Postprocessor Output\S14\97-S14_volume DO in averages)

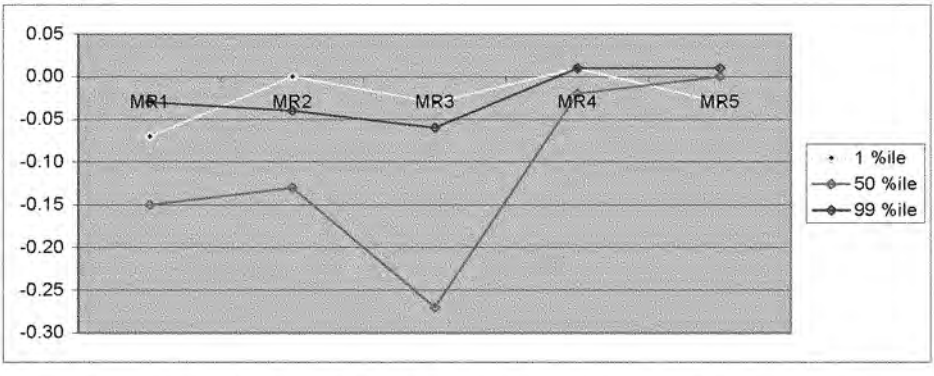
Front River



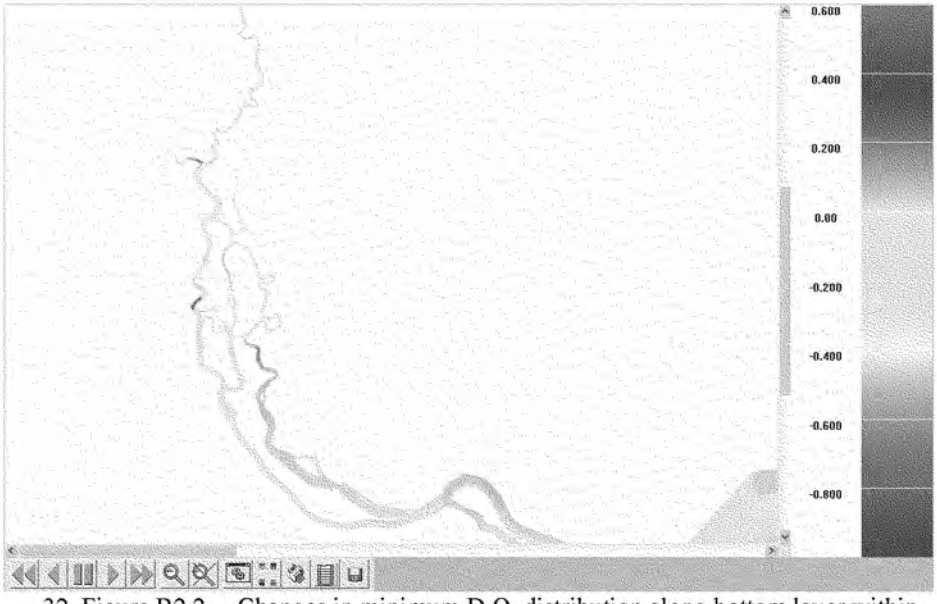
Back and Little Back Rivers



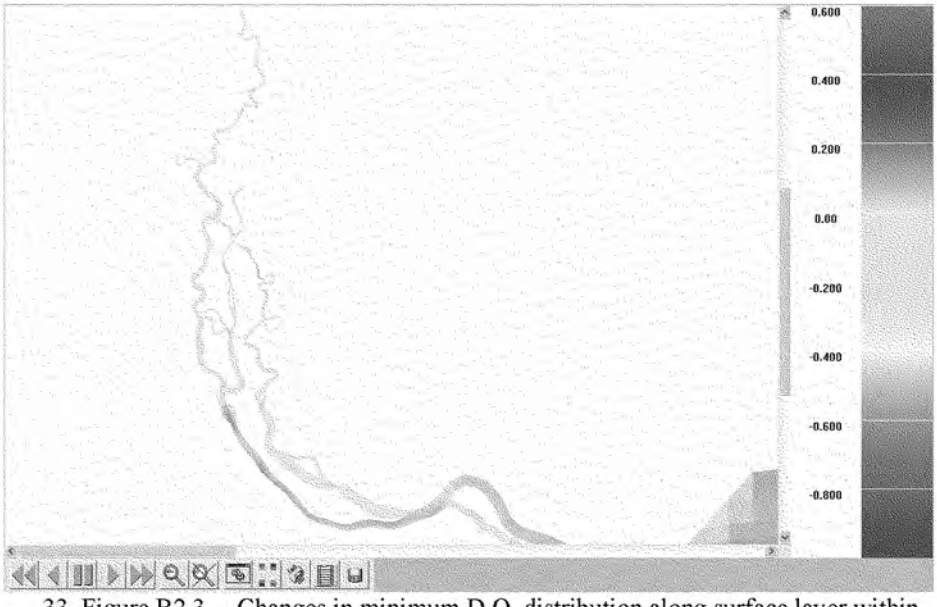
Middle River



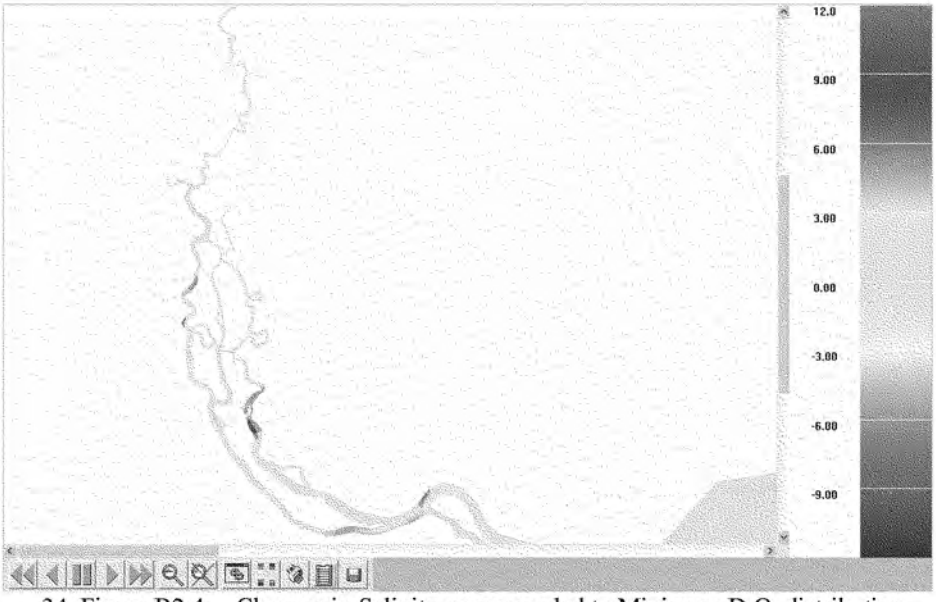
31. Figure B2.1. Changes in longitudinal profile of Dissolved Oxygen (mg/l) distribution along Critical cells of Savannah Estuary: 4 ft deepening



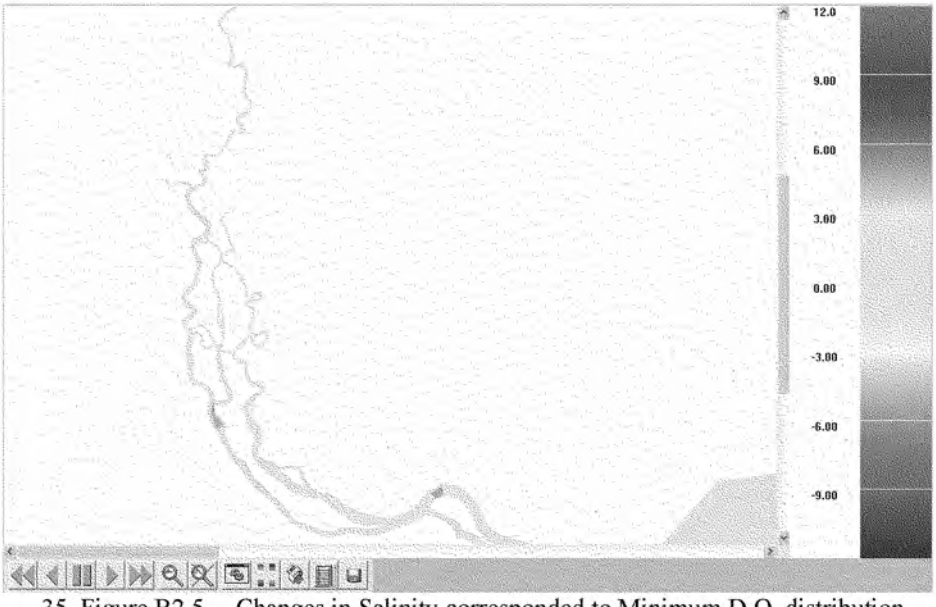
32. Figure B2.2. Changes in minimum D.O. distribution along bottom layer within the analyzed period of May 1 - October 30, 1997: 4 ft deepening



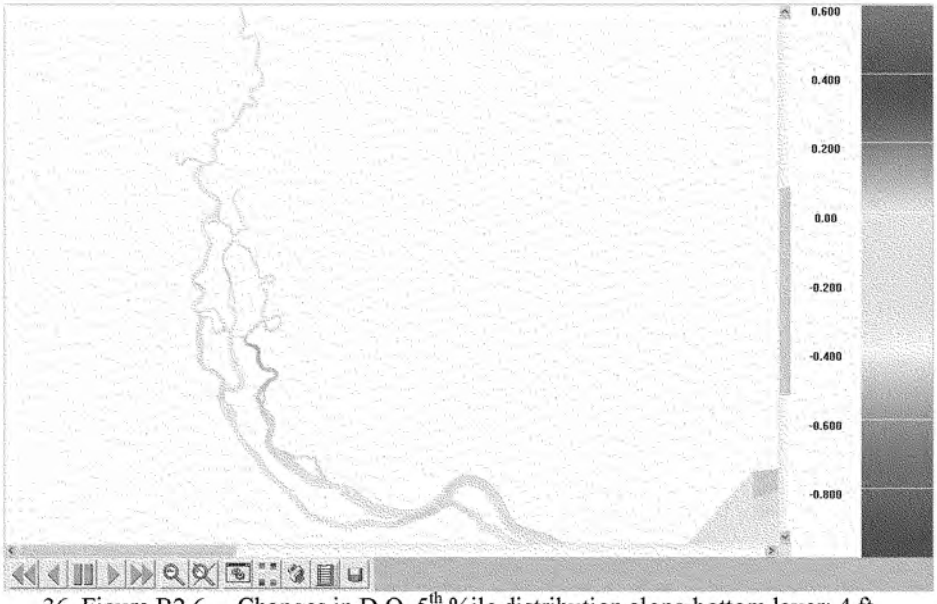
33. Figure B2.3. Changes in minimum D.O. distribution along surface layer within the analyzed period of May 1 - October 30, 1997: 4 ft deepening



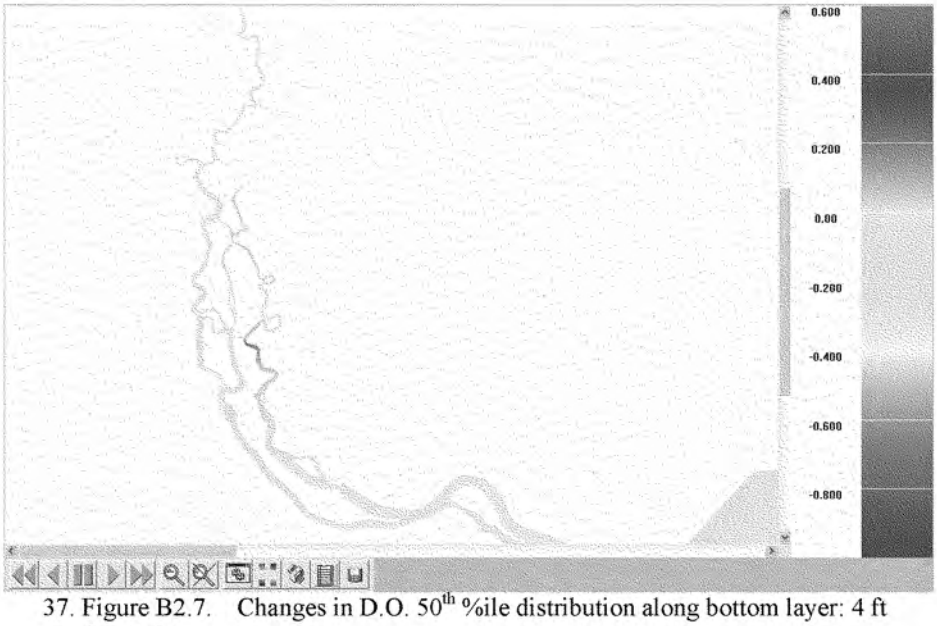
34. Figure B2.4. Changes in Salinity corresponded to Minimum D.O. distribution along bottom layer within the analyzed period of May 1 - October 30, 1997: 4 ft deepening



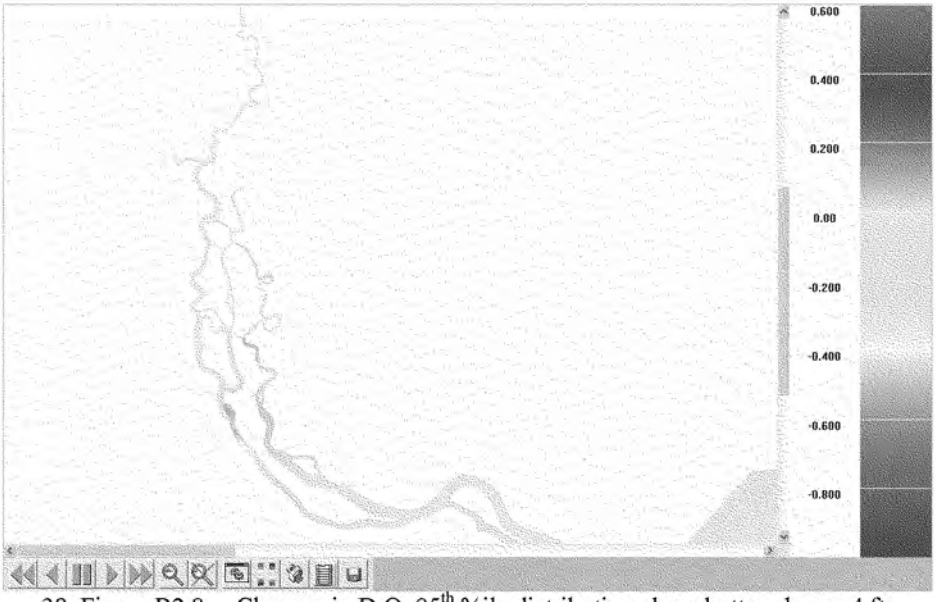
35. Figure B2.5. Changes in Salinity corresponded to Minimum D.O. distribution along Surface layer within the analyzed period of May 1 - October 30, 1997: 4 ft deepening



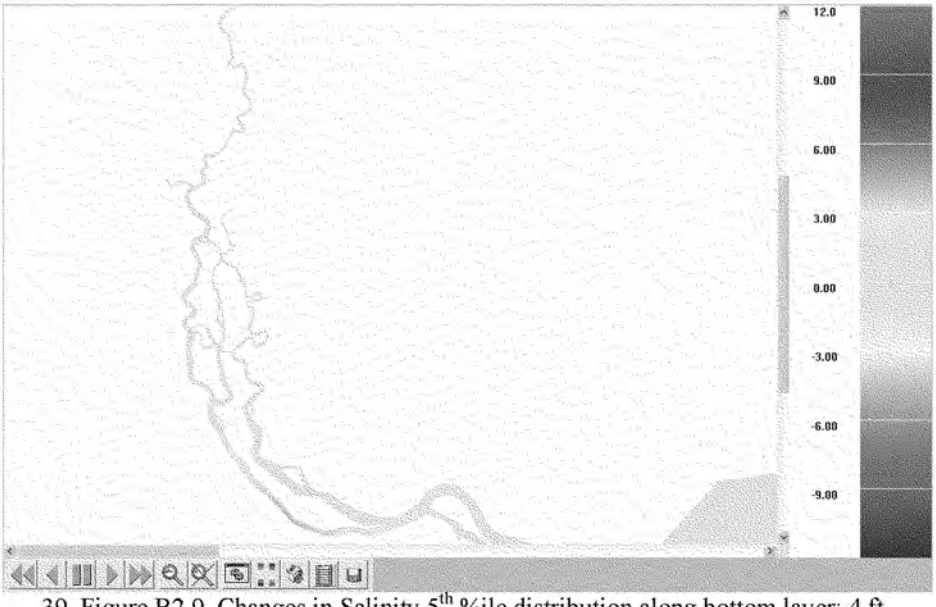
36. Figure B2.6. Changes in D.O. 5th %ile distribution along bottom layer: 4 ft deepening



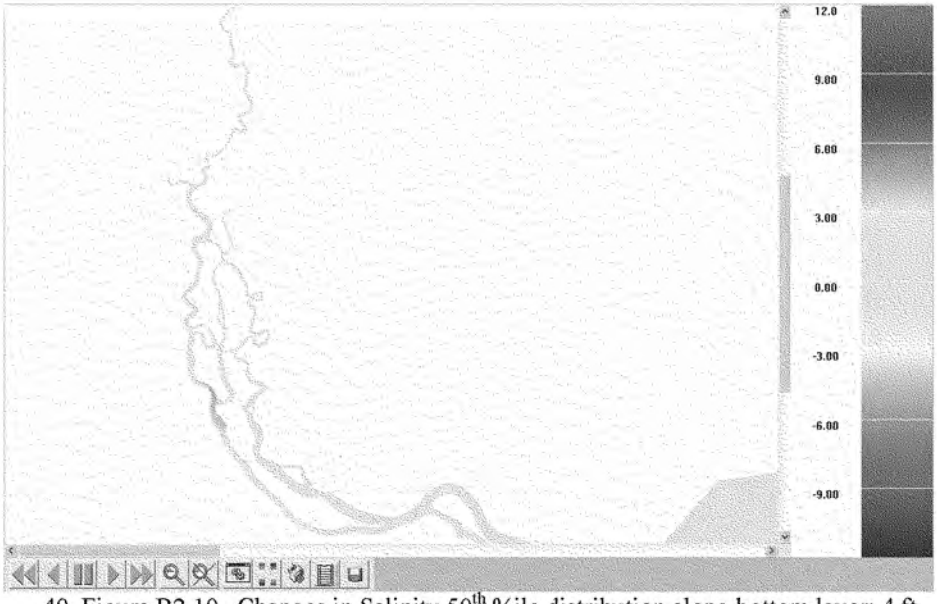
37. Figure B2.7. Changes in D.O. 50th %ile distribution along bottom layer: 4 ft deepening



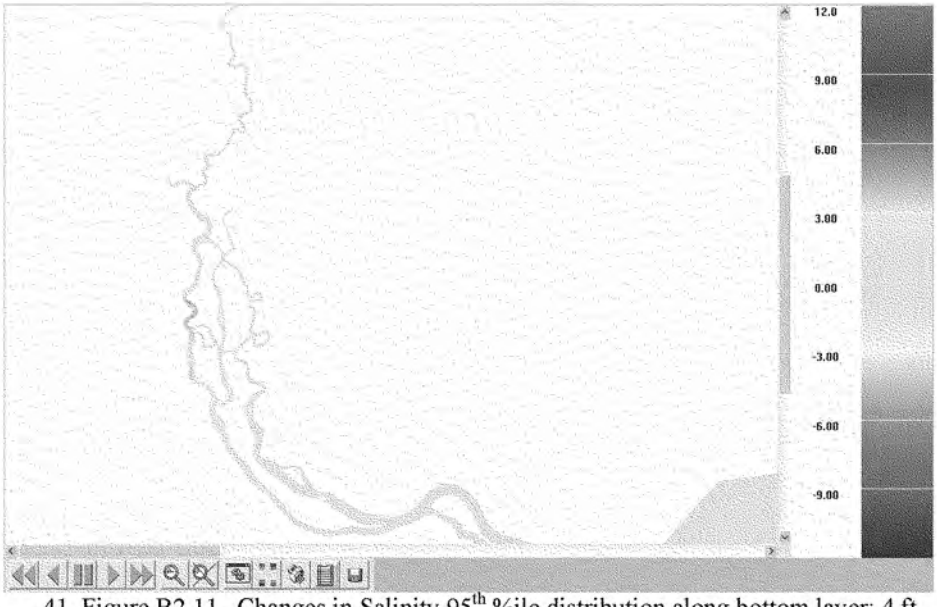
38. Figure B2.8. Changes in D.O. 95th %ile distribution along bottom layer: 4 ft deepening



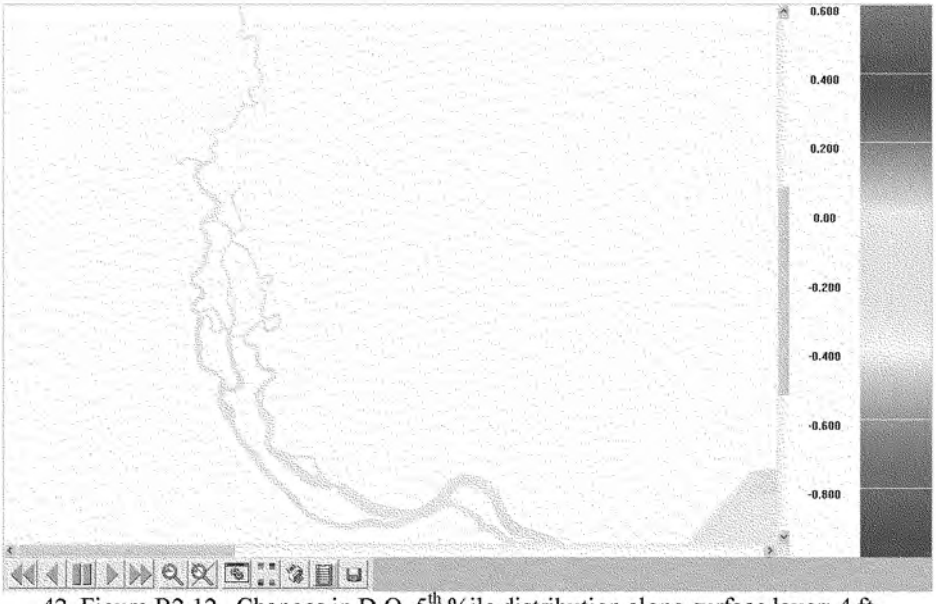
39. Figure B2.9. Changes in Salinity 5th %ile distribution along bottom layer: 4 ft deepening



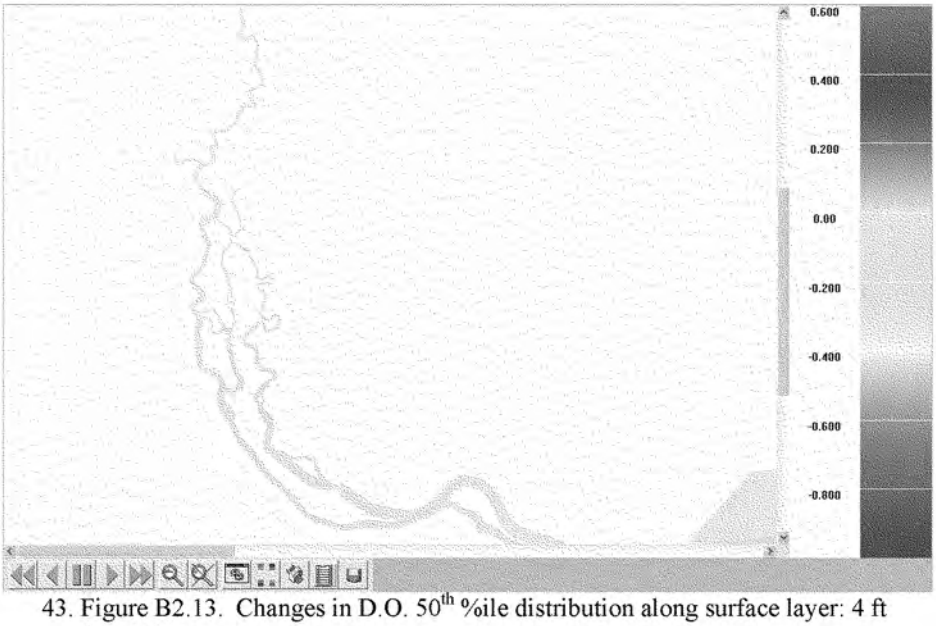
40. Figure B2.10. Changes in Salinity 50th %ile distribution along bottom layer: 4 ft deepening



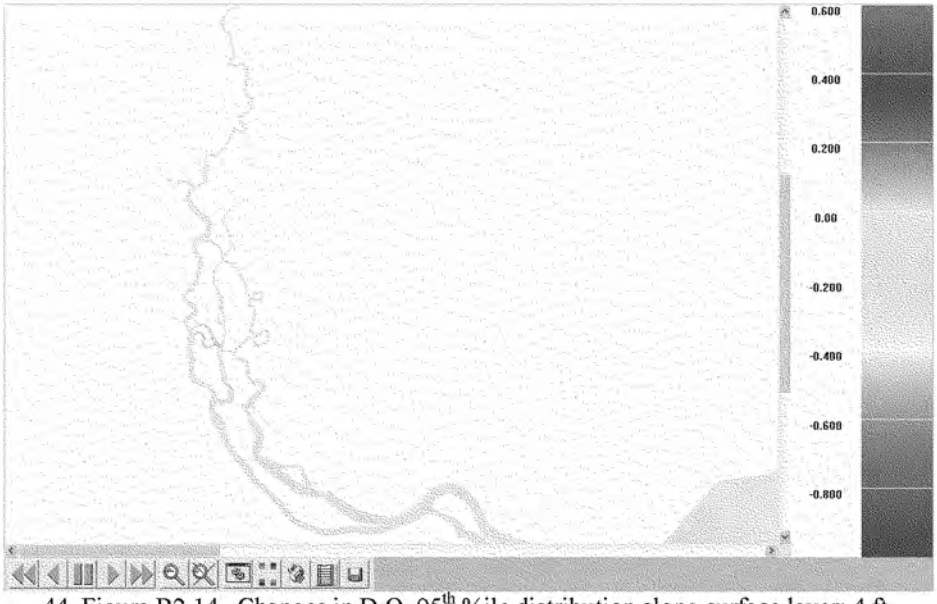
41. Figure B2.11. Changes in Salinity 95th %ile distribution along bottom layer: 4 ft deepening



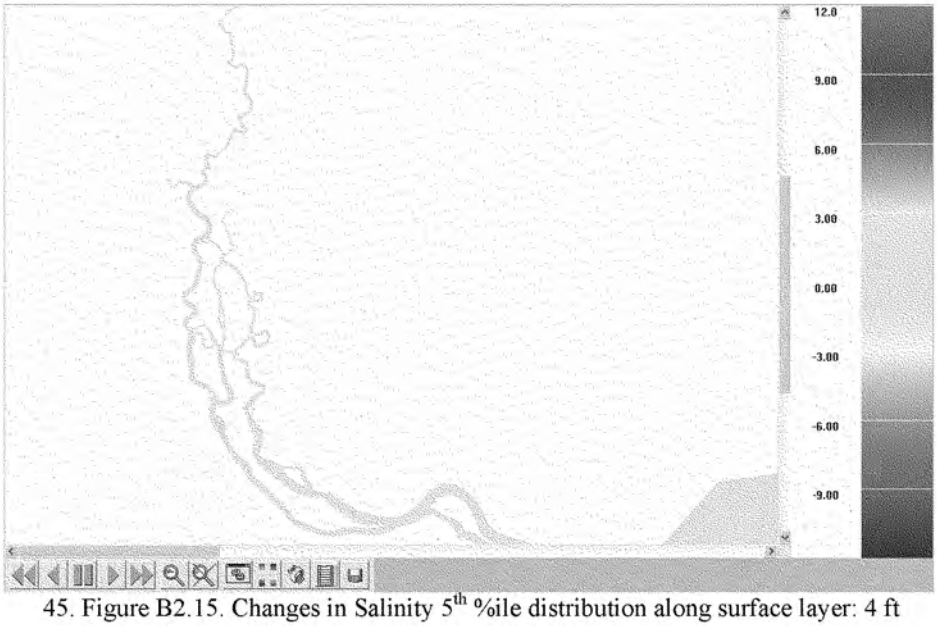
42. Figure B2.12. Changes in D.O. 5th %ile distribution along surface layer: 4 ft deepening



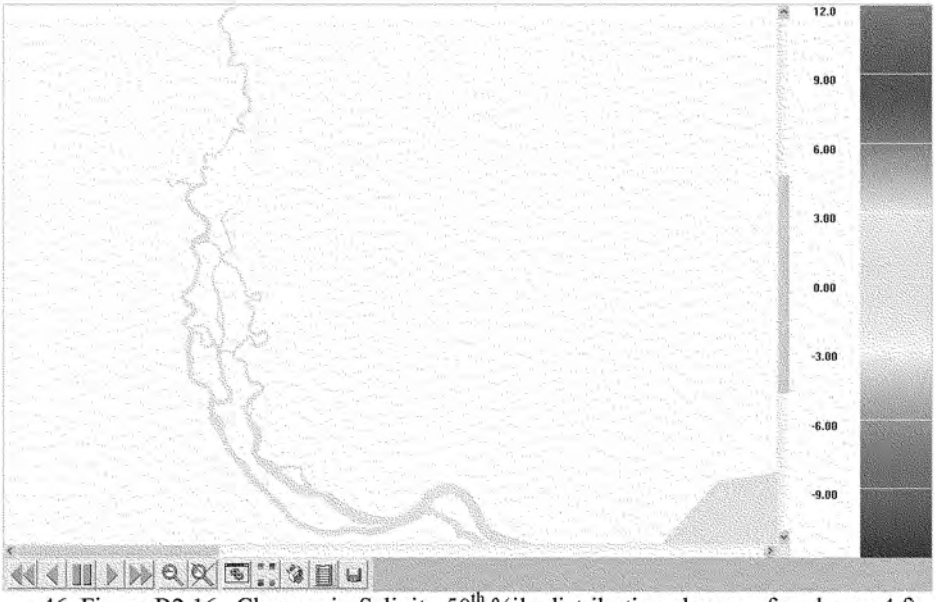
43. Figure B2.13. Changes in D.O. 50th %ile distribution along surface layer: 4 ft deepening



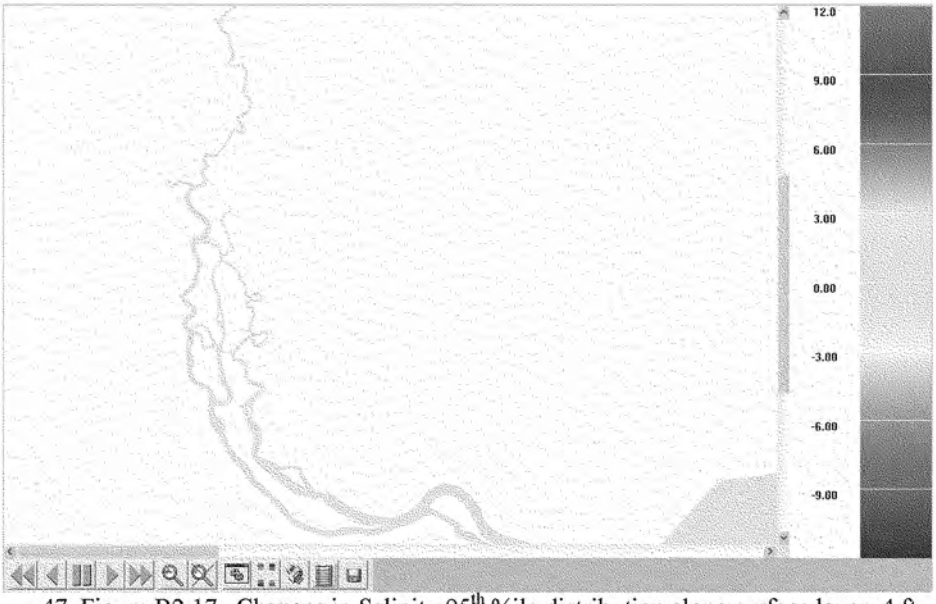
44. Figure B2.14. Changes in D.O. 95th %ile distribution along surface layer: 4 ft deepening



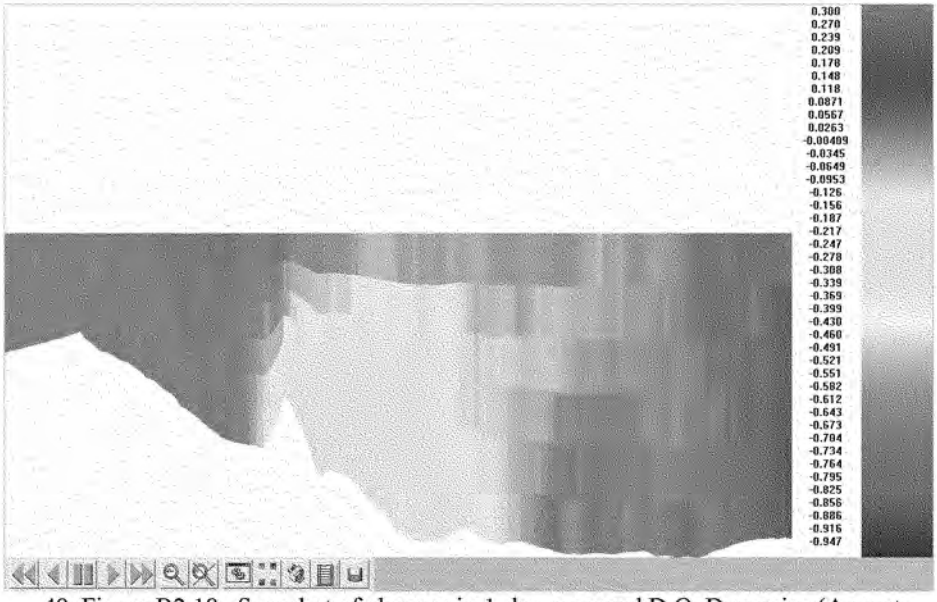
45. Figure B2.15. Changes in Salinity 5th %ile distribution along surface layer: 4 ft deepening



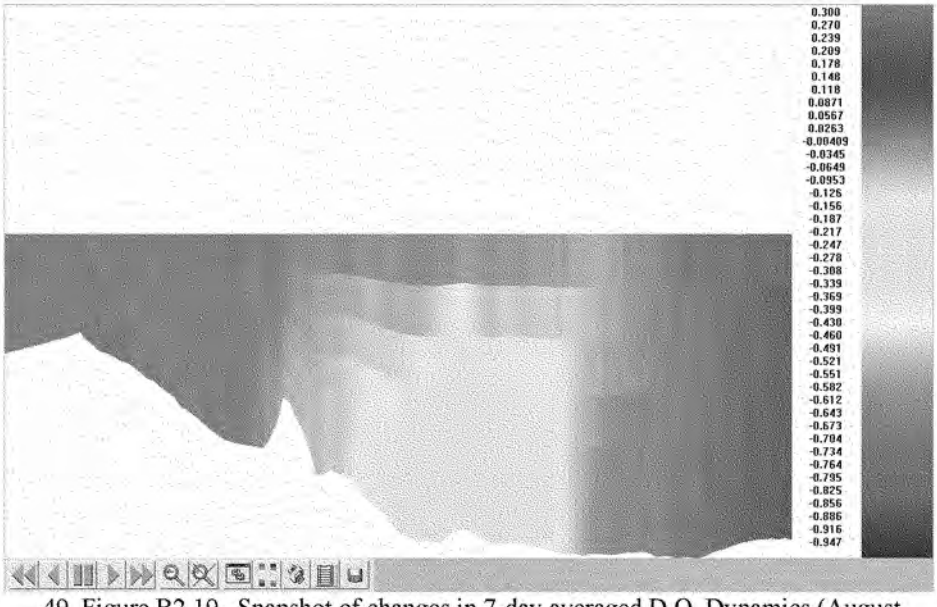
46. Figure B2.16. Changes in Salinity 50th %ile distribution along surface layer: 4 ft deepening



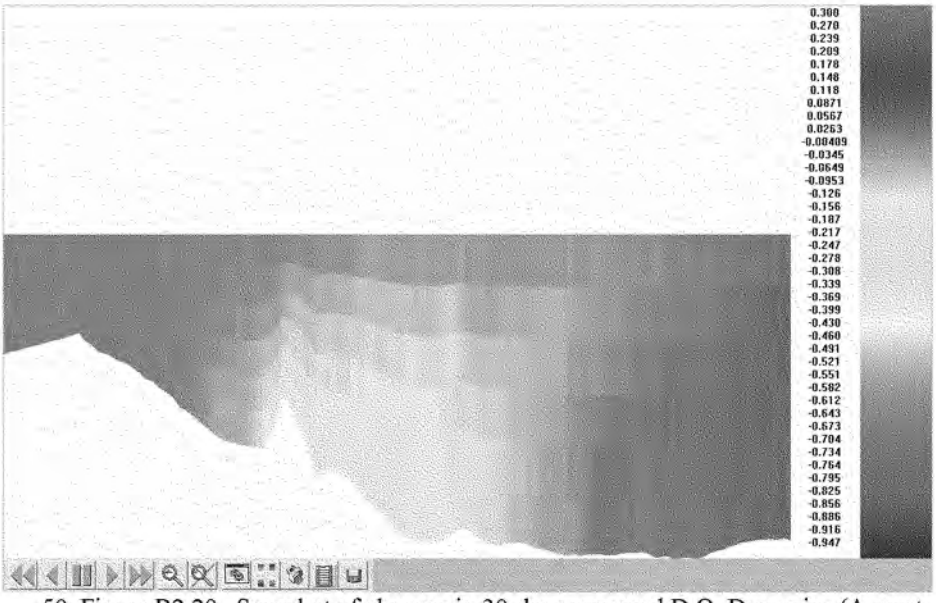
47. Figure B2.17. Changes in Salinity 95th %ile distribution along surface layer: 4 ft deepening



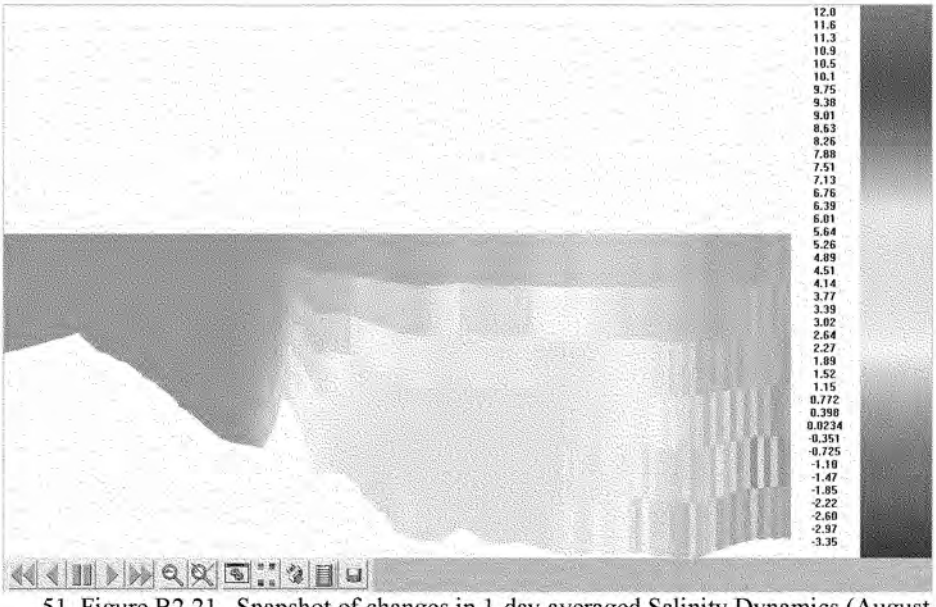
48. Figure B2.18. Snapshot of changes in 1-day averaged D.O. Dynamics (August 10, 1997) in vertical plane of Upper Harbor: 4 ft deepening



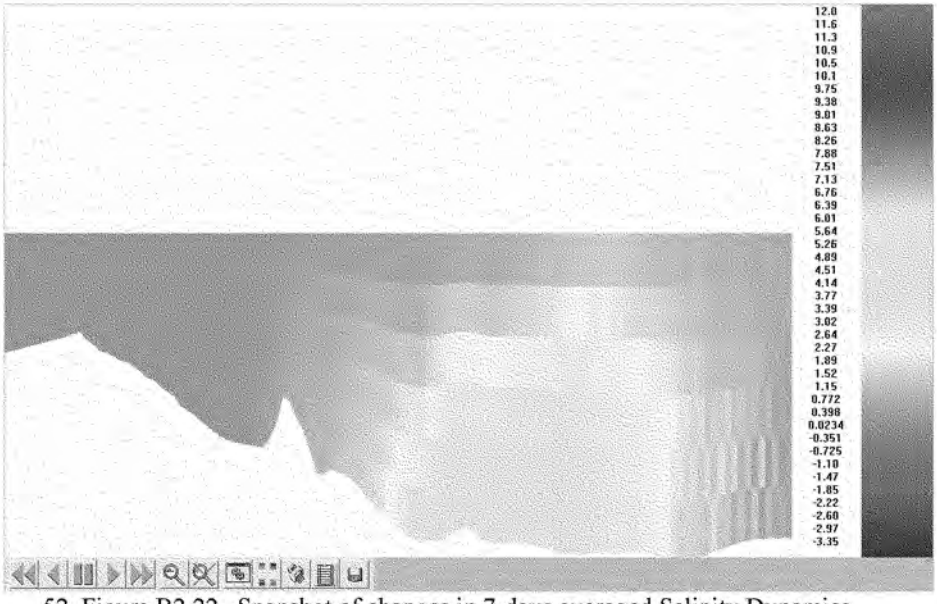
49. Figure B2.19. Snapshot of changes in 7-day averaged D.O. Dynamics (August 10, 1997) in vertical plane of Upper Harbor: 4 ft deepening



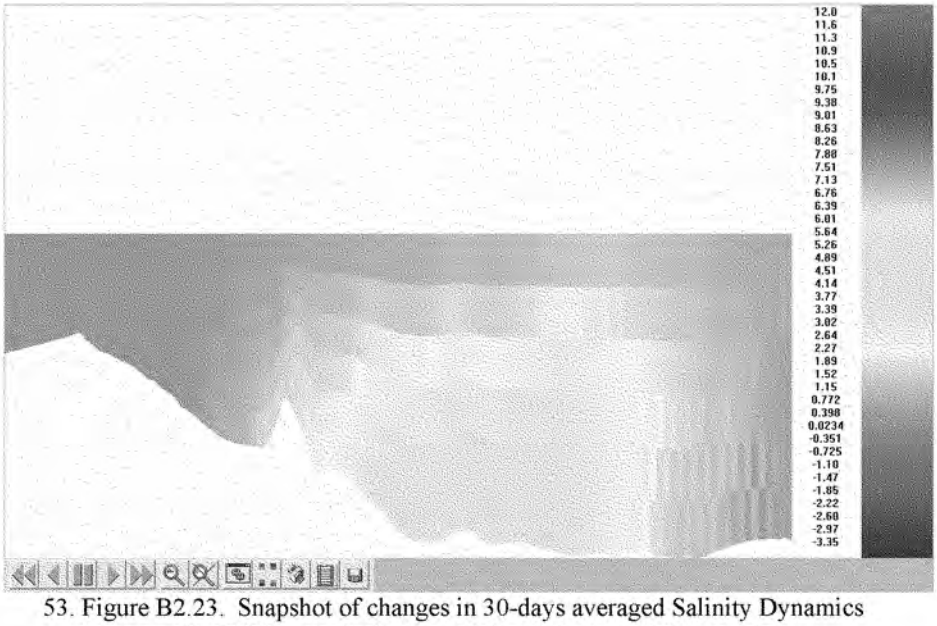
50. Figure B2.20. Snapshot of changes in 30-days averaged D.O. Dynamics (August 10, 1997) in vertical plane of Upper Harbor: 4 ft deepening



51. Figure B2.21. Snapshot of changes in 1-day averaged Salinity Dynamics (August 10, 1997) in vertical plane of Upper Harbor: 4 ft deepening



52. Figure B2.22. Snapshot of changes in 7-days averaged Salinity Dynamics (August 10, 1997) in vertical plane of Upper Harbor: 4 ft deepening



53. Figure B2.23. Snapshot of changes in 30-days averaged Salinity Dynamics (August 10, 1997) in vertical plane of Upper Harbor: 4 ft deepening

Appendix B3

SENSITIVITY ANALYSIS #1: 3 ft DEEPENING BATHYMETRY, 2004 POINT SOURCES LOADS, 1997 HYDROLOGICAL AND METEOROLOGICAL CONDITIONS

May 1 – October 30, 1997 Simulation Period

Water Quality Review Group

1. Table B3.1. Dissolved oxygen percentiles distribution in Critical cells

Zone	D.O. Percentile (mg/l)								
	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	3.41	3.74	3.91	4.12	4.44	4.93	5.37	5.5	5.62
FR2	3	3.27	3.4	3.64	3.98	4.46	5.01	5.25	5.48
FR3	2.82	3.1	3.23	3.43	3.81	4.26	4.87	5.19	5.97
FR4	2.8	3.09	3.21	3.4	3.79	4.25	4.83	5.35	6.18
FR5	2.91	3.15	3.25	3.47	3.86	4.29	4.87	5.54	6.21
FR6	2.99	3.16	3.26	3.48	3.86	4.32	4.86	5.59	6.31
FR7	3.18	3.32	3.49	3.73	4.2	4.81	5.41	6.22	6.44
FR8	3.41	3.76	3.98	4.48	5.01	5.45	5.99	6.38	6.55
FR9	3.45	3.81	4.02	4.48	5.08	5.51	5.99	6.45	6.57
FR10	3.18	3.5	3.75	4.29	4.89	5.42	5.81	5.97	6.18
FR11	2.93	3.36	3.6	4.06	4.54	5.17	5.69	5.88	6.01
MR1	3.24	3.41	3.55	3.81	4.21	4.66	5.09	5.64	6.31
MR2	2.82	3.1	3.27	3.63	4.09	4.6	5.01	5.29	6.2
MR3	2.63	2.8	2.94	3.22	3.66	4.33	4.87	5.16	5.95
MR4	2.75	3.01	3.13	3.38	3.68	4.14	4.68	5.02	5.29
MR5	0.85	1.49	1.84	2.49	4.13	5.22	5.68	5.89	6.05
MR6	1.44	2.07	2.42	3.16	4.65	5.45	5.88	6.11	6.72
LBR1	2.8	3.6	3.98	4.19	4.47	4.91	5.34	5.62	5.87
LBR2	3.12	3.26	3.35	3.49	3.7	4.15	4.51	4.99	5.21
LBR3	2.16	2.45	2.64	3.01	3.43	3.91	4.36	4.5	4.86
BR1	2.46	2.69	2.83	3.08	3.46	3.98	4.52	4.79	5.11
BR2	1.77	2.12	2.31	2.61	2.97	3.52	4.08	4.34	4.57
BR3	2.13	2.46	2.63	2.92	3.24	3.77	4.36	4.53	4.76
SCH1	1.73	2.16	2.4	2.81	3.57	4.33	4.86	5.2	5.61
SCH2	3.11	3.39	3.6	3.91	4.21	4.67	5.09	5.3	5.51
SR	3.38	3.47	3.56	3.9	4.22	4.7	5.37	5.85	5.89

2. Table B3.2. Delta of Dissolved Oxygen percentiles distribution in Critical cells: Deepening scenario minus Existing bathymetry scenario

Zone	Delta D.O. Percentile																	
	1%		5%		10%		25%		50%		75%		90%		95%		99	
	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%
FR1	0	0.0	0	0.0	0	0.0	-0.01	-0.2	-0.02	-0.4	0	0.0	0.01	0.2	0	0.0	-0.04	-0.7
FR2	-0.03	-1.0	-0.03	-0.9	0	0.0	-0.01	-0.3	-0.03	-0.7	0.01	0.2	0.02	0.4	-0.03	-0.6	-0.29	-5.0
FR3	-0.02	-0.7	-0.05	-1.6	-0.02	-0.6	-0.01	-0.3	-0.03	-0.8	-0.02	-0.5	0.01	0.2	-0.14	-2.6	-0.21	-3.4
FR4	-0.02	-0.7	0	0.0	-0.01	-0.3	-0.04	-1.2	-0.06	-1.6	-0.06	-1.4	0	0.0	-0.13	-2.4	-0.04	-0.6
FR5	0	0.0	0.03	1.0	-0.01	-0.3	-0.06	-1.7	-0.08	-2.0	-0.13	-2.9	0	0.0	-0.26	-4.5	-0.02	-0.3
FR6	-0.02	-0.7	-0.05	-1.6	-0.1	-3.0	-0.17	-4.7	-0.24	-5.9	-0.37	-7.9	-0.36	-6.9	-0.57	-9.3	0	0.0
FR7	-0.27	-7.8	-0.48	-12.6	-0.52	-13.0	-0.71	-16.0	-0.73	-14.8	-0.54	-10.1	-0.49	-8.3	-0.18	-2.8	-0.11	-1.7
FR8	-0.06	-1.7	-0.1	-2.6	-0.14	-3.4	-0.2	-4.3	-0.13	-2.5	-0.06	-1.1	-0.05	-0.8	-0.01	-0.2	0.02	0.3
FR9	-0.9	-20.7	-0.96	-20.1	-0.98	-19.6	-0.79	-15.0	-0.4	-7.3	-0.32	-5.5	-0.29	-4.6	-0.04	-0.6	-0.02	-0.3
FR10	0.01	0.3	0	0.0	0.01	0.3	0	0.0	0	0.0	0	0.0	0	0.0	0.01	0.2	0.03	0.5
FR11	0.06	2.1	0.01	0.3	0.01	0.3	0	0.0	0.01	0.2	0	0.0	0	0.0	-0.01	-0.2	0.02	0.3
MR1	-0.04	-1.2	-0.05	-1.4	-0.06	-1.7	-0.1	-2.6	-0.1	-2.3	-0.14	-2.9	-0.08	-1.5	-0.08	-1.4	-0.01	-0.2
MR2	-0.02	-0.7	-0.03	-1.0	-0.03	-0.9	-0.05	-1.4	-0.09	-2.2	-0.11	-2.3	-0.08	-1.6	-0.08	-1.5	-0.04	-0.6
MR3	-0.05	-1.9	-0.12	-4.1	-0.14	-4.5	-0.24	-6.9	-0.29	-7.3	-0.19	-4.2	-0.06	-1.2	-0.01	-0.2	0.02	0.3
MR4	0	0.0	0.01	0.3	-0.01	-0.3	-0.01	-0.3	-0.02	-0.5	-0.01	-0.2	-0.01	-0.2	-0.03	-0.6	0.02	0.4
MR5	-0.05	-5.6	-0.03	-2.0	-0.02	-1.1	0	0.0	-0.01	-0.2	0.01	0.2	0.01	0.2	0.01	0.2	0.01	0.2
MR6	0.02	1.4	0.04	2.0	0.03	1.3	0.04	1.3	0.02	0.4	0.02	0.4	0.01	0.2	0.01	0.2	0	0.0
LBR1	-0.08	-2.8	-0.01	-0.3	0.02	0.5	0.02	0.5	0.02	0.4	0.02	0.4	0.01	0.2	0.01	0.2	0	0.0
LBR2	0	0.0	0	0.0	0.01	0.3	0.02	0.6	0.02	0.5	0.01	0.2	-0.01	-0.2	0.02	0.4	0.03	0.6
LBR3	0.06	2.9	0.07	2.9	0.09	3.5	0.13	4.5	0.13	3.9	0.1	2.6	0.05	1.2	0.05	1.1	0.05	1.0
BR1	0.01	0.4	0.01	0.4	0.01	0.4	0	0.0	-0.01	-0.3	0	0.0	0.01	0.2	0.01	0.2	-0.02	-0.4
BR2	-0.07	-3.8	-0.07	-3.2	-0.08	-3.3	-0.18	-6.5	-0.22	-6.9	-0.2	-5.4	-0.15	-3.5	-0.22	-4.8	-0.43	-8.6
BR3	0.02	0.9	0.03	1.2	0.02	0.8	0.02	0.7	0.01	0.3	0	0.0	0.01	0.2	0.02	0.4	0.02	0.4
SCH1	0.02	1.2	-0.02	-0.9	0.01	0.4	0.01	0.4	-0.06	-1.7	-0.06	-1.4	-0.05	-1.0	-0.06	-1.1	-0.03	-0.5
SCH2	-0.03	-1.0	-0.03	-0.9	-0.03	-0.8	-0.04	-1.0	-0.02	-0.5	-0.01	-0.2	-0.02	-0.4	-0.02	-0.4	-0.05	-0.9
SR	0	0.0	0.01	0.3	0	0.0	0	0.0	0	0.0	0.01	0.2	0	0.0	0	0.0	0	0.0

3. Table B3.3. Dissolved oxygen percentiles distribution in Zones of Savannah Estuary

Zone	D.O. Concentration Percentiles (mg/l)								
Name	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	3.77	4.07	4.22	4.41	4.69	5.20	5.59	5.69	5.81
FR2	3.35	3.59	3.78	4.00	4.30	4.78	5.27	5.42	5.55
FR3	3.00	3.25	3.41	3.63	3.96	4.43	5.03	5.24	5.61
FR4	2.86	3.15	3.25	3.45	3.83	4.23	4.90	5.25	6.21
FR5	2.96	3.18	3.27	3.46	3.85	4.29	4.86	5.44	6.26
FR6	3.11	3.22	3.37	3.58	3.98	4.43	4.86	5.73	6.32
FR7	3.29	3.57	3.73	4.08	4.65	5.15	5.66	6.31	6.45
FR8	3.47	3.82	4.03	4.48	4.99	5.39	5.87	6.39	6.53
FR9	3.96	4.39	4.67	5.10	5.42	5.77	6.22	6.46	6.60
FR10	4.67	4.87	4.98	5.19	5.43	5.80	6.15	6.30	6.46
FR11	3.63	3.83	4.01	4.26	4.59	5.00	5.54	5.92	6.01
MR1	3.31	3.48	3.62	3.84	4.22	4.65	5.11	5.70	6.29
MR2	3.00	3.26	3.40	3.72	4.12	4.59	5.02	5.42	6.22
MR3	2.77	2.95	3.09	3.40	3.85	4.39	4.86	5.10	5.82
MR4	3.41	3.53	3.63	3.82	4.07	4.50	4.94	5.26	5.48
MR5	1.45	1.99	2.32	2.95	4.47	5.16	5.62	5.85	6.00
MR6	1.48	2.10	2.45	3.20	4.69	5.39	5.82	6.03	6.59
LBR1	3.48	3.61	3.69	3.84	4.03	4.50	4.84	5.31	5.47
LBR2	2.69	2.90	3.01	3.20	3.48	3.93	4.33	4.80	5.04
LBR3	2.54	2.66	2.77	2.94	3.18	3.69	4.21	4.39	4.57
BR1	2.77	2.96	3.04	3.25	3.60	4.11	4.63	4.94	5.24
BR2	2.38	2.63	2.75	2.95	3.27	3.81	4.40	4.60	4.90
BR3	2.47	2.66	2.76	2.94	3.19	3.76	4.32	4.43	4.59
SCh1	2.78	3.06	3.35	3.57	3.85	4.39	4.95	5.10	5.25
SCh2	3.29	3.49	3.78	4.01	4.29	4.77	5.19	5.37	5.52
SR	3.70	3.76	3.81	4.14	4.44	4.90	5.54	5.97	6.00

4. Table B3.4. Delta of Dissolved Oxygen percentiles distribution in Zones of Savannah Estuary: Deepening scenario minus Existing bathymetry scenario

Zone	Project - Baseline Difference (mg/l)									Project - Baseline Relative Difference (%)								
Name	1%	5%	10%	25%	50%	75%	90%	95%	99%	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	0.02	0.00	0.00	0.00	-0.01	0.02	0.02	0.01	0.02	0.5	0.0	0.0	-0.1	-0.2	0.3	0.3	0.2	0.4
FR2	-0.01	0.01	0.02	0.00	0.00	0.01	0.03	-0.02	-0.04	-0.2	0.2	0.5	0.1	0.0	0.3	0.6	-0.3	-0.8
FR3	-0.01	-0.03	0.01	0.02	-0.02	0.03	0.05	-0.03	-0.43	-0.3	-0.8	0.2	0.6	-0.6	0.7	1.0	-0.6	-7.2
FR4	-0.03	-0.02	-0.02	-0.01	-0.04	-0.08	0.04	-0.14	-0.04	-0.9	-0.6	-0.7	-0.3	-1.2	-1.9	0.8	-2.5	-0.7
FR5	-0.01	0.01	-0.04	-0.08	-0.09	-0.14	-0.01	-0.30	-0.03	-0.5	0.4	-1.2	-2.3	-2.3	-3.1	-0.3	-5.3	-0.5
FR6	-0.01	-0.02	-0.07	-0.11	-0.13	-0.23	-0.20	-0.35	-0.02	-0.3	-0.6	-2.1	-2.9	-3.2	-4.8	-4.0	-5.7	-0.3
FR7	-0.03	-0.11	-0.13	-0.22	-0.24	-0.14	-0.10	-0.04	0.00	-1.0	-2.9	-3.4	-5.2	-4.9	-2.7	-1.8	-0.6	0.1
FR8	-0.13	-0.17	-0.22	-0.23	-0.18	-0.13	-0.10	0.00	0.00	-3.6	-4.2	-5.1	-4.9	-3.4	-2.3	-1.6	0.0	0.0
FR9	-0.23	-0.25	-0.24	-0.15	-0.07	-0.07	-0.04	-0.01	0.00	-5.6	-5.4	-4.9	-2.9	-1.2	-1.2	-0.7	-0.2	0.0
FR10	-0.01	-0.01	-0.01	-0.02	-0.01	0.00	-0.01	0.00	0.00	-0.2	-0.2	-0.2	-0.3	-0.1	-0.1	-0.2	0.0	0.0
FR11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.1	-0.1	-0.1	0.0	0.0	0.1	0.0	0.0	0.0
MR1	-0.03	-0.06	-0.08	-0.11	-0.12	-0.15	-0.08	-0.10	-0.03	-0.8	-1.7	-2.2	-2.8	-2.9	-3.2	-1.5	-1.7	-0.5
MR2	-0.04	-0.04	-0.04	-0.07	-0.12	-0.13	-0.10	-0.03	-0.05	-1.3	-1.2	-1.3	-1.9	-2.9	-2.7	-2.0	-0.5	-0.7
MR3	0.01	0.00	-0.01	-0.03	-0.05	-0.06	-0.05	-0.04	-0.01	0.2	0.1	-0.3	-0.8	-1.4	-1.3	-1.0	-0.8	-0.1
MR4	0.01	0.01	0.01	0.01	0.01	0.01	0.00	-0.01	0.00	0.3	0.3	0.2	0.3	0.2	0.3	0.1	-0.2	0.0
MR5	0.01	0.02	0.04	0.04	0.00	0.00	0.00	0.00	0.01	0.6	0.9	1.6	1.3	0.1	0.1	0.1	0.0	0.2
MR6	0.02	0.03	0.05	0.03	0.00	0.01	0.01	0.00	0.00	1.0	1.5	2.1	0.9	0.1	0.2	0.2	0.0	-0.1
LBR1	0.01	0.01	0.01	0.02	0.02	0.01	0.00	0.02	0.02	0.3	0.2	0.4	0.5	0.5	0.2	0.1	0.3	0.3
LBR2	-0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.02	0.01	-0.3	0.0	0.1	0.3	0.3	0.1	-0.1	0.4	0.2
LBR3	0.06	0.07	0.06	0.06	0.06	0.06	0.05	0.00	0.02	2.3	2.6	2.2	2.2	1.8	1.6	1.1	0.1	0.5
BR1	0.00	0.01	0.00	-0.01	-0.02	-0.01	0.01	-0.03	-0.05	0.0	0.2	0.0	-0.3	-0.5	-0.1	0.3	-0.5	-1.0
BR2	0.01	0.00	0.00	0.00	0.01	0.01	0.02	0.02	-0.01	0.5	0.2	0.2	0.2	0.2	0.3	0.4	0.5	-0.3
BR3	0.03	0.03	0.03	0.03	0.02	0.00	0.03	0.03	0.06	1.4	1.3	1.1	0.9	0.6	0.0	0.7	0.7	1.3
SCh1	0.01	-0.01	0.00	-0.01	0.00	0.01	0.02	0.00	0.01	0.4	-0.3	0.0	-0.2	-0.1	0.3	0.3	0.1	0.1
SCh2	0.00	-0.02	0.00	-0.02	-0.01	0.00	0.00	-0.01	-0.02	0.2	-0.5	0.0	-0.4	-0.3	0.0	-0.1	-0.2	-0.3
SR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0

5. Table B3.5. Percentage of the volume of waters with violation of Dissolved Oxygen standards for Zones of Savannah Estuary within the period of May 1 – October 30, 1997: Deepening (Project) and Existing (Baseline) bathymetry

Zones	D.O. STANDARDS														
	1-Day Average			7-Day Average			30-Day Average			GA MINIMUM D.O.			SC MINIMUM D.O.		
	Baseline(B)	Project(P)	Delta=P-B	Baseline(B)	Project(P)	Delta=P-B	Baseline(B)	Project(P)	Delta=P-B	Baseline(B)	Project(P)	Delta=P-B	Baseline(B)	Project(P)	Delta=P-B
FR1	0	0	0	0	0	0	0	0	0	0	0	0	4	4	0
FR2	0	0	0	0	0	0	0	0	0	0	0	0	17	17	0
FR3	0	0	0	0	0	0	3	4	1	0	0	0	N/A	N/A	N/A
FR4	0	0	0	0	0	0	5	7	2	0	0	0	N/A	N/A	N/A
FR5	0	0	0	0	0	0	3	5	2	0	0	0	N/A	N/A	N/A
FR6	0	0	0	0	0	0	1	3	2	0	0	0	N/A	N/A	N/A
FR7	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
FR8	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
FR9	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
FR10	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
FR11	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0
MR1	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
MR2	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
MR3	0	0	0	0	0	0	3	4	1	1	1	0	N/A	N/A	N/A
MR4	0	0	0	0	0	0	1	1	0	0	0	0	N/A	N/A	N/A
MR5	0	0	0	0	0	0	2	1	-1	4	4	0	9	9	0
MR6	0	0	0	0	0	0	0	0	0	2	2	0	7	7	0
LBR1	0	0	0	0	0	0	1	1	0	0	0	0	11	11	0
LBR2	0	0	0	2	1	-1	11	11	0	3	3	0	25	25	0
LBR3	0	0	0	6	5	-1	21	21	0	8	7	-1	36	37	1
BR1	0	0	0	1	2	1	18	19	1	2	2	0	50	51	1
BR2	0	0	0	6	6	0	36	36	0	7	7	0	60	61	1
BR3	0	0	0	9	8	-1	35	36	1	11	10	-1	57	58	1
SCh1	0	0	0	2	2	0	6	6	0	3	3	0	N/A	N/A	N/A
SCh2	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
SR	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0

26. Table B3.6. Percentage of water volumes with salinity in %iles within the period of May 1 – October 30, 1997

Percen-tile	Harbor / River			Stations					
	Upper Hrb %	Middle Rvr %	Back Rvr %	Houlih Brg %	Broad Str %	Pulaski Frt %	Lucknow Cnl %	USF&W Dck %	I-95 Brg %
5	21.1	7.1	4.7	5.7	4.5	4.3	9.3	5.2	95.5
10	25	10.7	9.2	9.9	9.1	8.6	9.3	9.9	95.5
25	37.1	22.4	22.9	23	23.1	22.1	23.4	20.7	95.5
50	57.8	44	47	47.1	47.7	46.1	49.3	43.7	95.5
75	79.3	69.6	72.8	72.8	73.3	72.9	72.4	69.7	95.5
90	91.3	87.3	88.9	89	89.2	89.2	89	87.4	95.5
95	95.3	93.5	94.4	94.5	94.5	94.6	94.4	93.7	95.5
Total Volume 100*km3:	32564.8	653.2	4770.8	24.8	39	135.5	9.9	9.4	43.6

27. Table B3.7. Percentage of water volumes with D.O. in %iles within the period of May 1 – October 30, 1997

Percen-tile	Harbor / River			Stations					
	Upper Hrb %	Middle Rvr %	Back Rvr %	Houlih Brg %	Broad Str %	Pulaski Frt %	Lucknow Cnl %	USF&W Dck %	I-95 Brg %
5	5.3	5.1	5	5.7	5.5	4.7	5.7	5.6	5.8
10	10.6	10.1	10	11.2	10.8	9.6	11.2	11	11.2
25	26.2	24.5	25	27.5	26.2	24.2	26.4	26.3	26.5
50	52	49.3	50.1	53.2	51.5	49.5	50.6	51	51.1
75	76.3	74.6	75.4	76.8	75.9	74.7	75.7	75.8	75.9
90	90.4	89.8	90.2	90.4	90.3	90	90.1	90.4	90.2
95	95.1	94.7	95	95.5	95.4	94.9	95.1	95.3	95.2
Total Volume 100*km3:	32564.8	653.2	4770.8	24.8	39	135.5	9.9	9.4	43.6

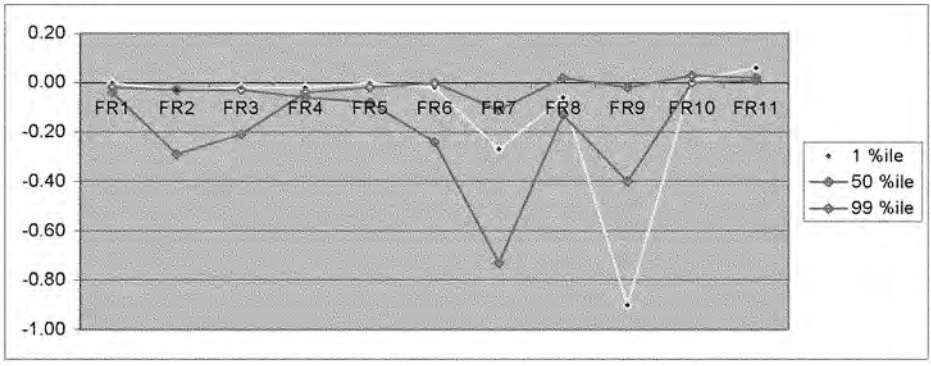
28. Table B3.8. Water volumes in Upper Harbor in increments of 1° C of water temperature within the period of May 1 – October 30, 1997

Temperature C°	Total Volume %
17	0.11
18	0.46
19	1.27
20	4.39
21	12.97
22	17.69
23	22.31
24	32.56
25	42.94
26	50.88
27	62.05
28	81.56
29	94
30	99.83
31	100

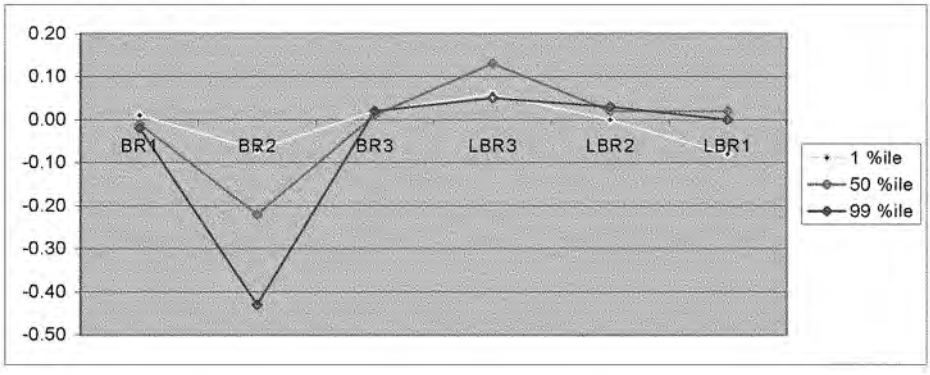
29. Table B3.9. Water volumes in Upper Harbor in increments of 0.1 mg/l of D.O. within the period of May 1 – October 30, 1997
(See file: Postprocessor Output\S13\97-S13_DO Increment Volume)

30. Table B3.10. Percentage of water volumes corresponding to 1-, 7-, and 30-days averages of D.O. depth-averaged concentrations in Upper Harbor within the period of May 1 – October 30, 1997
(See file: Postprocessor Output\S13\97-S13_volume DO in averages)

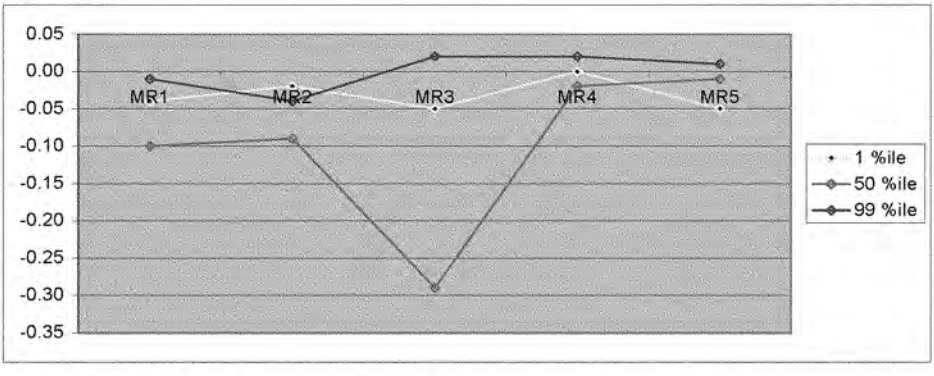
Front River



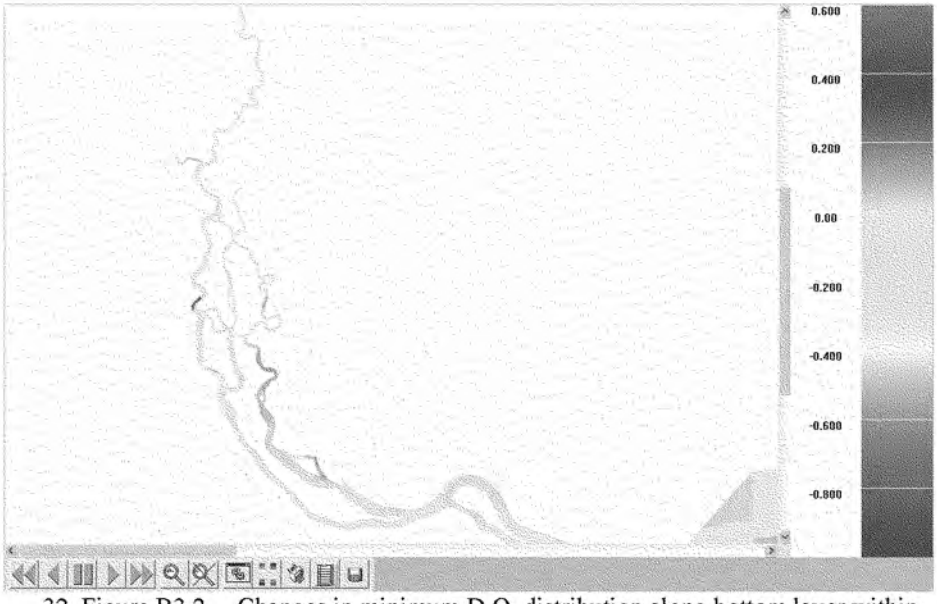
Back and Little Back Rivers



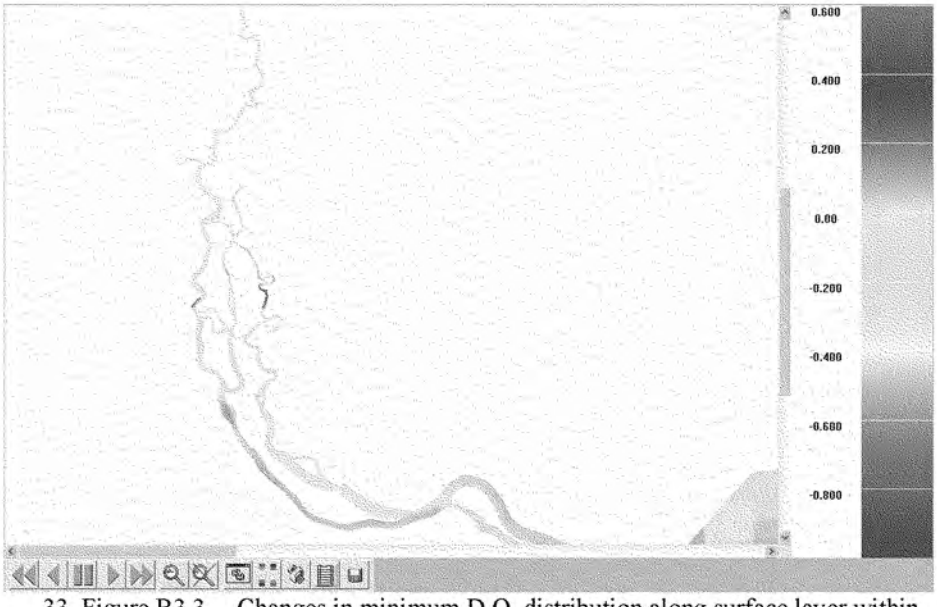
Middle River



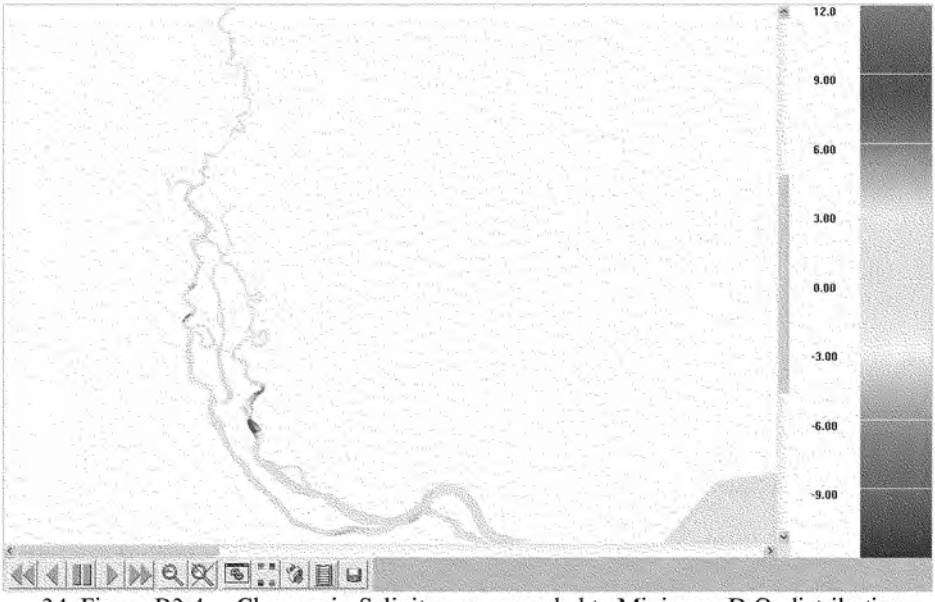
31. Figure B3.1. Changes in longitudinal profile of Dissolved Oxygen (mg/l) distribution along Critical cells of Savannah Estuary: 3 ft deepening



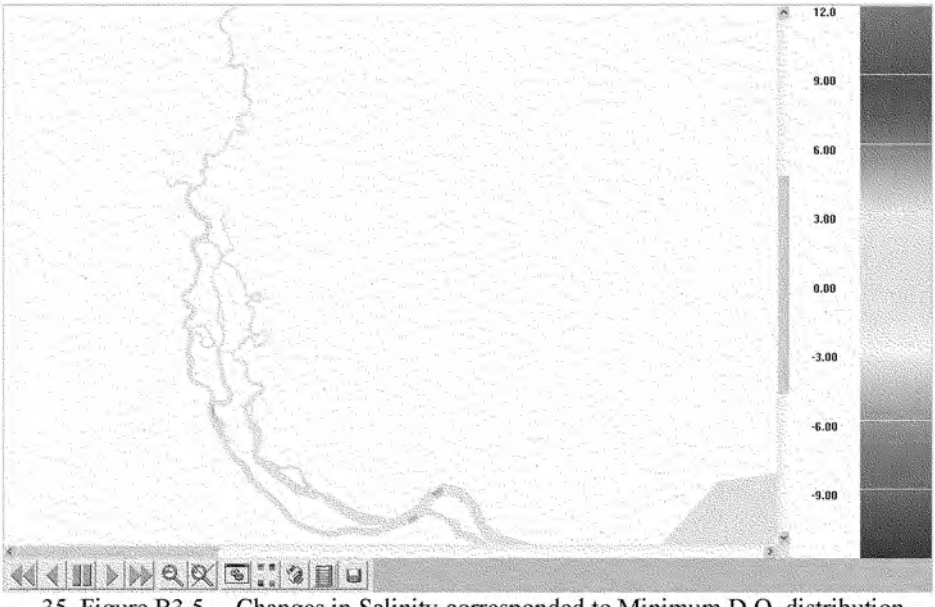
32. Figure B3.2. Changes in minimum D.O. distribution along bottom layer within the analyzed period of May 1 - October 30, 1997: 3 ft deepening



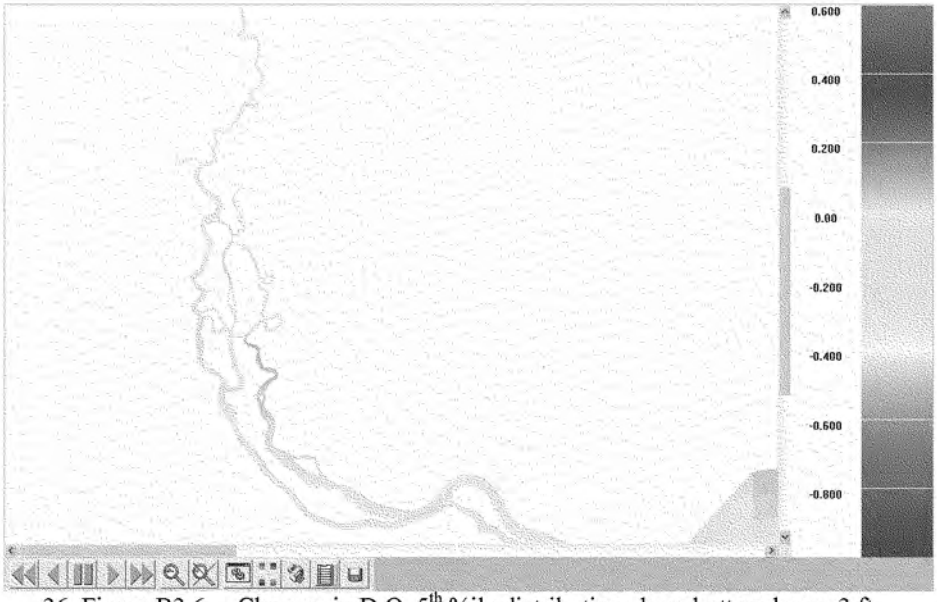
33. Figure B3.3. Changes in minimum D.O. distribution along surface layer within the analyzed period of May 1 - October 30, 1997: 3 ft deepening



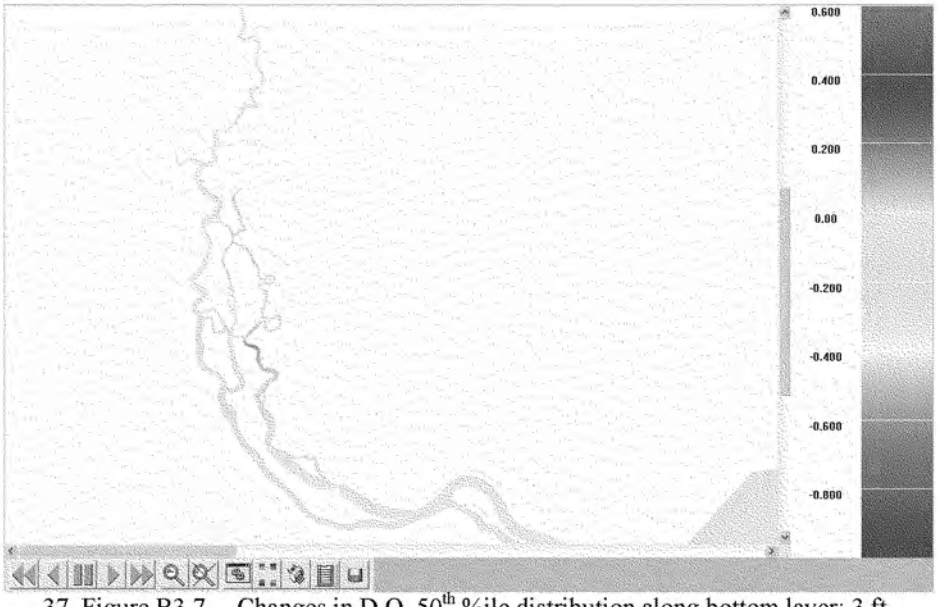
34. Figure B3.4. Changes in Salinity corresponded to Minimum D.O. distribution along bottom layer within the analyzed period of May 1 - October 30, 1997: 3 ft deepening



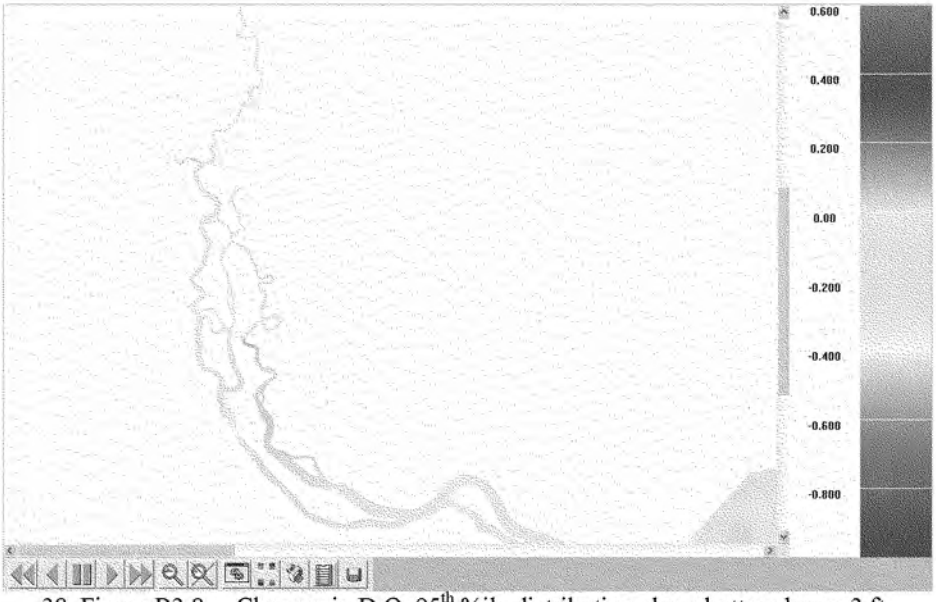
35. Figure B3.5. Changes in Salinity corresponded to Minimum D.O. distribution along Surface layer within the analyzed period of May 1 - October 30, 1997: 3 ft deepening



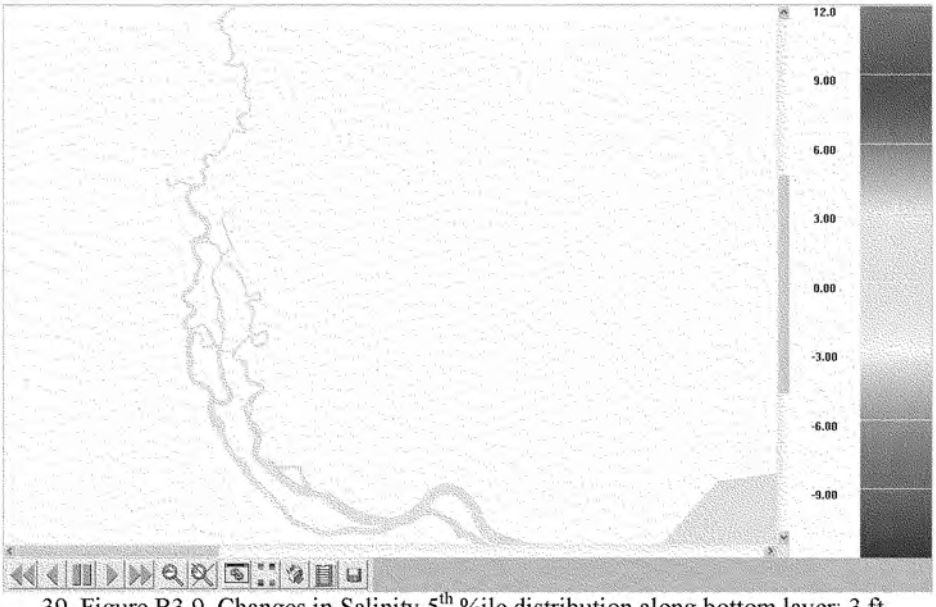
36. Figure B3.6. Changes in D.O. 5th %ile distribution along bottom layer: 3 ft deepening



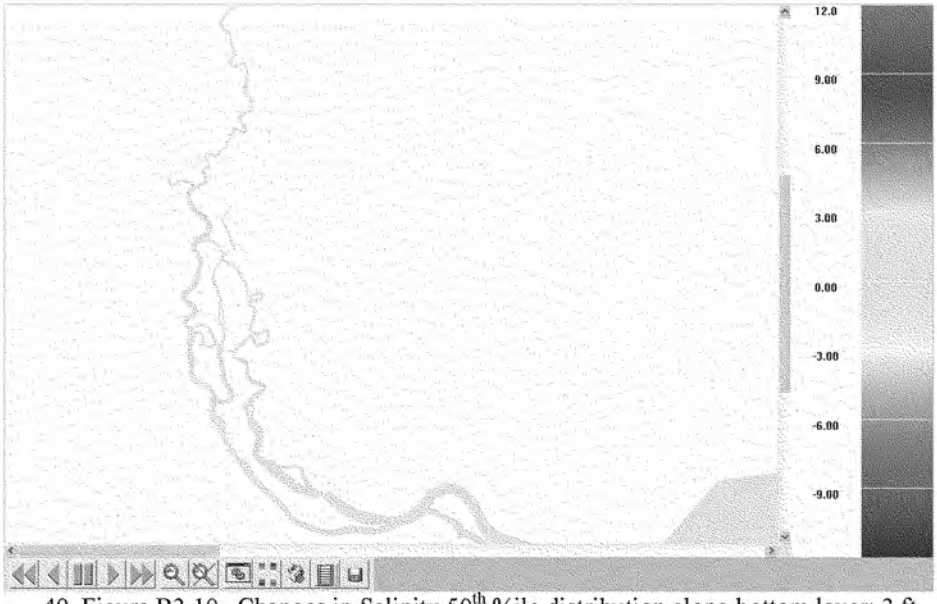
37. Figure B3.7. Changes in D.O. 50th %ile distribution along bottom layer: 3 ft deepening



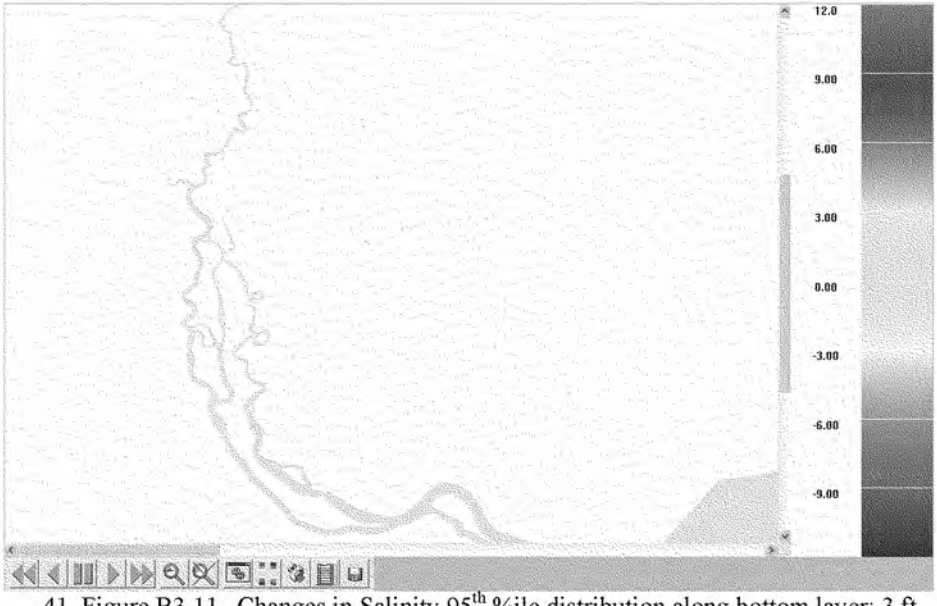
38. Figure B3.8. Changes in D.O. 95th %ile distribution along bottom layer: 3 ft deepening



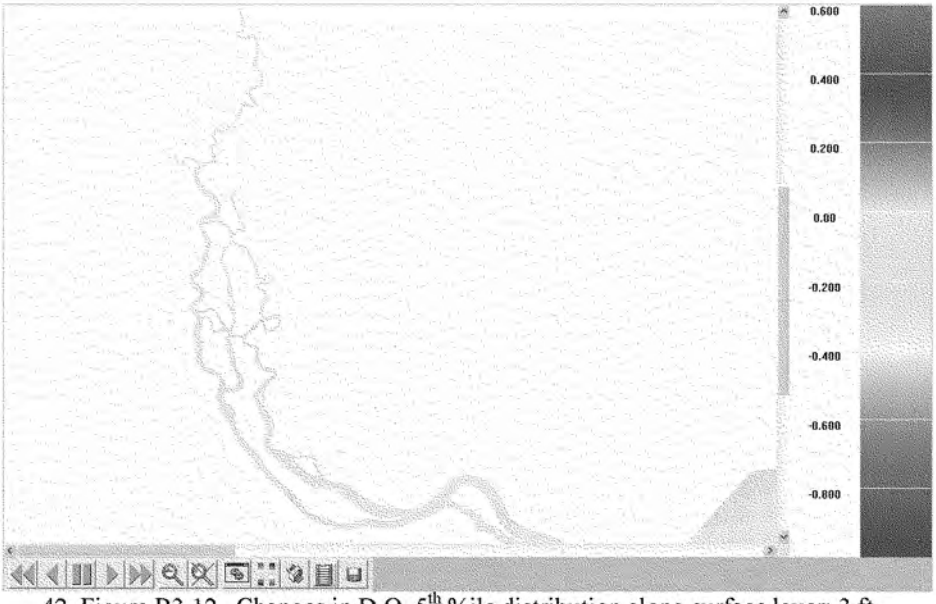
39. Figure B3.9. Changes in Salinity 5th %ile distribution along bottom layer: 3 ft deepening



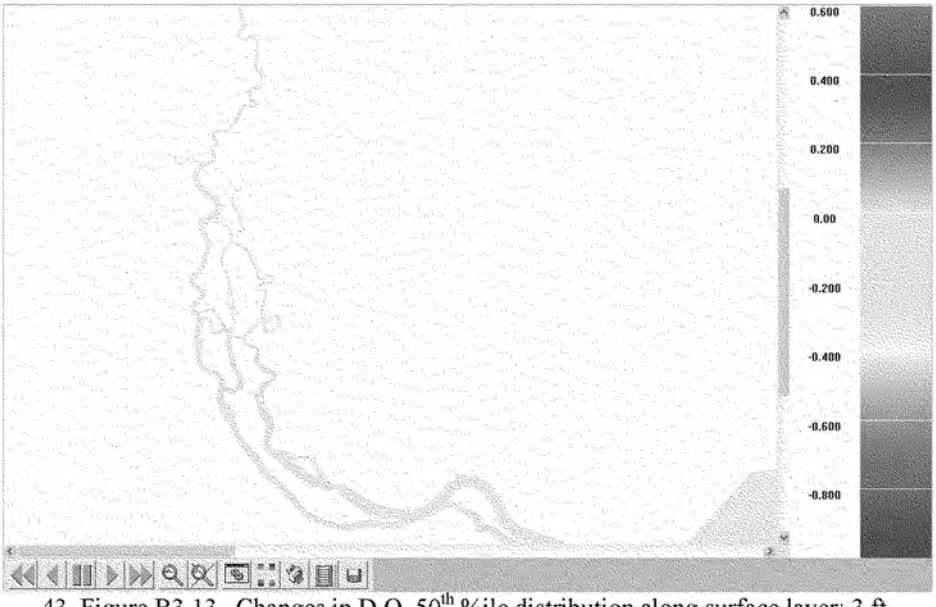
40. Figure B3.10. Changes in Salinity 50th %ile distribution along bottom layer: 3 ft deepening



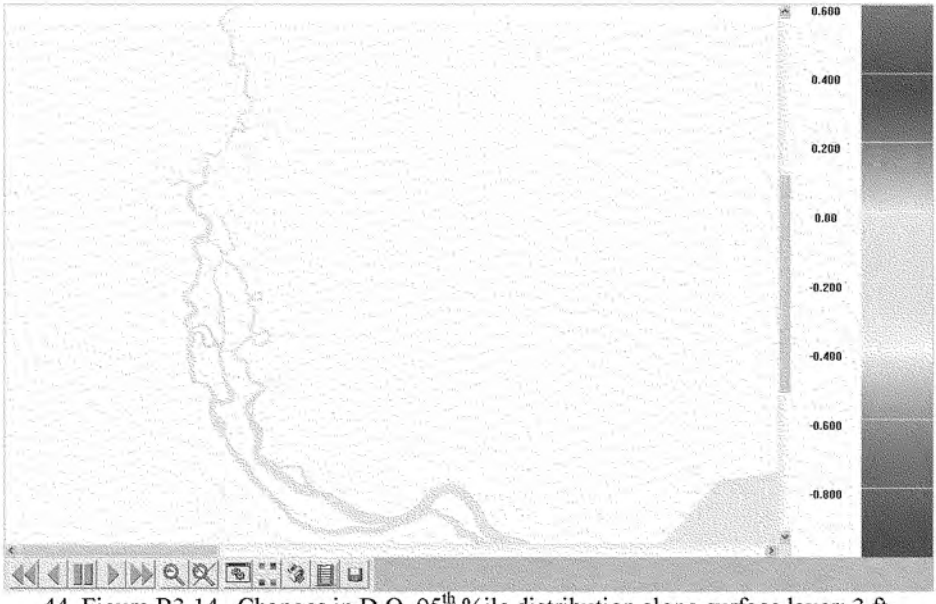
41. Figure B3.11. Changes in Salinity 95th %ile distribution along bottom layer: 3 ft deepening



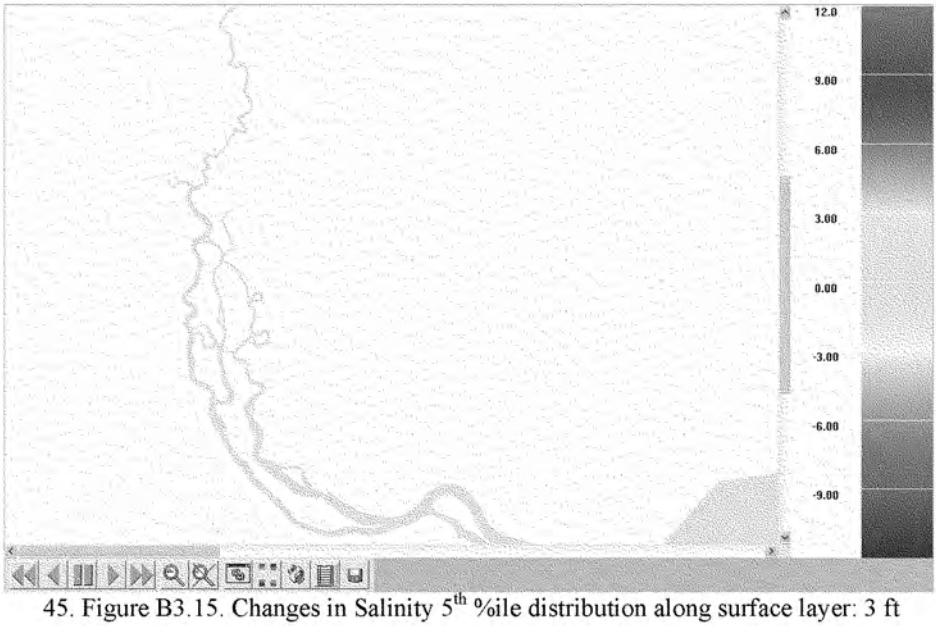
42. Figure B3.12. Changes in D.O. 5th %ile distribution along surface layer: 3 ft deepening



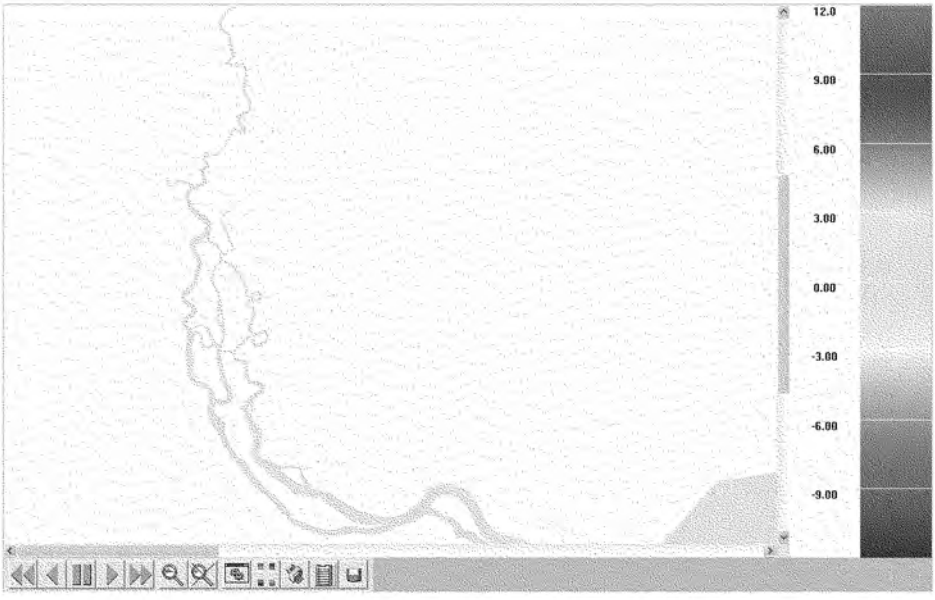
43. Figure B3.13. Changes in D.O. 50th %ile distribution along surface layer: 3 ft deepening



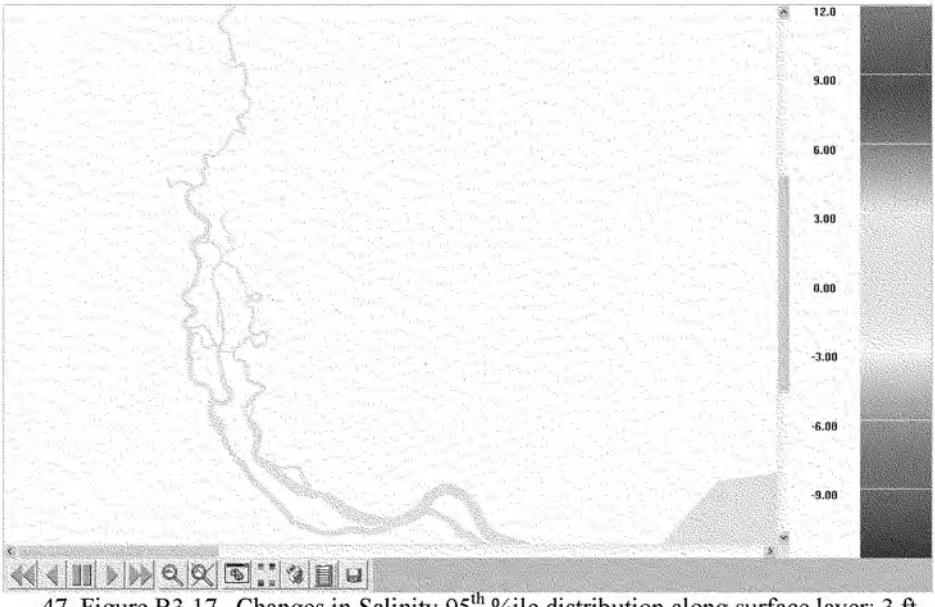
44. Figure B3.14. Changes in D.O. 95th %ile distribution along surface layer: 3 ft deepening



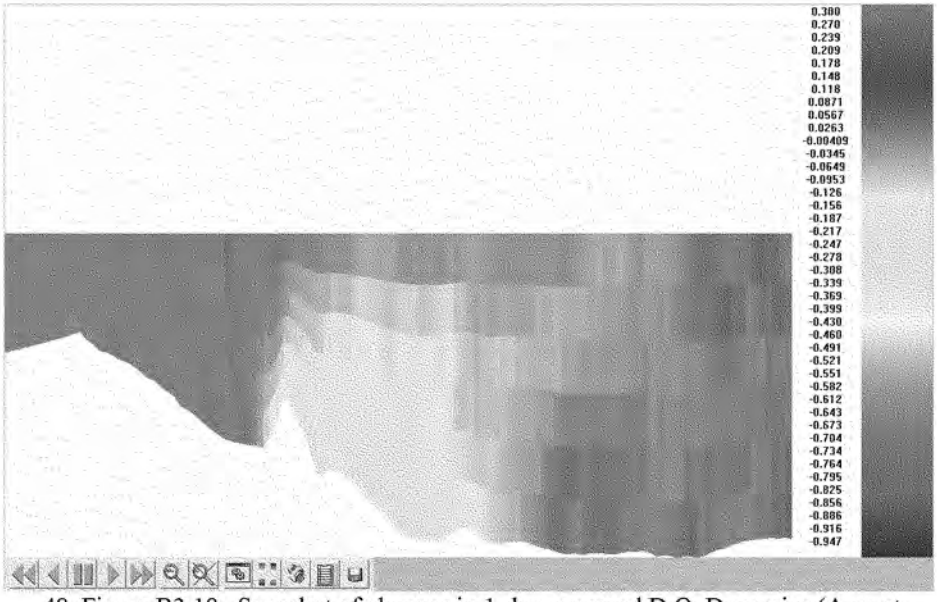
45. Figure B3.15. Changes in Salinity 5th %ile distribution along surface layer: 3 ft deepening



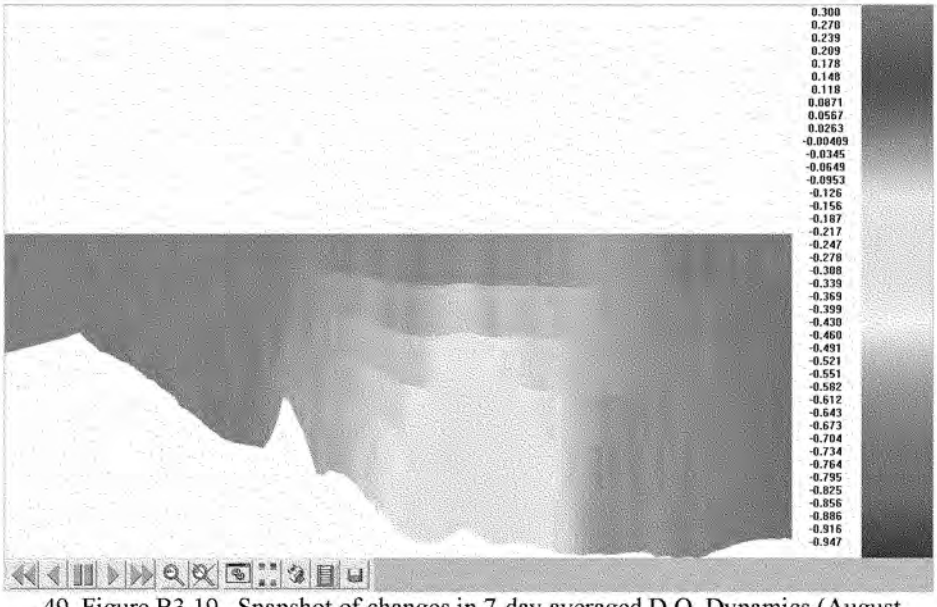
46. Figure B3.16. Changes in Salinity 50th %ile distribution along surface layer: 3 ft deepening



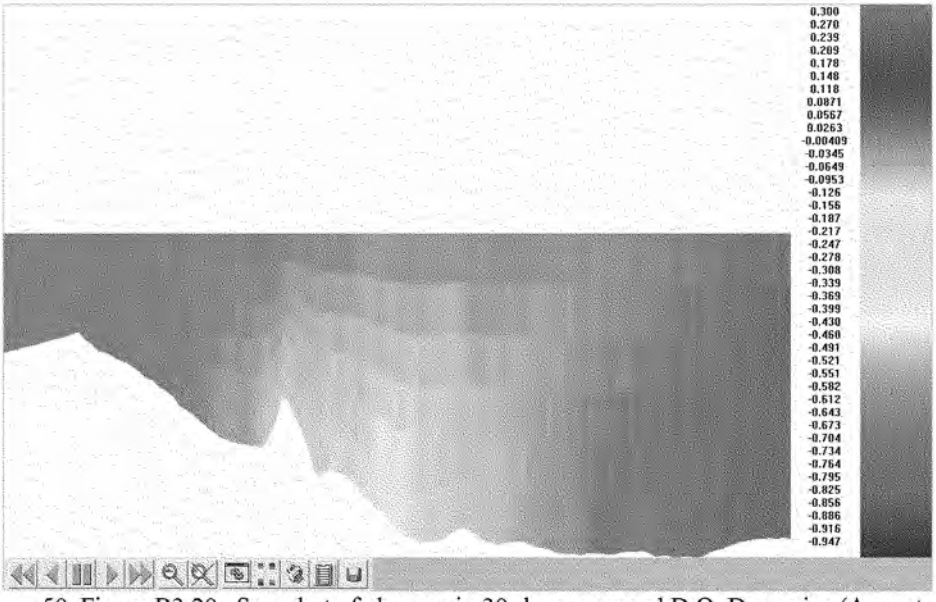
47. Figure B3.17. Changes in Salinity 95th %ile distribution along surface layer: 3 ft deepening



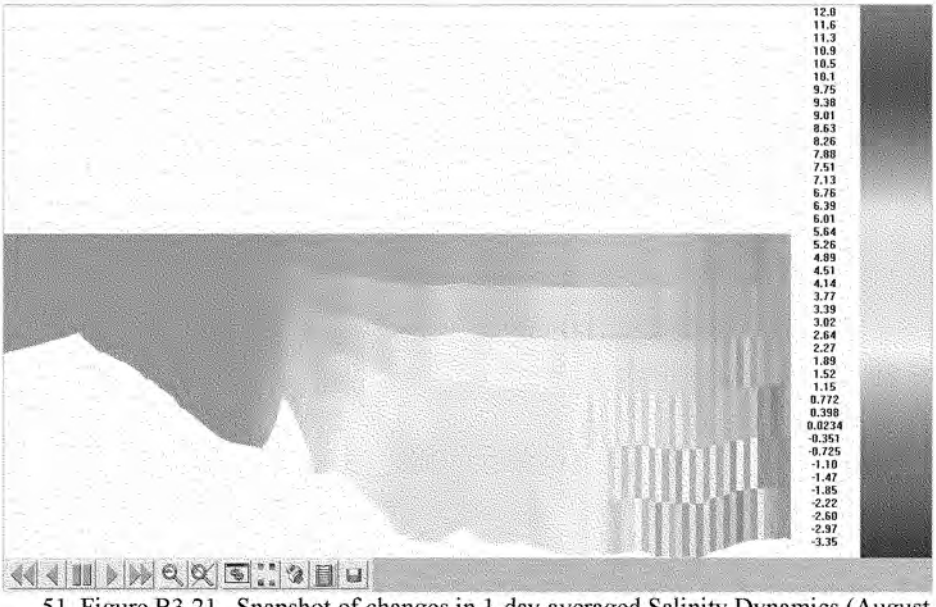
48. Figure B3.18. Snapshot of changes in 1-day averaged D.O. Dynamics (August 10, 1997) in vertical plane of Upper Harbor: 3 ft deepening



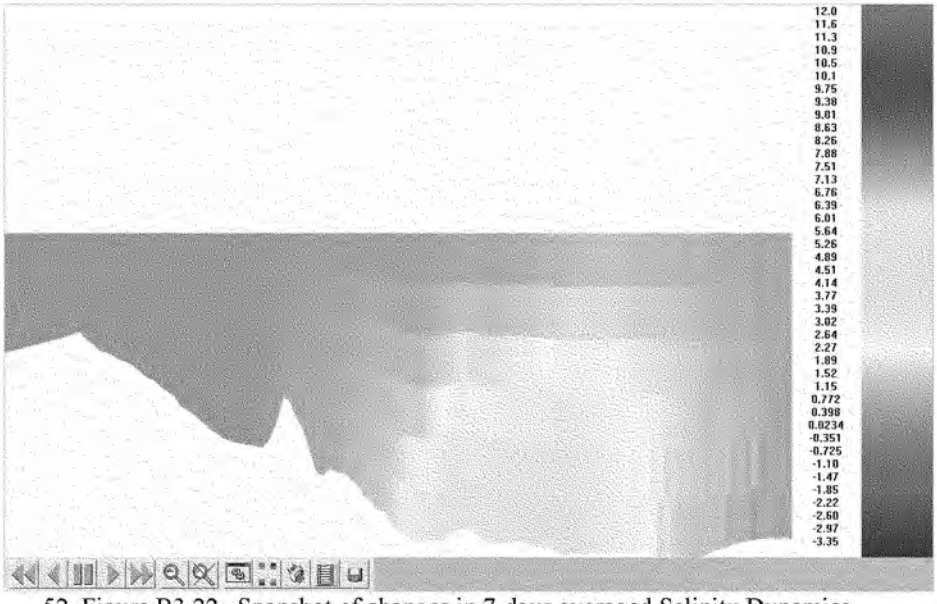
49. Figure B3.19. Snapshot of changes in 7-day averaged D.O. Dynamics (August 10, 1997) in vertical plane of Upper Harbor: 3 ft deepening



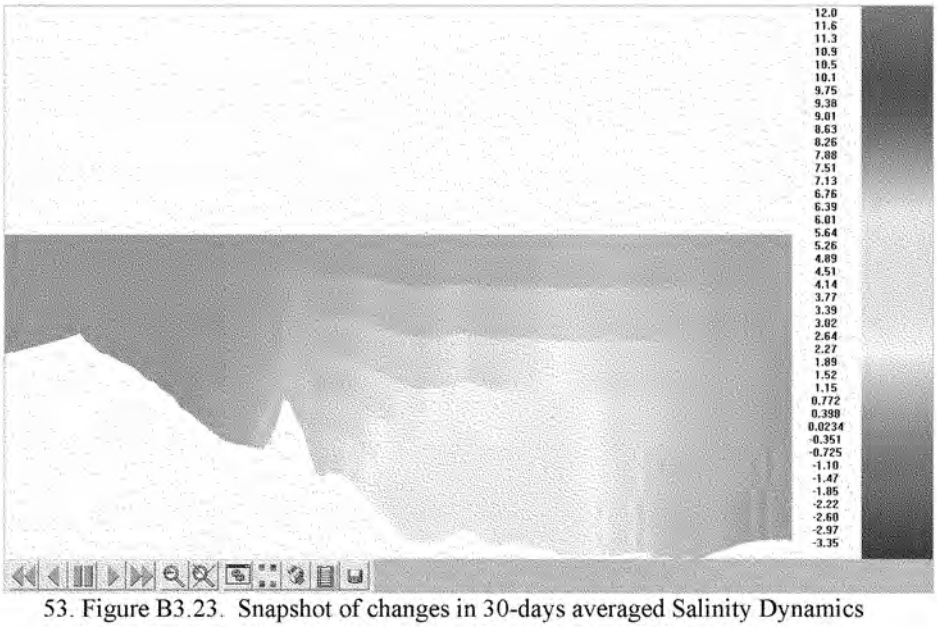
50. Figure B3.20. Snapshot of changes in 30-days averaged D.O. Dynamics (August 10, 1997) in vertical plane of Upper Harbor: 3 ft deepening



51. Figure B3.21. Snapshot of changes in 1-day averaged Salinity Dynamics (August 10, 1997) in vertical plane of Upper Harbor: 3 ft deepening



52. Figure B3.22. Snapshot of changes in 7-days averaged Salinity Dynamics (August 10, 1997) in vertical plane of Upper Harbor: 3 ft deepening



53. Figure B3.23. Snapshot of changes in 30-days averaged Salinity Dynamics (August 10, 1997) in vertical plane of Upper Harbor: 3 ft deepening

Appendix B4

SENSITIVITY ANALYSIS #1: 2 ft DEEPENING BATHYMETRY, 2004 POINT SOURCES LOADS, 1997 HYDROLOGICAL AND METEOROLOGICAL CONDITIONS

May 1 – October 30, 1997 Simulation Period

Water Quality Review Group

1. Table B4.1. Dissolved oxygen percentiles distribution in Critical cells

Zone	D.O. Percentile (mg/l)								
	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	3.43	3.77	3.91	4.12	4.45	4.92	5.37	5.49	5.66
FR2	3.02	3.28	3.4	3.64	3.99	4.45	5	5.25	5.53
FR3	2.83	3.12	3.21	3.41	3.81	4.26	4.84	5.31	6.15
FR4	2.82	3.1	3.22	3.41	3.81	4.26	4.83	5.39	6.2
FR5	2.95	3.17	3.26	3.5	3.89	4.32	4.85	5.57	6.29
FR6	2.99	3.15	3.26	3.5	3.9	4.38	4.89	5.69	6.32
FR7	3.34	3.7	3.86	4.26	4.78	5.23	5.82	6.38	6.53
FR8	3.41	3.8	4.04	4.55	5.06	5.47	6.02	6.39	6.53
FR9	3.99	4.48	4.82	5.2	5.48	5.83	6.3	6.47	6.59
FR10	3.18	3.5	3.75	4.29	4.89	5.42	5.81	5.97	6.17
FR11	2.91	3.36	3.6	4.06	4.54	5.17	5.69	5.89	6
MR1	3.25	3.42	3.57	3.85	4.23	4.7	5.1	5.68	6.3
MR2	2.82	3.11	3.28	3.65	4.12	4.63	5.04	5.32	6.22
MR3	2.62	2.8	2.93	3.22	3.67	4.34	4.89	5.18	5.94
MR4	2.74	3.01	3.13	3.38	3.69	4.14	4.67	5.03	5.28
MR5	0.85	1.48	1.84	2.48	4.11	5.22	5.67	5.89	6.05
MR6	1.43	2.06	2.42	3.15	4.64	5.44	5.88	6.11	6.72
LBR1	2.82	3.59	3.98	4.18	4.47	4.9	5.34	5.62	5.88
LBR2	2.64	2.94	3.07	3.23	3.51	3.96	4.39	4.84	5.11
LBR3	2.11	2.38	2.53	2.87	3.34	3.93	4.37	4.59	5.02
BR1	2.46	2.69	2.83	3.08	3.46	3.98	4.52	4.78	5.11
BR2	1.76	2.11	2.3	2.61	2.98	3.52	4.08	4.33	4.55
BR3	2.13	2.46	2.62	2.91	3.24	3.77	4.35	4.53	4.75
SCH1	1.75	2.14	2.39	2.82	3.61	4.36	4.88	5.22	5.63
SCH2	3.12	3.4	3.61	3.92	4.21	4.68	5.11	5.3	5.53
SR	3.38	3.47	3.56	3.9	4.22	4.7	5.37	5.85	5.89

2. Table B4.2. Delta of Dissolved Oxygen percentiles distribution in Critical cells: Deepening scenario minus Existing bathymetry scenario

Zone	Delta D.O. Percentile																	
	1%		5%		10%		25%		50%		75%		90%		95%		99%	
	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%
FR1	0.02	0.6	0.03	0.8	0	0.0	-0.01	-0.2	-0.01	-0.2	-0.01	-0.2	0.01	0.2	-0.01	-0.2	0	0.0
FR2	-0.01	-0.3	-0.02	-0.6	0	0.0	-0.01	-0.3	-0.02	-0.5	0	0.0	0.01	0.2	-0.03	-0.6	-0.24	-4.2
FR3	-0.01	-0.4	-0.03	-1.0	-0.04	-1.2	-0.03	-0.9	-0.03	-0.8	-0.02	-0.5	-0.02	-0.4	-0.02	-0.4	-0.03	-0.5
FR4	0	0.0	0.01	0.3	0	0.0	-0.03	-0.9	-0.04	-1.0	-0.05	-1.2	0	0.0	-0.09	-1.6	-0.02	-0.3
FR5	0.04	1.4	0.05	1.6	0	0.0	-0.03	-0.8	-0.05	-1.3	-0.1	-2.3	-0.02	-0.4	-0.23	-4.0	0.06	1.0
FR6	-0.02	-0.7	-0.06	-1.9	-0.1	-3.0	-0.15	-4.1	-0.2	-4.9	-0.31	-6.6	-0.33	-6.3	-0.47	-7.6	0.01	0.2
FR7	-0.11	-3.2	-0.1	-2.6	-0.15	-3.7	-0.18	-4.1	-0.15	-3.0	-0.12	-2.2	-0.08	-1.4	-0.02	-0.3	-0.02	-0.3
FR8	-0.06	-1.7	-0.06	-1.6	-0.08	-1.9	-0.13	-2.8	-0.08	-1.6	-0.04	-0.7	-0.02	-0.3	0	0.0	0	0.0
FR9	-0.36	-8.3	-0.29	-6.1	-0.18	-3.6	-0.07	-1.3	0	0.0	0	0.0	0.02	0.3	-0.02	-0.3	0	0.0
FR10	0.01	0.3	0	0.0	0.01	0.3	0	0.0	0	0.0	0	0.0	0	0.0	0.01	0.2	0.02	0.3
FR11	0.04	1.4	0.01	0.3	0.01	0.3	0	0.0	0.01	0.2	0	0.0	0	0.0	0	0.0	0.01	0.2
MR1	-0.03	-0.9	-0.04	-1.2	-0.04	-1.1	-0.06	-1.5	-0.08	-1.9	-0.1	-2.1	-0.07	-1.4	-0.04	-0.7	-0.02	-0.3
MR2	-0.02	-0.7	-0.02	-0.6	-0.02	-0.6	-0.03	-0.8	-0.06	-1.4	-0.08	-1.7	-0.05	-1.0	-0.05	-0.9	-0.02	-0.3
MR3	-0.06	-2.2	-0.12	-4.1	-0.15	-4.9	-0.24	-6.9	-0.28	-7.1	-0.18	-4.0	-0.04	-0.8	0.01	0.2	0.01	0.2
MR4	-0.01	-0.4	0.01	0.3	-0.01	-0.3	-0.01	-0.3	-0.01	-0.3	-0.01	-0.2	-0.02	-0.4	-0.02	-0.4	0.01	0.2
MR5	-0.05	-5.6	-0.04	-2.6	-0.02	-1.1	-0.01	-0.4	-0.03	-0.7	0.01	0.2	0	0.0	0.01	0.2	0.01	0.2
MR6	0.01	0.7	0.03	1.5	0.03	1.3	0.03	1.0	0.01	0.2	0.01	0.2	0.01	0.2	0.01	0.2	0	0.0
LBR1	-0.06	-2.1	-0.02	-0.6	0.02	0.5	0.01	0.2	0.02	0.4	0.01	0.2	0.01	0.2	0.01	0.2	0.01	0.2
LBR2	-0.48	-15.4	-0.32	-9.8	-0.27	-8.1	-0.24	-6.9	-0.17	-4.6	-0.18	-4.3	-0.13	-2.9	-0.13	-2.6	-0.07	-1.4
LBR3	0.01	0.5	0	0.0	-0.02	-0.8	-0.01	-0.3	0.04	1.2	0.12	3.1	0.06	1.4	0.14	3.1	0.21	4.4
BR1	0.01	0.4	0.01	0.4	0.01	0.4	0	0.0	-0.01	-0.3	0	0.0	0.01	0.2	0	0.0	-0.02	-0.4
BR2	-0.08	-4.3	-0.08	-3.7	-0.09	-3.8	-0.18	-6.5	-0.21	-6.6	-0.2	-5.4	-0.15	-3.5	-0.23	-5.0	-0.45	-9.0
BR3	0.02	0.9	0.03	1.2	0.01	0.4	0.01	0.3	0.01	0.3	0	0.0	0	0.0	0.02	0.4	0.01	0.2
SCH1	0.04	2.3	-0.04	-1.8	0	0.0	0.02	0.7	-0.02	-0.6	-0.03	-0.7	-0.03	-0.6	-0.04	-0.8	-0.01	-0.2
SCH2	-0.02	-0.6	-0.02	-0.6	-0.02	-0.6	-0.03	-0.8	-0.02	-0.5	0	0.0	0	0.0	-0.02	-0.4	-0.03	-0.5
SR	0	0.0	0.01	0.3	0	0.0	0	0.0	0	0.0	0.01	0.2	0	0.0	0	0.0	0	0.0

3. Table B4.3. Dissolved oxygen percentiles distribution in Zones of Savannah Estuary

Zone Name	D.O. Concentration Percentiles (mg/l)								
	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	3.80	4.09	4.22	4.41	4.70	5.19	5.59	5.70	5.81
FR2	3.36	3.61	3.78	4.00	4.31	4.77	5.26	5.43	5.58
FR3	3.03	3.27	3.40	3.62	3.97	4.41	5.00	5.25	5.78
FR4	2.88	3.16	3.26	3.44	3.84	4.25	4.88	5.30	6.23
FR5	2.96	3.18	3.28	3.47	3.87	4.32	4.84	5.52	6.28
FR6	3.12	3.20	3.39	3.61	4.02	4.49	4.89	5.85	6.33
FR7	3.29	3.59	3.75	4.15	4.73	5.19	5.69	6.33	6.44
FR8	3.50	3.86	4.10	4.54	5.04	5.43	5.90	6.39	6.52
FR9	4.03	4.46	4.75	5.15	5.45	5.80	6.24	6.47	6.59
FR10	4.67	4.87	4.98	5.19	5.44	5.80	6.15	6.30	6.47
FR11	3.63	3.83	4.01	4.26	4.59	5.00	5.55	5.92	6.01
MR1	3.30	3.49	3.64	3.88	4.25	4.70	5.12	5.73	6.29
MR2	3.01	3.26	3.41	3.74	4.17	4.63	5.04	5.42	6.23
MR3	2.76	2.95	3.09	3.41	3.86	4.40	4.87	5.10	5.83
MR4	3.40	3.52	3.63	3.82	4.07	4.50	4.93	5.27	5.48
MR5	1.45	1.99	2.31	2.94	4.48	5.16	5.61	5.85	5.99
MR6	1.47	2.09	2.44	3.19	4.69	5.39	5.82	6.03	6.58
LBR1	3.48	3.62	3.69	3.84	4.02	4.50	4.83	5.30	5.46
LBR2	2.69	2.90	3.01	3.20	3.48	3.93	4.33	4.78	5.03
LBR3	2.52	2.64	2.75	2.93	3.16	3.67	4.19	4.39	4.55
BR1	2.77	2.96	3.04	3.25	3.61	4.11	4.62	4.95	5.26
BR2	2.39	2.63	2.75	2.95	3.27	3.80	4.39	4.58	4.91
BR3	2.47	2.66	2.75	2.94	3.19	3.75	4.31	4.42	4.57
SCh1	2.81	3.09	3.33	3.57	3.86	4.39	4.92	5.10	5.28
SCh2	3.30	3.52	3.77	4.02	4.29	4.77	5.20	5.38	5.54
SR	3.70	3.76	3.81	4.14	4.44	4.90	5.54	5.97	5.99

4. Table B4.4. Delta of Dissolved Oxygen percentiles distribution in Zones of Savannah Estuary: Deepening scenario minus Existing bathymetry scenario

Zone	Project - Baseline Difference (mg/l)									Project - Baseline Relative Difference (%)								
Name	1%	5%	10%	25%	50%	75%	90%	95%	99%	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	0.05	0.02	0.00	0.00	0.00	0.00	0.02	0.02	0.03	1.3	0.5	0.0	-0.1	0.0	0.0	0.3	0.4	0.5
FR2	0.01	0.03	0.02	0.00	0.00	0.00	0.02	-0.01	-0.02	0.2	0.7	0.4	0.0	0.0	0.0	0.3	-0.2	-0.3
FR3	0.02	-0.01	0.00	0.01	-0.01	0.02	0.03	-0.02	-0.26	0.6	-0.3	0.0	0.3	-0.3	0.4	0.5	-0.5	-4.2
FR4	-0.01	-0.01	-0.01	-0.02	-0.03	-0.06	0.02	-0.09	-0.02	-0.3	-0.2	-0.4	-0.5	-0.8	-1.5	0.4	-1.7	-0.4
FR5	-0.01	0.01	-0.03	-0.07	-0.07	-0.11	-0.03	-0.22	-0.02	-0.4	0.2	-0.9	-2.0	-1.9	-2.4	-0.6	-3.8	-0.3
FR6	-0.01	-0.03	-0.05	-0.07	-0.10	-0.16	-0.18	-0.22	-0.01	-0.3	-0.9	-1.5	-2.0	-2.3	-3.5	-3.6	-3.7	-0.2
FR7	-0.04	-0.08	-0.11	-0.15	-0.16	-0.10	-0.07	-0.02	0.00	-1.2	-2.3	-2.7	-3.5	-3.2	-1.9	-1.3	-0.4	0.0
FR8	-0.10	-0.13	-0.15	-0.17	-0.12	-0.09	-0.07	0.00	-0.01	-2.8	-3.1	-3.4	-3.6	-2.4	-1.6	-1.1	0.0	-0.1
FR9	-0.17	-0.18	-0.17	-0.10	-0.04	-0.05	-0.02	0.00	-0.01	-4.0	-3.9	-3.4	-1.8	-0.8	-0.9	-0.4	0.0	-0.1
FR10	-0.01	0.00	-0.01	-0.01	0.00	0.00	-0.01	0.00	0.00	-0.2	-0.1	-0.1	-0.2	-0.1	-0.1	-0.1	0.0	0.1
FR11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
MR1	-0.04	-0.05	-0.06	-0.07	-0.09	-0.11	-0.07	-0.06	-0.03	-1.1	-1.4	-1.6	-1.8	-2.1	-2.2	-1.3	-1.1	-0.5
MR2	-0.03	-0.03	-0.04	-0.05	-0.08	-0.09	-0.08	-0.03	-0.04	-0.9	-1.0	-1.1	-1.3	-1.8	-1.8	-1.6	-0.5	-0.6
MR3	0.00	0.00	0.00	-0.02	-0.04	-0.05	-0.04	-0.04	0.00	-0.1	0.0	0.0	-0.5	-1.0	-1.0	-0.8	-0.7	0.0
MR4	0.01	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.2	0.1	0.2	0.3	0.2	0.2	0.0	-0.1	-0.1
MR5	0.01	0.01	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.3	0.8	1.2	0.9	0.1	0.1	0.0	0.0	0.1
MR6	0.00	0.03	0.04	0.02	0.00	0.01	0.01	0.00	-0.01	0.1	1.3	1.6	0.6	0.1	0.1	0.2	0.0	-0.2
LBR1	0.01	0.01	0.01	0.02	0.01	0.01	0.00	0.01	0.02	0.3	0.2	0.3	0.4	0.4	0.3	0.0	0.1	0.3
LBR2	-0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.01	-0.3	0.0	0.1	0.2	0.3	0.1	0.0	0.1	0.1
LBR3	0.04	0.05	0.04	0.05	0.04	0.04	0.03	0.00	0.00	1.6	1.8	1.4	1.7	1.4	1.2	0.7	0.0	-0.1
BR1	0.00	0.00	0.00	-0.01	-0.01	-0.01	0.01	-0.02	-0.03	0.1	0.1	-0.1	-0.3	-0.2	-0.2	0.2	-0.5	-0.5
BR2	0.01	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.00	0.6	0.1	0.1	0.2	0.2	0.1	0.3	0.2	-0.1
BR3	0.03	0.03	0.02	0.02	0.02	0.00	0.02	0.02	0.04	1.3	1.1	0.6	0.7	0.6	0.0	0.5	0.4	0.9
SCh1	0.04	0.02	-0.02	-0.01	0.01	0.01	-0.01	0.01	0.04	1.6	0.5	-0.5	-0.3	0.2	0.3	-0.1	0.2	0.7
SCh2	0.02	0.01	-0.01	-0.01	-0.01	0.00	0.00	-0.01	0.00	0.5	0.2	-0.2	-0.2	-0.2	0.0	0.1	-0.1	0.0
SR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0

5. Table B4.5. Percentage of the volume of waters with violation of Dissolved Oxygen standards for Zones of Savannah Estuary within the period of May 1 – October 30, 1997: Deepening (Project) and Existing (Baseline) bathymetry

Zones	D.O. STANDARDS														
	1-Day Average			7-Day Average			30-Day Average			GA MINIMUM D.O.			SC MINIMUM D.O.		
	Baseline(B)	Project(P)	Delta=P-B	Baseline(B)	Project(P)	Delta=P-B	Baseline(B)	Project(P)	Delta=P-B	Baseline(B)	Project(P)	Delta=P-B	Baseline(B)	Project(P)	Delta=P-B
FR1	0	0	0	0	0	0	0	0	0	0	0	0	4	4	0
FR2	0	0	0	0	0	0	0	0	0	0	0	0	17	17	0
FR3	0	0	0	0	0	0	3	3	0	0	0	0	N/A	N/A	N/A
FR4	0	0	0	0	0	0	5	6	1	0	0	0	N/A	N/A	N/A
FR5	0	0	0	0	0	0	3	4	1	0	0	0	N/A	N/A	N/A
FR6	0	0	0	0	0	0	1	2	1	0	0	0	N/A	N/A	N/A
FR7	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
FR8	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
FR9	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
FR10	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
FR11	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0
MR1	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
MR2	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
MR3	0	0	0	0	0	0	3	4	1	1	1	0	N/A	N/A	N/A
MR4	0	0	0	0	0	0	1	1	0	0	0	0	N/A	N/A	N/A
MR5	0	0	0	0	0	0	2	1	-1	4	4	0	9	9	0
MR6	0	0	0	0	0	0	0	0	0	2	2	0	7	7	0
LBR1	0	0	0	0	0	0	1	1	0	0	0	0	11	11	0
LBR2	0	0	0	2	1	-1	11	11	0	3	3	0	25	25	0
LBR3	0	0	0	6	6	0	21	21	0	8	7	-1	36	37	1
BR1	0	0	0	1	2	1	18	19	1	2	2	0	50	51	1
BR2	0	0	0	6	6	0	36	36	0	7	7	0	60	60	0
BR3	0	0	0	9	8	-1	35	36	1	11	10	-1	57	58	1
SCh1	0	0	0	2	2	0	6	6	0	3	3	0	N/A	N/A	N/A
SCh2	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
SR	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0

26. Table B4.6. Percentage of water volumes with salinity in %iles within the period of May 1 – October 30, 1997

Percen-tile	Harbor / River			Stations					
	Upper Hrb %	Middle Rvr %	Back Rvr %	Houlih Brg %	Broad Str %	Pulaski Frt %	Lucknow Cnl %	USF&W Dck %	I-95 Brg %
5	21.4	7.3	4.8	6.5	4.5	4.3	10.6	5.7	95.7
10	25.3	11	9.2	10.4	9.1	8.6	10.6	10.9	95.7
25	37.3	22.9	23	23.2	23.1	22.1	25.1	22.8	95.7
50	57.9	44.5	47.1	47.1	47.6	46.1	51.9	44.1	95.7
75	79.7	69.8	72.8	72.8	73.3	72.8	74.8	69.9	95.7
90	91.3	87.4	88.9	89	89.1	89.3	89	87.7	95.7
95	95.5	93.6	94.4	94.5	94.5	94.7	94.4	93.7	95.7
Total Volume 100*km3:	32274.8	653.4	4771.5	24.1	39	135.5	9.9	9.4	43.6

27. Table B4.7. Percentage of water volumes with D.O. in %iles within the period of May 1 – October 30, 1997

Percen-tile	Harbor / River			Stations					
	Upper Hrb %	Middle Rvr %	Back Rvr %	Houlih Brg %	Broad Str %	Pulaski Frt %	Lucknow Cnl %	USF&W Dck %	I-95 Brg %
5	5.3	5.1	5	5.6	5.5	4.8	5.5	5.4	5.9
10	10.6	10	9.9	11.2	10.9	9.7	11	10.8	11.2
25	26.2	24.4	25	27.5	26.4	24.4	26.7	26.1	26.5
50	52	49.1	50.1	53.3	51.5	49.6	50.5	50.8	51.1
75	76.7	74.5	75.4	76.7	76	74.9	75.8	75.9	75.8
90	90.5	89.8	90.2	90.4	90.3	89.8	90.1	90.3	90.3
95	95.2	94.7	95	95.5	95.3	94.9	95.1	95.3	95.2
Total Volume 100*km3:	32274.8	653.4	4771.5	24.1	39	135.5	9.9	9.4	43.6

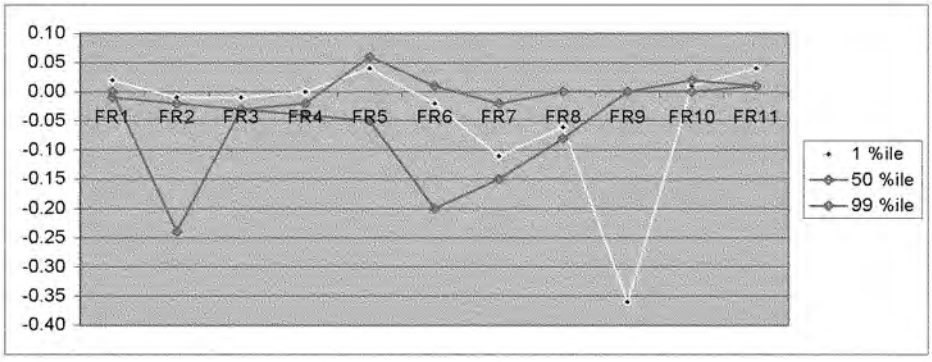
28. Table B4.8. Water volumes in Upper Harbor in increments of 1° C of water temperature within the period of May 1 – October 30, 1997

Temperature C°	Total Volume %
17	0.12
18	0.46
19	1.29
20	4.41
21	12.94
22	17.7
23	22.35
24	32.54
25	42.91
26	50.88
27	61.86
28	81.47
29	93.9
30	99.8
31	100

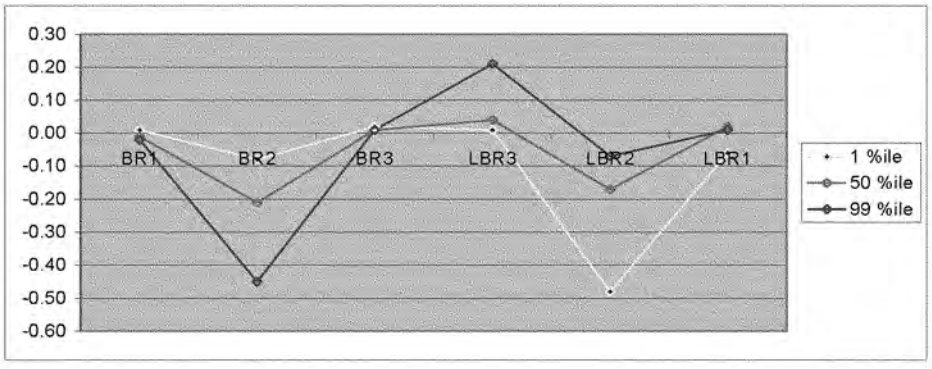
29. Table B4.9. Water volumes in Upper Harbor in increments of 0.1 mg/l of D.O. within the period of May 1 – October 30, 1997
(See file: Postprocessor Output\S12\97-S12_DO Increment Volume)

30. Table B4.10. Percentage of water volumes corresponding to 1-, 7-, and 30-days averages of D.O. depth-averaged concentrations in Upper Harbor within the period of May 1 – October 30, 1997
(See file: Postprocessor Output\S12\97-S12_volume DO in averages)

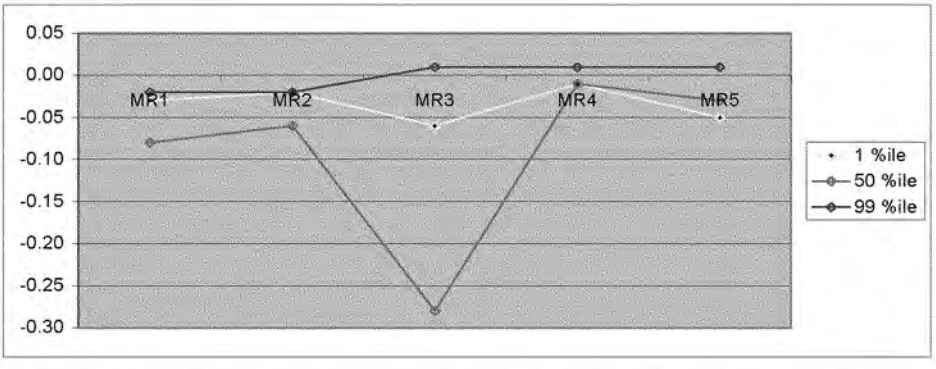
Front River



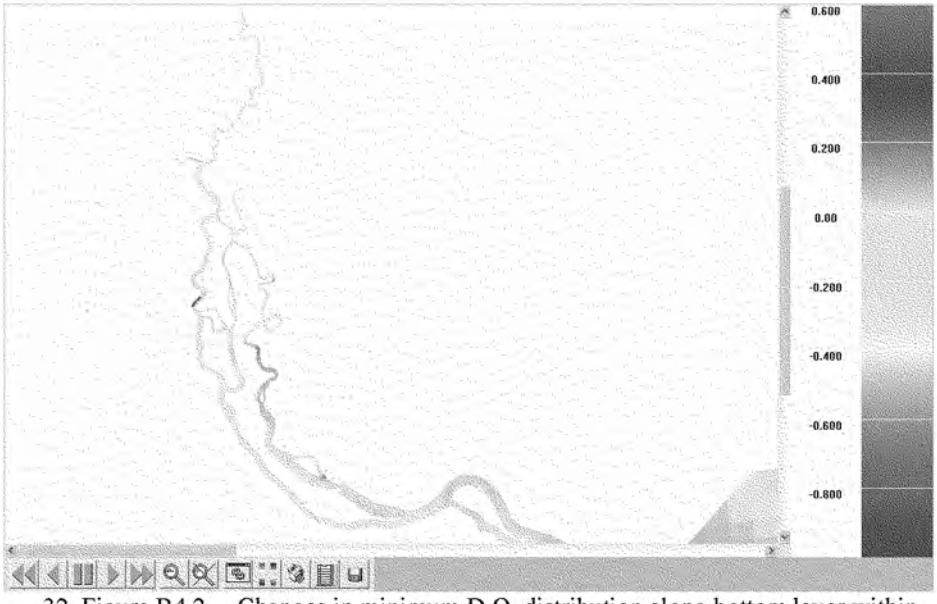
Back and Little Back Rivers



Middle River

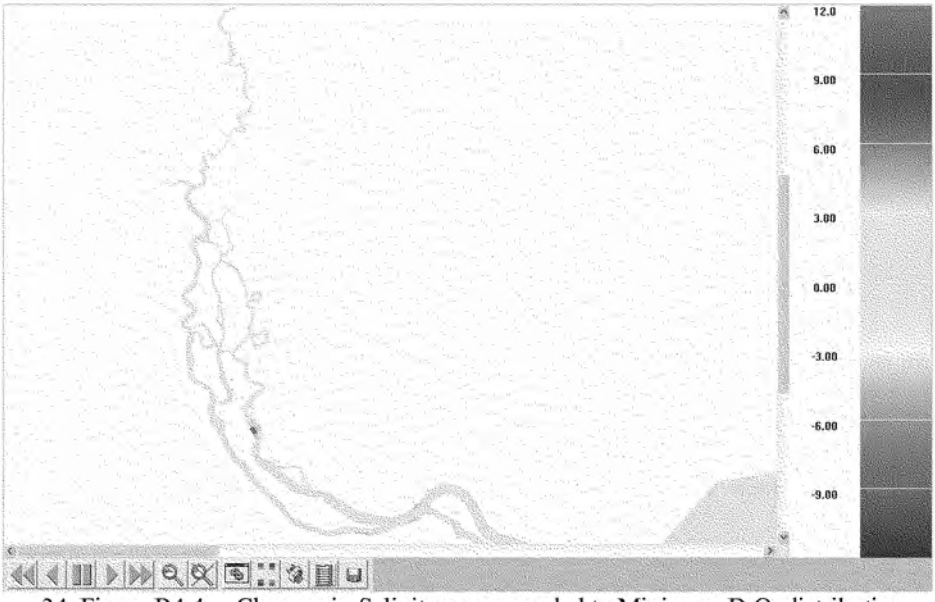


31. Figure B4.1. Changes in longitudinal profile of Dissolved Oxygen (mg/l) distribution along Critical cells of Savannah Estuary: 2 ft deepening



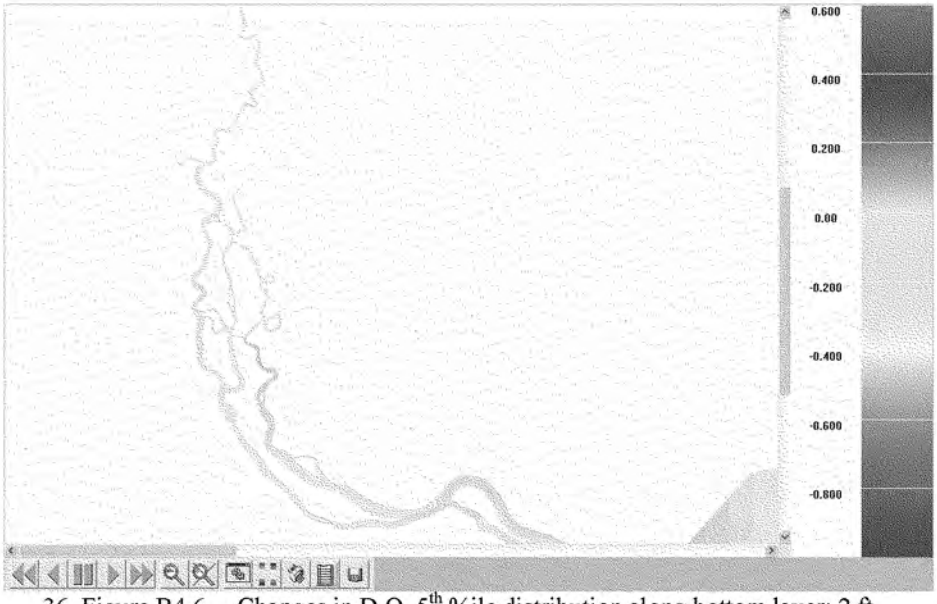
32. Figure B4.2. Changes in minimum D.O. distribution along bottom layer within the analyzed period of May 1 - October 30, 1997: 2 ft deepening

33. Figure B4.3. Changes in minimum D.O. distribution along surface layer within the analyzed period of May 1 - October 30, 1997: 2 ft deepening

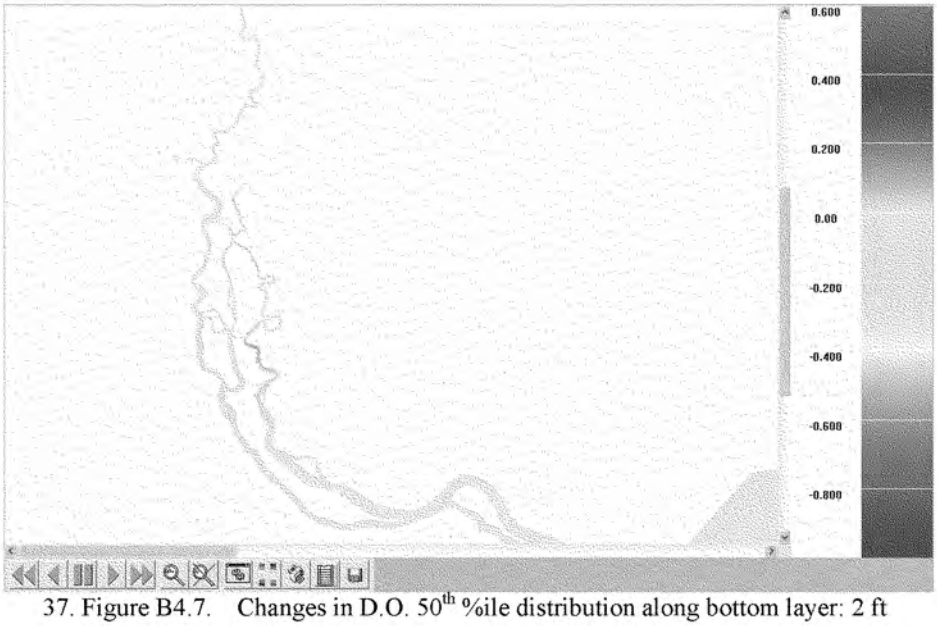


34. Figure B4.4. Changes in Salinity corresponded to Minimum D.O. distribution along bottom layer within the analyzed period of May 1 - October 30, 1997: 2 ft deepening

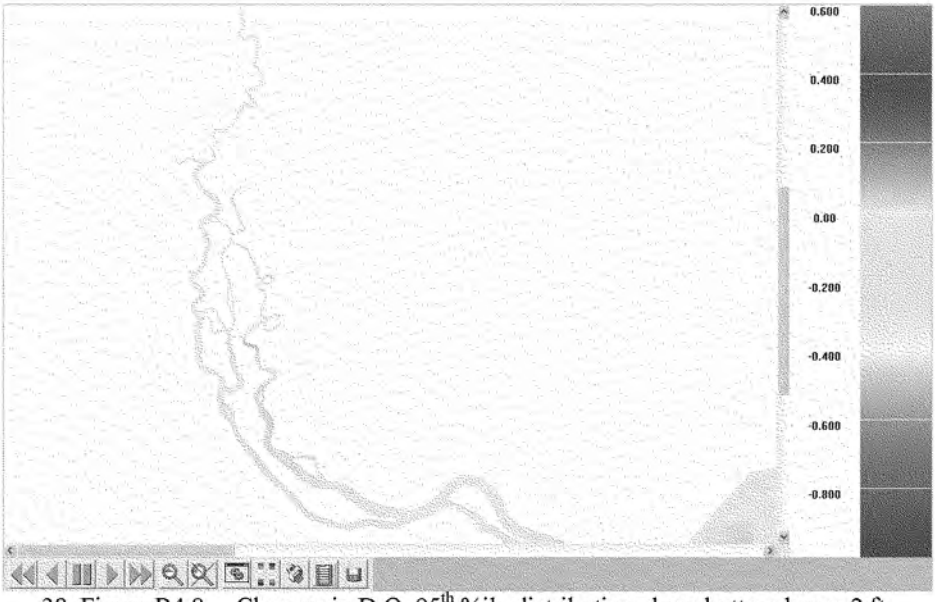
35. Figure B4.5. Changes in Salinity corresponded to Minimum D.O. distribution along Surface layer within the analyzed period of May 1 - October 30, 1997: 2 ft deepening



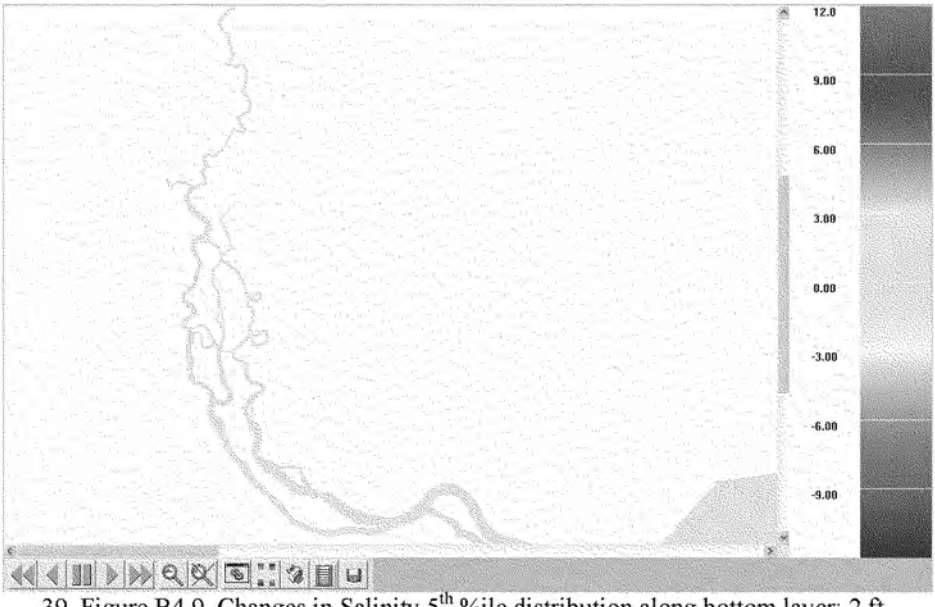
36. Figure B4.6. Changes in D.O. 5th %ile distribution along bottom layer: 2 ft deepening



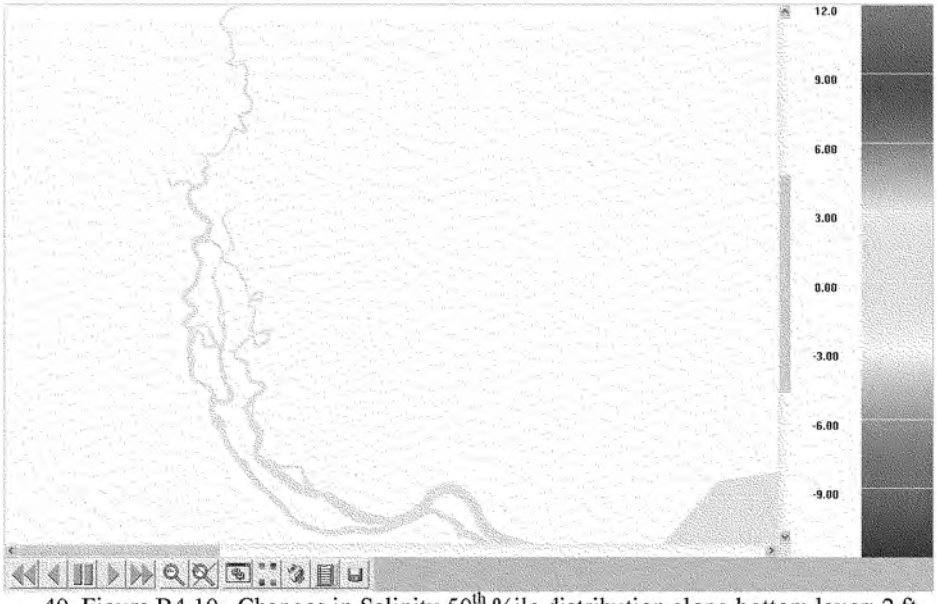
37. Figure B4.7. Changes in D.O. 50th %ile distribution along bottom layer: 2 ft deepening



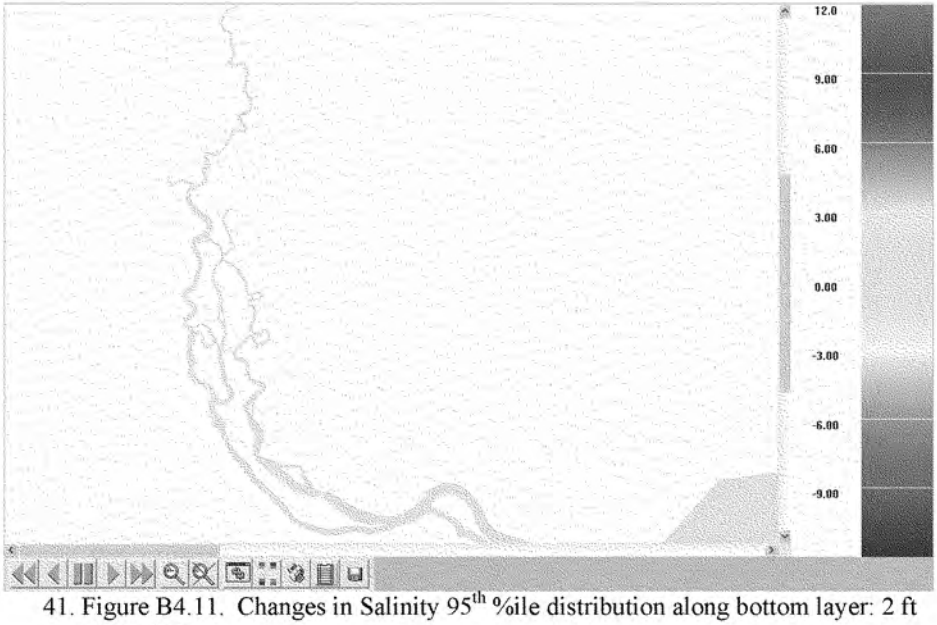
38. Figure B4.8. Changes in D.O. 95th %ile distribution along bottom layer: 2 ft deepening



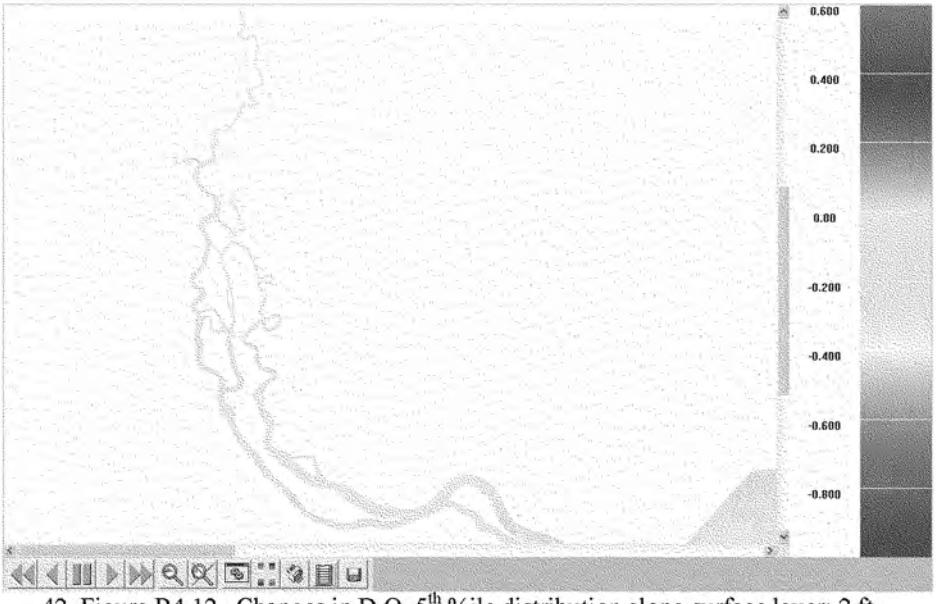
39. Figure B4.9. Changes in Salinity 5th %ile distribution along bottom layer: 2 ft deepening



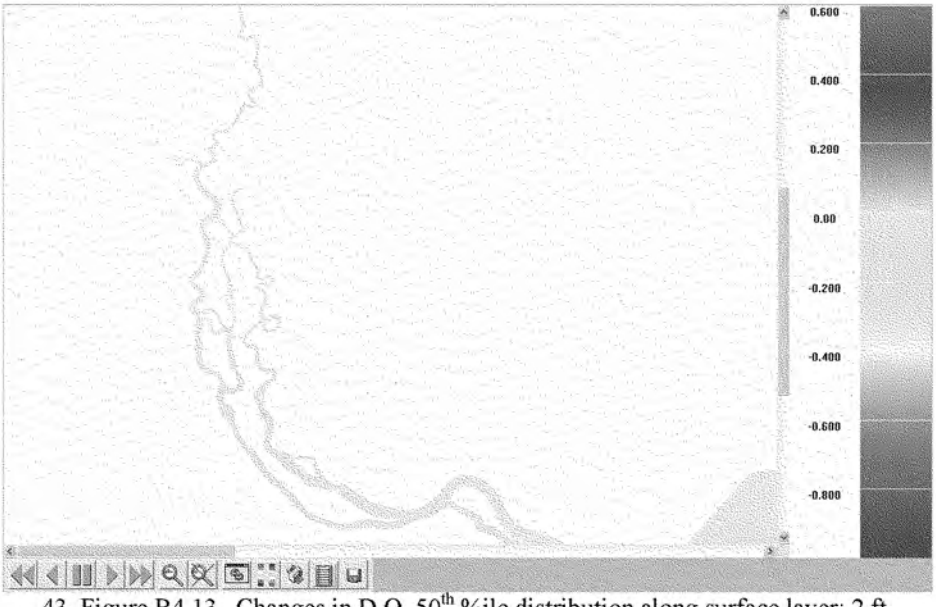
40. Figure B4.10. Changes in Salinity 50th %ile distribution along bottom layer: 2 ft deepening



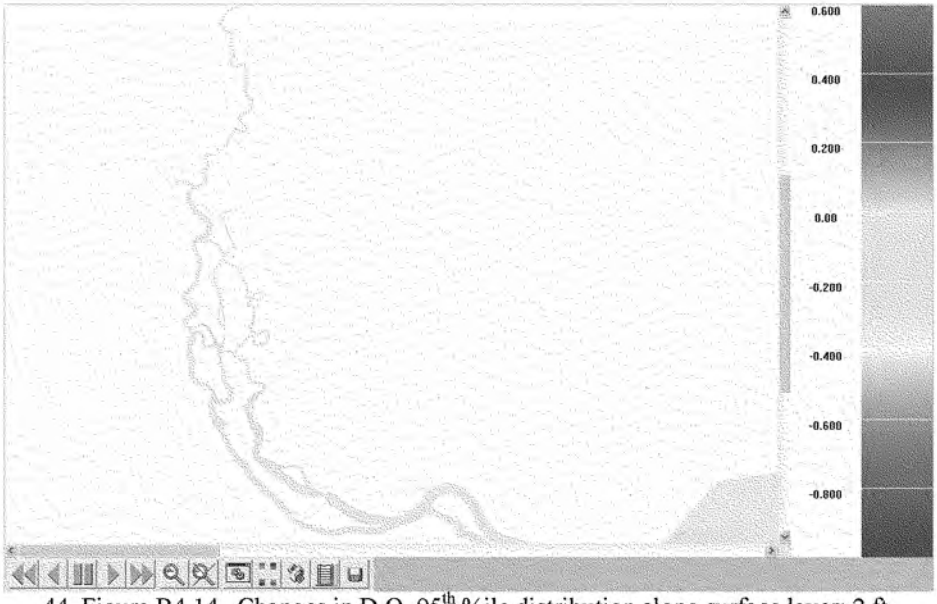
41. Figure B4.11. Changes in Salinity 95th %ile distribution along bottom layer: 2 ft deepening



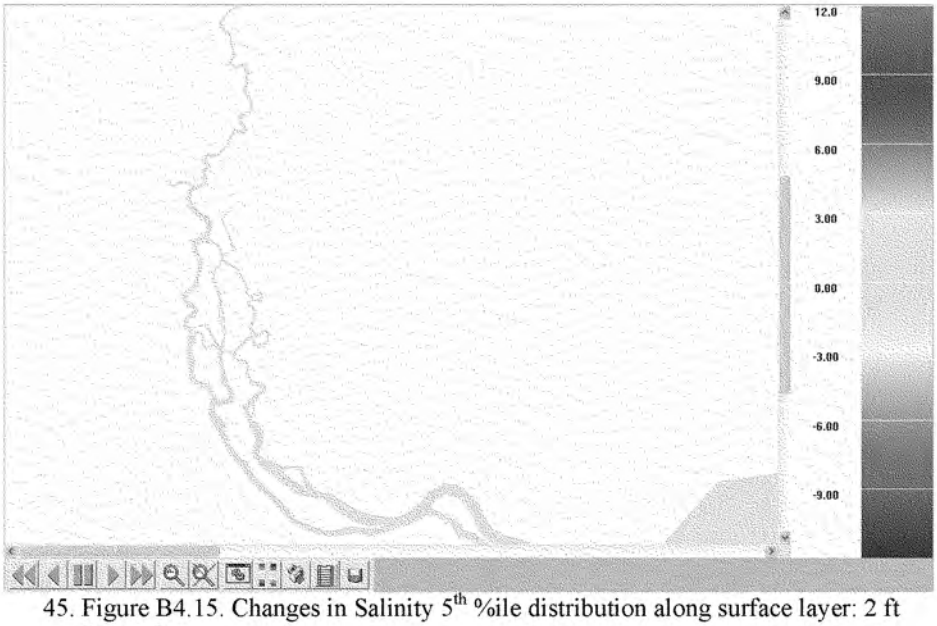
42. Figure B4.12. Changes in D.O. 5th %ile distribution along surface layer: 2 ft deepening



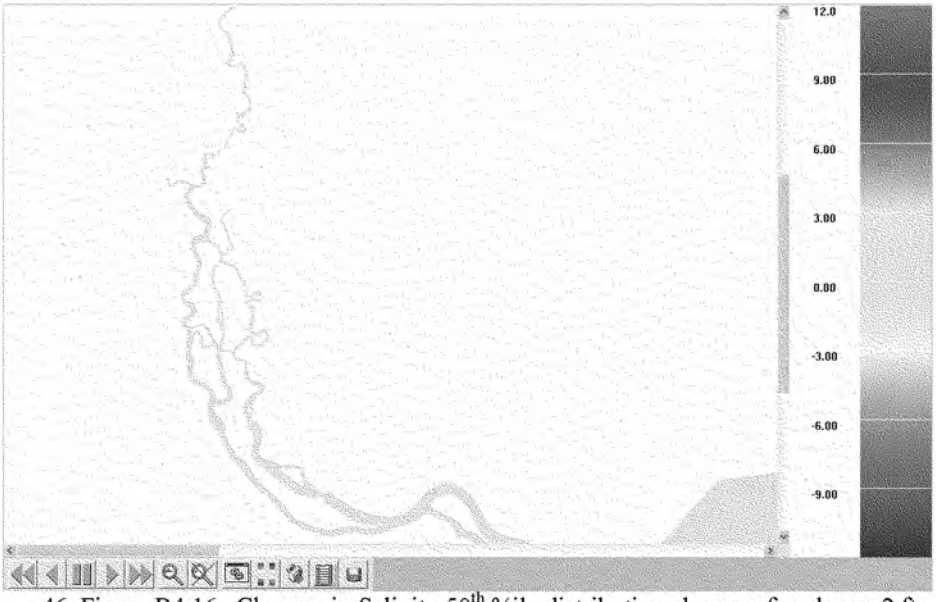
43. Figure B4.13. Changes in D.O. 50th %ile distribution along surface layer: 2 ft deepening



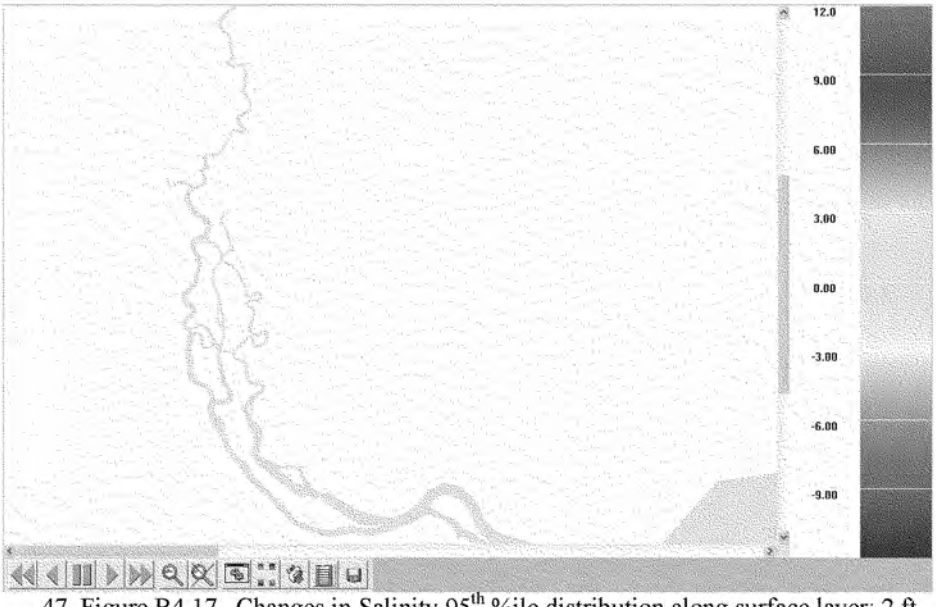
44. Figure B4.14. Changes in D.O. 95th %ile distribution along surface layer: 2 ft deepening



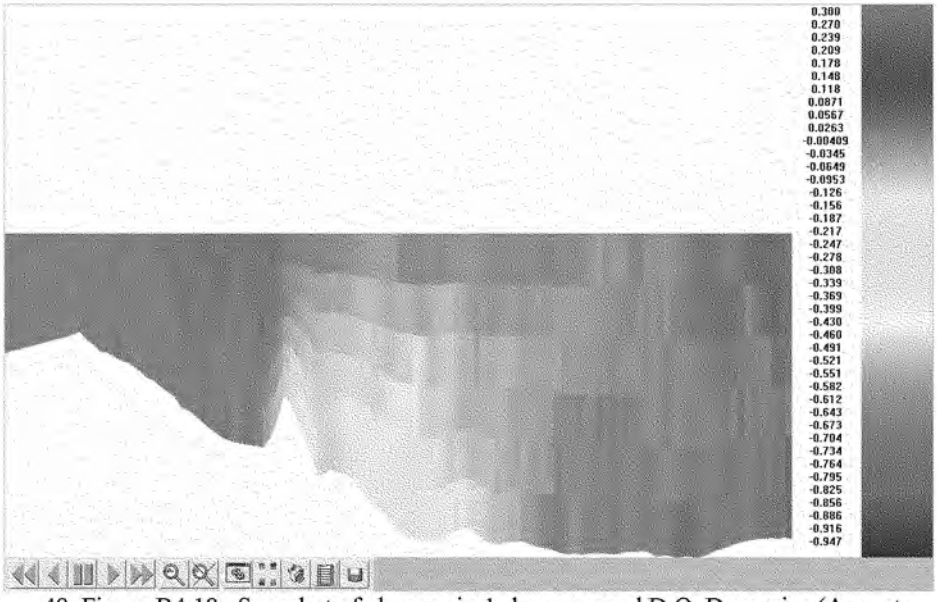
45. Figure B4.15. Changes in Salinity 5th %ile distribution along surface layer: 2 ft deepening



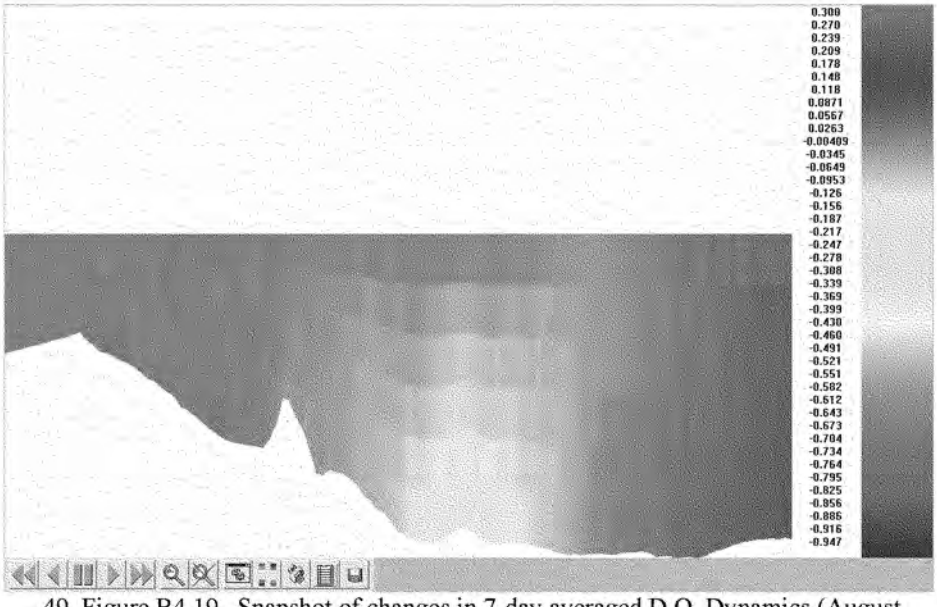
46. Figure B4.16. Changes in Salinity 50th %ile distribution along surface layer: 2 ft deepening



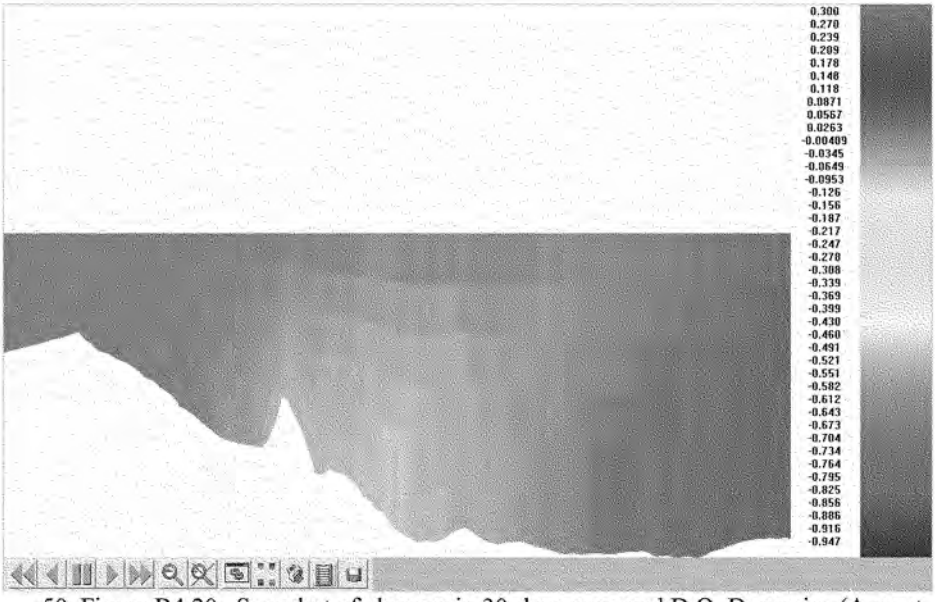
47. Figure B4.17. Changes in Salinity 95th %ile distribution along surface layer: 2 ft deepening



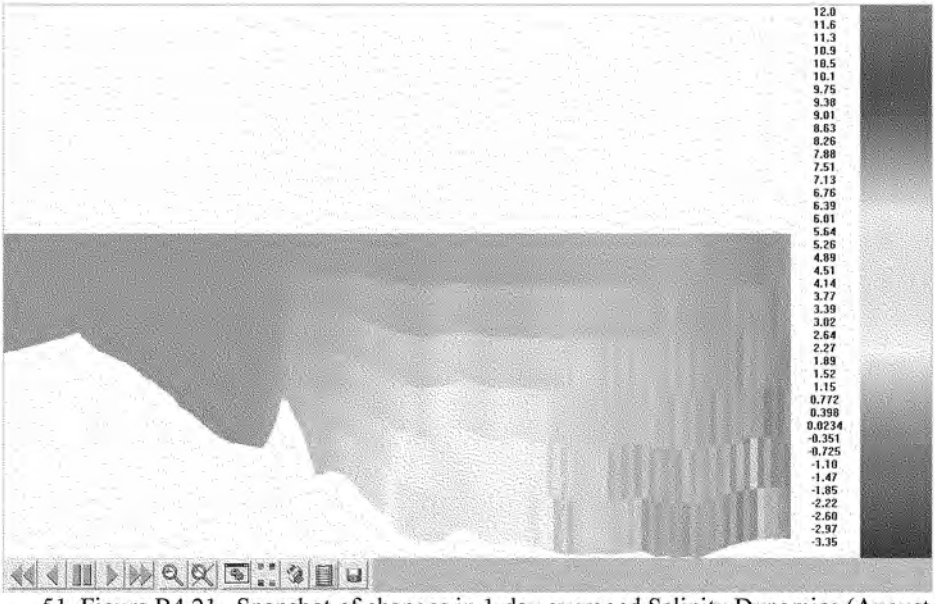
48. Figure B4.18. Snapshot of changes in 1-day averaged D.O. Dynamics (August 10, 1997) in vertical plane of Upper Harbor: 2 ft deepening



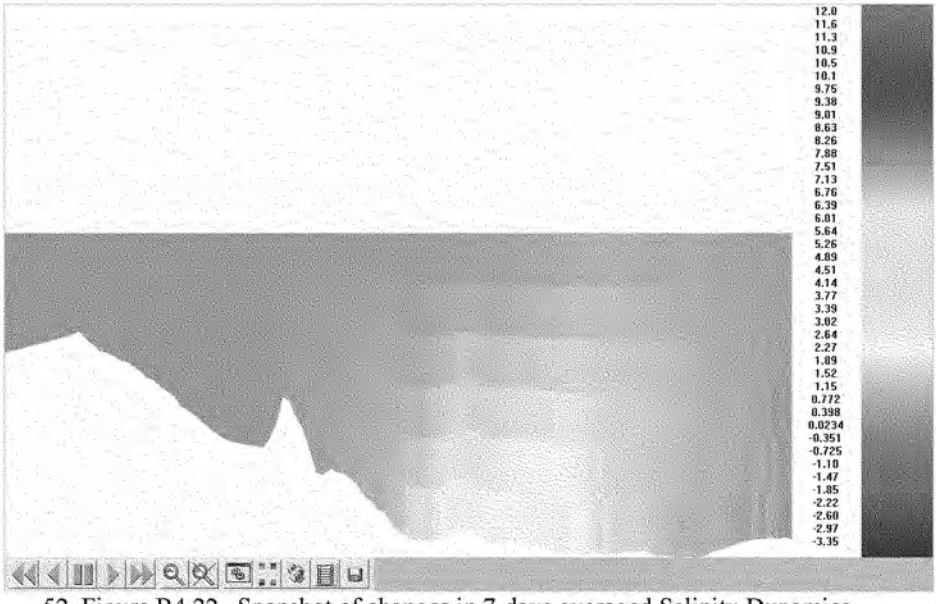
49. Figure B4.19. Snapshot of changes in 7-day averaged D.O. Dynamics (August 10, 1997) in vertical plane of Upper Harbor: 2 ft deepening



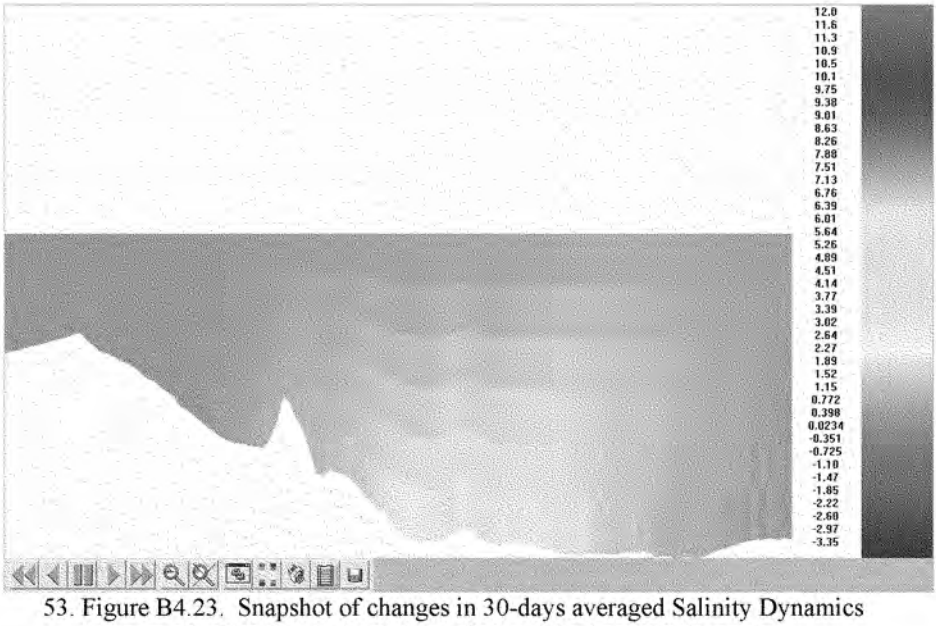
50. Figure B4.20. Snapshot of changes in 30-days averaged D.O. Dynamics (August 10, 1997) in vertical plane of Upper Harbor: 2 ft deepening



51. Figure B4.21. Snapshot of changes in 1-day averaged Salinity Dynamics (August 10, 1997) in vertical plane of Upper Harbor: 2 ft deepening



52. Figure B4.22. Snapshot of changes in 7-days averaged Salinity Dynamics (August 10, 1997) in vertical plane of Upper Harbor: 2 ft deepening



53. Figure B4.23. Snapshot of changes in 30-days averaged Salinity Dynamics (August 10, 1997) in vertical plane of Upper Harbor: 2 ft deepening

Appendix C

SENSITIVITY ANALYSIS #2A: EXISTING BATHYMETRY, 1999 POINT SOURCES LOADS, 1999 HYDROLOGICAL AND METEOROLOGICAL CONDITIONS

May 1 – October 30, 1999 Simulation Period

Water Quality Review Group

1. Table C.1. Dissolved oxygen percentiles distribution in Critical cells

Zone	D.O. Percentile (mg/l)								
	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	3.53	3.7	3.81	4.02	4.37	4.79	5.05	5.27	5.64
FR2	2.93	3.12	3.25	3.53	3.87	4.29	4.62	4.78	5.1
FR3	2.64	2.87	2.97	3.19	3.65	4.06	4.38	4.54	4.84
FR4	2.72	2.92	3.02	3.25	3.68	4.07	4.39	4.54	4.84
FR5	2.69	2.87	2.97	3.29	3.69	4.06	4.38	4.58	4.76
FR6	2.76	2.92	3.01	3.33	3.7	4.08	4.45	4.65	4.83
FR7	3.31	3.57	3.75	4.1	4.54	4.96	5.28	5.52	6.05
FR8	3.4	3.71	3.88	4.23	4.64	5	5.28	5.45	5.78
FR9	3.55	3.79	3.99	4.36	4.82	5.25	5.5	5.65	5.91
FR10	2.29	3.13	3.38	3.92	4.59	5.24	5.65	5.82	6.04
FR11	2.17	2.78	3.15	3.63	4.22	4.85	5.4	5.62	5.95
MR1	2.67	3.11	3.31	3.68	4.05	4.38	4.69	4.88	5.09
MR2	2.26	2.62	2.96	3.46	3.92	4.32	4.63	4.86	5.1
MR3	2.12	2.5	2.8	3.35	3.82	4.27	4.59	4.82	5.07
MR4	2.09	2.47	2.66	3.08	3.51	3.88	4.23	4.39	4.74
MR5	0.45	0.99	1.39	2.21	3.63	5.13	5.57	5.73	5.97
MR6	1.05	1.66	2.11	3.03	4.42	5.3	5.71	5.9	6.17
LBR1	2.68	3.3	3.51	3.97	4.32	4.61	4.93	5.1	5.43
LBR2	2.11	2.34	2.52	2.99	3.34	3.65	3.95	4.14	4.43
LBR3	1.37	1.79	2.08	2.6	3.2	3.7	4.05	4.26	4.61
BR1	2.16	2.39	2.57	2.93	3.36	3.78	4.15	4.35	4.61
BR2	1.52	1.88	2.16	2.6	3.1	3.53	3.92	4.17	4.5
BR3	1.83	2.17	2.36	2.69	3.2	3.61	3.94	4.15	4.5
SCH1	1.4	1.76	2.05	2.61	3.4	4.16	4.71	5.02	5.34
SCH2	3.21	3.44	3.57	3.81	4.15	4.55	4.87	5.05	5.35
SR	2.24	2.52	2.96	3.6	3.86	4.2	4.5	4.64	4.91

2. Table C.2. Delta of Dissolved Oxygen percentiles distribution in Critical cells: 1999 (Project) and 2004 (Baseline) point sources loading scenarios

Zone	Delta D.O. Percentile																	
	1%		5%		10%		25%		50%		75%		90%		95%		99	
	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%
FR1	0.1	2.9	0.09	2.5	0.09	2.4	0.07	1.8	0.08	1.9	0.07	1.5	0.05	1.0	0.07	1.3	0.07	1.3
FR2	0.19	6.9	0.13	4.3	0.14	4.5	0.14	4.1	0.13	3.5	0.13	3.1	0.1	2.2	0.11	2.4	0.13	2.6
FR3	0.19	7.8	0.18	6.7	0.16	5.7	0.14	4.6	0.15	4.3	0.15	3.8	0.12	2.8	0.13	2.9	0.13	2.8
FR4	0.21	8.4	0.18	6.6	0.17	6.0	0.15	4.8	0.16	4.5	0.16	4.1	0.14	3.3	0.11	2.5	0.13	2.8
FR5	0.19	7.6	0.18	6.7	0.19	6.8	0.19	6.1	0.19	5.4	0.19	4.9	0.15	3.5	0.17	3.9	0.14	3.0
FR6	0.22	8.7	0.18	6.6	0.2	7.1	0.18	5.7	0.19	5.4	0.19	4.9	0.15	3.5	0.17	3.8	0.14	3.0
FR7	0.18	5.8	0.16	4.7	0.16	4.5	0.15	3.8	0.12	2.7	0.09	1.8	0.07	1.3	0.07	1.3	0.02	0.3
FR8	0.2	6.2	0.19	5.4	0.19	5.1	0.12	2.9	-0.05	-1.1	-0.11	-2.2	-0.14	-2.6	-0.16	-2.9	-0.12	-2.0
FR9	0.16	4.7	0.15	4.1	0.15	3.9	0.13	3.1	0.08	1.7	0.05	1.0	0.04	0.7	0.04	0.7	0.03	0.5
FR10	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0.01	0.2
FR11	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0.01	0.2
MR1	0.09	3.5	0.12	4.0	0.13	4.1	0.13	3.7	0.12	3.1	0.13	3.1	0.11	2.4	0.13	2.7	0.11	2.2
MR2	0.06	2.7	0.06	2.3	0.05	1.7	0.09	2.7	0.1	2.6	0.11	2.6	0.1	2.2	0.12	2.5	0.1	2.0
MR3	0.04	1.9	0.05	2.0	0.04	1.4	0.07	2.1	0.08	2.1	0.1	2.4	0.09	2.0	0.09	1.9	0.1	2.0
MR4	0.04	2.0	0.03	1.2	0.03	1.1	0.03	1.0	0.03	0.9	0.05	1.3	0.05	1.2	0.03	0.7	0.06	1.3
MR5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0.01	0.2	0	0.0	0	0.0	0	0.0
MR6	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0.01	0.2	0	0.0
LBR1	0.01	0.4	0.01	0.3	0.01	0.3	0.01	0.3	0.01	0.2	0.01	0.2	0.01	0.2	0	0.0	0	0.0
LBR2	0.01	0.5	0.01	0.4	0.01	0.4	0.01	0.3	0.01	0.3	0.01	0.3	0.01	0.3	0.01	0.2	0	0.0
LBR3	0.03	2.2	0.04	2.3	0.04	2.0	0.04	1.6	0.07	2.2	0.07	1.9	0.07	1.8	0.08	1.9	0.05	1.1
BR1	0.16	8.0	0.16	7.2	0.16	6.6	0.15	5.4	0.15	4.7	0.15	4.1	0.14	3.5	0.13	3.1	0.13	2.9
BR2	0.15	10.9	0.27	16.8	0.33	18.0	0.4	18.2	0.32	11.5	0.34	10.7	0.35	9.8	0.39	10.3	0.35	8.4
BR3	0.14	8.3	0.14	6.9	0.14	6.3	0.13	5.1	0.14	4.6	0.14	4.0	0.15	4.0	0.1	2.5	0.11	2.5
SCH1	0.11	8.5	0.11	6.7	0.13	6.8	0.12	4.8	0.09	2.7	0.06	1.5	0.05	1.1	0.04	0.8	0.02	0.4
SCH2	0.13	4.2	0.13	3.9	0.12	3.5	0.12	3.3	0.11	2.7	0.11	2.5	0.1	2.1	0.09	1.8	0.1	1.9
SR	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0

3. Table C.3. Dissolved oxygen percentiles distribution in Zones of Savannah Estuary

Zone Name	D.O. Concentration Percentiles (mg/l)								
	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	3.86	4.00	4.08	4.29	4.64	5.05	5.30	5.51	5.84
FR2	3.37	3.55	3.65	3.87	4.20	4.62	4.91	5.06	5.38
FR3	2.91	3.10	3.19	3.44	3.82	4.22	4.55	4.70	4.99
FR4	2.70	2.90	2.99	3.22	3.67	4.03	4.39	4.52	4.80
FR5	2.75	2.92	3.02	3.28	3.68	4.06	4.41	4.57	4.77
FR6	2.89	3.06	3.14	3.46	3.83	4.18	4.53	4.72	4.90
FR7	3.20	3.43	3.63	3.99	4.44	4.92	5.20	5.38	5.67
FR8	3.49	3.77	3.95	4.33	4.77	5.14	5.39	5.56	5.81
FR9	4.05	4.34	4.53	4.88	5.24	5.52	5.78	5.92	6.15
FR10	4.01	4.51	4.71	5.00	5.29	5.57	5.81	5.93	6.16
FR11	2.63	3.18	3.56	3.96	4.30	4.63	4.94	5.12	5.37
MR1	2.92	3.20	3.36	3.71	4.06	4.38	4.69	4.87	5.05
MR2	2.43	2.84	3.15	3.56	3.98	4.34	4.62	4.86	5.07
MR3	2.13	2.39	2.70	3.18	3.65	4.10	4.45	4.66	5.00
MR4	2.77	2.96	3.17	3.57	3.92	4.23	4.53	4.70	4.87
MR5	1.07	1.47	1.87	2.73	4.13	5.08	5.50	5.66	5.92
MR6	1.10	1.68	2.13	3.10	4.46	5.28	5.66	5.85	6.11
LBR1	2.87	3.04	3.18	3.64	3.92	4.17	4.48	4.61	4.76
LBR2	2.04	2.27	2.50	2.92	3.30	3.61	3.90	4.10	4.30
LBR3	1.80	1.94	2.05	2.55	3.10	3.39	3.71	3.86	4.20
BR1	2.55	2.69	2.81	3.10	3.51	3.92	4.28	4.47	4.74
BR2	2.11	2.31	2.46	2.76	3.22	3.65	4.02	4.20	4.47
BR3	2.06	2.23	2.36	2.68	3.17	3.56	3.92	4.13	4.38
SCh1	2.71	2.97	3.09	3.35	3.73	4.20	4.51	4.65	4.90
SCh2	3.46	3.59	3.69	3.90	4.21	4.62	4.91	5.09	5.38
SR	2.62	2.79	3.29	3.88	4.12	4.44	4.71	4.85	5.11

4. Table C.4. Delta of Dissolved Oxygen percentiles distribution in Zones: 1999 (Project) and 2004 (Baseline) point sources loading scenarios

Zone	Project - Baseline Difference (mg/l)									Project - Baseline Relative Difference (%)								
Name	1%	5%	10%	25%	50%	75%	90%	95%	99%	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	0.06	0.04	0.04	0.04	0.04	0.04	0.03	0.04	0.03	1.4	1.1	0.9	0.9	0.9	0.9	0.5	0.7	0.5
FR2	0.14	0.11	0.10	0.10	0.10	0.11	0.09	0.09	0.08	4.4	3.3	2.9	2.7	2.5	2.3	1.8	1.9	1.5
FR3	0.17	0.15	0.15	0.13	0.14	0.14	0.13	0.11	0.11	6.2	5.1	4.9	4.0	3.9	3.5	2.9	2.4	2.2
FR4	0.20	0.18	0.18	0.15	0.17	0.16	0.15	0.13	0.13	8.0	6.5	6.5	4.9	4.9	4.1	3.4	2.9	2.9
FR5	0.20	0.17	0.19	0.19	0.17	0.18	0.15	0.16	0.13	7.8	6.2	6.6	6.0	4.8	4.7	3.4	3.7	2.9
FR6	0.22	0.19	0.19	0.19	0.18	0.18	0.15	0.17	0.15	8.2	6.4	6.4	5.9	5.1	4.4	3.3	3.6	3.2
FR7	0.18	0.16	0.18	0.16	0.13	0.10	0.07	0.06	0.05	5.9	5.0	5.2	4.0	3.1	2.0	1.3	1.2	0.9
FR8	0.17	0.15	0.14	0.13	0.10	0.06	0.05	0.04	0.04	5.1	4.3	3.8	3.0	2.1	1.1	0.9	0.8	0.7
FR9	0.13	0.11	0.09	0.07	0.04	0.03	0.02	0.02	0.01	3.3	2.6	2.1	1.4	0.8	0.5	0.4	0.4	0.2
FR10	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0
FR11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MR1	0.13	0.15	0.15	0.14	0.13	0.14	0.12	0.12	0.11	4.7	5.0	4.7	4.0	3.4	3.2	2.6	2.6	2.2
MR2	0.07	0.06	0.09	0.10	0.12	0.14	0.10	0.12	0.11	3.1	2.0	3.1	3.0	3.0	3.2	2.2	2.5	2.3
MR3	0.04	0.04	0.04	0.05	0.07	0.08	0.08	0.08	0.09	1.8	1.6	1.4	1.7	2.0	1.9	1.8	1.6	1.8
MR4	0.04	0.03	0.01	0.01	0.02	0.02	0.02	0.02	0.01	1.4	0.9	0.4	0.3	0.4	0.5	0.4	0.4	0.2
MR5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.1	0.3	0.1	0.1	0.0	0.0	0.0	0.1	0.1
MR6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.1	0.1	0.0	0.1	0.1	0.1	0.0
LBR1	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00	0.2	0.3	0.3	0.1	0.2	0.2	0.2	0.2	0.1
LBR2	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00	0.4	0.3	0.5	0.2	0.3	0.3	0.3	0.2	0.1
LBR3	0.04	0.04	0.04	0.03	0.06	0.06	0.05	0.04	0.04	2.5	2.2	2.1	1.0	1.9	1.9	1.4	1.1	1.0
BR1	0.14	0.15	0.15	0.15	0.15	0.15	0.13	0.13	0.14	5.8	5.7	5.6	5.0	4.5	3.9	3.1	3.0	3.0
BR2	0.16	0.14	0.15	0.15	0.15	0.15	0.13	0.13	0.13	8.2	6.6	6.6	5.8	4.9	4.3	3.4	3.1	3.0
BR3	0.15	0.13	0.12	0.10	0.12	0.13	0.12	0.10	0.09	7.7	6.0	5.4	3.9	3.8	3.8	3.0	2.5	2.0
SCh1	0.10	0.09	0.08	0.08	0.09	0.09	0.07	0.07	0.06	3.9	3.0	2.7	2.6	2.5	2.1	1.7	1.5	1.3
SCh2	0.12	0.12	0.12	0.11	0.11	0.11	0.09	0.09	0.09	3.7	3.4	3.2	2.8	2.6	2.3	1.8	1.9	1.6
SR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

5. Table C.5. Percentage of the volume of waters with violation of Dissolved Oxygen standards for Zones of Savannah Estuary within the period of May 1 – October 30, 1999: 1999 (Project) and 2004 (Baseline) point sources loading scenarios

Zones	D.O. STANDARDS														
	1-Day Average			7-Day Average			30-Day Average			GA MINIMUM D.O.			SC MINIMUM D.O.		
	Baseline(B)	Project(P)	Delta=P-B	Baseline(B)	Project(P)	Delta=P-B	Baseline(B)	Project(P)	Delta=P-B	Baseline(B)	Project(P)	Delta=P-B	Baseline(B)	Project(P)	Delta=P-B
FR1	0	0	0	0	0	0	0	0	0	0	0	0	7	4	-3
FR2	0	0	0	0	0	0	3	1	-2	0	0	0	31	23	-8
FR3	0	0	0	2	0	-2	19	11	-8	3	1	-2	N/A	N/A	N/A
FR4	0	0	0	5	2	-3	22	14	-8	6	2	-4	N/A	N/A	N/A
FR5	0	0	0	4	1	-3	19	11	-8	5	2	-3	N/A	N/A	N/A
FR6	0	0	0	2	0	-2	12	6	-6	4	1	-3	N/A	N/A	N/A
FR7	0	0	0	0	0	0	1	0	-1	0	0	0	N/A	N/A	N/A
FR8	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
FR9	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
FR10	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
FR11	0	0	0	0	0	0	2	2	0	1	1	0	6	6	0
MR1	0	0	0	0	0	0	5	3	-2	1	0	-1	N/A	N/A	N/A
MR2	0	0	0	1	0	-1	6	5	-1	1	1	0	N/A	N/A	N/A
MR3	0	0	0	3	3	0	10	9	-1	3	3	0	N/A	N/A	N/A
MR4	0	0	0	1	1	0	5	4	-1	2	2	0	N/A	N/A	N/A
MR5	0	0	0	1	1	0	5	5	0	5	5	0	11	11	0
MR6	0	0	0	0	0	0	3	3	0	3	3	0	9	9	0
LBR1	0	0	0	1	1	0	6	6	0	1	1	0	18	18	0
LBR2	1	1	0	6	6	0	18	18	0	7	7	0	34	34	0
LBR3	3	3	0	13	12	-1	30	28	-2	14	13	-1	47	45	-2
BR1	0	0	0	10	6	-4	39	28	-11	12	7	-5	67	58	-9
BR2	2	0	-2	19	15	-4	49	42	-7	20	15	-5	75	68	-7
BR3	3	1	-2	21	17	-4	48	42	-6	22	18	-4	70	66	-4
SCh1	1	1	0	4	3	-1	8	7	-1	5	4	-1	N/A	N/A	N/A
SCh2	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
SR	0	0	0	1	1	0	3	3	0	1	1	0	6	6	0

6. Table C.6. Percentage of water volumes with salinity in %iles within the period of May 1 – October 30, 1999

Percen-tile	Harbor / River			Stations					
	Upper Hrb %	Middle Rvr %	Back Rvr %	Houlih Brg %	Broad Str %	Pulaski Frt %	Lucknow Cnl %	USF&W Dck %	I-95 Brg %
5	19.6	5.2	4.4	4.8	4.4	4.3	4.5	3.8	88
10	23.6	9.1	8.8	9.1	8.9	8.7	9.1	8.4	88
25	35.8	20.7	22.4	22.3	22.8	22.1	26.1	21.6	88
50	57	43.1	46.6	46.5	47.1	46.1	47.1	43	88
75	79.7	69.8	72.8	72.8	73.1	72.8	74.2	69.7	88
90	91.1	87.5	89	89	89.2	89.2	89.3	87.5	89.3
95	95.6	93.6	94.4	94.5	94.6	94.6	94.1	93.7	95.3
Total Volume 100*km3:	31414.5	659.1	4809.2	22.6	39.2	136.3	10	9.5	43.6

7. Table C.7. Percentage of water volumes with D.O. in %iles within the period of May 1 – October 30, 1999

Percen-tile	Harbor / River			Stations					
	Upper Hrb %	Middle Rvr %	Back Rvr %	Houlih Brg %	Broad Str %	Pulaski Frt %	Lucknow Cnl %	USF&W Dck %	I-95 Brg %
5	5.3	4.7	4.8	5.7	5.3	4.8	5.3	5.3	5.8
10	10.5	9.5	9.7	11.2	10.4	9.7	10.2	10.5	10.9
25	26.2	24.1	24.7	27.4	25.9	24.4	25.3	25.4	26.5
50	52.2	48.8	49.7	53.5	51.3	49.2	50.7	50.9	51.4
75	77.4	74.1	75	77.7	76.1	74.5	75.4	75.7	75.6
90	90.7	89.5	90	91.3	90.5	89.8	90.3	90.1	90.4
95	95.4	94.8	95	95.7	95.3	94.8	95.2	95.2	95.2
Total Volume 100*km3:	31414.5	659.1	4809.2	22.6	39.2	136.3	10	9.5	43.6

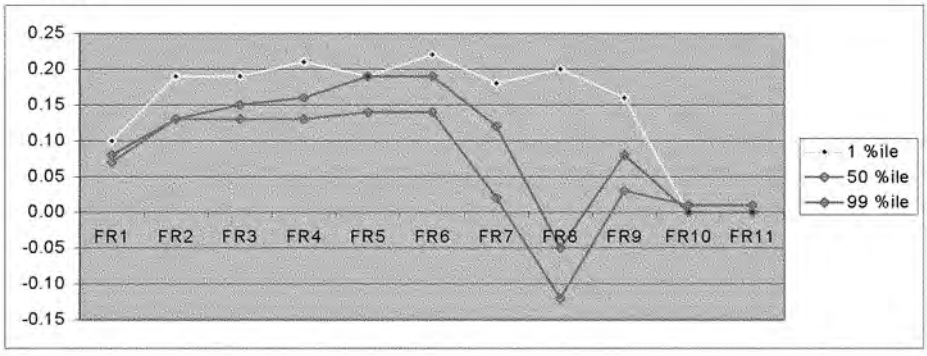
8. Table C.8. Water volumes in Upper Harbor in increments of 1° C of water temperature within the period of May 1 – October 30, 1999

Temperature C°	Total Volume %
19	0.01
20	0.7
21	3.71
22	8.89
23	14.26
24	22.76
25	33.67
26	48.48
27	59.67
28	68.63
29	77.56
30	85.3
31	89.56
32	96.42
33	99.99
34	100

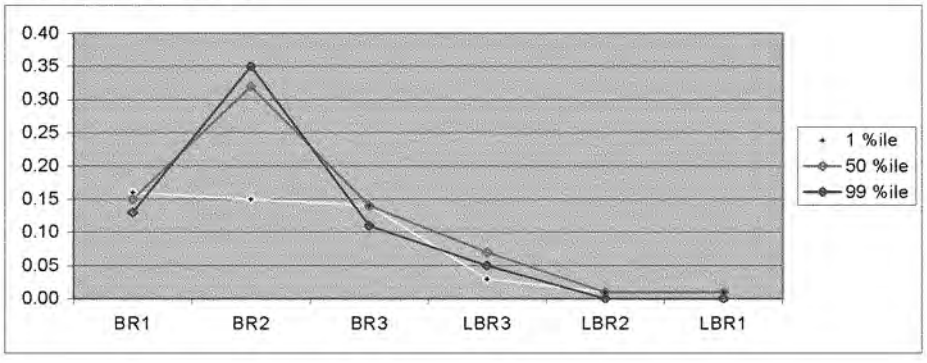
9. Table C.9. Water volumes in Upper Harbor in increments of 0.1 mg/l of D.O. within the period of May 1 – October 30, 1999
(See file: Postprocessor Output\99-S2E\99-S2E_DO Increment Volume)

10. Table C.10. Percentage of water volumes corresponding to 1-, 7-, and 30-days averages of D.O. depth-averaged concentrations in Upper Harbor within the period of May 1 – October 30, 1999
(See file: Postprocessor Output99-\S2E\99-S2E_volume DO in averages)

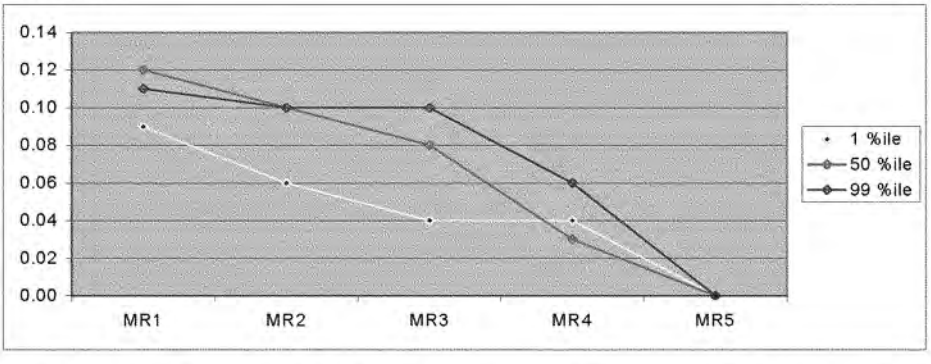
Front River



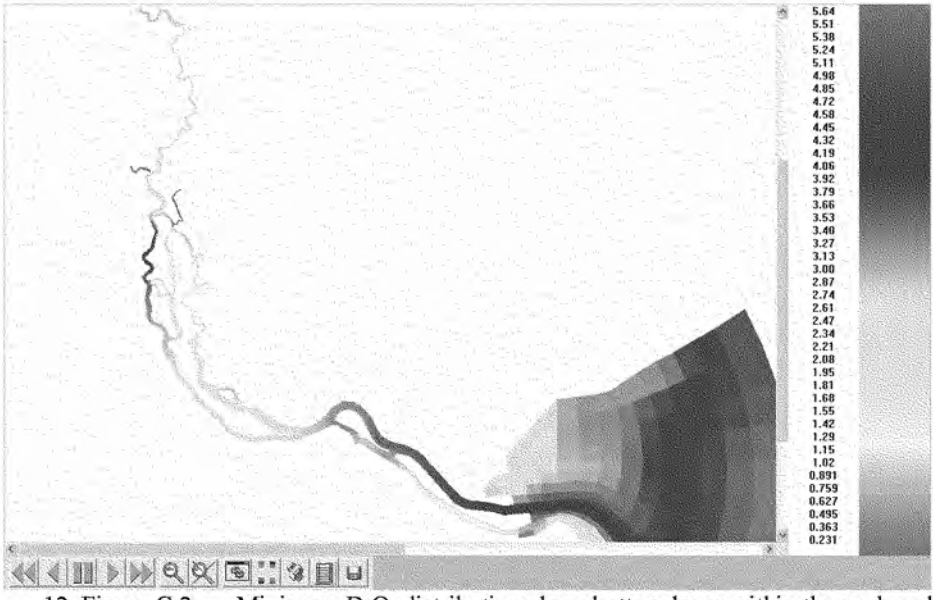
Back and Little Back Rivers



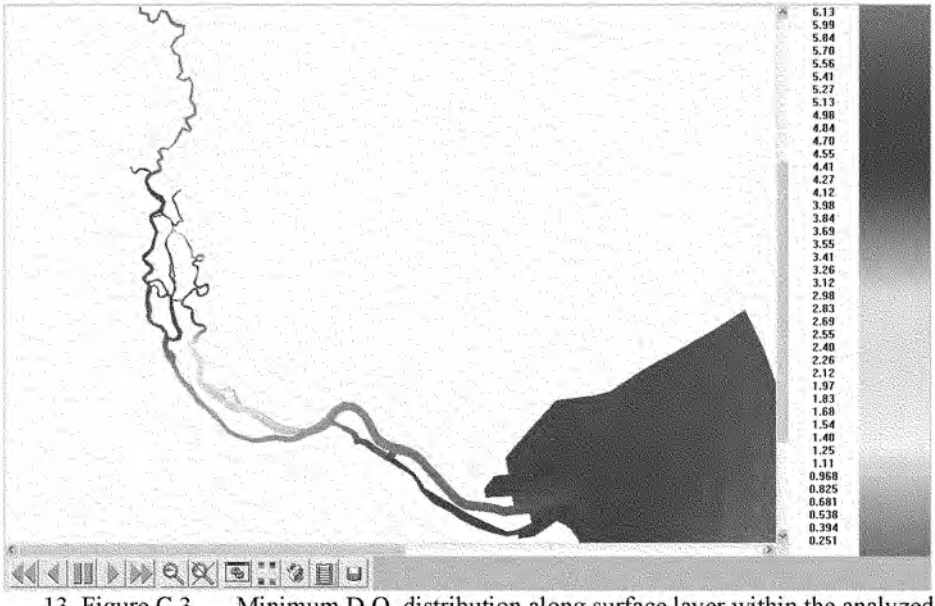
Middle River



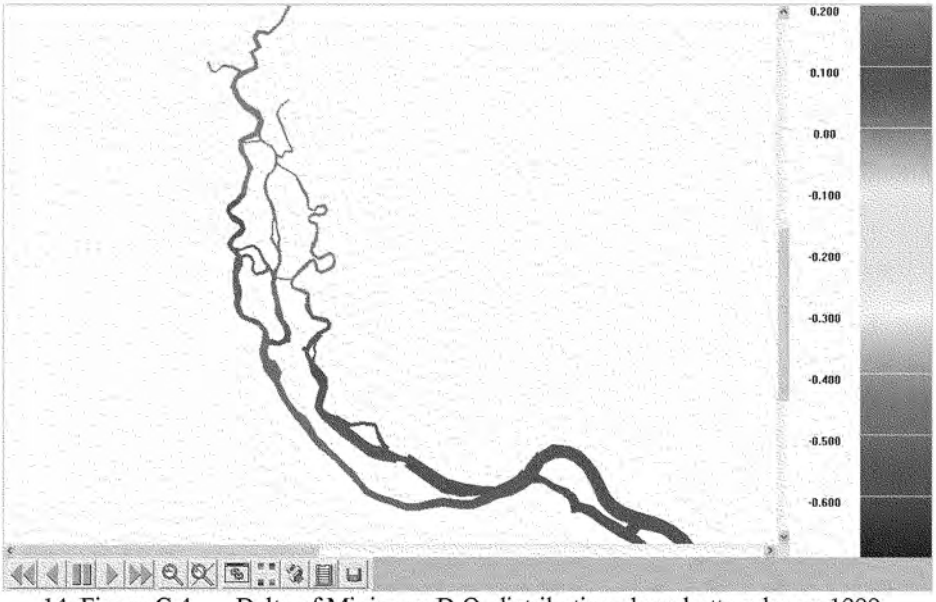
11. Figure C.1. Longitudinal profile of Dissolved Oxygen (mg/l) distribution along Critical cells of Savannah Estuary: Existing bathymetry



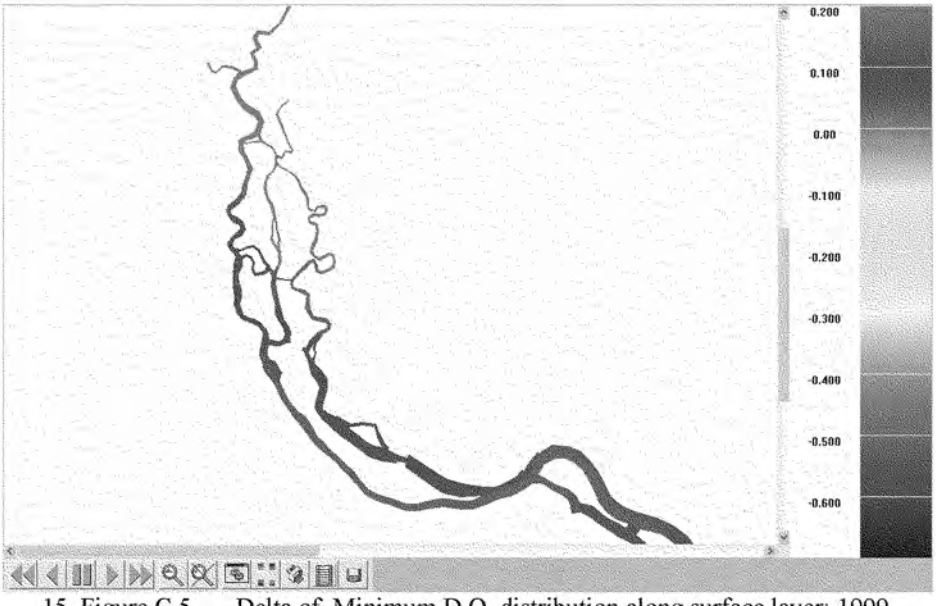
12. Figure C.2. Minimum D.O. distribution along bottom layer within the analyzed period of May 1 - October 30, 1999: Existing bathymetry



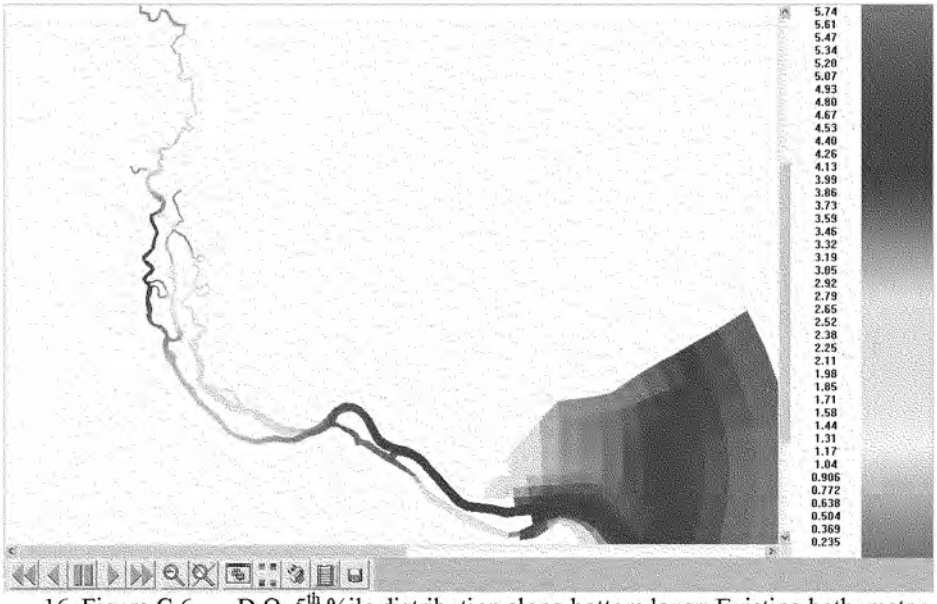
13. Figure C.3. Minimum D.O. distribution along surface layer within the analyzed period of May 1 - October 30, 1999: Existing bathymetry



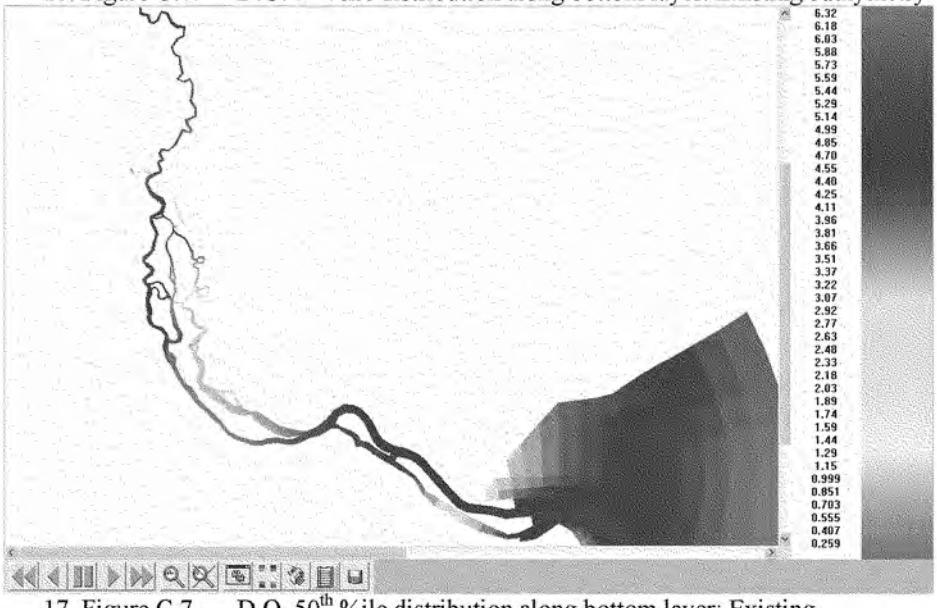
14. Figure C.4. Delta of Minimum D.O. distribution along bottom layer: 1999 minus 2004 loading scenarios



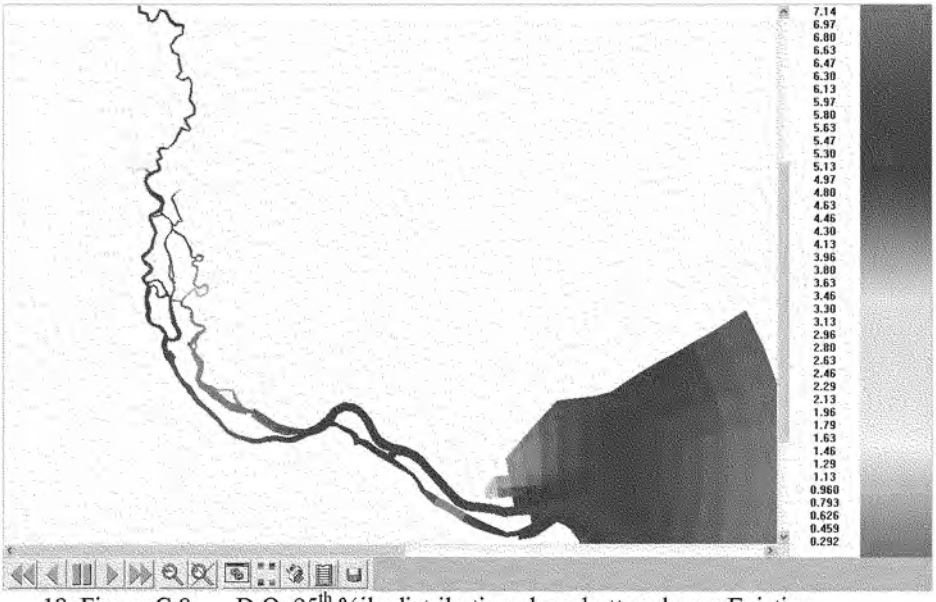
15. Figure C.5. Delta of Minimum D.O. distribution along surface layer: 1999 minus 2004 loading scenarios



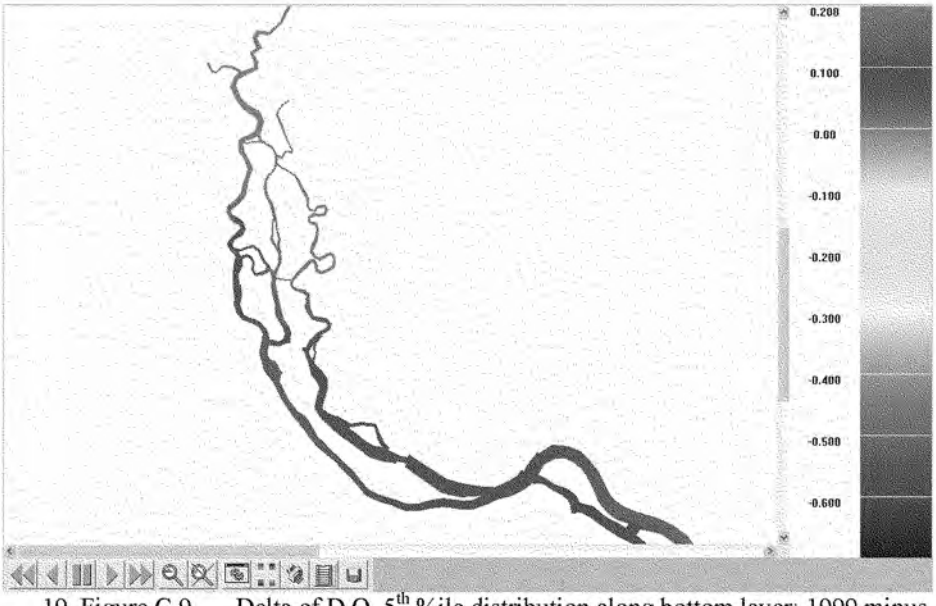
16. Figure C.6. D.O. 5th %ile distribution along bottom layer: Existing bathymetry



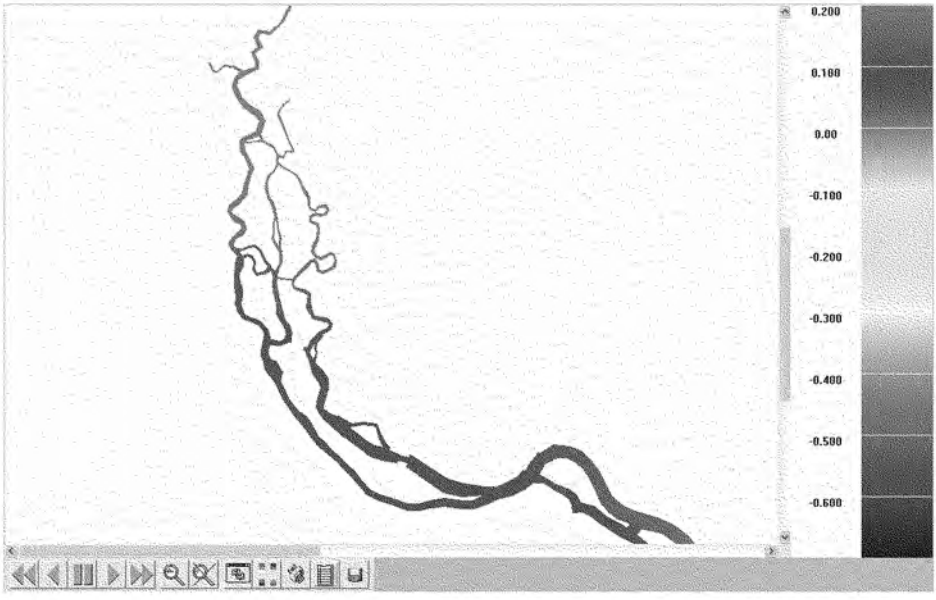
17. Figure C.7. D.O. 50th %ile distribution along bottom layer: Existing bathymetry



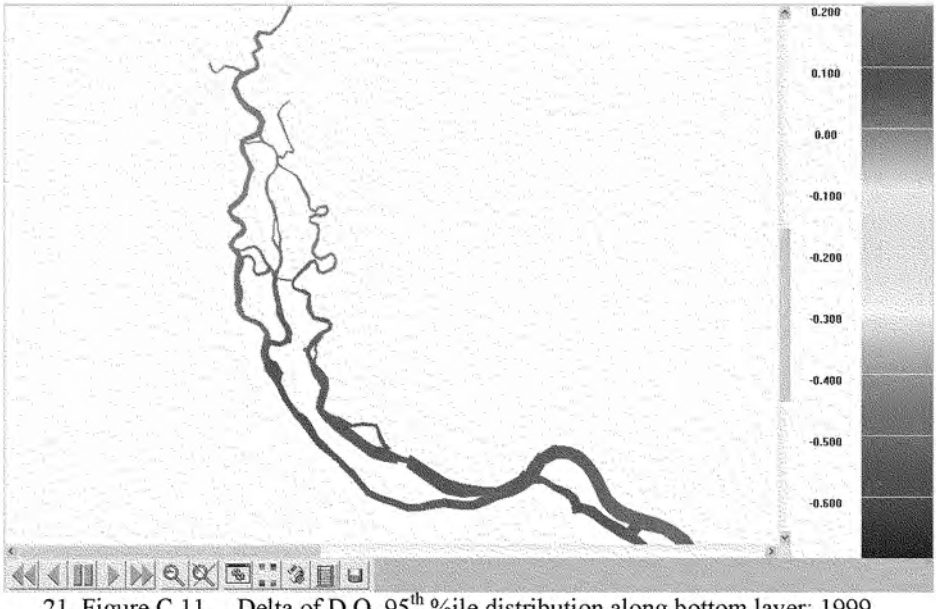
18. Figure C.8. D.O. 95th %ile distribution along bottom layer: Existing bathymetry



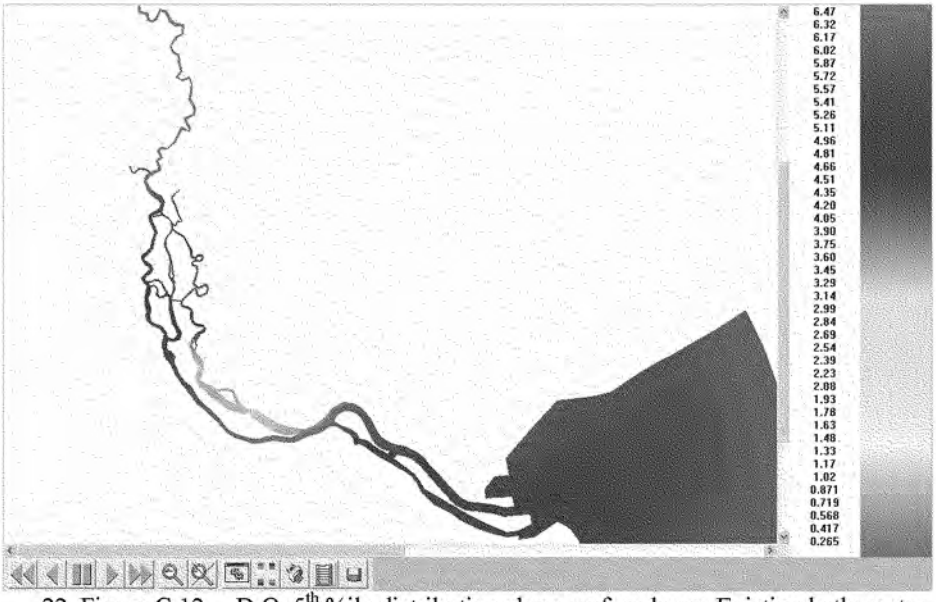
19. Figure C.9. Delta of D.O. 5th %ile distribution along bottom layer: 1999 minus 2004 loading scenarios



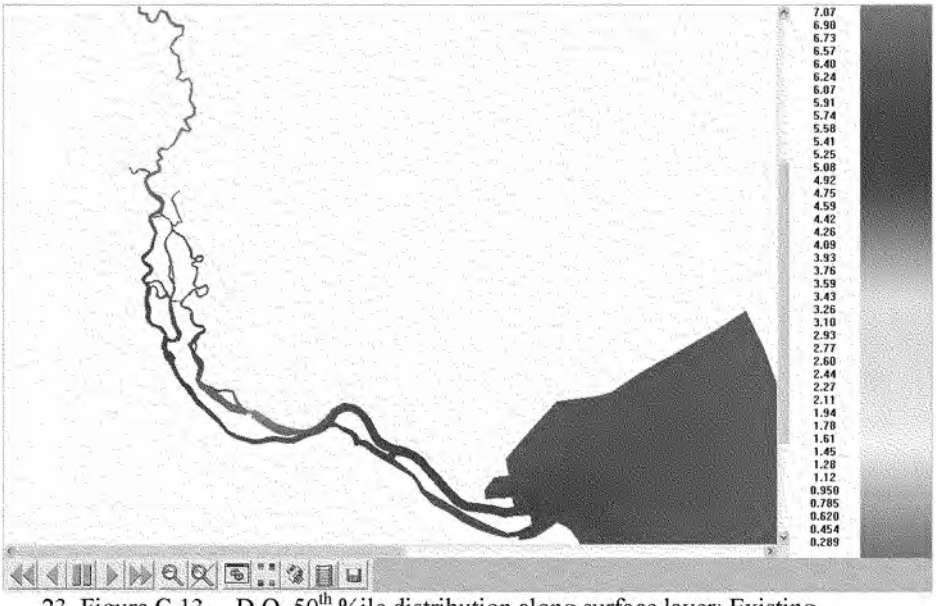
20. Figure C.10. Delta of D.O. 50th %ile distribution along bottom layer: 1999 minus 2004 loading scenarios



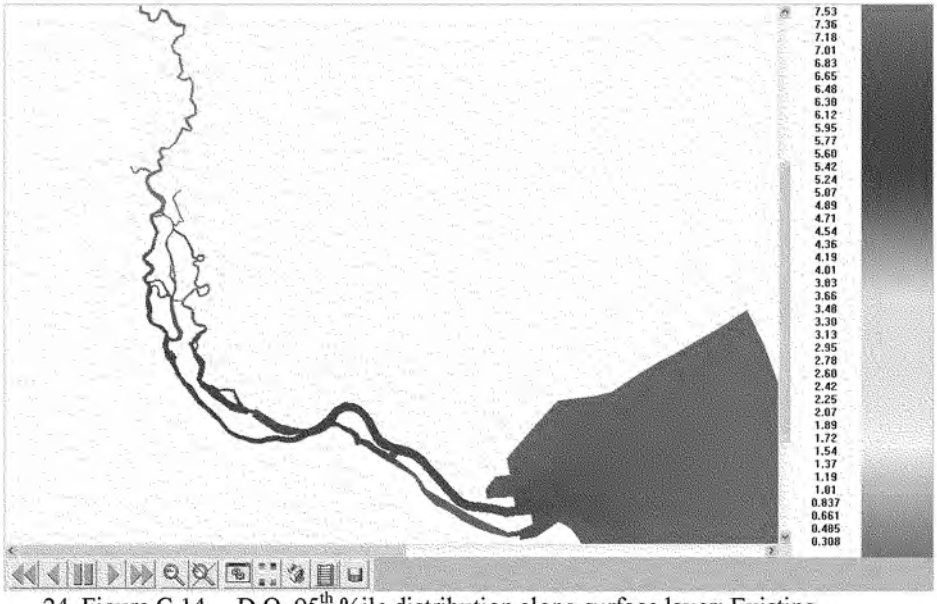
21. Figure C.11. Delta of D.O. 95th %ile distribution along bottom layer: 1999 minus 2004 loading scenarios



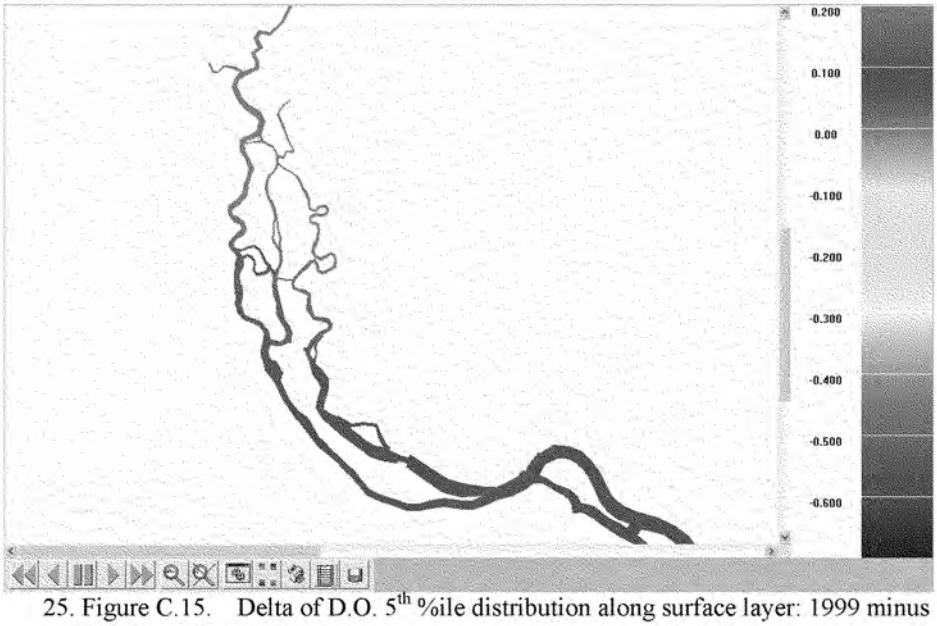
22. Figure C.12. D.O. 5th %ile distribution along surface layer: Existing bathymetry



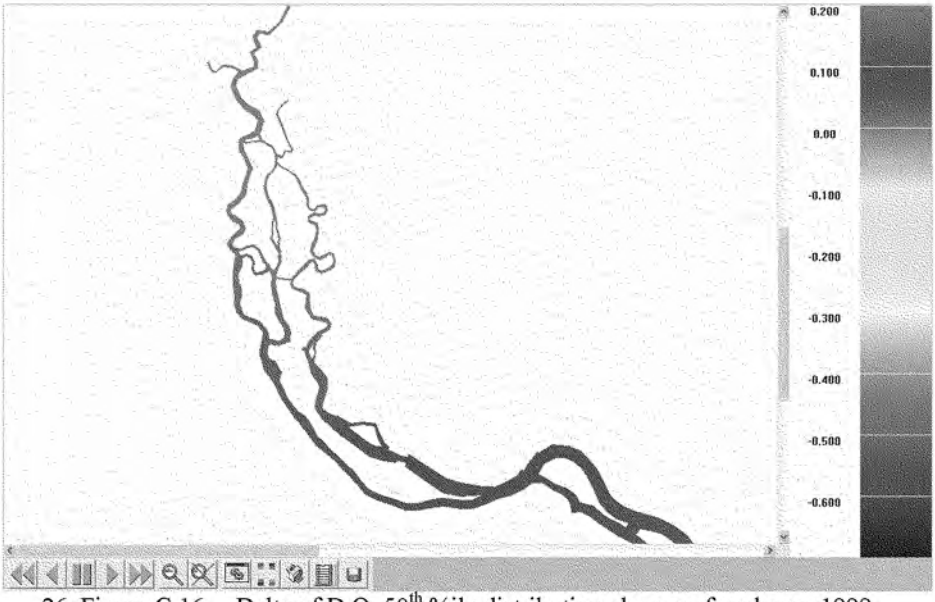
23. Figure C.13. D.O. 50th %ile distribution along surface layer: Existing bathymetry



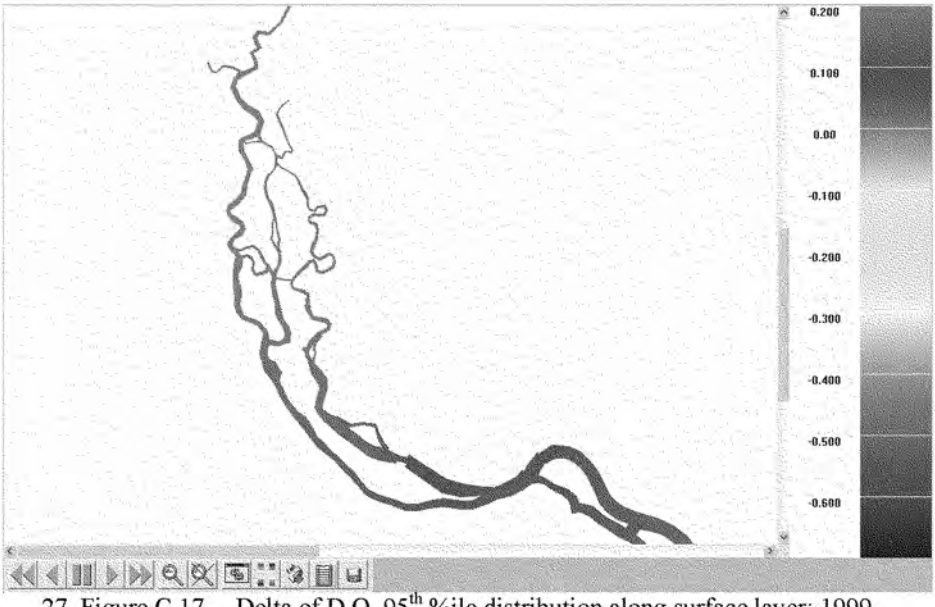
24. Figure C.14. D.O. 95th %ile distribution along surface layer: Existing bathymetry



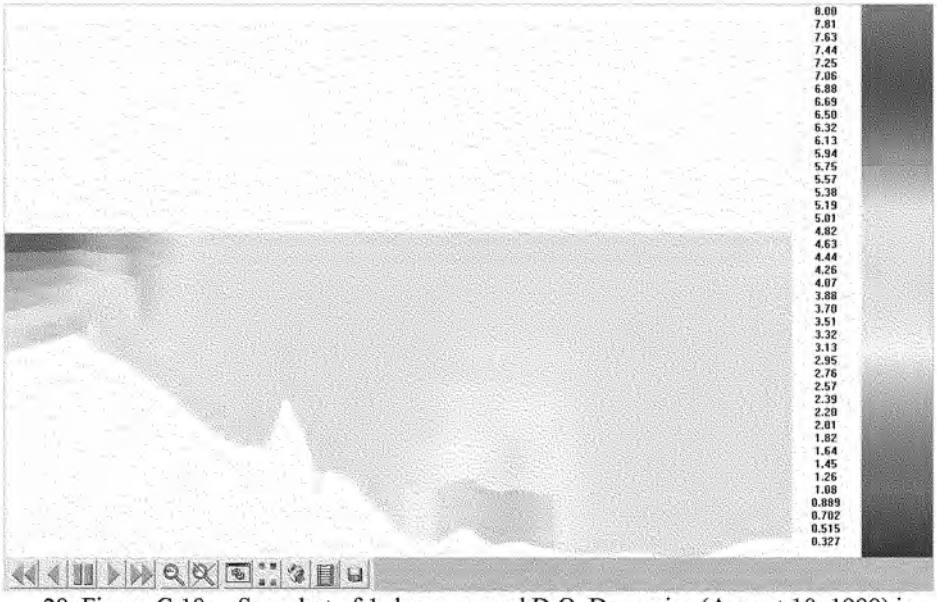
25. Figure C.15. Delta of D.O. 5th %ile distribution along surface layer: 1999 minus 2004 loading scenarios



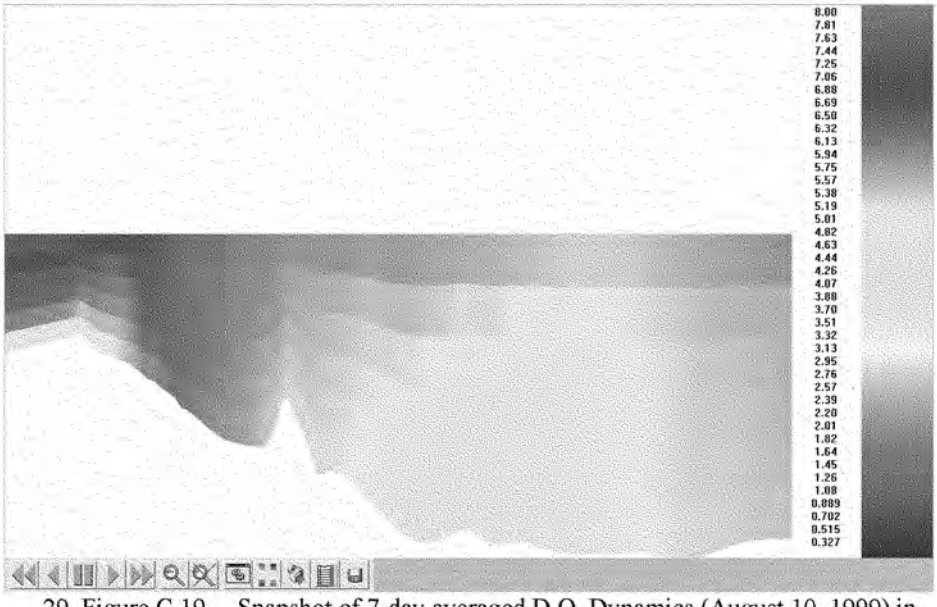
26. Figure C.16. Delta of D.O. 50th %ile distribution along surface layer: 1999 minus 2004 loading scenarios



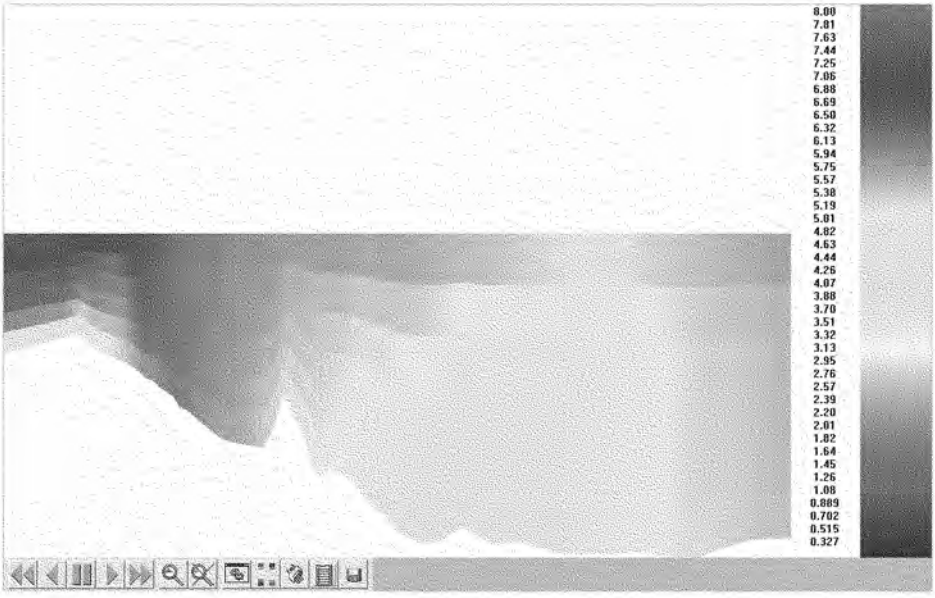
27. Figure C.17. Delta of D.O. 95th %ile distribution along surface layer: 1999 minus 2004 loading scenarios



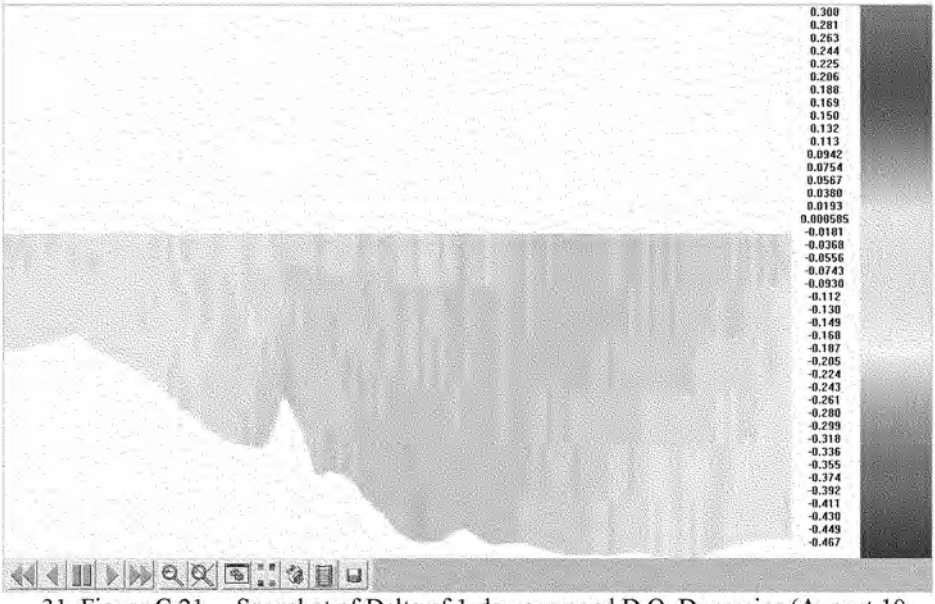
28. Figure C.18. Snapshot of 1-day averaged D.O. Dynamics (August 10, 1999) in vertical plane of Upper Harbor: Existing bathymetry



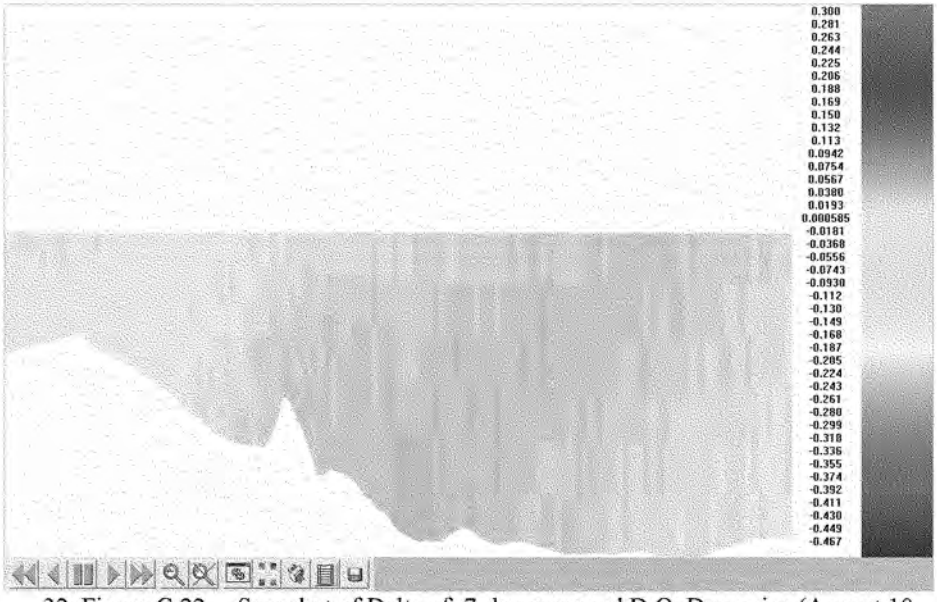
29. Figure C.19. Snapshot of 7-day averaged D.O. Dynamics (August 10, 1999) in vertical plane of Upper Harbor: Existing bathymetry



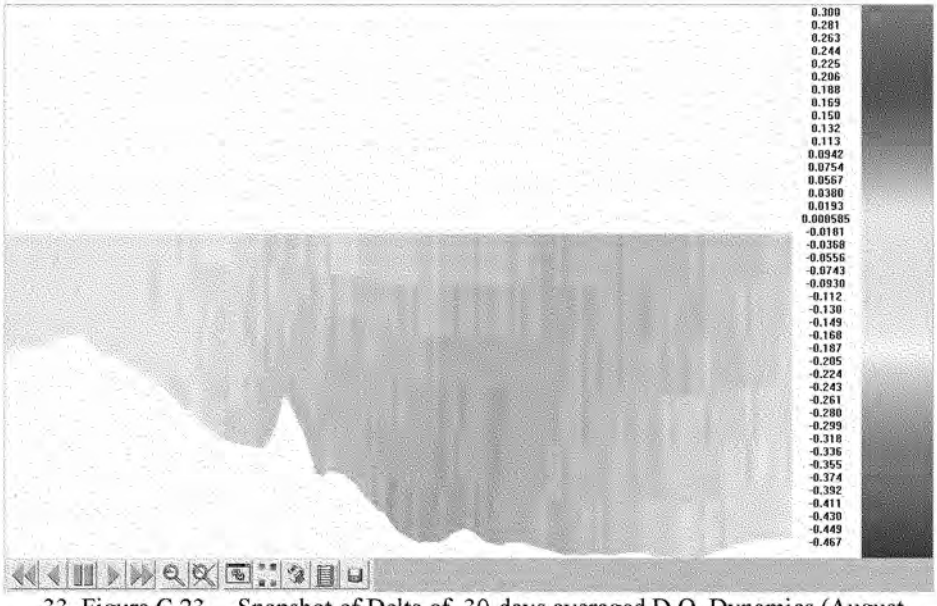
30. Figure C.20. Snapshot of 30-days averaged D.O. Dynamics (August 10, 1999) in vertical plane of Upper Harbor: Existing bathymetry



31. Figure C.21. Snapshot of Delta of 1-day averaged D.O. Dynamics (August 10, 1999) in vertical plane of Upper Harbor: 1999 minus 2004 loading scenarios



32. Figure C.22. Snapshot of Delta of 7-day averaged D.O. Dynamics (August 10, 1999) in vertical plane of Upper Harbor: 1999 minus 2004 loading scenarios



33. Figure C.23. Snapshot of Delta of 30-days averaged D.O. Dynamics (August 10, 1999) in vertical plane of Upper Harbor: 1999 minus 2004 loading scenarios

Appendix D

SENSITIVITY ANALYSIS #2B: EXISTING BATHYMETRY, 1999 POINT SOURCES LOADS, 1999 HYDROLOGICAL AND METEOROLOGICAL CONDITIONS

May 1 – October 30, 1999 Simulation Period

Water Quality Review Group

1. Table D.1. Dissolved oxygen percentiles distribution in Critical cells

Zone	D.O. Percentile (mg/l)								
	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	3.16	3.41	3.53	3.76	4.12	4.55	4.86	5.04	5.37
FR2	2.27	2.64	2.77	3.07	3.42	3.84	4.25	4.41	4.73
FR3	1.99	2.26	2.42	2.72	3.13	3.56	3.95	4.16	4.51
FR4	2.01	2.29	2.45	2.75	3.11	3.54	3.92	4.14	4.47
FR5	2.01	2.26	2.37	2.73	3.1	3.5	3.93	4.08	4.38
FR6	2.03	2.24	2.36	2.68	3.07	3.47	3.93	4.07	4.36
FR7	2.35	2.64	2.85	3.27	3.82	4.48	4.96	5.13	5.45
FR8	2.76	3.12	3.29	3.76	4.44	4.89	5.27	5.47	5.77
FR9	2.97	3.25	3.45	3.88	4.47	5.01	5.32	5.47	5.73
FR10	2.28	3.12	3.37	3.91	4.57	5.19	5.57	5.73	5.96
FR11	2.14	2.77	3.14	3.62	4.22	4.82	5.35	5.55	5.88
MR1	2.24	2.61	2.83	3.17	3.57	3.91	4.27	4.45	4.72
MR2	1.91	2.34	2.64	3.07	3.5	3.9	4.25	4.45	4.74
MR3	1.8	2.21	2.53	2.99	3.43	3.88	4.23	4.45	4.71
MR4	1.8	2.2	2.42	2.88	3.26	3.6	3.96	4.18	4.47
MR5	0.43	0.96	1.34	2.17	3.58	5.08	5.49	5.66	5.9
MR6	1.03	1.61	2.06	2.98	4.37	5.24	5.62	5.81	6.1
LBR1	2.58	3.12	3.36	3.86	4.19	4.47	4.81	4.99	5.34
LBR2	1.87	2.14	2.33	2.84	3.17	3.45	3.78	3.98	4.27
LBR3	1.1	1.49	1.81	2.32	2.85	3.34	3.7	3.91	4.34
BR1	1.57	1.85	2.03	2.4	2.83	3.27	3.68	3.91	4.23
BR2	0.94	1.25	1.46	1.83	2.4	2.83	3.22	3.49	3.9
BR3	1.28	1.65	1.87	2.22	2.69	3.12	3.45	3.76	4.15
SCH1	1.01	1.39	1.63	2.22	3.08	3.96	4.53	4.87	5.21
SCH2	2.76	2.99	3.13	3.4	3.75	4.16	4.55	4.72	5.01
SR	2.24	2.52	2.96	3.6	3.86	4.2	4.5	4.64	4.91

2. Table D.2. Delta of Dissolved Oxygen percentiles distribution in Critical cells: Permitted (Project) and 2004 (Baseline) point sources loading scenarios

Zone	Delta D.O. Percentile																	
	1%		5%		10%		25%		50%		75%		90%		95%		99	
	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%
FR1	-0.27	-7.9	-0.2	-5.5	-0.19	-5.1	-0.19	-4.8	-0.17	-4.0	-0.17	-3.6	-0.14	-2.8	-0.16	-3.1	-0.2	-3.6
FR2	-0.47	-17.2	-0.35	-11.7	-0.34	-10.9	-0.32	-9.4	-0.32	-8.6	-0.32	-7.7	-0.27	-6.0	-0.26	-5.6	-0.24	-4.8
FR3	-0.46	-18.8	-0.43	-16.0	-0.39	-13.9	-0.33	-10.8	-0.37	-10.6	-0.35	-9.0	-0.31	-7.3	-0.25	-5.7	-0.2	-4.2
FR4	-0.5	-19.9	-0.45	-16.4	-0.4	-14.0	-0.35	-11.3	-0.41	-11.6	-0.37	-9.5	-0.33	-7.8	-0.29	-6.5	-0.24	-5.1
FR5	-0.49	-19.6	-0.43	-16.0	-0.41	-14.7	-0.37	-11.9	-0.4	-11.4	-0.37	-9.6	-0.3	-7.1	-0.33	-7.5	-0.24	-5.2
FR6	-0.51	-20.1	-0.5	-18.2	-0.45	-16.0	-0.47	-14.9	-0.44	-12.5	-0.42	-10.8	-0.37	-8.6	-0.41	-9.2	-0.33	-7.0
FR7	-0.78	-24.9	-0.77	-22.6	-0.74	-20.6	-0.68	-17.2	-0.6	-13.6	-0.39	-8.0	-0.25	-4.8	-0.32	-5.9	-0.58	-9.6
FR8	-0.44	-13.8	-0.4	-11.4	-0.4	-10.8	-0.35	-8.5	-0.25	-5.3	-0.22	-4.3	-0.15	-2.8	-0.14	-2.5	-0.13	-2.2
FR9	-0.42	-12.4	-0.39	-10.7	-0.39	-10.2	-0.35	-8.3	-0.27	-5.7	-0.19	-3.7	-0.14	-2.6	-0.14	-2.5	-0.15	-2.6
FR10	-0.01	-0.4	-0.01	-0.3	-0.01	-0.3	-0.01	-0.3	-0.02	-0.4	-0.05	-1.0	-0.08	-1.4	-0.09	-1.5	-0.07	-1.2
FR11	-0.03	-1.4	-0.01	-0.4	-0.01	-0.3	-0.01	-0.3	0	0.0	-0.03	-0.6	-0.05	-0.9	-0.07	-1.2	-0.06	-1.0
MR1	-0.34	-13.2	-0.38	-12.7	-0.35	-11.0	-0.38	-10.7	-0.36	-9.2	-0.34	-8.0	-0.31	-6.8	-0.3	-6.3	-0.26	-5.2
MR2	-0.29	-13.2	-0.22	-8.6	-0.27	-9.3	-0.3	-8.9	-0.32	-8.4	-0.31	-7.4	-0.28	-6.2	-0.29	-6.1	-0.26	-5.2
MR3	-0.28	-13.5	-0.24	-9.8	-0.23	-8.3	-0.29	-8.8	-0.31	-8.3	-0.29	-7.0	-0.27	-6.0	-0.28	-5.9	-0.26	-5.2
MR4	-0.25	-12.2	-0.24	-9.8	-0.21	-8.0	-0.17	-5.6	-0.22	-6.3	-0.23	-6.0	-0.22	-5.3	-0.18	-4.1	-0.21	-4.5
MR5	-0.02	-4.4	-0.03	-3.0	-0.05	-3.6	-0.04	-1.8	-0.05	-1.4	-0.04	-0.8	-0.08	-1.4	-0.07	-1.2	-0.07	-1.2
MR6	-0.02	-1.9	-0.05	-3.0	-0.05	-2.4	-0.05	-1.7	-0.05	-1.1	-0.06	-1.1	-0.09	-1.6	-0.08	-1.4	-0.07	-1.1
LBR1	-0.09	-3.4	-0.17	-5.2	-0.14	-4.0	-0.1	-2.5	-0.12	-2.8	-0.13	-2.8	-0.11	-2.2	-0.11	-2.2	-0.09	-1.7
LBR2	-0.23	-11.0	-0.19	-8.2	-0.18	-7.2	-0.14	-4.7	-0.16	-4.8	-0.19	-5.2	-0.16	-4.1	-0.15	-3.6	-0.16	-3.6
LBR3	-0.24	-17.9	-0.26	-14.9	-0.23	-11.3	-0.24	-9.4	-0.28	-8.9	-0.29	-8.0	-0.28	-7.0	-0.27	-6.5	-0.22	-4.8
BR1	-0.43	-21.5	-0.38	-17.0	-0.38	-15.8	-0.38	-13.7	-0.38	-11.8	-0.36	-9.9	-0.33	-8.2	-0.31	-7.3	-0.25	-5.6
BR2	-0.43	-31.4	-0.36	-22.4	-0.37	-20.2	-0.37	-16.8	-0.38	-13.7	-0.36	-11.3	-0.35	-9.8	-0.29	-7.7	-0.25	-6.0
BR3	-0.41	-24.3	-0.38	-18.7	-0.35	-15.8	-0.34	-13.3	-0.37	-12.1	-0.35	-10.1	-0.34	-9.0	-0.29	-7.2	-0.24	-5.5
SCH1	-0.28	-21.7	-0.26	-15.8	-0.29	-15.1	-0.27	-10.8	-0.23	-6.9	-0.14	-3.4	-0.13	-2.8	-0.11	-2.2	-0.11	-2.1
SCH2	-0.32	-10.4	-0.32	-9.7	-0.32	-9.3	-0.29	-7.9	-0.29	-7.2	-0.28	-6.3	-0.22	-4.6	-0.24	-4.8	-0.24	-4.6
SR	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0

3. Table D.3. Dissolved oxygen percentiles distribution in Zones of Savannah Estuary

Zone Name	D.O. Concentration Percentiles (mg/l)								
	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	3.68	3.85	3.94	4.16	4.50	4.91	5.21	5.39	5.72
FR2	2.86	3.16	3.29	3.52	3.87	4.28	4.63	4.78	5.10
FR3	2.26	2.58	2.70	2.99	3.33	3.75	4.14	4.32	4.62
FR4	2.00	2.27	2.38	2.69	3.07	3.50	3.90	4.08	4.43
FR5	2.05	2.27	2.39	2.67	3.08	3.46	3.91	4.06	4.38
FR6	2.17	2.41	2.51	2.81	3.20	3.60	4.03	4.21	4.44
FR7	2.53	2.84	3.01	3.43	3.99	4.56	4.94	5.12	5.43
FR8	2.91	3.24	3.43	3.86	4.42	4.88	5.18	5.35	5.62
FR9	3.57	3.93	4.15	4.59	5.04	5.37	5.63	5.78	6.03
FR10	3.98	4.45	4.65	4.95	5.22	5.48	5.71	5.85	6.09
FR11	2.64	3.18	3.56	3.96	4.30	4.62	4.92	5.11	5.34
MR1	2.34	2.64	2.83	3.18	3.56	3.91	4.25	4.45	4.68
MR2	2.05	2.50	2.74	3.13	3.53	3.88	4.24	4.44	4.69
MR3	1.82	2.12	2.48	2.88	3.32	3.76	4.11	4.32	4.67
MR4	2.49	2.75	3.00	3.43	3.76	4.05	4.34	4.54	4.75
MR5	1.04	1.41	1.83	2.67	4.10	5.03	5.43	5.59	5.85
MR6	1.08	1.63	2.09	3.04	4.43	5.22	5.58	5.77	6.04
LBR1	2.67	2.84	3.02	3.53	3.75	4.00	4.33	4.47	4.64
LBR2	1.78	2.06	2.29	2.76	3.12	3.41	3.72	3.94	4.15
LBR3	1.45	1.59	1.78	2.33	2.77	3.05	3.43	3.60	3.96
BR1	2.01	2.19	2.31	2.60	3.01	3.42	3.85	4.03	4.31
BR2	1.51	1.79	1.93	2.24	2.69	3.13	3.54	3.76	4.08
BR3	1.51	1.74	1.92	2.29	2.72	3.08	3.51	3.75	4.07
SCh1	2.35	2.66	2.79	3.05	3.43	3.90	4.26	4.42	4.71
SCh2	3.02	3.19	3.29	3.54	3.85	4.27	4.63	4.78	5.08
SR	2.62	2.79	3.29	3.88	4.12	4.44	4.71	4.85	5.11

4. Table D.4. Delta of Dissolved Oxygen percentiles distribution in Zones: Permitted (Project) and 2004 (Baseline) point sources loading scenarios

Zone	Project - Baseline Difference (mg/l)									Project - Baseline Relative Difference (%)								
Name	1%	5%	10%	25%	50%	75%	90%	95%	99%	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	-0.13	-0.11	-0.10	-0.09	-0.09	-0.09	-0.07	-0.09	-0.09	-3.4	-2.8	-2.4	-2.2	-2.1	-1.9	-1.3	-1.6	-1.6
FR2	-0.36	-0.28	-0.27	-0.25	-0.24	-0.24	-0.19	-0.18	-0.20	-11.2	-8.1	-7.5	-6.5	-5.8	-5.3	-4.0	-3.7	-3.8
FR3	-0.48	-0.37	-0.35	-0.32	-0.35	-0.33	-0.28	-0.26	-0.26	-17.5	-12.7	-11.4	-9.7	-9.5	-8.0	-6.3	-5.7	-5.3
FR4	-0.50	-0.46	-0.43	-0.38	-0.42	-0.37	-0.34	-0.31	-0.24	-20.0	-16.9	-15.2	-12.2	-12.1	-9.6	-8.1	-7.1	-5.1
FR5	-0.50	-0.47	-0.44	-0.43	-0.44	-0.42	-0.36	-0.35	-0.25	-19.6	-17.2	-15.6	-13.7	-12.4	-10.7	-8.4	-7.9	-5.4
FR6	-0.50	-0.46	-0.44	-0.46	-0.44	-0.41	-0.35	-0.35	-0.30	-18.8	-16.1	-15.0	-14.0	-12.1	-10.1	-8.0	-7.7	-6.4
FR7	-0.49	-0.43	-0.44	-0.41	-0.32	-0.26	-0.20	-0.19	-0.19	-16.3	-13.1	-12.8	-10.7	-7.5	-5.5	-3.8	-3.6	-3.4
FR8	-0.41	-0.38	-0.37	-0.35	-0.26	-0.20	-0.17	-0.17	-0.16	-12.3	-10.4	-9.7	-8.3	-5.5	-4.0	-3.1	-3.1	-2.7
FR9	-0.35	-0.30	-0.29	-0.23	-0.16	-0.13	-0.13	-0.12	-0.10	-9.0	-7.1	-6.4	-4.8	-3.1	-2.4	-2.2	-2.0	-1.7
FR10	-0.03	-0.05	-0.06	-0.05	-0.06	-0.08	-0.09	-0.08	-0.07	-0.7	-1.2	-1.3	-1.0	-1.2	-1.5	-1.6	-1.3	-1.1
FR11	0.01	0.00	0.00	0.00	0.00	-0.01	-0.02	-0.02	-0.03	0.3	0.0	0.0	-0.1	0.0	-0.2	-0.4	-0.4	-0.5
MR1	-0.45	-0.41	-0.39	-0.38	-0.38	-0.33	-0.32	-0.30	-0.26	-16.2	-13.4	-12.0	-10.7	-9.5	-7.8	-7.0	-6.3	-5.2
MR2	-0.31	-0.29	-0.31	-0.33	-0.34	-0.32	-0.29	-0.30	-0.26	-13.1	-10.2	-10.1	-9.4	-8.8	-7.7	-6.3	-6.4	-5.3
MR3	-0.27	-0.23	-0.19	-0.25	-0.27	-0.27	-0.26	-0.26	-0.25	-12.8	-10.0	-7.1	-8.1	-7.4	-6.7	-6.0	-5.7	-5.0
MR4	-0.25	-0.18	-0.16	-0.14	-0.14	-0.15	-0.17	-0.14	-0.10	-9.1	-6.2	-4.9	-3.8	-3.7	-3.7	-3.7	-3.0	-2.1
MR5	-0.03	-0.05	-0.05	-0.06	-0.03	-0.05	-0.07	-0.07	-0.07	-2.9	-3.6	-2.4	-2.1	-0.7	-0.9	-1.3	-1.2	-1.2
MR6	-0.03	-0.05	-0.04	-0.06	-0.03	-0.06	-0.08	-0.07	-0.07	-2.5	-3.2	-1.7	-2.0	-0.8	-1.1	-1.4	-1.2	-1.1
LBR1	-0.19	-0.19	-0.16	-0.10	-0.16	-0.16	-0.14	-0.14	-0.11	-6.6	-6.2	-4.9	-2.9	-4.1	-3.8	-3.1	-3.0	-2.4
LBR2	-0.25	-0.20	-0.20	-0.16	-0.17	-0.19	-0.17	-0.15	-0.14	-12.4	-8.8	-7.9	-5.4	-5.3	-5.1	-4.4	-3.8	-3.2
LBR3	-0.31	-0.31	-0.23	-0.19	-0.28	-0.28	-0.24	-0.21	-0.20	-17.8	-16.4	-11.3	-7.6	-9.1	-8.3	-6.4	-5.6	-4.9
BR1	-0.40	-0.35	-0.35	-0.35	-0.35	-0.35	-0.30	-0.31	-0.29	-16.7	-13.9	-13.1	-11.8	-10.5	-9.4	-7.3	-7.2	-6.3
BR2	-0.44	-0.37	-0.38	-0.37	-0.38	-0.37	-0.34	-0.32	-0.26	-22.6	-17.3	-16.4	-14.0	-12.2	-10.6	-8.8	-7.8	-5.9
BR3	-0.41	-0.36	-0.32	-0.29	-0.34	-0.36	-0.30	-0.28	-0.23	-21.4	-17.3	-14.4	-11.4	-11.2	-10.3	-7.9	-6.8	-5.2
SCh1	-0.26	-0.22	-0.21	-0.22	-0.21	-0.21	-0.18	-0.16	-0.13	-9.9	-7.7	-7.1	-6.6	-5.8	-5.2	-4.0	-3.5	-2.7
SCh2	-0.32	-0.29	-0.28	-0.25	-0.25	-0.25	-0.20	-0.22	-0.21	-9.5	-8.2	-7.9	-6.7	-6.1	-5.6	-4.2	-4.4	-3.9
SR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0

5. Table D.5. Percentage of the volume of waters with violation of Dissolved Oxygen standards for Zones of Savannah Estuary within the period of May 1 – October 30, 1999: Permitted (Project) and 2004 (Baseline) point sources loading scenarios

Zones	D.O. STANDARDS														
	1-Day Average			7-Day Average			30-Day Average			GA MINIMUM D.O.			SC MINIMUM D.O.		
	Baseline(B)	Project(P)	Delta=P-B	Baseline(B)	Project(P)	Delta=P-B	Baseline(B)	Project(P)	Delta=P-B	Baseline(B)	Project(P)	Delta=P-B	Baseline(B)	Project(P)	Delta=P-B
FR1	0	0	0	0	0	0	0	0	0	0	0	0	7	16	9
FR2	0	0	0	0	1	1	3	17	14	0	4	4	31	52	21
FR3	0	0	0	2	12	10	19	42	23	3	13	10	N/A	N/A	N/A
FR4	0	1	1	5	16	11	22	44	22	6	18	12	N/A	N/A	N/A
FR5	0	1	1	4	15	11	19	39	20	5	17	12	N/A	N/A	N/A
FR6	0	0	0	2	11	9	12	30	18	4	14	10	N/A	N/A	N/A
FR7	0	0	0	0	1	1	1	4	3	0	4	4	N/A	N/A	N/A
FR8	0	0	0	0	0	0	0	0	0	0	1	1	N/A	N/A	N/A
FR9	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
FR10	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A	N/A
FR11	0	0	0	0	0	0	2	2	0	1	1	0	6	6	0
MR1	0	0	0	0	4	4	5	14	9	1	5	4	N/A	N/A	N/A
MR2	0	0	0	1	4	3	6	14	8	1	4	3	N/A	N/A	N/A
MR3	0	1	1	3	5	2	10	15	5	3	6	3	N/A	N/A	N/A
MR4	0	0	0	1	2	1	5	7	2	2	2	0	N/A	N/A	N/A
MR5	0	0	0	1	2	1	5	5	0	5	5	0	11	12	1
MR6	0	0	0	0	0	0	3	3	0	3	3	0	9	9	0
LBR1	0	0	0	1	2	1	6	9	3	1	2	1	18	23	5
LBR2	1	2	1	6	9	3	18	24	6	7	10	3	34	41	7
LBR3	3	5	2	13	20	7	30	37	7	14	21	7	47	54	7
BR1	0	2	2	10	25	15	39	64	25	12	26	14	67	84	17
BR2	2	9	7	19	37	18	49	65	16	20	38	18	75	86	11
BR3	3	10	7	21	36	15	48	59	11	22	38	16	70	79	9
SCh1	1	2	1	4	5	1	8	13	5	5	7	2	N/A	N/A	N/A
SCh2	0	0	0	0	0	0	0	4	4	0	1	1	N/A	N/A	N/A
SR	0	0	0	1	1	0	3	3	0	1	1	0	6	6	0

6. Table D.6. Percentage of water volumes with salinity in %iles within the period of May 1 – October 30, 1999

Percen-tile	Harbor / River			Stations					
	Upper Hrb %	Middle Rvr %	Back Rvr %	Houlih Brg %	Broad Str %	Pulaski Frt %	Lucknow Cnl %	USF&W Dck %	I-95 Brg %
5	19.6	5.2	4.4	4.8	4.4	4.3	4.5	3.8	88
10	23.6	9.1	8.8	9.1	8.9	8.7	9.1	8.4	88
25	35.8	20.7	22.4	22.3	22.8	22.1	26.1	21.6	88
50	57	43.1	46.6	46.5	47.1	46.1	47.1	43	88
75	79.7	69.8	72.8	72.8	73.1	72.8	74.2	69.7	88
90	91.1	87.5	89	89	89.2	89.2	89.3	87.5	89.3
95	95.6	93.6	94.4	94.5	94.6	94.6	94.1	93.7	95.3
Total Volume 100*km3:	31414.5	659.1	4809.2	22.6	39.2	136.3	10	9.5	43.6

7. Table D.7. Percentage of water volumes with D.O. in %iles within the period of May 1 – October 30, 1999

Percen-tile	Harbor / River			Stations					
	Upper Hrb %	Middle Rvr %	Back Rvr %	Houlih Brg %	Broad Str %	Pulaski Frt %	Lucknow Cnl %	USF&W Dck %	I-95 Brg %
5	5.2	5	4.9	5.7	5.2	4.7	5.3	5.4	5.7
10	10.4	10	9.9	11.3	10.5	9.3	10.2	10.6	11.1
25	26	25.1	24.9	27.7	25.9	23.9	25.5	25.7	26.6
50	52	49.8	50	53.6	51.3	48.8	51.1	51.1	51.4
75	77.4	74.6	75.3	77.8	76	74.3	75.6	76	75.9
90	90.6	89.8	90.2	91.2	90.5	89.7	90.2	90.4	90.5
95	95.4	94.9	95.1	95.7	95.3	94.7	95.2	95.3	95.3
Total Volume 100*km3:	31414.5	659.1	4809.2	22.6	39.2	136.3	10	9.5	43.6

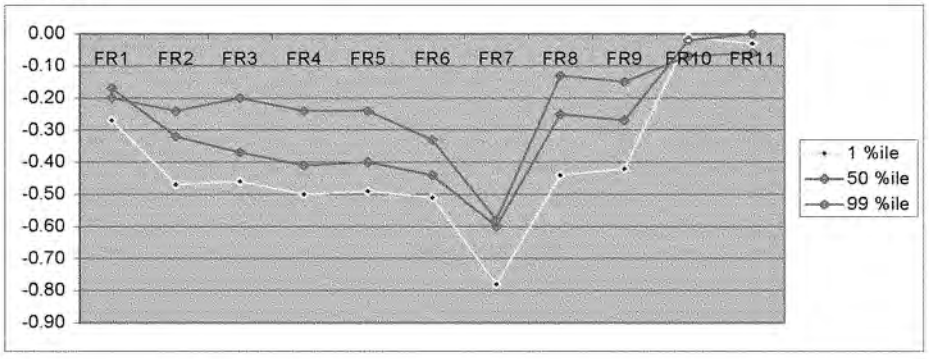
8. Table D.8. Water volumes in Upper Harbor in increments of 1° C of water temperature within the period of May 1 – October 30, 1999

Temperature C°	Total Volume %
19	0.01
20	0.7
21	3.71
22	8.89
23	14.26
24	22.76
25	33.67
26	48.48
27	59.67
28	68.63
29	77.56
30	85.3
31	89.56
32	96.42
33	99.99
34	100

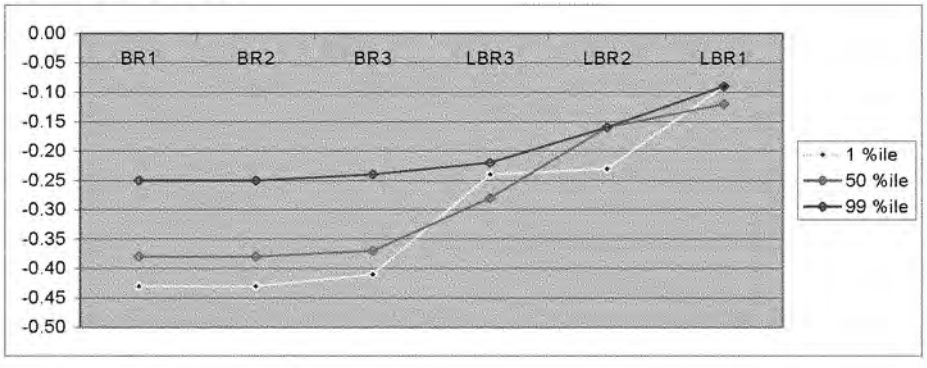
9. Table D.9. Water volumes in Upper Harbor in increments of 0.1 mg/l of D.O. within the period of May 1 – October 30, 1999
(See file: Postprocessor Output\99-S3E\99-S3E_DO Increment Volume)

10. Table D.10. Percentage of water volumes corresponding to 1-, 7-, and 30-days averages of D.O. depth-averaged concentrations in Upper Harbor within the period of May 1 – October 30, 1999
(See file: Postprocessor Output\99-S3E\99-S3E_volume DO in averages)

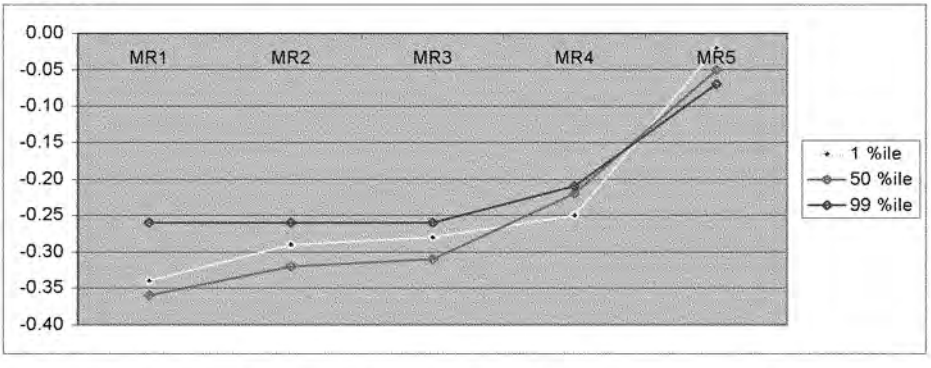
Front River



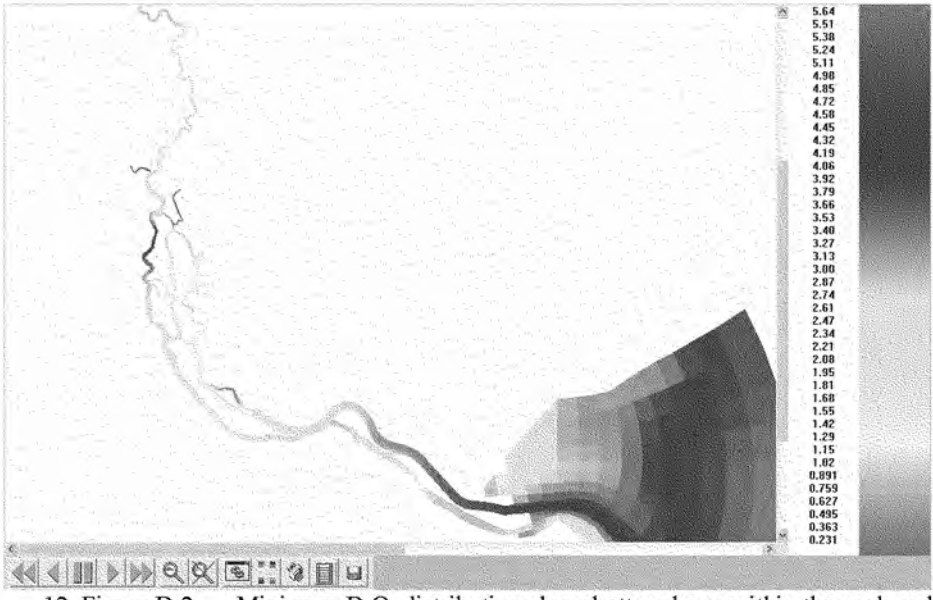
Back and Little Back Rivers



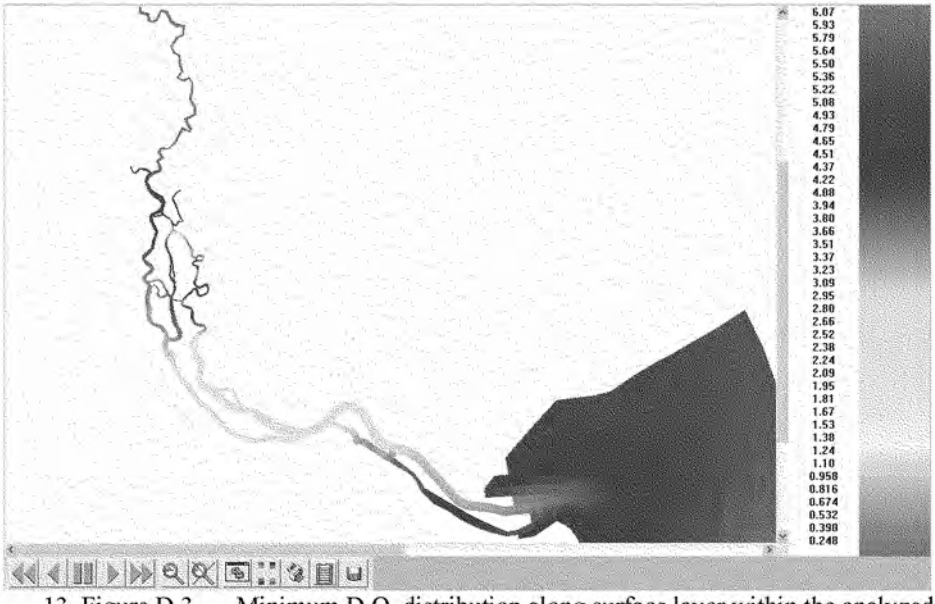
Middle River



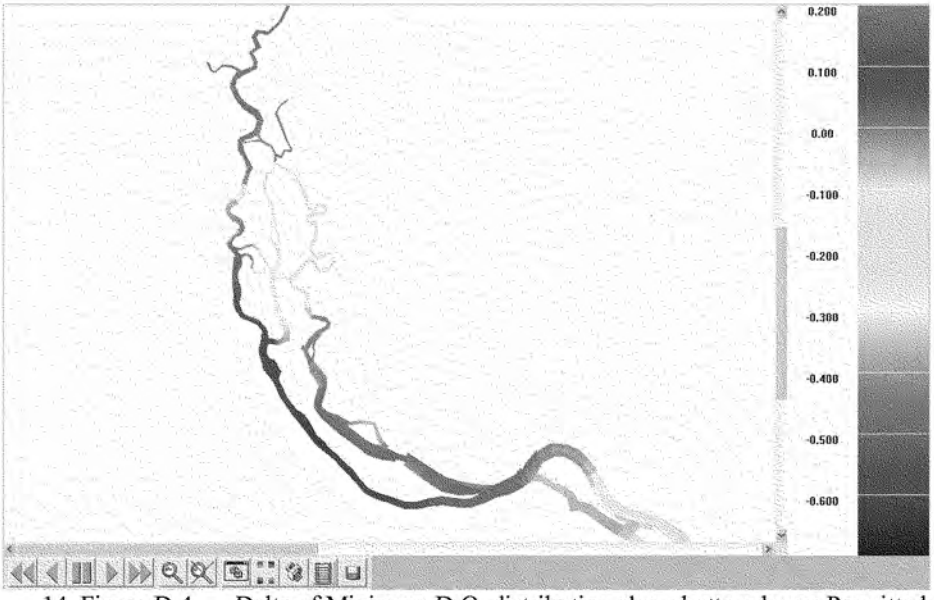
11. Figure D.1. Longitudinal profile of Dissolved Oxygen (mg/l) distribution along Critical cells of Savannah Estuary: Existing bathymetry



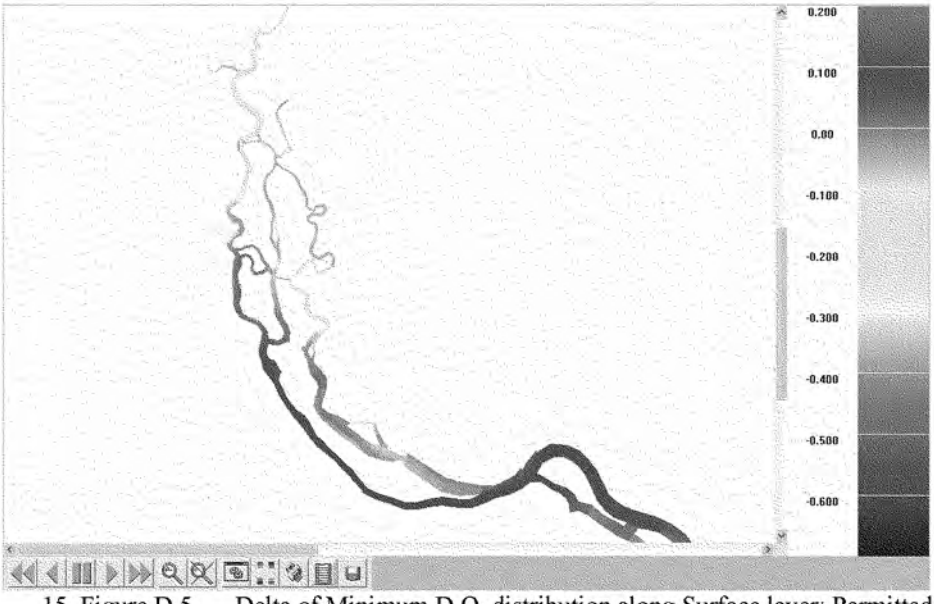
12. Figure D.2. Minimum D.O. distribution along bottom layer within the analyzed period of May 1 - October 30, 1999: Existing bathymetry



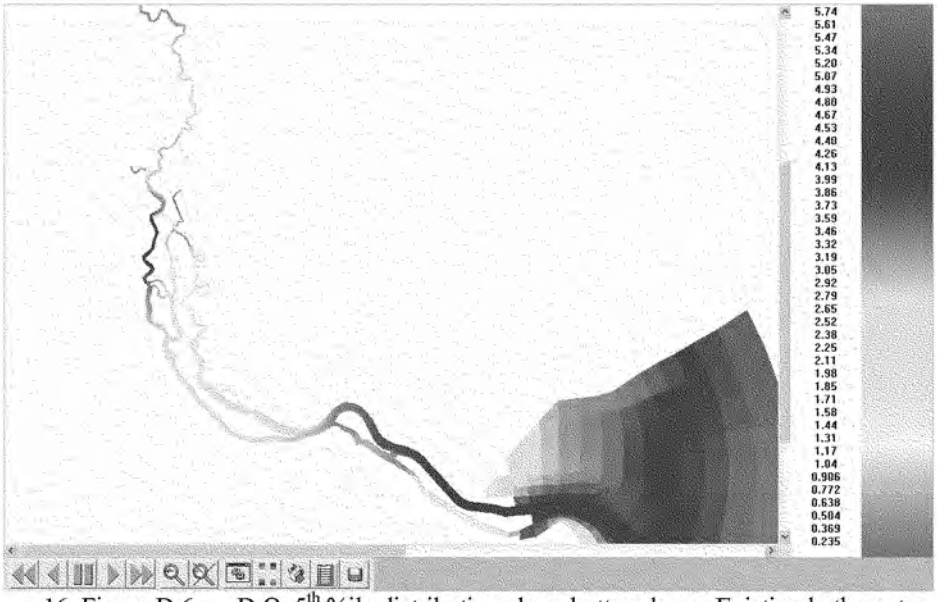
13. Figure D.3. Minimum D.O. distribution along surface layer within the analyzed period of May 1 - October 30, 1999: Existing bathymetry



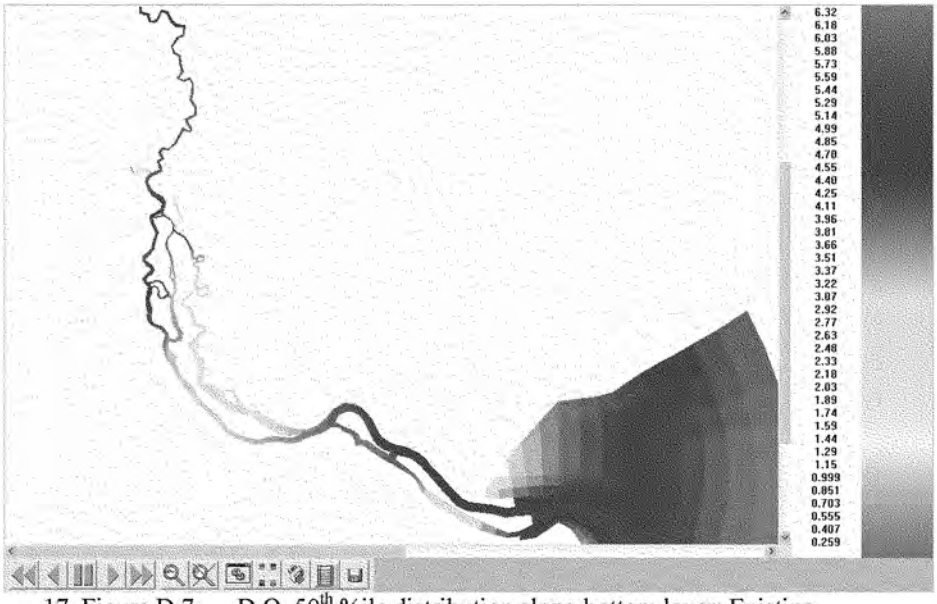
14. Figure D.4. Delta of Minimum D.O. distribution along bottom layer: Permitted minus 2004 loading scenarios



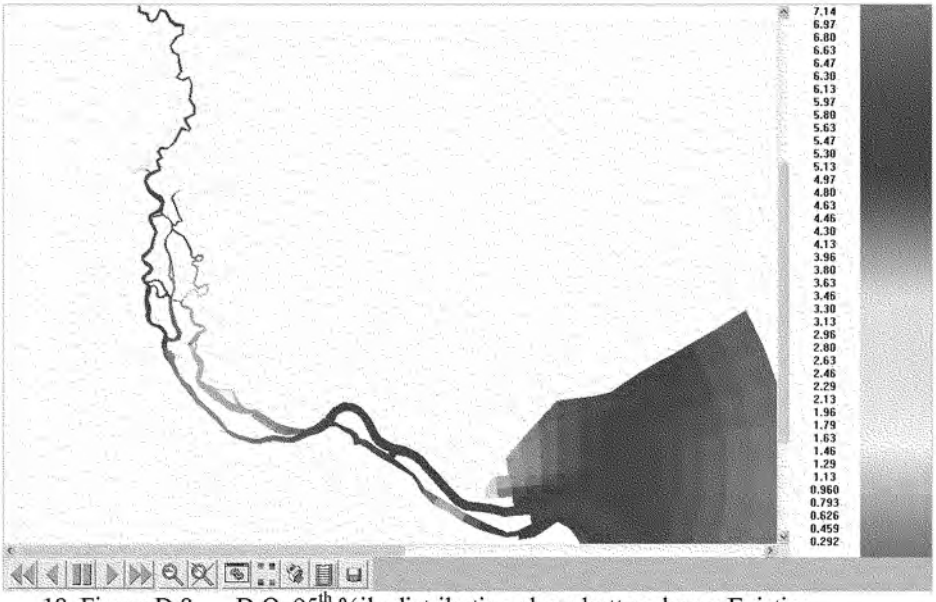
15. Figure D.5. Delta of Minimum D.O. distribution along Surface layer: Permitted minus 2004 loading scenarios



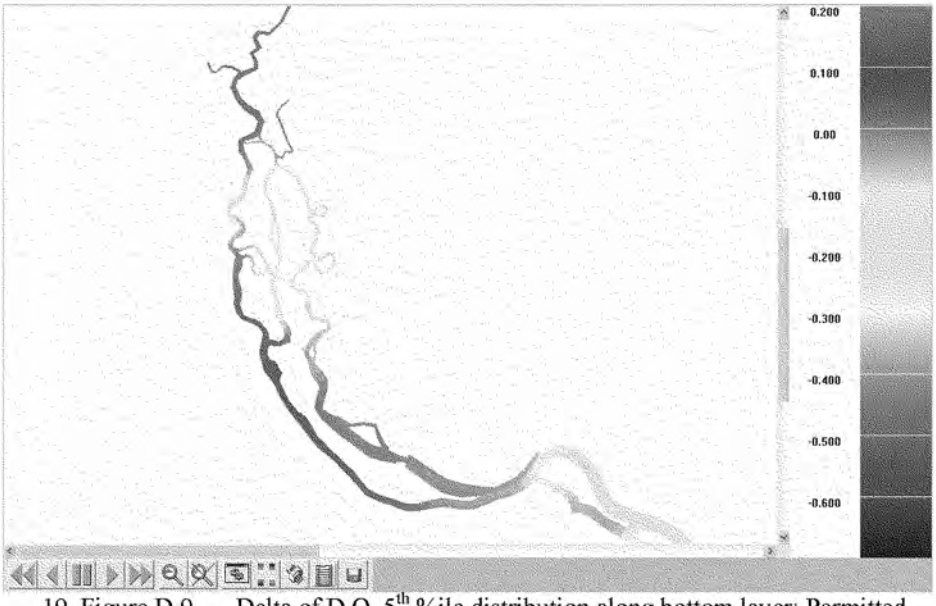
16. Figure D.6. D.O. 5th %ile distribution along bottom layer: Existing bathymetry



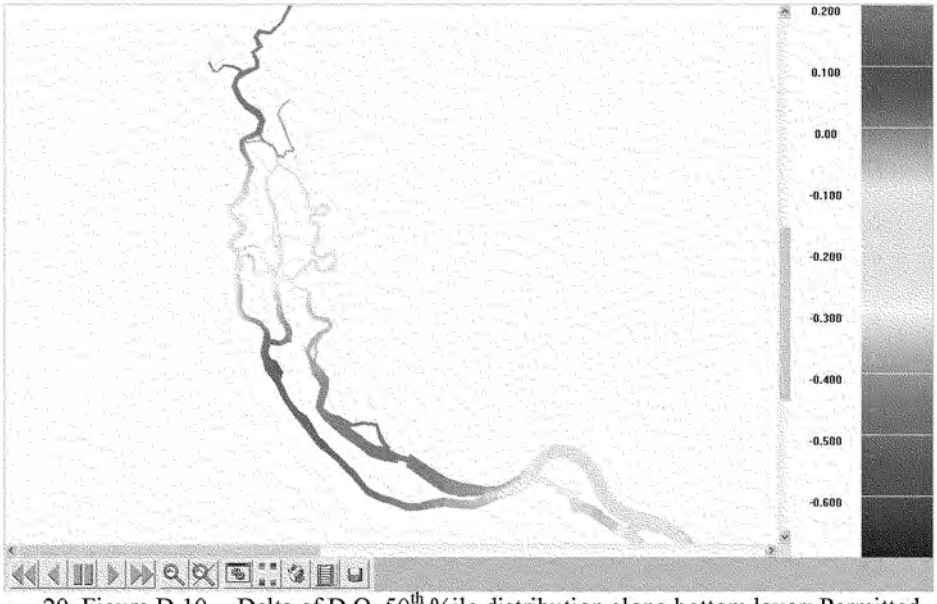
17. Figure D.7. D.O. 50th %ile distribution along bottom layer: Existing bathymetry



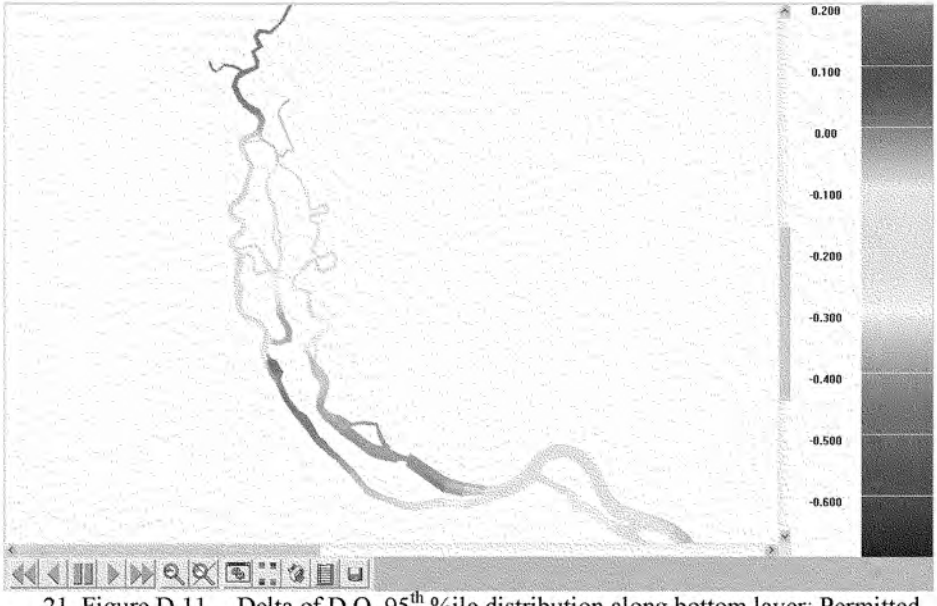
18. Figure D.8. D.O. 95th %ile distribution along bottom layer: Existing bathymetry



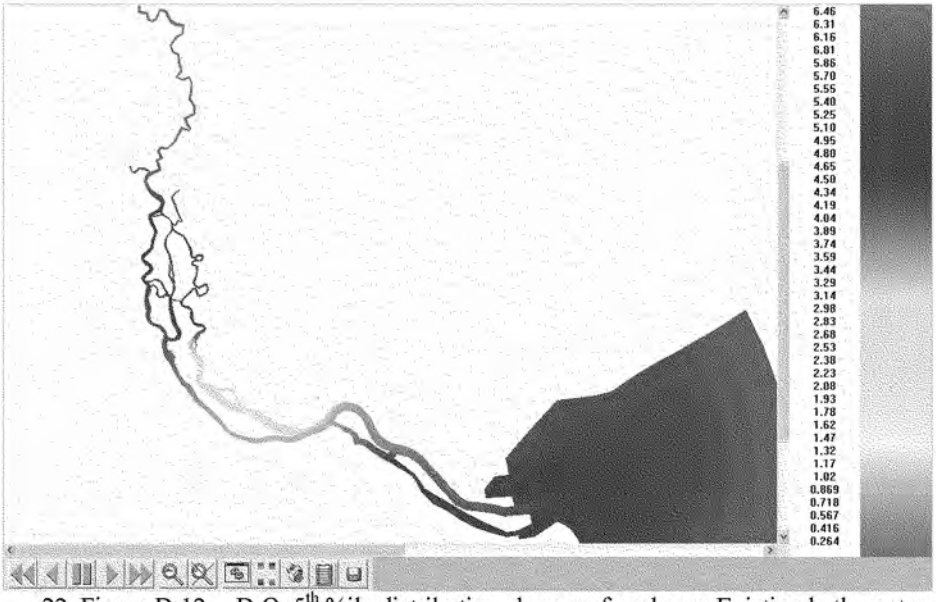
19. Figure D.9. Delta of D.O. 5th %ile distribution along bottom layer: Permitted minus 2004 loading scenarios



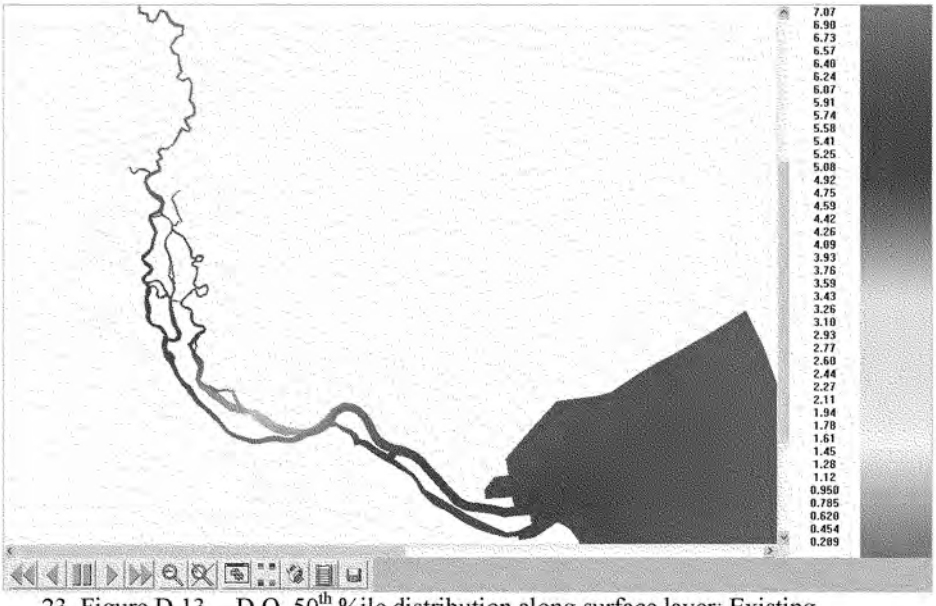
20. Figure D.10. Delta of D.O. 50th %ile distribution along bottom layer: Permitted minus 2004 loading scenarios



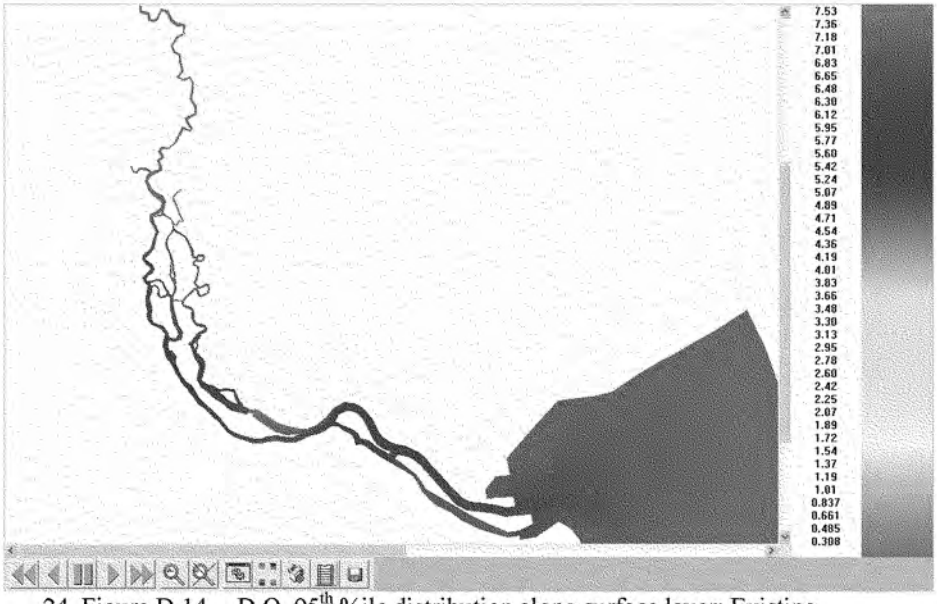
21. Figure D.11. Delta of D.O. 95th %ile distribution along bottom layer: Permitted minus 2004 loading scenarios



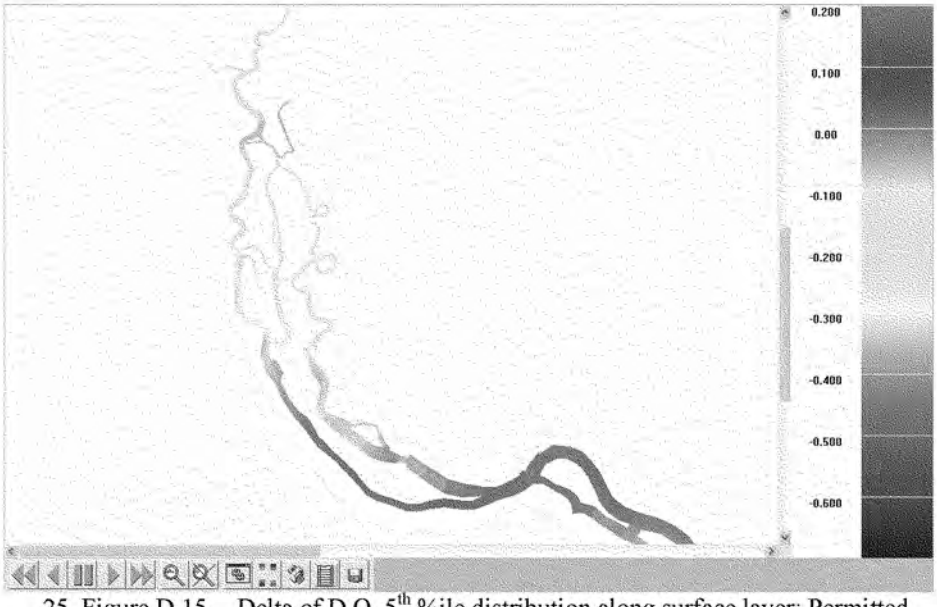
22. Figure D.12. D.O. 5th %ile distribution along surface layer: Existing bathymetry



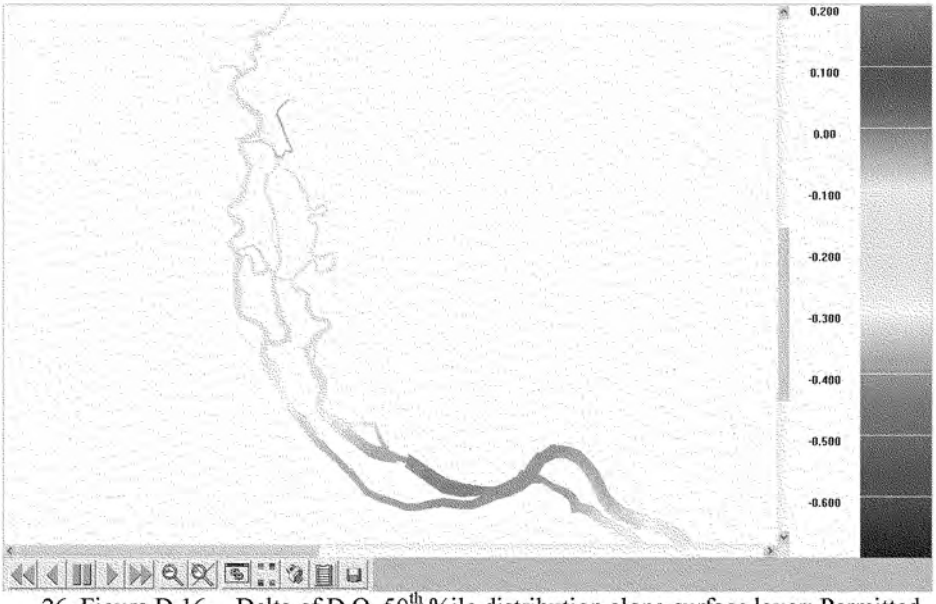
23. Figure D.13. D.O. 50th %ile distribution along surface layer: Existing bathymetry



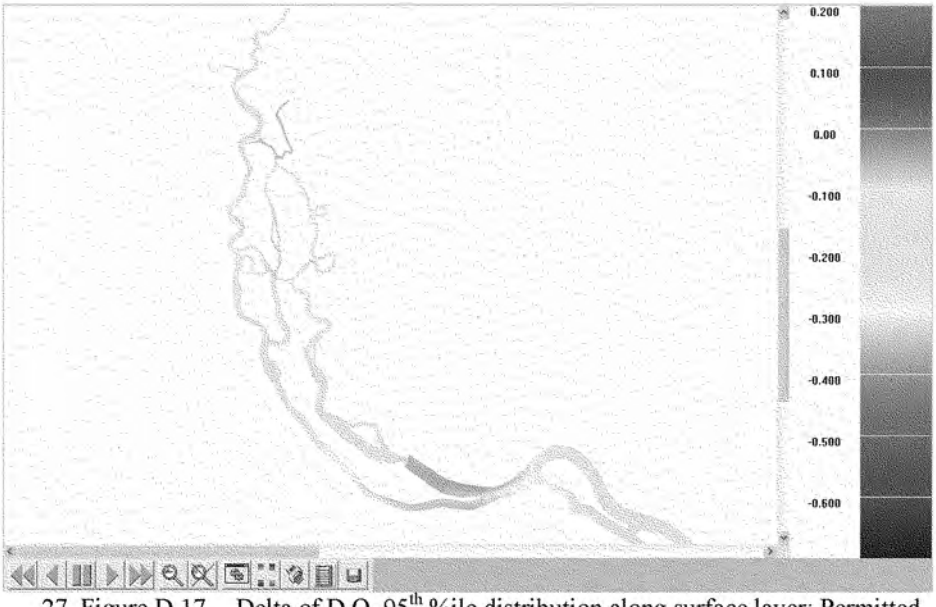
24. Figure D.14. D.O. 95th %ile distribution along surface layer: Existing bathymetry



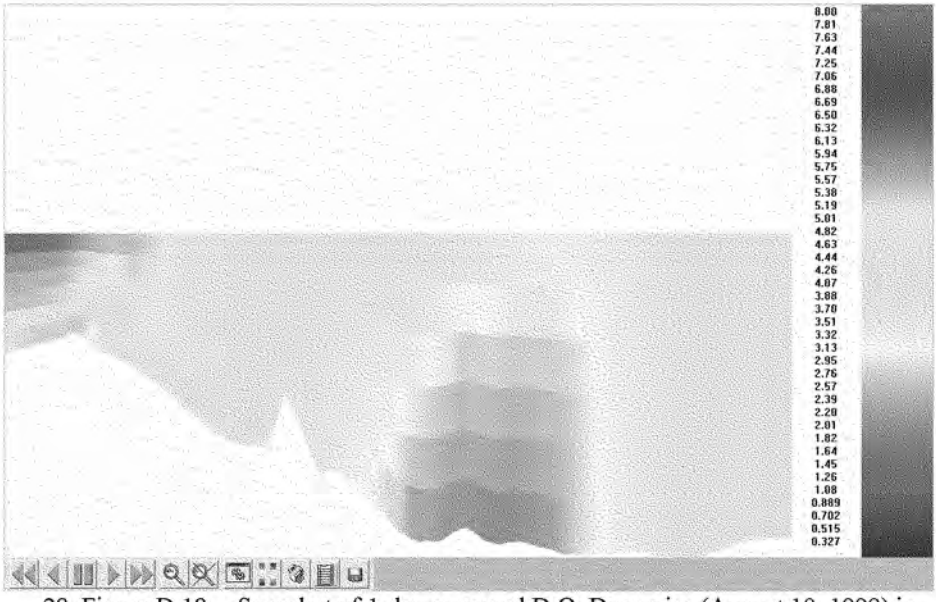
25. Figure D.15. Delta of D.O. 5th %ile distribution along surface layer: Permitted minus 2004 loading scenarios



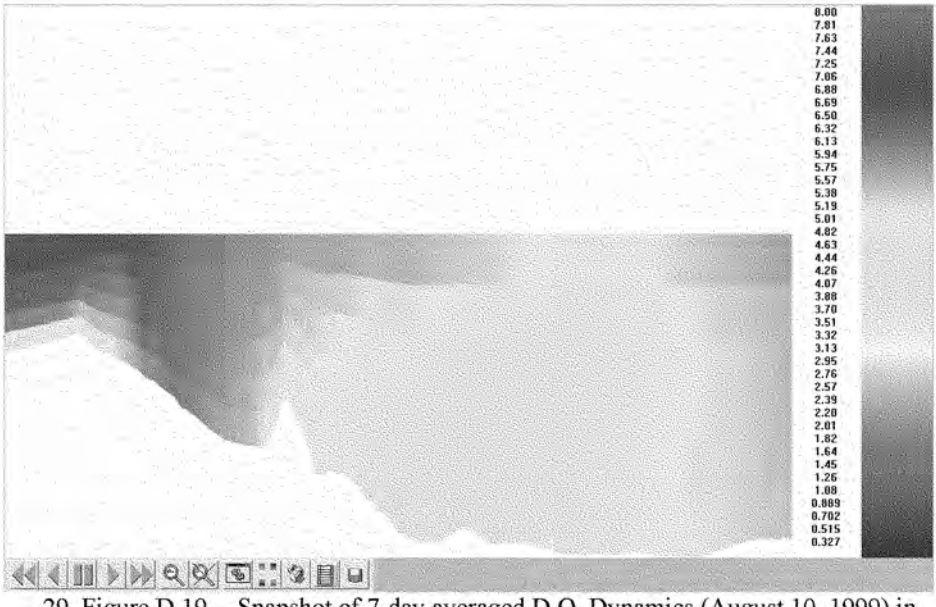
26. Figure D.16. Delta of D.O. 50th %ile distribution along surface layer: Permitted minus 2004 loading scenarios



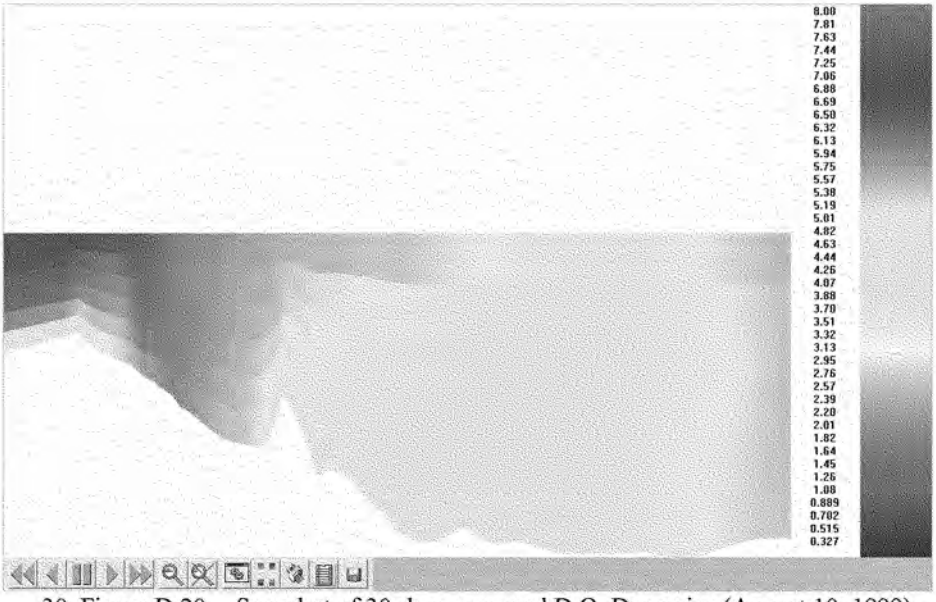
27. Figure D.17. Delta of D.O. 95th %ile distribution along surface layer: Permitted minus 2004 loading scenarios



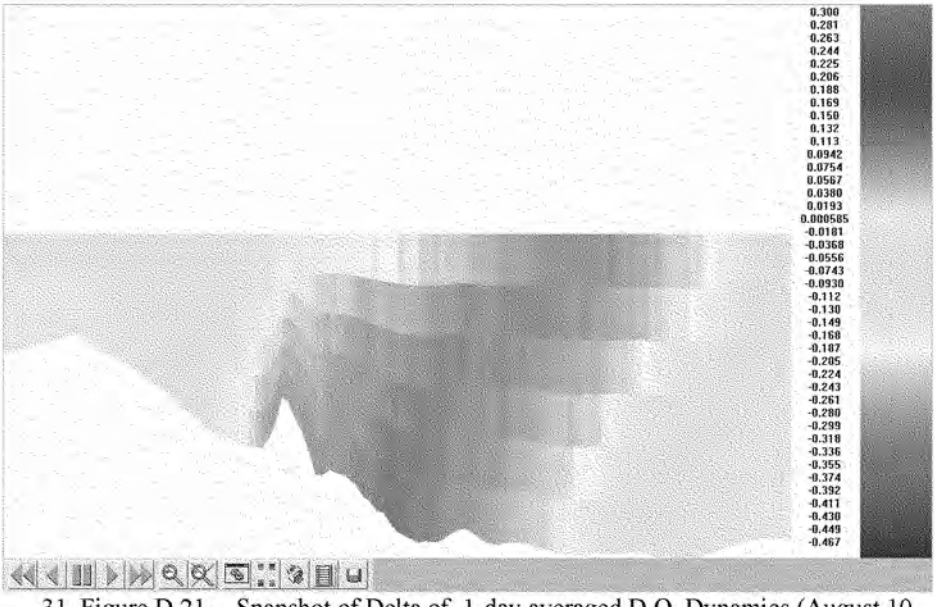
28. Figure D.18. Snapshot of 1-day averaged D.O. Dynamics (August 10, 1999) in vertical plane of Upper Harbor: Existing bathymetry



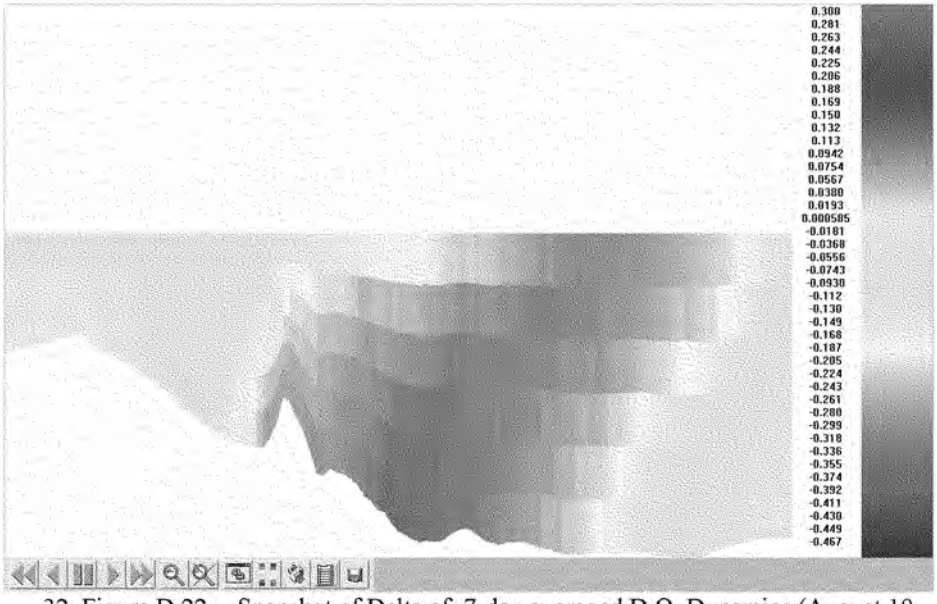
29. Figure D.19. Snapshot of 7-day averaged D.O. Dynamics (August 10, 1999) in vertical plane of Upper Harbor: Existing bathymetry



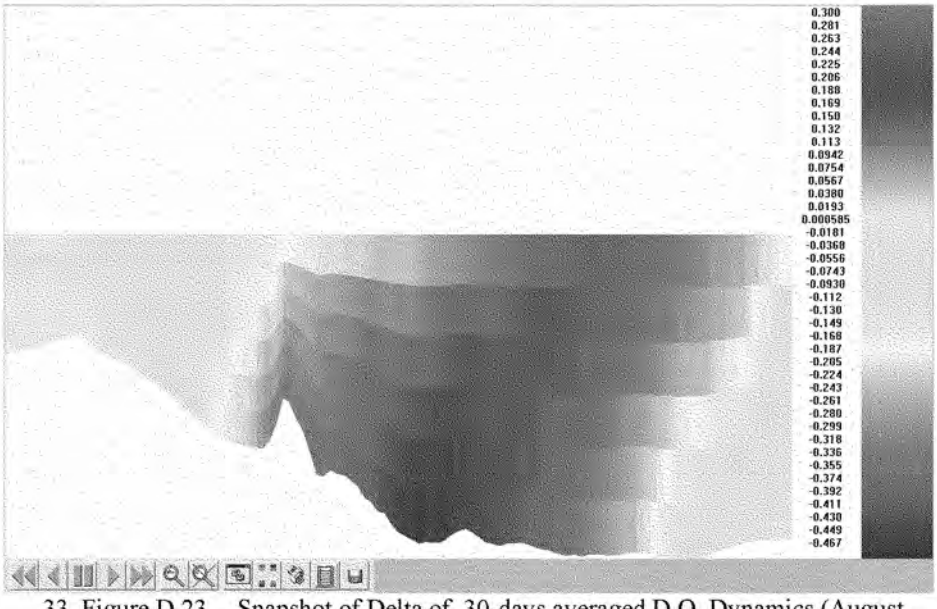
30. Figure D.20. Snapshot of 30-days averaged D.O. Dynamics (August 10, 1999) in vertical plane of Upper Harbor: Existing bathymetry



31. Figure D.21. Snapshot of Delta of 1-day averaged D.O. Dynamics (August 10, 1999) in vertical plane of Upper Harbor: Permitted minus 2004 loading scenarios



32. Figure D.22. Snapshot of Delta of 7-day averaged D.O. Dynamics (August 10, 1999) in vertical plane of Upper Harbor: Permitted minus 2004 loading scenarios

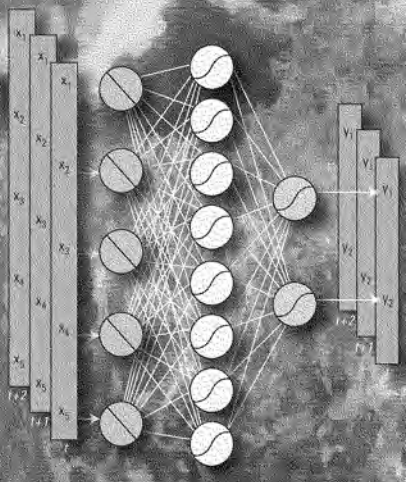


33. Figure D.23. Snapshot of Delta of 30-days averaged D.O. Dynamics (August 10, 1999) in vertical plane of Upper Harbor: Permitted minus 2004 loading scenarios

USGS
science for a changing world

Simulation of Water Levels and Salinity in the Rivers and Tidal Marshes in the Vicinity of the Savannah National Wildlife Refuge, Coastal South Carolina and Georgia

Prepared in cooperation with the
Georgia Ports Authority



Scientific Investigations Report 2006–5187

U.S. Department of the Interior
U.S. Geological Survey

Simulation of Water Levels and Salinity in the Rivers and Tidal Marshes in the Vicinity of the Savannah National Wildlife Refuge, Coastal South Carolina and Georgia

By Paul A. Conrads, Edwin A. Roehl, Ruby C. Daamen, and Wiley M. Kitchens

Prepared in cooperation with the Georgia Ports Authority

Scientific Investigations Report 2006–5187

U.S. Department of the Interior
U.S. Geological Survey

U.S. Department of the Interior
DIRK A. KEMPTHORNE, Secretary

U.S. Geological Survey
Mark Myers, Director

U.S. Geological Survey, Reston, Virginia: 2006

For product and ordering information:
World Wide Web: *http://www.usgs.gov/pubprod*
Telephone: 1-888-ASK-USGS

For more information on the USGS—the Federal source for science about the Earth, its natural and living resources, natural hazards, and the environment:
World Wide Web: *http://www.usgs.gov*
Telephone: 1-888-ASK-USGS

Any use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Although this report is in the public domain, permission must be secured from the individual copyright owners to reproduce any copyrighted materials contained within this report.

Suggested citation:
Conrads, P.A., Roehl, E.A., Daamen, R.C., and Kitchens, W.M., 2006, Simulation of water levels and salinity in the rivers and tidal marshes in the vicinity of the Savannah National Wildlife Refuge, coastal South Carolina and Georgia: U.S. Geological Survey Scientific Investigations Report 2006–5187, 134 p., available online at *http://pubs.usgs.gov/sir/2006/5187/*

Contents

Abstract 1
Introduction 2
Purpose and Scope 3
Description of Study Area 4
Previous Studies 5
Plant Ecology Studies 5
Hydrodynamic and Water-Quality Studies 5
Approach 7
Acknowledgments 8
Data Collection Networks 8
River Networks 8
Tidal Marsh Networks 8
Characterization of Streamflow, Water Level, and Specific Conductance 8
Calculated Variables, Data Preparation, and Signal Processing 12
Characterization of Streamflow 12
Characterization of River and Marsh Water Levels 13
Characterization of River and Marsh Specific Conductance 14
Simulating Riverine and Marsh Water Levels and Salinity 18
Limitations of the Data Sets 18
Signal Decomposition, Correlation Analysis, and State-Space Reconstruction 18
Signal Decomposition 19
Correlation Analysis 20
State-Space Reconstruction 21
Input-Output Mapping and Problem Representation 22
Decorrelation of Variables 22
Artificial Neural Network Models 22
Statistical Measures of Prediction Accuracy 24
Development of Artificial Neural Network Models 24
Riverine Water-Level Model at Little Back River near Limehouse 25
Riverine Specific-Conductance Model at Little Back River at USFW Dock 25
Marsh Water-Level Model at Little Back River at Site B2 31
Marsh Specific-Conductance Model at Site B2 31
Analysis of Estuary Dynamics Using Three-Dimensional Response Surfaces 37
Development of a Model-to-Marsh Decision Support System 43
Architecture 44
Historical Database 44
Linkage to the Three-Dimensional Hydrodynamic Model 44
Model Simulation Control, User-Defined Hydrographs Program, Streaming Graphics, and Two-Dimensional Color-Gradient Visualization Program 45
Application of the Model-to-Marsh Decision Support System 46
User-Defined Hydrology 46
Percentile and Constant Streamflow 47

Percent of Historical Streamflow....49
Percentile Hydrograph of Daily Streamflow....50
User-Defined Streamflow Hydrograph....52
Inputs to Model-to-Marsh from Three-Dimensional Model Output....54
Summary....57
References....59
Appendix I. Summary statistics for the water-level and specific-conductance models used in the study....65
Appendix II. Model summary of artificial neural network models used in the Model-to-Marsh application....71
Appendix III. Variables used in artificial neural network models....97
Appendix IV. User's Manual for Model-to-Marsh Decision Support System....105

Figures

1–5. Maps showing:
1. Study area in the vicinity of the Savannah National Wildlife Refuge, coastal South Carolina and Georgia....2
2. The Savannah, Front, Middle, Back, and Little Back Rivers in the vicinity of the Savannah National Wildlife Refuge....3
3. The physiographic provinces of the Savannah River Basin in South Carolina, Georgia, and North Carolina....4
4. Location of the saltwater and freshwater interface for four channel depths: 13–15 feet in 1875; 26–30 feet in 1940; 34 feet in 1965; and 42 feet in 1997....6
5. River and marsh continuous monitoring stations in the vicinity of the Savannah National Wildlife Refuge: U.S. Geological Survey river stations; Georgia Ports Authority river stations; U.S. Geological Survey marsh stations; and Georgia Ports Authority marsh and canal sites....9
6. Duration hydrographs for Savannah River near Clyo, Ga....12
7–12. Graphs showing:
7. Daily streamflow and mean annual streamflow for Savannah River near Clyo, Ga., for the period October 1, 1994, to September 30, 2004....12
8. Hourly water levels at three gaging stations on the Savannah River for the period October 1 to October 31, 2002....13
9. Daily tidal range at Savannah River at Fort Pulaski for the period June 2001 to May 2003....14
10. Hourly water-level data for the four Back River marsh gaging stations and Little Back River gaging stations for the period December 15, 2001, to February 15, 2002....14
11. Hourly water-level data for three marsh gaging stations along the Middle and Front Rivers and Savannah River water level at Houlihan Bridge for the period November 10, 2001, to January 7, 2002....15
12. Daily specific conductance at Little Back River at U.S. Fish and Wildlife Service Dock gaging station and streamflow at Savannah River near Clyo, Ga., gaging station for the period January 1, 1994, to September 30, 2004....15

Figures—continued

13. Diagram showing conceptual model of the location of the freshwater-saltwater interface and salinity stratification-destratification cycle in estuarine rivers 16
14. Graph showing surface and bottom salinities for station GPA04 for the period July 15 to September 13, 1997 16
15. Diagram showing tidal marsh types classified by interstitial salinity and average surface salinities 16
16–20. Graphs showing:
16. Hourly specific conductance at four marsh gaging stations along the Little Back and Back Rivers and specific-conductance values at the Houlihan Bridge on the Savannah River for the period August 6 to November 30, 2001 17
17. Hourly specific conductance for two marsh gaging stations on the Middle River, one marsh gaging station on the Front River, and at Houlihan Bridge on the Savannah River for the period July 26 to September 27, 2002 17
18. The daily mean streamflow at Savannah River at Clyo, Ga., and daily mean specific conductance at U.S. Fish and Wildlife Service Dock, Little Back River, for the conditions during which the gaging network was active 19
19. Hourly water levels at Fort Pulaski (station 02198980), low-pass filtered water levels, and 1-day change in filtered water levels for the 90-day period September 13 to December 13, 1994 20
20. Daily flows, 14-day average flows, and 14-day differences in 14-day average flows for the Savannah River at Clyo, Ga., for the period 1994–2004 21
21. Diagram showing multilayer perceptron artificial neural network architecture 23
22–33. Graphs showing:
22. Measured and simulated hourly water levels at Little Back River near Limestone (station 02198979) for the period January 1 to March 31, 2002 28
23. Measured and simulated daily water levels for four USGS river gages for the period 1994 to 2004 29
24. Measured and simulated hourly water levels for four USGS river gages 30
25. Measured and simulated hourly salinity at Little Back River at U.S. Fish and Wildlife Service Dock (station 02198979) for the period June 1 to August 31, 2002 31
26. Measured and simulated daily specific conductance for four USGS river gages for the period 1994 to 2004 32
27. Measured and simulated hourly specific conductance for four USGS river gages for the period 1994 to 2004 33
28. Measured and simulated hourly water levels at Site B2 on the Little Back River for the period January 1 to March 31, 2002 34
29. Measured and simulated hourly water levels for four USGS marsh gages along the Little Back and Back Rivers for the period June 2000 to May 2005 35
30. Measured and simulated hourly water levels for the three USGS gages along the Middle Back and Front Rivers for the period June 2000 to May 2005 36
31. Measured and simulated hourly salinities at Little Back River at Site B2 for the period June 1 to August 31, 2002 37

Figures—continued

32. Measured and simulated hourly specific conductance for four USGS gages along the Little Back and Back Rivers for the period June 2000 to May 2005 38
33. Measured and simulated hourly specific conductance for four USGS gages along the Front and Middle Back Rivers for the period June 2000 to May 2005 39
34–39. Three-dimensional response surfaces showing:
34. The interaction of water level (FWL8980A) and streamflow (Q8500A) on specific conductance for Front River at Houlihan Bridge (station 02198920) for neap and spring tide conditions 40
35. The interaction of water level (FWL8980A) and streamflow (Q8500A) on specific conductance at Savannah River at I-95 (station 02198840) for neap and spring tide conditions 41
36. The interaction of tidal range (XWL8980A) and streamflow (Q8500A) on specific conductance at Savannah River at I-95 (station 02198840) 41
37. The interaction of tidal range (XWL8980A) and streamflow (Q8500A) on specific conductance at Little Back River at U.S. Fish and Wildlife Service Dock (station 021989791) and for Little Back River at Lucknow Canal (station 021989784) 42
38. The interaction of harbor water level (FWL8980A) and streamflow (Q8500A) on local water levels at Savannah River at I-95 (station 02198840) and for Front River at Houlihan Bridge (station 02198920) 42
39. The interaction of harbor water level (FWL8980A) and streamflow (Q8500A) on local water levels at Little Back River at Limehouse (station 02198979) and at Front River at Broad Street (station 02198977) 43
40. Diagram showing architecture of the lower Savannah River Estuary Decision Support System 44
41. Simulator controls used to set parameters and run a simulation 45
42. Streaming graphics displayed during simulation 46
43. Screen capture of the Two-Dimensional Color-Gradient Visualization Program 47
44. Duration hydrographs for Savannah River near Clyo, Ga., and daily hydrograph for the calendar year 2002 streamflows 48
45–54. Graphs showing:
45. Salinity response at Little Back River at U.S. Fish and Wildlife Service Dock (station 021989791) for calendar year 2002 streamflows and constant 6,000 ft^3/s streamflows 48
46. Hourly salinity response for two tidal marsh sites (B1 and B2) off the Little Back River for calendar year 2002 streamflows and constant 6,000 ft^3/s streamflows 49
47. Hourly salinity response at Little Back River at U.S. Fish and Wildlife Service Dock (station 021989791) for calendar year 2002 streamflows and a 25-percent increase in streamflows 50
48. Hourly salinity response for three tidal marsh sites (B1, B2, and B3) along the Little Back River for a 25-percent increase in calendar year 2002 streamflows 51
49. Frequency-distribution curves of salinity occurrence for three tidal marsh sites (B1, B2, and B3) along the Little Back River for 2002 streamflow conditions and a 25-percent increase in streamflow conditions 51

Figures—continued

50. Hourly salinity response at U.S. Fish and Wildlife Service Dock (station 021989791) for calendar year 2002 streamflows and the 25th percentile duration hydrograph 52
51. Frequency-distribution curves of salinity occurrence for three tidal marsh sites (B1, B2, and B3) along the Little Back River for 5th, 15th, and 25th percentile duration hydrographs 53
52. Hourly salinity response at U.S. Fish and Wildlife Service Dock (station 021989791) for calendar year 2002 streamflows and minimum flows set at 5,000 ft^3/s 53
53. The 2002 streamflow hydrograph and a user-defined hydrograph for input into the Model-to-Marsh application 55
54. Hourly salinity response at U.S. Fish and Wildlife Service Dock (station 021989791) for calendar year 2002 streamflows and user-defined hydrograph with streamflow pulses inserted to occur during spring tides to reduce salinity intrusion 55
55. Two-dimensional color-gradient visualization of marsh salinity predictions for actual conditions and a deepened condition for the period July 1 to August 31, 1999 56
56. Two-dimensional color-gradient visualization of differences in average marsh salinity prediction for actual conditions and a deepened condition for the period July 1 to August 31, 1999 56

Tables

1. U.S. Geological Survey and Georgia Ports Authority continuous river and marsh gaging network data used in the study 10
2. Period of record and range of daily flow conditions measured for the river and marsh gaging networks used in the study 19
3. Model name and model summary for four types of models used in the study 26

Conversion Factors

Inch/Pound to SI

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
square foot (ft^2)	0.09290	square meter (m^2)
square mile (mi^2)	2.590	square kilometer (km^2)
	Volume	
cubic foot (ft^3)	0.02832	cubic meter (m^3)
	Flow rate	
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
picocurie per liter (pCi/L)	0.037	becquerel per liter (Bq/L)

SI to Inch/Pound

Multiply	By	To obtain
	Area	
square meter (m^2)	10.76	square foot (ft^2)

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Acronyms and Abbreviations Used in the Report

AI	artificial intelligence
ANN	artificial neural network
ASA	Applied Science Associates
ATM	Applied Technology and Management
BEP	back error propagation
BFHYDRO	Boundary Fitted Hydrodynamic Model
CRADA	Cooperative Research and Development Agreement
DSS	decision support system
EFDC	Environmental Fluid Dynamics Code
EIS	Environmental Impact Statement
FCFWRU	Florida Cooperative Fish and Wildlife Unit
GaEPD	Georgia Environmental Protection Division
GPA	Georgia Ports Authority
GUI	Graphical User Interface
LMS	Lawler, Matusky, and Skelly
ME	mean error
MLP	multilayer perceptron
MSE	mean square error
M2M	Model-to-Marsh application
NWIS	National Water Information System
OLS	ordinary least squares
PME	percent model error
psu	practical salinity units
Q	streamflow
RMSE	root mean square error
R^2	coefficient of determination
SISO	single input single output
SNWR	Savannah National Wildlife Refuge
SSE	sum of square error
SSR	state space reconstruction
USACOE	U.S. Army Corps of Engineers
USFW	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WASP7	Water Assessment and Simulation Program–Version 7
WES	Waterways Experiment Station–U.S. Army Corps of Engineers
WL	water level
XWL	tidal range

Simulation of Water Levels and Salinity in the Rivers and Tidal Marshes in the Vicinity of the Savannah National Wildlife Refuge, Coastal South Carolina and Georgia

By Paul A. Conrads, Edwin A. Roehl, Ruby C. Daamen, and Wiley M. Kitchens

Abstract

The Savannah Harbor is one of the busiest ports on the East Coast of the United States and is located downstream from the Savannah National Wildlife Refuge, which is one of the Nation's largest freshwater tidal marshes. The Georgia Ports Authority and the U.S. Army Corps of Engineers funded hydrodynamic and ecological studies to evaluate the potential effects of a proposed deepening of Savannah Harbor as part of the Environmental Impact Statement. These studies included a three-dimensional (3D) model of the Savannah River estuary system, which was developed to simulate changes in water levels and salinity in the system in response to geometry changes as a result of the deepening of Savannah Harbor, and a marsh-succession model that predicts plant distribution in the tidal marshes in response to changes in the water-level and salinity conditions in the marsh. Beginning in May 2001, the U.S. Geological Survey entered into cooperative agreements with the Georgia Ports Authority to develop empirical models to simulate the water level and salinity of the rivers and tidal marshes in the vicinity of the Savannah National Wildlife Refuge and to link the 3D hydrodynamic river-estuary model and the marsh-succession model.

For the development of these models, many different databases were created that describe the complexity and behaviors of the estuary. The U.S. Geological Survey has maintained a network of continuous streamflow, water-level, and specific-conductance (field measurement to compute salinity) river gages in the study area since the 1980s and a network of water-level and salinity marsh gages in the study area since 1999. The Georgia Ports Authority collected water-level and salinity data during summer 1997 and 1999 and collected continuous water-level and salinity data in the marsh and connecting tidal creeks from 1999 to 2002. Most of the databases comprise time series that differ by variable type, periods of record, measurement frequency, location, and reliability.

Understanding freshwater inflows, tidal water levels, and specific conductance in the rivers and marshes is critical to enhancing the predictive capabilities of a successful marsh succession model. Data-mining techniques, including artificial neural network (ANN) models, were applied to address various needs of the ecology study and to integrate the riverine predictions from the 3D model to the marsh-succession model. ANN models were developed to simulate riverine water levels and specific conductance in the vicinity of the tidal marshes for the full range of historical conditions using data from the river gaging networks. ANN models were also developed to simulate the marsh water levels and pore-water salinities using data from the marsh gaging networks. Using the marsh ANN models, the continuous marsh network was hindcasted to be concurrent with the long-term riverine network. The hindcasted data allow ecologists to compute hydrologic parameters—such as hydroperiods and exposure frequency—to help analyze historical vegetation data.

To integrate the 3D hydrodynamic model, the marsh-succession model, and various time-series databases, a decision support system (DSS) was developed to support the various needs of regulatory and scientific stakeholders. The DSS required the development of a spreadsheet application that integrates the database, 3D hydrodynamic model output, and ANN riverine and marsh models into a single package that is easy to use and can be readily disseminated. The DSS allows users to evaluate water-level and salinity response for different hydrologic conditions. Savannah River streamflows can be controlled by the user as constant flow, a percentage of historical flows, a percentile daily flow hydrograph, or as a user-specified hydrograph. The DSS can also use output from the 3D model at stream gages near the Savannah National Wildlife Refuge to simulate the effects in the tidal marshes. The DSS is distributed with a two-dimensional (plan view), color-gradient visualization routine that interpolates and extrapolates model output to fill and color a grid of the study area. Grid cell size is either 10 or 100 meters (100.76 or 1,076 square feet). Interpolation is performed using a simple ratio of linear distance between nearest marsh gages and actual distance from each cell between nearest marsh gages. The salinity values and grid parameter, and corner coordinates, can be exported as an ASCII file for input into a mapping package such as ArcView™.

Introduction

The Savannah Harbor, as with many major estuarine systems, meets many local and regional water-resource needs. The tidal parts of the Savannah River provide water supply for coastal South Carolina and Georgia, provide habitat for the extensive freshwater marsh, provide assimilative capacity for municipal and industrial dischargers, and provide navigation for a major shipping terminal on the East Coast (fig. 1). With increases in industrial and residential development in Georgia and South Carolina, there are competing, and often conflicting, interests in the water resources of the Savannah River. As part of a proposed deepening of Savannah Harbor and modification of the navigation channel geometry, the environmental effect on many of the ecological and economic resources in Savannah, including the freshwater tidal marshes, are being evaluated.

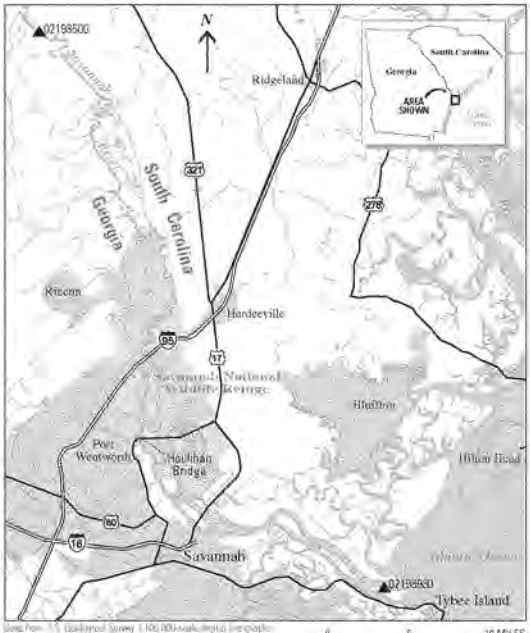


Figure 1. Study area in the vicinity of the Savannah National Wildlife Refuge, coastal South Carolina and Georgia. Savannah Harbor is located in the lower 21 miles of the Savannah River. The U.S. Geological Survey gaging stations at Savannah River near Clyo, Ga. (02198500) and Savannah River at Fort Pulaski (02198980) also are shown.

The freshwater-dominated parts of the tidal marsh may be the most sensitive of the tidal marshes to alterations of environmental gradients. Freshwater tidal marshes generally have a greater diversity of plant communities compared to saltwater tidal marshes. As numerous studies have shown (Odum and others, 1984; Latham, 1990; Gough and Grace, 1998; Howard and Mendelsson, 1999), the salinity gradient is a driving force in shaping the vegetative communities of a tidal marsh. A study by Odum and others (1984) estimated that there were 405,000 acres of tidal freshwater marshes along the Atlantic Coast, of which 28 percent were in coastal South Carolina and Georgia. In the late 1960s, the tidal freshwater wetlands of the lower Savannah River were estimated at 24,000 acres (Tiner, 1977), with approximately one-fifth of the tidal freshwater marsh in South Carolina and Georgia. Since that time, the amount of tidal freshwater marsh in the Savannah Estuary has been greatly reduced due to salinity intrusion. The remaining tidal freshwater marsh is an essential part of the 28,000-acre Savannah National Wildlife Refuge (SNWR), which was established in 1927 (*http://www.fws.gov/savannah/*).

As part of the Environmental Impact Statement (EIS) for a potential deepening of the harbor, two studies were undertaken (independent from the study described in this report) by plant ecologists from the U.S. Geological Survey (USGS) and Applied Technology and Management (ATM) to study the tidal marshes of the SNWR to understand how the plant communities respond to changing hydrologic and pore-water salinity conditions in the marsh. Using data and analysis from the marsh studies, plant succession models were developed that predict plant communities based on water-level and pore-water salinity conditions. Concurrently with the marsh studies, a three-dimensional (3D) hydrodynamic and water-quality model (also independent of the study described in this report) was applied to the Savannah Harbor to simulate changing flow and water-quality conditions in the rivers surrounding the tidal marshes. The plant succession models and the 3D hydrodynamic model will be used in conjunction to evaluate the effect of the harbor deepening on the tidal marshes. The 3D model simulates only changing flow and salinity in the rivers and not in the marshes. Defining the linkage between the water level and salinity of the Savannah River and tidal marshes and simulating marsh water-level and salinity conditions was critical to developing a successful plant succession model.

The U.S. Geological Survey (USGS), in cooperation with the Georgia Ports Authority (GPA), initiated a study to (1) develop empirical models to simulate water level and pore-water salinity at river gaging stations; (2) develop empirical models to simulate water level and salinity at marsh gaging

stations; (3) develop a spreadsheet application that integrates historical databases, empirical river and marsh models, output from the 3D model of Savannah Harbor, and marsh predictions that is easy to use and can be readily disseminated; and (4) develop a visualization routine that will spatially extrapolate the model results across the marsh. The USGS collaborated with Advanced Data Mining on the study.

The USGS entered into a Cooperative Research and Development Agreement with Advanced Data Mining in 2002 to collaborate on applying data-mining techniques and artificial neural network (ANN) models to water-resources investigations. The emerging field of data mining addresses the issue of extracting information from large databases (Weiss and Indurkhya, 1998). Data mining is a powerful tool for converting large databases into knowledge to solve problems that are otherwise imponderable because of the large numbers of explanatory variables or poorly understood process physics. Data-mining methods come from different technical fields such as signal processing, statistics, artificial intelligence, and advanced visualization. Data mining uses methods for maximizing the information content of data, determining which variables have the strongest correlations to the problems of interest, and developing models that predict future outcomes. This knowledge encompasses both understanding of cause-effect relations and predicting the consequences of alternative actions. Data mining is used extensively in financial services, banking, advertising, manufacturing, and e-commerce to classify the behaviors of organizations and individuals, and to predict future outcomes.

Purpose and Scope

This report presents the results of a study that links water-level and salinity conditions of the Back River, Little Back River, Middle River, and Front River to tidal marshes in the vicinity of the SNWR (fig. 2). This report documents the development of the Model-to-Marsh application (also referred to as the M2M application) including the results of applying data mining and ANN models to the Savannah, Back, Little Back, Middle, and Front Rivers. The modeling scope of effort consisted of four phases: (1) simulating the long-term USGS water-level and salinity river data from the period 1994–2005; (2) simulating the short-term water-level and salinity river data collected by the GPA during summer 1997 and 1999 and the marsh water-level and pore-water salinity data collected by the USGS and the GPA during 1999 to 2005; (3) integrating the 3D model input into the application and spatially extrapolating the simulated salinity response across the marsh; and (4) integrating the developed models of the riverine and marsh gaging sites and historical databases into a spreadsheet application.

An important part of the USGS mission is to provide scientific information for the effective water-resources management of the Nation. To assess the quantity and quality of the Nation's surface-water, the USGS collects hydrologic and water-quality data from rivers, lakes, and estuaries using standardized methods, and maintains the data from these stations in a national database. Often these databases are under utilized and under interpreted for addressing contemporary hydrologic issues. The techniques presented in this report demonstrate how valuable information can be extracted from existing databases to assist local, State, and Federal agencies. The application of data-mining techniques, including ANN models, to the Savannah River Estuary demonstrates how empirical models of complex hydrologic systems can be developed, disparate databases and models can be integrated to support multidisciplinary research, and study results can be easily disseminated to meet the needs of a broad range of end users.

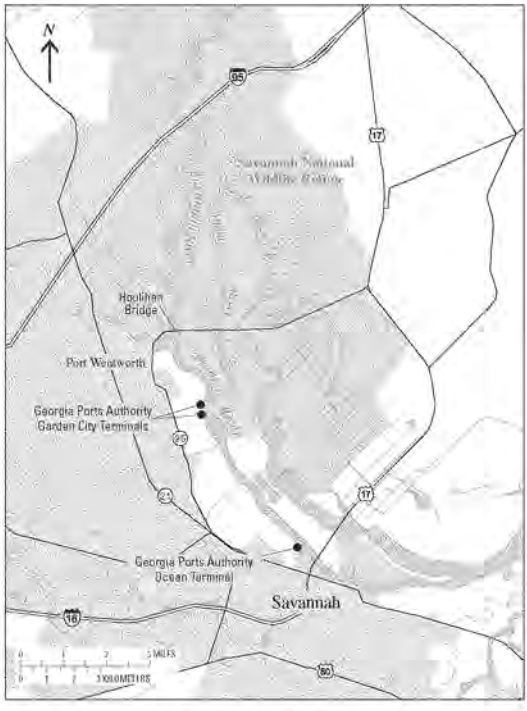


Figure 2. The Savannah, Front, Middle, Back, and Little Back Rivers in the vicinity of the Savannah National Wildlife Refuge.

Description of Study Area

The Savannah River originates at the confluence of the Seneca and Tugaloo Rivers, near Hartwell, Ga., and forms the State boundary between South Carolina and Georgia to the divergence of the Little Back River near the coast (figs. 2, 3). From Lake Hartwell, the Savannah River flows through two physiographic provinces, the Piedmont and the Coastal Plain (fig. 3). The city of Augusta, Ga., is on the Fall Line, which separates these two provinces. The slope of the river ranges from an average of about 3 feet per mile in the Piedmont to less that 1 foot per mile in the Coastal Plain. Upstream from the Fall Line, three large Federal multipurpose dams (Lake Hartwell, Richard B. Russell Lake, and J. Strom Thurmond Lake) provide hydropower, water supply, recreational facilities and a limited degree of flood control. Thurmond Dam is responsible for most of the flow regulation that affects the Savannah River at Augusta (Sanders and others, 1990).

From Augusta, Ga., the Savannah River flows 187 miles to the coast (fig. 3). The lower Savannah River is a deltaic system that branches into a series of interconnected distributary channels including the Little Back, Middle, Back, and Front Rivers (fig. 2). The hydrology of the system is dependent upon

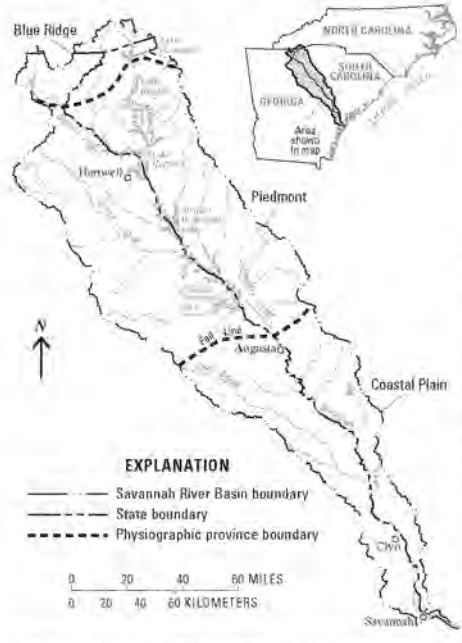


Figure 3. The physiographic provinces of the Savannah River Basin in South Carolina, Georgia, and North Carolina.

precipitation, runoff, channel configuration, streamflow, and seasonal and daily tidal fluctuations (Latham, 1990; Pearlstine and others, 1990). Savannah Harbor experiences semidiurnal tides of two high and two low tides in a 24.8-hour period with pronounced differences in tidal range between neap and spring tides occurring on a 14-day and 28-day lunar cycle. Periods of greatest tidal ranges are known as "spring" tides and the period of lowest tidal amplitude are known as "neap" tides. The tidal amplitude in the lower parts of the estuary is approximately 5 to 6 feet (ft) during neap tides and greater than 8 ft during spring tides. The resultant interaction of stream flow and tidal range allows the salinity intrusion to be detected more than 25 miles upstream and the tidal water-level signal to reach approximately 40 miles upstream, near Hardeeville (fig. 1, Bossart and others, 2001).

Rice plantations, with large diked fields along the banks of the Little Back, Back, Middle, and Savannah Rivers flourished in the 18th and 19th centuries. Many of the marshes and swamps were cleared, diked, impounded, and converted to rice fields during this period. With the advent of mechanized rice harvesting, rice production diminished because the heavy machinery was unsuitable for the clayey soil of the area. The rice fields were abandoned, and subsequently, many of the dikes were broken and the impoundments have reverted to tidal marshes.

Typical of coastal rivers in Georgia and South Carolina, the shallow, deltaic branches of the Savannah River did not provide natural features for a harbor, such as deep embayments or natural scouring of deep channels. Historically, the Back River had the largest channel geometry and the largest proportion of streamflow compared with the Front River (Barber and Gann, 1989). The Savannah Harbor was developed along the lower 21 miles of the Savannah River from the mid-1800s to the present (2006). The Savannah Harbor has a history of channel deepening, widening, creation of turning and sedimentation basins, and maintenance dredging and disposal as the harbor changed from a natural river system with a controlling depth of 10 ft at low tide to its currently maintained depth of 42 ft at low tide (Barber and Gann, 1989).

Two important resources are located in the Savannah River Estuary—the SNWR and the GPA (fig. 2). The tidal freshwater marsh is an essential part of the 28,000-acre SNWR. Located between river mile 18 and river mile 40, the SNWR is home to a diverse variety of wildlife and plant communities. Neighboring the SNWR, the GPA maintains two deepwater terminal facilities—Garden City Terminal and Ocean Terminal (fig. 2). To support navigation and the terminal activities of the GPA, the river channel and turning basins are maintained by dredging below U.S. Highway 17 Bridge (Houlihan Bridge) to approximately 20 miles offshore from the harbor entrance.

Substantial modifications made to the system during the past 30 years include the installation and operation of a tide gate on the Back River in 1977, deepening of the shipping channel to 38 ft (from 34 ft) in 1978, decommissioning of the tide gate in 1991, and deepening the shipping channel

to 42 ft (from 38 ft) in 1994. The tide gate was operated to facilitate the maintenance dredging of the harbor by increasing scour in the Front River and creating a sedimentation basin in the Back River that was near the dredge disposal area. The tide gate opened on flood tides (incoming) and closed on ebb tides (outgoing). The increased flows on the Front River increased scouring of the channel and minimized maintenance dredging (Latham, 1990). The operation of the tide gate had the unintended consequence of moving the saltwater wedge (salinity value of 0.5 practical salinity units, [psu]) 2 to 6 miles upstream in the Back, Little Back, and Middle Rivers (Pearlstine and others, 1990, 1993). The approximate location of the freshwater-saltwater interface for four historical periods (1875, 1940, 1965, and 1997) and their associated channel depths are shown in figure 4 (E. EuDaly, U.S. Fish and Wildlife Service, written commun., 2005). Data used in figure 4 were obtained from available historical sources, and provide a qualitative comparison of the position of the freshwater/saltwater interface and the spatial extent of the freshwater marsh.

Previous Studies

Numerous ecological and hydrodynamic studies have been conducted to support the modification and management of the harbor and the resulting changes of the flow and salinity dynamics of the Savannah River Estuary. Many of the plant ecology studies have focused on the characterization of the plant communities in freshwater tidal marshes of the SNWR and how these communities respond to changing pore-water salinity conditions. Many of the hydrodynamic and water-quality studies have focused on how modifications to the harbor (deepening, connecting rivers, creating sedimentation basin) affect flow, sedimentation, salinity, and water quality. The following sections highlight some of these studies.

Plant Ecology Studies

The operation of the tide gate had substantial effect on the saltwater intrusion into the Little Back River and ultimately on the interstitial salinity concentration in the soils of the freshwater tidal marsh of the SNWR. In 1985, a study was initiated to characterize the plant communities and environmental conditions of the tidal marsh of the lower Savannah River (Latham, 1990). That study reported that plant species are closely linked to interstitial and riverine salinity levels. The changing salinity conditions also affect the ability of freshwater species to compete with brackish species. The increased salinity corresponded to changes in the plant communities from fresh-marsh to brackish-marsh conditions.

Pearlstine and others (1990, 1993) studied vegetation responses to salinity changes in the marshes and developed a plant succession model to predict plant communities for selected environmental conditions. The study reported that if the elevated salinity levels caused by the tide gate were maintained, salt marsh cordgrass (*Spartina alterniflora*) and salt marsh bulrush (*Scirpus robustus*) would become established in the freshwater tidal marshes in the SNWR. After the removal of the tide gate and the 4-ft deepening of the harbor, Latham and Kitchens (1995) revisited transects used by Latham (1990) and Pearlstine and others (1990, 1993), and concluded that the interstitial salinities had been reduced, especially in the areas with salinities ranging between 0.5 and 3.0 psu. Loftin and others (2003) reported that although the marsh was more characteristic of a freshwater marsh than prior to removal of the tide gate, the extent of recovery was not as great as predicted by Pearlstine and others (1993). The benefits of removing the tide gate and lowering the interstitial salinity may have been limited by salinity changes caused by the 4-ft deepening of the harbor. As part of the EIS concerning the proposed deepening of the harbor to 48 ft, two studies were initiated to evaluate changes in the tidal marsh plant community in response to changing salinity conditions (Bossart and others, 2001; Dusek, 2003; Applied Technology and Management, 2003).

Hydrodynamic and Water-Quality Studies

There is a long history of scientific and engineering studies of the tides and currents of Savannah Harbor and their effects on navigation and channel maintenance (Barber and Gann, 1989). In 1940, a physical model was built at the U.S. Army Corps of Engineers, Waterway Experiment Station (WES) in Vicksburg, Miss., to analyze shoaling dynamics. This early model had a horizontal scale of 1:1,000 and a vertical scale of 1:150 and could simulate a complete tidal cycle every 18 minutes (Rhodes, 1949). In 1956, an improved physical model was built at the WES to study reducing shoaling or to control shoaling in areas where it was easy to remove the dredged material. The new model reduced the horizontal and vertical scales to 1:800 and 1:80, respectively, and covered an area of 25,000 square feet (ft^2) (U.S. Army Corps of Engineers, 1961a, 1961b, 1963). One of the solutions presented in the study was to construct a tide gate and sedimentation basin on the Back River to allow for the maximum possible rate of shoaling near the dredge disposal areas. The tide gate and sedimentation basin construction was authorized in 1965, and the project was completed in 1977 (Barber and Gann, 1989).

The application of digital computer models to the Savannah River and Savannah Harbor replaced the use of physical models in the 1970s. Huvel and others (1979) at WES developed a one-dimensional model to re-evaluate the results of the freshwater control plan, including the tide gate and increased salinities in Little Back River; the plan was based on results from physical models of the 1950s and 60s. The model was based on the long-wave equations and the convective-dispersion equation, and was calibrated to field data collected in July 1950 and September 1972 (Huvel and others, 1979).

To evaluate proposals to deepen the harbor from 38 to 42 ft, the WES initiated a study to apply a two-dimensional, laterally averaged model called LAEMSED to the estuary. The objectives of the study were to simulate how channel deepening and widening would effect salinity intrusion and shoaling

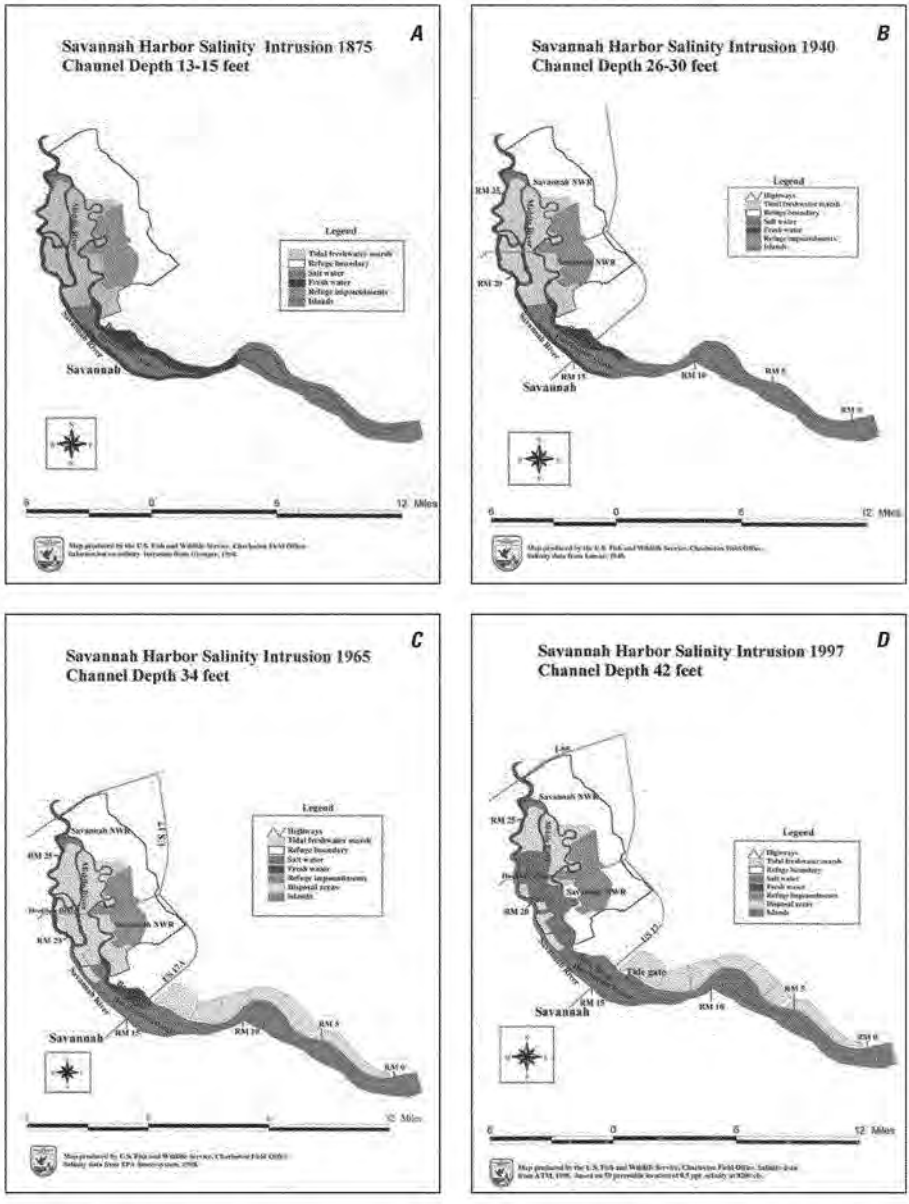


Figure 4. Location of the saltwater and freshwater interface for four channel depths: (*A*) 13–15 feet in 1875; (*B*) 26–30 feet in 1940; (*C*) 34 feet in 1965; and (*D*) 42 feet in 1997. Maps produced by the U.S. Fish and Wildlife Service, Charleston Field Office. Data references include: (*A*) Granger (1968); (*B*) Lamar (1942); (*C*) U.S. Environmental Protection Agency, STORET Database, 1998 (*http://www.epa.gov/STORET/*); and (*D*) Applied Technology and Management, 1998.

(U.S. Army Corps of Engineers, 1991). The model was verified using field data collected in 1986, 1988, and 1990. River flows ranged from 5,000 to 43,000 cubic feet per second (ft^3/s) over the sampling periods.

To evaluate a potential deepening of the harbor from 42 to 48 ft, the 3D model, Boundary Fitted Hydrodynamics (BFHYDRO) (Spaulding, 1984; Swanson, 1986; and Muin and Spaulding, 1997), was used by Applied Science Associates (ASA) and Applied Technology and Management (ATM) (Applied Science Associates and Applied Technology and Management, 1998). In addition to simulating tides, currents, and salinity, the model simulated dissolved oxygen using the Streeter-Phelps equation (Streeter and Phelps, 1925). The model was calibrated to field data collected in summer 1997 (Applied Technology and Management, 1998).

Results from the model were incorporated in the EIS regarding the potential deepening of the harbor from 42 to 48 ft (Georgia Ports Authority, 1998). After review of the EIS by State and Federal agencies, it was agreed that additional data collection was necessary to improve the water-quality model and to further refine the hydrodynamic model. To meet these goals, the 3D model, Environmental Fluid Dynamics Code (EFDC) (Hamrick, 1992) and U.S. Environmental Protection Agency (USEPA) Water Quality Assessment and Simulation Program version 7 (WASP7) (Ambrose and others, 1993; Wool and others, 2001) was applied to Savannah Harbor (Tetra Tech, 2005).

A number of mechanistic water-quality models of the river and estuary have been developed to investigate various regulatory issues of water-quality classification and assimilative capacity. A good summary of the technical history of mathematical water-quality models applied to the system from 1970 to 1988 can be found in the Georgia Environmental Protection Division (GaEPD) report, "Savannah River Classification Study" (Georgia Environmental Protection Division, 1988). Early models were either simplified steady-state calculations to estimate the assimilative capacity of the Savannah River (Olinger, 1970) or steady-state, one- and two-dimensional models to evaluate the effects of major discharges on the Savannah River (Hydroscience, Inc., 1970). The first dynamic water-quality model applied to the system was the Massachusetts Institute of Technology Transient Water Quality Network Model (Harleman, 1977). Additional field data for the model were collected in 1979 and 1980 (Pennington and Bond, 1981; Shingler, 1981). Lawler, Matusky, and Skelly Engineers (LMS) made modifications to the code and recalibrated the model in 1982 (Lawler, Matusky, and Skelly Engineers, 1983). The model was further refined by GaEPD and LMS to include more complex nutrient and algal dynamics and to validate the model with new data collected in October 1985 (Lawler, Mutusky, and Skelly Engineers, 1986; Georgia Environmental Protection Division, 1988). The USEPA has used the application of the EFDC and WASP7 codes for evaluating water-quality standards classification and Total Maximum Daily Loads for the harbor (U.S. Environmental Protection Agency, 2004).

Approach

The variability of salinity in the Savannah River is a result of many factors, including streamflow in the Savannah River and tidal conditions in the Savannah Harbor. The variability of pore-water salinity in the tidal marshes is a result of the adjacent river salinity concentration, the tidal creek connections to the river, elevation of the marsh and surrounding berms, soil type and the conditions of old abandoned rice fields and berms, and volume of water within the marsh. Although many of the plant succession models use hydrology and salinity inputs, these inputs have been derived from either field measurements or assumptions that long-term averaging from riverine-estuarine model simulations are adequate estimates of pore-water salinity in the marshes.

In order to simulate the dynamic response of the water level and salinity in the tidal marshes, empirical models were developed to simulate water levels and salinities in the river and marshes for changing hydrologic conditions (streamflow) and changing channel geometries simulated by a 3D mechanistic model (Tetra Tech, 2005). The empirical models were developed using data-mining techniques and ANN models. This is the first study in the Savannah River Estuary to integrate the dynamic water-level and salinity response of the estuary with the dynamic water-level and salinity response of the tidal marshes.

For the Savannah River and the tidal marsh, there are extensive continuous data sets of streamflow, tidal water level, and salinity in the river, harbor, and tidal marshes. Time-series data of the streamflow, salinity, and water levels in the rivers and marshes near the SNWR have been collected by various agencies during the past 20 years. The USGS has collected streamflow, water-level, and salinity data in the rivers near SNWR, and tidal conditions of the Savannah Harbor since the 1980s. The USGS Florida Cooperative Fish and Wildlife Research Unit (FCFWRU) has collected continuous water-level and pore-water salinity data in the tidal marshes since 2000. The GPA collected riverine data at more than 20 sites during summer 1997 and 1999 and marsh data for a 2-year period beginning in June 1999.

The application of data-mining techniques to simulate the water-level and pore-water response in the tidal marshes was undertaken in four phases. The first phase was to develop ANN models to simulate the riverine water-level and salinity response caused by changing streamflow condition. The second phase was to develop ANN models to simulate the marsh water-level and pore-water salinity response attributed to changing river conditions. The third phase was to incorporate the results from a 3D model of changing river conditions and a visualization module that spatially extrapolates the marsh response at selected marsh gages to the entire marsh. The final phase was the development of a Decision Support System (DSS) that integrates historical databases, model simulations, and streaming graphics with a graphical user interface (GUI) that allows a user to simulate scenarios of interest.

Acknowledgments

The complexity of this study required interagency cooperation, in addition to individual contributions. The authors thank David Schaller and Hope Moorer of the Georgia Ports Authority for their support and patience throughout the project; Larry Keegan of Lockwood Greene for his coordination of project activities with the Georgia Ports Authority; Bill Bailey, Alan Garrett, Joe Hoke, and Doug Plachy of the U.S. Army Corp of Engineers, Savannah District, for their project inputs; Ed EuDaly and John Robinette of the U.S. Fish and Wildlife Service for their support; and Steven Davie and Yuri Plis of Tetra Tech for their cooperation in integrating the 3D model output into the DSS.

Data Collection Networks

Many resource entities have been collecting data in the Savannah River Estuary, including the USGS, National Oceanic Atmospheric Administration, USEPA, GaEPD, South Carolina Department of Health and Environmental Control, the City of Savannah, the GPA, and local colleges and universities. Four existing continuous water-level and specific-conductance data sets for the harbor, river, and tidal marshes were used to build, train, and test the ANN water-level and salinity models. A description of each data set follows.

River Networks

The USGS streamflow gage near Clyo, Ga. (station 02198500; fig. 1) was established in 1929 and records streamflow on an hourly interval. The USGS has maintained a data-collection network in the Little Back River near the SNWR and in the lower Savannah River since the late 1980s. These stations collect water level and(or) specific-conductance data on a 15-minute interval (fig. 5*A*). Specific conductance is a measure of the ability of water to conduct an electrical current and is expressed in microsiemens per centimeter at 25° C. Specific conductance is related to the type and concentration of ions in solution and is a field measurement often used to compute salinity. The USGS stations are part of the USGS National Water Information System (NWIS) and are available in near real-time on the Web (*http://waterdata.usgs.gov/sc/nwis*). The USGS maintains NWIS, a distributed network of computers and fileservers for the storage and retrieval of water data collected through its activities at approximately 1.5 million sites around the country, as part of the USGS program of disseminating water data to the public. Locations of specific-conductance, water-level, and streamflow gages used in the study are listed in table 1 and shown in figures 1 and 5.

The GPA established a network of stations to support the application of the 3D hydrodynamic and water-quality model of the system (fig. 5*B*; table 1). The GPA network was maintained for the summer and fall of 1997 and 1999 by Applied Technology and Management (Applied Technology and Management, 2000). Fourteen stations were located in the vicinity of the SNWR during the two deployments. Six of the stations recorded specific-conductance values for the top and bottom of the water column.

Tidal Marsh Networks

Two continuous gaging networks were established in the tidal marshes as part of the ecological studies to evaluate potential effects to the plant communities as a result of harbor deepening (Bossart and others, 2001). The FCFWRU of the USGS has been collecting water-level and pore-water specific-conductance time-series data from a tidal-marsh gaging network since June 1999 (fig. 5*C*). The USGS network comprises four sites on the Little Back and Back Rivers, two on the Middle River, and one on the Front River. The monitoring sites consist of a pressure transducer and a specific-conductance probe just below the surface of the marsh. The locations of the USGS continuous monitors correspond to locations where the FCFWRU has been conducting plant studies since the 1980s. The GPA collected water-level and specific-conductance time-series data from June 1999 to October 2002 in tidal feeder creeks and marsh surface water, and marsh pore-water salinity at 10 locations (fig. 5*D*; table 1).

Characterization of Streamflow, Water Level, and Specific Conductance

> "The main drawback in studying estuaries is that river flow, tidal range, and sediment distribution are continually changing and this is exacerbated by the continually changing weather influences. Consequently, some estuaries may never really be steady-state systems; they may be trying to reach a balance they never achieve."
>
> *Keith Dyer*, from "Estuaries—A Physical Introduction" (1997)

Estuarine systems are complex systems that are constantly responding to changing hydrologic, tidal, and meteorological conditions. The Savannah River Estuary is constantly integrating the changing streamflow of the Savannah River, changing tidal condition of the Atlantic Ocean, and changing meteorological conditions including wind direction and speed, rainfall, low and high pressure systems, and hurricanes. The following sections characterize the streamflow and tidal water levels and how these affect the salinity intrusion in the rivers and the interstitial salinity concentrations in the marshes.

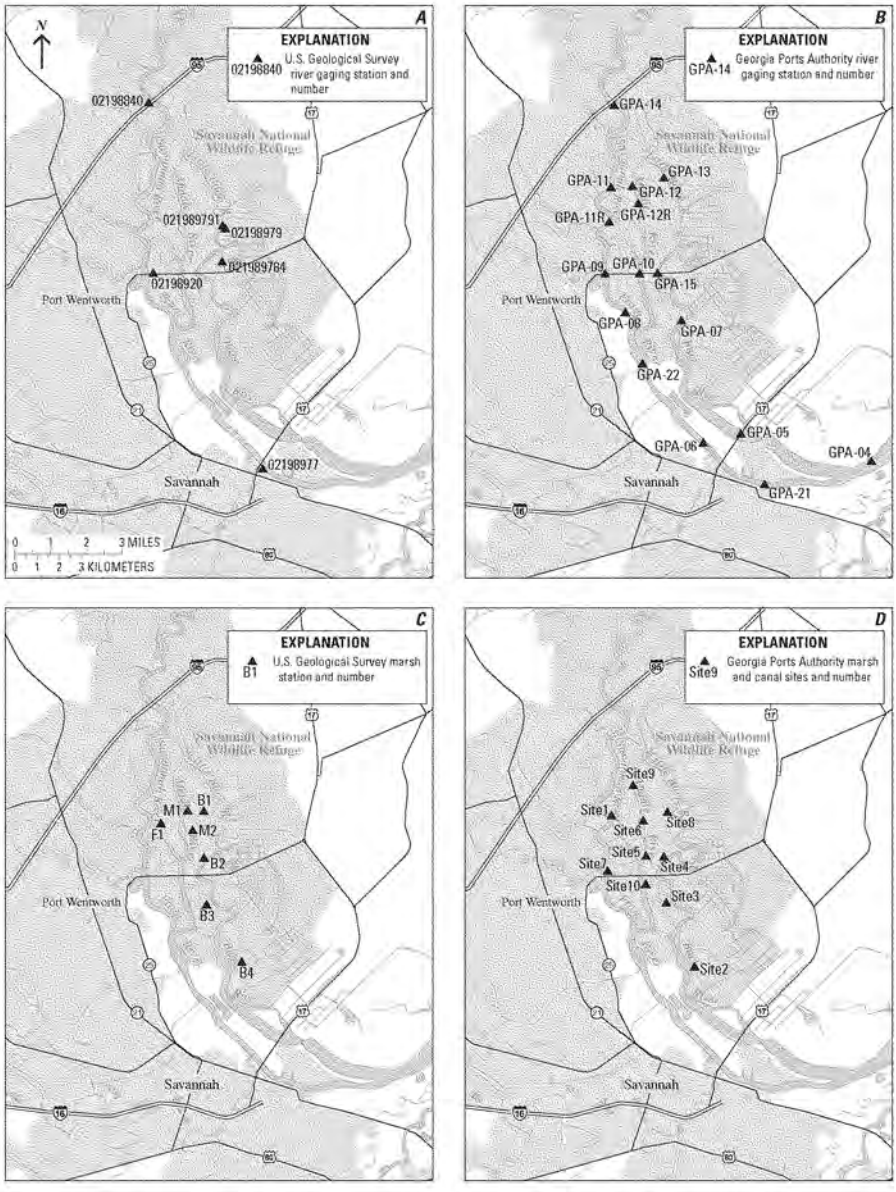


Figure 5. River and marsh continuous monitoring stations in the vicinity of the Savannah National Wildlife Refuge: (*A*) U.S. Geological Survey river stations; (*B*) Georgia Ports Authority river stations; (*C*) U.S. Geological Survey marsh stations; and (*D*) Georgia Ports Authority marsh and canal sites.

Table 1. U.S. Geological Survey and Georgia Ports Authority continuous river and marsh gaging network data used in the study.

[NAD 83, North American Datum of 1983; Q, flow; wl, water level; sc, specific conductance; scb, specific conductance-bottom probe; sbt, specific conductance-top probe]

Site identification	Station location and name used in this report	Parameters	Period of record	Longitude (decimal degrees, NAD 83)	Latitude (decimal degrees, NAD 83)
U.S. Geological Survey River Gaging Network					
02198500	Savannah River near Clyo	Q	October 1929–May 2005	81.26871649	32.52823709
02198840	Savannah River at I-95 Bridge	wl, sc	June 1987–May 2005	81.15122387	32.23575482
02198920	Front River at Houlihan Bridge	wl, sc	October 1987–May 2005	81.15122363	32.16603583
02198977	Front River at Broad Street	wl	October 1987–May 2005	81.09566748	32.1840911)
021989784	Little Back River at Lucknow Canal	sc	May 1990–May 2005	81.11816773	32.17075822
02198979	Little Back River near Limehouse	wl	June 1987–May 2005	81.11705662	32.18492418
021989791	Little Back River at USFW Dock	sc	October 1989–May 2005	81.11788997	32.18575747
02198980	Savannah River at Fort Pulaski	wl	October 1987–May 2005	80.90316645	32.0341019
Georgia Ports Authority River Gaging Network					
GPA04	Savannah River near Fort Jackson	wl, scb, sct	July–September 1997 July–October 1999	81.026817	32.089001
GPA05	Back River upstream of Tide Gate	wl, scb	July–September 1997 July–October 1999	81.089816	32.100018
GPA06	Front River upstream of Broad Street	wl, scb, sct	July–September 1997 July–October 1999	81.107403	32.096371
GPA07	Back River downstream of Houlihan Bridge	wl, scb, sct	July–September 1997 July–October 1999	81.118187	32.146400
GPA08	Front River downstream of Houlihan Bridge	wl, scb, sct	July–September 1997 July–October 1999	81.144326	32.149994
GPA09	Front River at Houlihan Bridge	wl, scb, sct	July–September 1997 July–October 1999	81.155296	32.165272
GPA10	Middle River at Houlihan Bridge	wl, scb, sct	July–September 1997 July–October 1999	81.138367	32.165272
GPA11	Front River upstream of Houlihan Bridge	wl, scb	July–September 1997 July–October 1999	81.152778	32.201389
GPA11R	Front River upstream of Houlihan Bridge	wl, scb	July–September 1997 July–October 1999	81.152505	32.186568
GPA12	Middle River upstream of Houlihan Bridge	wl, sct	July–September 1997	81.141167	32.201229
GPA12R	Middle River upstream of Houlihan Bridge		July–October 1999	81.138367	32.194567
GPA13	Little Back River downstream of Union Creek	wl, scb	July–September 1997 July–October 1999	81.126183	32.204788
GPA14	Savannah River at I-95 Bridge	wl, scb	July–September 1997 July–October 1999	81.150048	32.234661
GPA15	Little Back River at Houlihan Bridge	sct	July–September 1997 July–October 1999	81.129593	32.165379
GPA21	Front River downstream of U.S. Highway 17 Bridge	wl, scb, sct	July–September 1997 July–October 1999	81.078194	32.079369
GPA22	Front River downstream of confluence with Middle River	wl, scb, sct	July–September 1997 July–October 1999	81.136643	32.128628

Table 1. U.S. Geological Survey and Georgia Ports Authority continuous river and marsh gaging network data used in the study.—Continued

[NAD 83, North American Datum of 1983; Q, flow; wl, water level; sc, specific conductance; scb, specific conductance-bottom probe; sbt, specific conductance-top probe]

Site identification	Station location and name used in this report	Parameters	Period of record	Longitude (decimal degrees, NAD 83)	Latitude (decimal degrees, NAD 83)
U.S. Geological Survey Marsh Network					
B1	Little Back River marsh	wl, sc	June 1999–May 2005	81.12750163	32.19237988
B2	Little Back River marsh	wl, sc	June 1999–May 2005	81.12707183	32.17320051
B3	Back River marsh	wl, sc	June 1999–May 2005	81.12595301	32.15408492
B4	Back River marsh	wl, sc	June 1999–May 2005	81.10885151	32.13068071
F1	Front River marsh	wl, sc	June 1999–May 2005	81.14764018	32.18721571
M1	Middle River marsh	wl, sc	June 1999–May 2005	81.13492806	32.19237218
M2	Middle River marsh	wl, sc	June 1999–May 2005	81.13266729	32.18436345
Georgia Ports Authority Marsh and Canal Network					
Site 1 marsh	Front River upstream of Houlihan Bridge	wl, sc	June 1999–October 2002	81.15105474	32.19017614
Site 1 canal	Front River upstream of Houlihan Bridge	wl, sc	June 1999–October 2002	81.15124878	32.19074944
Site 2 marsh	Back River	wl, sc	June 1999–October 2002	81.11120968	32.12842341
Site 2 canal	Back River	wl, sc	June 1999–October 2002	81.111181	32.12895093
Site 3 marsh	Back River	wl, sc	June 1999–October 2002	81.12476284	32.15492387
Site 3 canal	Back River	wl, sc	June 1999–October 2002	81.12479598	32.1545668
Site 4 marsh	Back River	wl, sc	June 1999–October 2002	81.12582291	32.1730909
Site 4 canal	Back River	wl, sc	June 1999–October 2002	81.12586215	32.17361898
Site 5 marsh	Middle River upstream of Houlihan Bridge	wl, sc	June 1999–October 2002	81.13409274	32.17312569
Site 5 canal	Middle River upstream of Houlihan Bridge	wl, sc	June 1999–October 2002	81.13404276	32.17383171
Site 6 marsh	Middle River upstream of Houlihan Bridge	wl, sc	June 1999–October 2002	81.13577841	32.18815865
Site 6 canal	Middle River upstream of Houlihan Bridge	wl, sc	June 1999–October 2002	81.13600421	32.1879131
Site 7 marsh	Front River upstream of Houlihan Bridge	wl, sc	June 1999–October 2002	81.15330879	32.16761313
Site 7 canal	Front River upstream of Houlihan Bridge	wl, sc	June 1999–October 2002	81.15307175	32.16800705
Site 8 marsh	Little Back River	wl, sc	June 1999–October 2002	81.12381219	32.19099895
Site 8 canal	Little Back River	wl, sc	June 1999–October 2002	81.12426637	32.19170637
Site 9 marsh	Middle River upstream of Houlihan Bridge	wl, sc	June 1999–October 2002	81.14075216	32.20263829
Site 9 canal	Middle River upstream of Houlihan Bridge	wl, sc	June 1999–October 2002	81.1408484	32.20241642
Site 10 marsh	Middle River downstream of Houlihan Bridge	wl, sc	June 1999–October 2002	81.13462583	32.16196182
Site 10 canal	Middle River downstream of Houlihan Bridge	wl, sc	June 1999–October 2002	81.13461947	32.16223939

Calculated Variables, Data Preparation, and Signal Processing

Tidal systems are highly dynamic and exhibit complex behaviors that evolve over multiple time scales. The complex behaviors of the variables in a natural system result from interactions between multiple physical forces. The semidiurnal tide is dominated by the lunar cycle, which is more influential than the 24-hour solar cycle; thus, a 24-hour average is inappropriate to use to reduce tidal data to daily values. For analysis and model development, the USGS data were digitally filtered to remove semidiurnal and diurnal variability. The filtering method of choice is frequency domain filtering, which is applied to a signal, or time series of data, after it has been converted into a frequency distribution by Fourier transform. This allows a signal component that lies within a window of frequencies (for example, the 12.4-hour tidal cycle lies between periods of 12.0 to 13.0 hours) to be excised, analyzed, and modeled independently of other components (Press and others, 1993). The filter for removing the high frequency tidal cycle often is referred to as a "low-pass" filter. Time series of the daily response of tidally affected signals were generated using a low-pass filter. The resulting time series represents the daily change in the tidal signal for a 30-minute time increment. Digital filtering also can diminish the effect of noise in a signal to improve the amount of useful information that a signal contains. Working from filtered signals makes the modeling process more efficient, precise, and accurate.

One variable was computed from the field measurements of the physical parameters—tidal range. Tidal dynamics are a dominant force for estuarine systems, and the tidal range is an important variable for determining the lunar phase of the tide. Tidal range is calculated from water level and is defined as the water level at high tide minus the water level at low tide for each semidiurnal tidal cycle.

Characterization of Streamflow

Streamflows at Savannah River near Clyo, Ga. (station 02198500) are regulated by releases from Lake Thurmond Dam near Augusta, Ga., and range from a minimum of 4,000 ft^3/s during periods of low flow to 50,000 ft^3/s or more during periods of high flows (fig. 6). Seasonally, the highest flows occur in late winter and early spring (February through March), and the lowest flows occur in late summer and early fall (August through October). Figure 6 shows daily duration hydrographs based on 75 years of data. Daily duration graphs characterize the state of a stream with respect to time. The plotted percentiles are best explained by an example. Suppose 75 years of daily value flow data exist for a station and the 10-percentile flow is 7,000 ft^3/s for a particular day of the year, say January 3. This means that 10 percent of all flows that occurred on January 3 of each of the 75 years of data were equal to or less than 7,000 ft^3/s. It is assumed that flows between the 0- and 10-percentiles occur during very dry hydrologic conditions and, likewise, it is assumed that flows between the 90- and 100-percentile occur during very wet hydrologic conditions. It is assumed that flows between the 25- and 75-percentiles occur during normal hydrologic conditions.

During the 11-year period from 1994 to 2004, inclusive, the Savannah River experienced extreme streamflow conditions. During the winter-spring of 1998, floods resulting from above-normal rainfall during El Niño conditions resulted in streamflows of greater than 50,000 ft^3/s (fig. 7) that were often between the 95th percentile and historical maximum daily streamflow for the period of record. After the El Niño of 1998, the southeastern United States experienced drought from 1998 to 2002, inclusive, with minimum flows of 4,500 ft^3/s. Streamflows during the drought generally ranged from the 5th percentile to the historical minimums for the period of record.

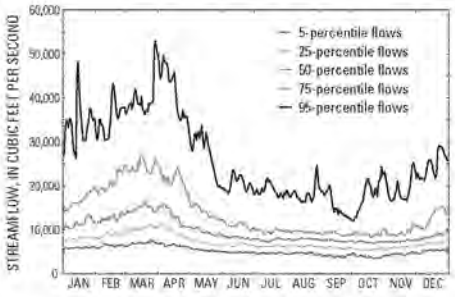


Figure 6. Duration hydrographs for Savannah River near Clyo, Ga. Percentile flows are based on streamflow data from 1929 to 2003.

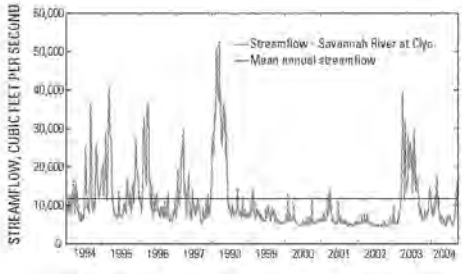


Figure 7. Daily streamflow and mean annual streamflow for Savannah River near Clyo, Ga., for the period October 1, 1994, to September 30, 2004.

Characterization of River and Marsh Water Levels

Savannah Harbor experiences semidiurnal tides of two high tides and two low tides in a 24.8-hour period. The semidiurnal tides exhibit periodic cycles of high- and low-tidal ranges (water-level difference between high and low tide) on a 14-day cycle. The mean tidal range is 6.92 ft at Fort Pulaski (*http://Co-ops.nos.noaa.gov/tides05/tab2ec3b.html#79*). As the tidal wave propagates upstream, the tidal ranges can be larger than those in the harbor. For example, the mean tidal ranges at Fort Jackson (near the confluence of the Back and Front Rivers), Port Wentworth, and the Back River U.S. Highway 17 are 8.1, 7.0, and 7.64 ft, respectively (fig. 2). Upstream from the U.S. Highway 17 Bridge, the tidal range decreases with the increased effects of the freshwater flow of the Savannah River and decrease in channel geometry. There is approximately a 1-hour lag of the tide from Fort Pulaski to the Little Back and Back Rivers at the U.S. Highway 17 Bridge.

Figure 8 shows the water levels at three USGS stations on the Savannah River for the period during October 2002. The neap tidal period, characterized by a relatively smaller amplitude in tidal range, occurred around October 14 and 28, and the spring tidal period, characterized by a larger amplitude in tidal range, occurred around October 7 and 21. During the spring tide early in the month, the highest water levels occurred at the Broad Street water-level gage (station 02198920, fig. 5)—greater than the downstream water-level gage at Fort Pulaski (station 02198980, fig. 1). As the tidal range diminished during October, the highest water levels were experienced at the most upstream gaging station at I-95 where the high water is often affected by the streamflow of the Savannah River.

A plot of the daily tidal range clearly shows the 14-day spring-neap tidal cycles along with seasonal and semiannual cycles. The tidal range for the Fort Pulaski water-level gage (station 02198980) is shown in figure 9 for the 2002 calendar year. The 14-day spring-neap cycles are clearly shown. For example, a high spring tide (tidal range greater than 8 ft) is followed by a low spring tide (tidal range less than 8 ft). A similar pattern is apparent in the neap tides where a low neap tide (tidal range less than 5.5 ft) is followed by a high neap tide (tidal range greater than 5.5 ft).

Seasonal and semiannual cycles of minimum and maximum tidal ranges can also be seen in figure 9. The highest difference in spring and neap tides occur in the spring (March and April) and the fall (October and November) of the year. Minimum differences between the spring and neap tides occur in the summer (June and July) and in the winter (December and January) of the year.

Water-level dynamics in the tidal marshes are dependent on the height of the water levels, the surface elevation of the tidal marsh, and inertial affects. Tidal fluctuations in marsh water levels are greatest during the high spring tides and are minimal during neap tides. Marsh water-level time series for USGS gaging stations on the Back, Middle, and Front River marshes are shown in figures 10 and 11. In figure 10, hourly water levels in the Little Back River near Limehouse

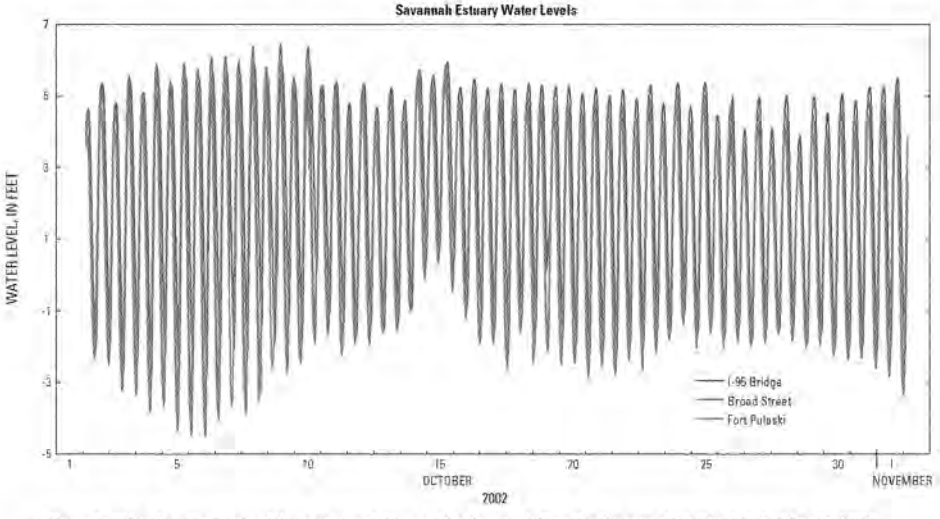


Figure 8. Hourly water levels at three gaging stations on the Savannah River for the period October 1 to October 31, 2002.

(station 02188979, left y-axis) are shown with marsh water levels (right y-axis). The Little Back River water-level time series show the periods of spring tides. Multiday periods of substantial tidal fluctuations for the four marsh sites along the Little Back and Back Rivers occur during spring tides beginning around December 15 and 29, and January 28, 2002. In figure 11, similar water-level responses are seen for the two marsh sites along the Middle River and the marsh site along the Front River. Multiday periods of substantial tidal fluctuations for the three marsh sites occur on spring tides beginning around November 10, November 29, December 10, and December 29, 2001.

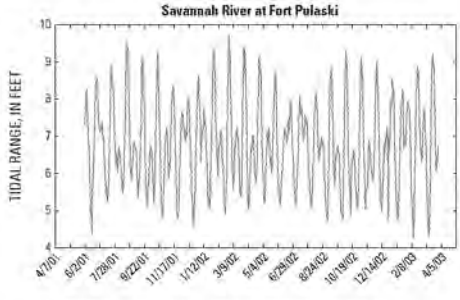


Figure 9. Daily tidal range at Savannah River at Fort Pulaski for the period June 2001 to May 2003.

Characterization of River and Marsh Specific Conductance

The location of the saltwater-freshwater interface is a balance between upstream river flows and downstream tidal forcing. During periods of high streamflow, it is difficult for salinity to intrude upstream, and thus, the saltwater-freshwater interface is moved downstream towards the ocean. During periods of low streamflow, salinity is able to intrude upstream; subsequently, the saltwater-freshwater interface is moved upstream. Historically, streamflows on the Savannah River range from 5,000 to 50,000 ft³/s. Salinity in the Savannah River Estuary constantly responds to changing streamflow and tidal conditions. The daily mean specific conductance for the Little Back River near Limehouse (station 02198979) and daily mean streamflow for Savannah River near Clyo (station 02198500) for the 1994 to 2004 period are shown in figure 12. The period includes the full range of flows for the system from the high flows of the El Niño in 1998 to the low flows of the extended drought in the southeast from

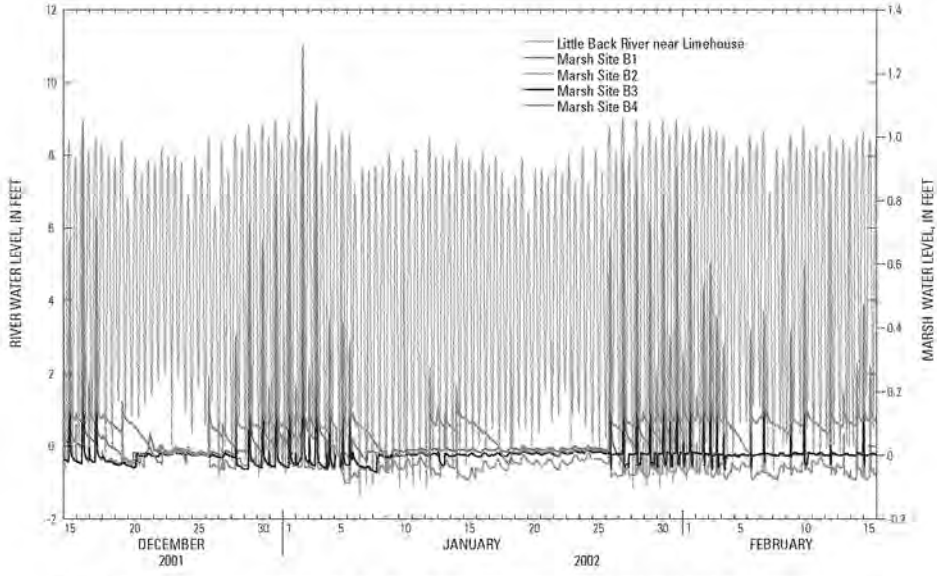


Figure 10. Hourly water-level data for the four Back River marsh gaging stations and Little Back River gaging stations for the period December 15, 2001, to February 15, 2002.

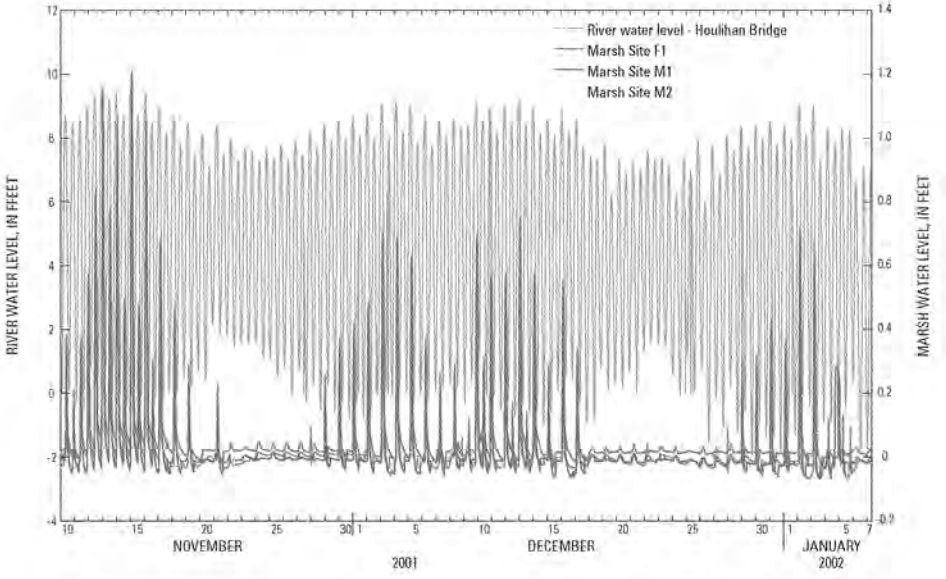


Figure 11. Hourly water-level data for three marsh gaging stations along the Middle and Front Rivers and Savannah River water level at Houlihan Bridge for the period November 10, 2001, to January 7, 2002.

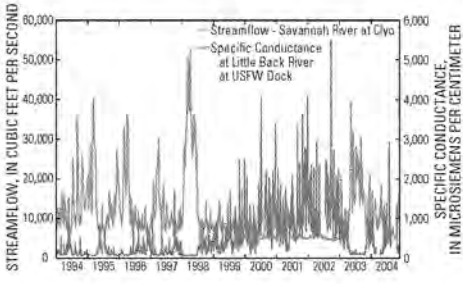


Figure 12. Daily specific conductance at Little Back River at U.S. Fish and Wildlife Service Dock gaging station and streamflow at Savannah River near Clyo, Ga., gaging station for the period January 1, 1994, to September 30, 2004.

1998 to 2002. During periods of medium streamflow and greater (streamflow greater than 10,000 ft^3/s), the specific-conductance values are low. During periods of low flow (streamflow less than 10,000 ft^3/s), specific-conductance values increase during periods of salinity intrusion. During the period prior to the high flows of El Niño in 1998, salinity intrusion with specific-conductance values of 500 to 1,000 microsiemens per centimeter (µS/cm) were not uncommon during low-flow periods. After the high flow of 1998 and the extended drought, flows were even lower and remained lower for extended periods. This resulted in greater salinity intrusions in the Little Back River with daily mean specific-conductance values as high as 4,000 µS/cm.

The Savannah River Estuary is considered a partially stratified system with large differences in surface and bottom salinities occurring during neap and spring tides over the 14- and 28-day cycles. A schematic of the largest factors that affect salinity transport along the Savannah River is shown in figure 13. During spring tides (tides with the largest tidal range), there is increased energy in the system and mixing of less dense freshwater of the river and denser saltwater of the harbor. The mixing results in smaller variation in vertical salinity concentrations. During neap tides (tides with the smallest tidal range), there is decreased energy in the system and less mixing between the freshwater and saltwater. The decreased mixing allows the freshwater to flow downstream over the saltwater intruding upstream. The decrease in mixing results in an increased salinity gradient from the surface to the bottom of the water column and increased salinity

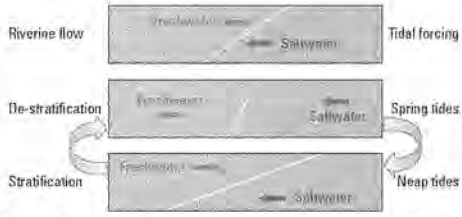


Figure 13. Conceptual model of the location of the freshwater-saltwater interface and salinity stratification-destratification cycle in estuarine rivers.

intrusion upstream. The stratification and de-stratification of salinity at station GPA04 for 2 months during summer 1997 is shown in figure 14. During the neap tides around Julian day 225, there is an approximate 15-psu difference between the bottom and surface salinities. During the spring tides around Julian day 205 and 235, the system de-stratifies and the differences between the bottom and surface salinities are only 3 to 5 psu.

The marsh salinities do not exhibit the semidiurnal salinity variability like the river and are dependent on the frequency and magnitude of the flooding of river water on the marsh. Tidal marshes are constantly integrating the changing river conditions in their water levels (frequency and duration of inundations) and the salinity concentration in the interstitial pore-water of the root zone. Plant distributions in the marshes are the result of the interstitial salinities. The interstitial salinities of the marshes with the surface salinities of the river, and the four marsh types and their corresponding estuarine salinity concentrations, are shown in figure 15.

Because the marshes do not flood every tide, the interstitial salinities are not the same as the river salinity. During low-flow periods and high tides, salinity intrudes farther upstream, and the surface salinities inundate the marshes. The highest salinity intrusions into the marshes occur when riverine salinity intrusions are concurrent with the spring-tide water levels. The specific-conductance time series of the four marsh gaging stations along the Little Back and Back Rivers with the specific conductance for the Front River at Houlihan Bridge (station 02198920) is shown in figure 16. The four marsh sites show a distinct gradient of increased specific-conductance values from upstream (Site B1) to downstream (Site B4). Increased specific conductance in the marsh generally occurs after increased specific conductance in the river. The specific-conductance time series of three marsh gaging stations along the Middle and Front Rivers and specific conductance for the Front River at the Houlihan Bridge water-level gage (station 02198920) are shown in figure 17.

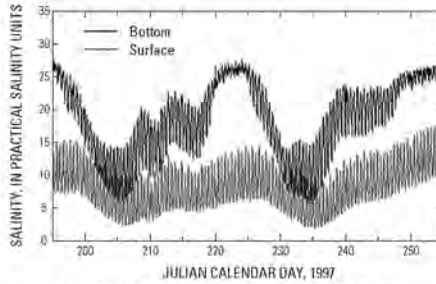


Figure 14. Surface and bottom salinities for station GPA04 for the period July 15 to September 13, 1997 (Tetra Tech, 2005). The plot shows the de-stratification of the Savannah River on about Julian days 205 and 235 and the stratification on about Julian day 225.

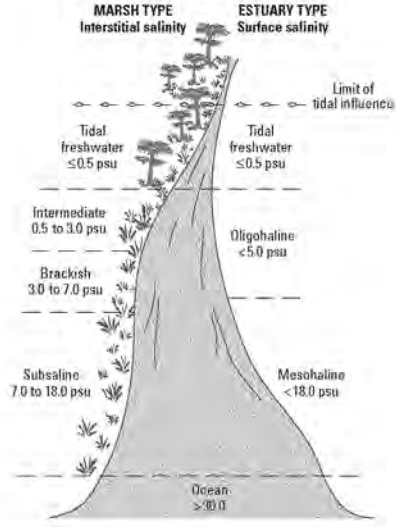


Figure 15. Tidal marsh types classified by interstitial salinity (Pearlstine and others, 1990) and average surface salinities (Cowardin and others, 1979) (modified from Odum and others, 1984).

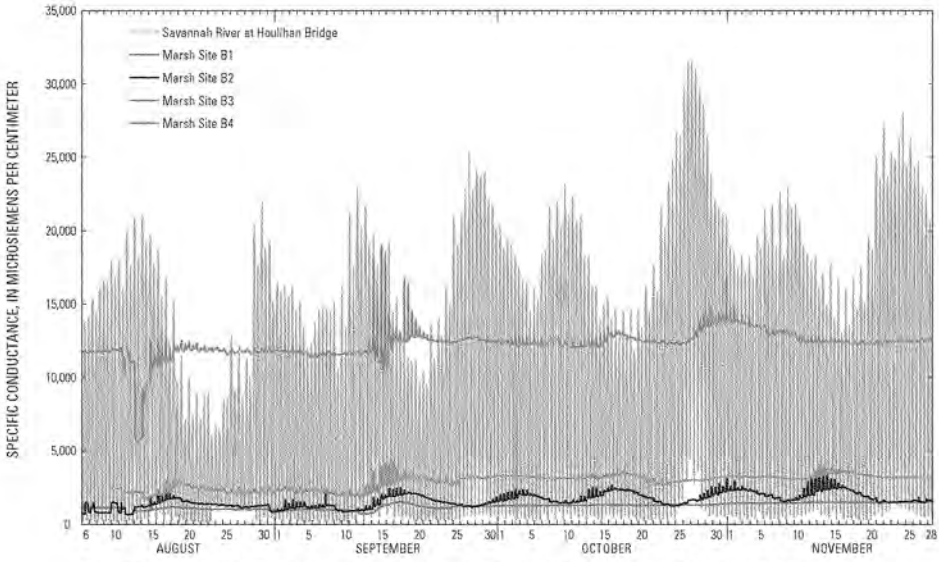


Figure 16. Hourly specific conductance at four marsh gaging stations along the Little Back and Back Rivers and specific-conductance values at the Houlihan Bridge on the Savannah River for the period August 6 to November 30, 2001.

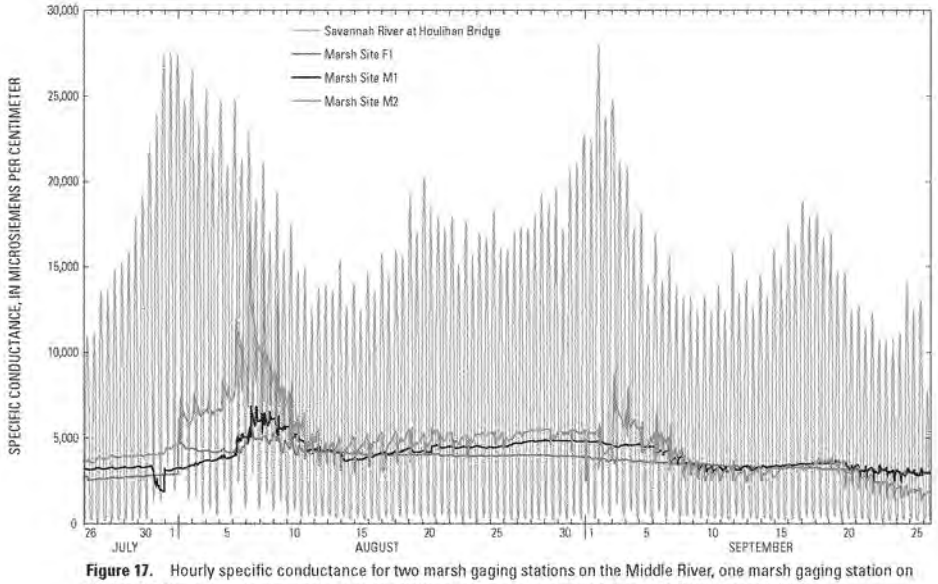


Figure 17. Hourly specific conductance for two marsh gaging stations on the Middle River, one marsh gaging station on the Front River, and at Houlihan Bridge on the Savannah River for the period July 26 to September 27, 2002.

Simulating Riverine and Marsh Water Levels and Salinity

Simulating salinity for estuarine systems typically is done using dynamic deterministic models that incorporate the mathematical descriptions of the physics of coastal hydrodynamics. These one-, two-, or three-dimensional models generally are expensive and time consuming to apply to complex coastal systems with satisfactory results. Conrads and Roehl (2005) assert that in estuaries, mechanistic model calibration is "... particularly difficult due to low watershed gradients, poorly defined drainage areas, tidal complexities, and a lack of understanding of watershed and marsh processes." Although mechanistic models have been the state of the practice for regulatory evaluations of anthropogenic effects on estuarine systems, developments in the field of advanced statistics, machine learning, and data mining offer opportunities to develop empirical ANN models that are often more accurate. Conrads and Roehl (1999) compared the application of a deterministic model and an ANN model to simulate dissolved oxygen on the tidally affected Cooper River in South Carolina. Results of their study indicated that the ANN models offer important advantages, including faster development time, use of larger amounts of data, the incorporation of optimization routines, and model dissemination in spreadsheet applications. With the real-time gaging network on the Savannah River and the availability of large databases of hydrologic and water-quality data, the GPA realized an opportunity to develop an empirical model using data-mining techniques, including ANN models, to simulate the water level and pore-water salinity of the tidal marshes in the vicinity of SNWR.

The emerging field of data mining addresses the issue of extracting information from large databases. Data mining comprises several technologies that include signal processing, advanced statistics, multidimensional visualization, chaos theory, and machine learning. Machine learning is a field of artificial intelligence (AI) in which computer programs are developed that automatically learn cause-effect relations from example cases and data. For numerical data, commonly used methods include ANN models, genetic algorithms, multivariate adaptive regression splines, and partial and ordinary least squares (OLS).

Data mining can solve complex problems that are unsolvable by any other means. Weiss and Indurkhya (1998) define data mining as "... the search for valuable information in large volumes of data. It is a cooperative effort of humans and computers." A number of previous studies by the authors and others have used data mining to simulate hydrodynamic and water-quality behaviors in the Beaufort, Cooper, and Savannah River estuaries (Roehl and Conrads, 1999; Conrads and Roehl, 1999; Roehl and others, 2000; Conrads and others, 2002a; 2002b) and stream temperatures in western Oregon (Risley and others, 2002). These studies have demonstrated the performance of data mining to simulate water level, water temperature, dissolved oxygen, and specific conductance, and for assessing the effects of reservoir releases and point and nonpoint sources on receiving streams.

The ultimate goal of this study is to produce an effective model to simulate water level and specific conductance in the tidal marsh for a given set of streamflow, water-level, and tidal range conditions. The approach taken uses all available streamflow, water-level, and specific-conductance measurements since the last major changes in channel configuration in 1994. The modeling approach uses correlation functions that were synthesized directly from data to simulate how the change in water level and specific conductance at each station location is affected by streamflow and tidal conditions over time.

Limitations of the Data Sets

As with any modeling effort, empirical or deterministic, the reliability of the model is dependent on the quality of the data and range of measured conditions used for training or calibrating the model. The available period of record for the river and marsh data-collection networks can limit the range of streamflow, water-level, tidal range, and salinity conditions that the ANN model can accurately simulate. As noted previously, substantial changes in the salinity response of the system can occur due to a small change in streamflow (fig. 12). Using the specific-conductance record for the Little Back River at USFW Dock (station 021989791) as representative of the salinity dynamics of the system, scatter plots of daily streamflow and specific-conductance data were generated for each network for the period that it was active (fig. 18). The period of record for the USGS river network (fig. 18*A*) covers the full range of historical conditions from extreme low to high flows. The GPA river network (fig. 18*A*), active during summer 1997 and 1999, covers a much smaller range of hydrologic conditions and did not measure streamflow and the corresponding salinity response for streamflows less than 5,440 ft^3/s or greater than 11,600 ft^3/s. The USGS marsh network (fig. 18*B*) was established in 2000 during the drought and measured a large range of marsh salinity conditions for streamflow ranging from 4,310 to 39,600 ft^3/s. The GPA marsh network (fig. 18*B*) also was established during the drought, but was discontinued in 2002 and only measured low-flow conditions less than 14,100 ft^3/s. Data networks and the range of flows measured for each gaging network are summarized in table 2.

Signal Decomposition, Correlation Analysis, and State-Space Reconstruction

The behavior, or dynamics, of a natural system results from interactions between multiple physical forces. For example, the specific conductance at a fixed location is subject to daily, seasonal, and annual streamflow conditions and semidiurnal, fortnightly, seasonal, and annual tidal water-level conditions. For the application of the ANN models to the

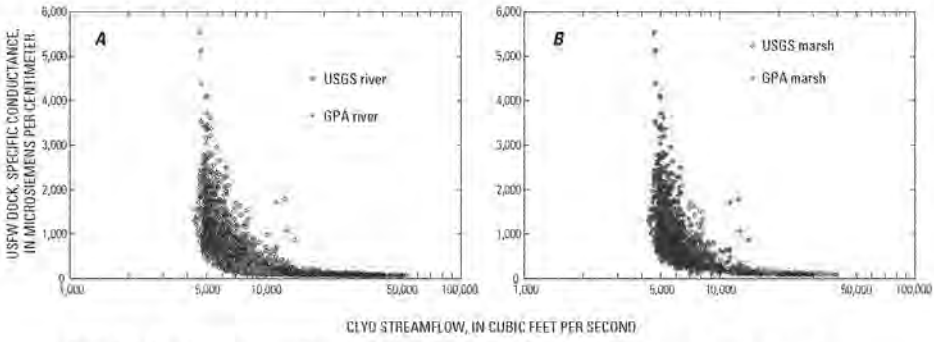


Figure 18. The daily mean streamflow at Savannah River at Clyo, Ga., and daily mean specific conductance at U.S. Fish and Wildlife Service Dock, Little Back River, for the conditions during which the gaging network was active. The two river networks are shown in the plot on the left (*A*), and two marsh networks are shown on the plot on the right (*B*).

Savannah River, data-mining methods are applied to maximize the information content in raw data while diminishing the influence of poor or missing measurements. Methods include digital filtering using fast Fourier Transforms, time derivatives, time delays, running averages, and differences between stations. Signals, or time series, manifest three types of behavior: periodic, chaotic, and noise. Periodic behavior is perfectly predictable. Examples of periodic behavior are the diurnal sunlight and temperature patterns caused by the rising and setting sun or tidal water levels attributed to orbital mechanics. Noise refers to random components, usually attributed to measurement error, and is unpredictable. Chaotic behavior neither is totally periodic nor noise, and always has a physical cause. Weather is an example of chaotic behavior. Chaotic behavior is somewhat predictable, especially for small time frames and prediction horizons.

Signal Decomposition

Signal decomposition involves splitting a signal into subsignals, called "components," which are independently attributable to different physical forces. To analyze and model these time series, the periodic and chaotic components of the signals need to be separated. Digital filtering can separate out the chaotic component in the water-level time series. Computation of the tidal range time series from the water-level time series separates out the periodic components of the water-level time series. Digital filtering can also diminish the effect of noise in a signal to improve the amount of useful information that it contains.

Time derivatives are a common analytical method used in the sciences to analyze the dynamics of a system. Time derivatives are also computed from the measured, computed, and filtered variables on the Savannah River to further understand the dynamics of the system. The 1-day derivative of the low-pass filtered water-level time series for a 90-day period was plotted with the original time series and the low-pass filtered data (fig. 19). The 1-day derivatives show the rate of change of the chaotic component of the water-level time series. For the 90-day period, the daily change in filtered water level is as high as 1.5 ft.

Often there are time delays between when an event is measured and the time that the response is observed in a system. Modeling a system is more complicated when two events of interest, a cause and an effect, do not occur simultaneously. The time between cause and effect is called the "time delay" or "delay." Each input variable of a model has its own delay. Determining the correct time delays for pulses and system response is critical to accurately simulating a dynamic system. For the Savannah River, there is a time delay between the measured streamflow at Clyo, Ga., and the response in specific conductance at the stations near the SNWF. Time delays between when the flow enters the system and the river response of the specific conductance were determined for each station by analyzing the correlation between lagged flow values for various time delays and the salinity response values at a station.

Table 2. Period of record and range of daily flow conditions measured for the river and marsh gaging networks used in the study.

[ft³/s, cubic foot per second; USGS, U.S. Geological Survey; GPA, Georgia Ports Authority]

Gaging network	Period of record used in this study	Range of flow conditions (ft³/s)
USGS River	Jan 1994–May 2005	4,320 – 52,600
GPA River	July–Sept 1997 July–Oct 1999	5,440 – 11,600
USGS Marsh	June 1999–May 2005	4,320 – 39,600
GPA Marsh	June 1999–Oct 2002	4,320 – 14,100

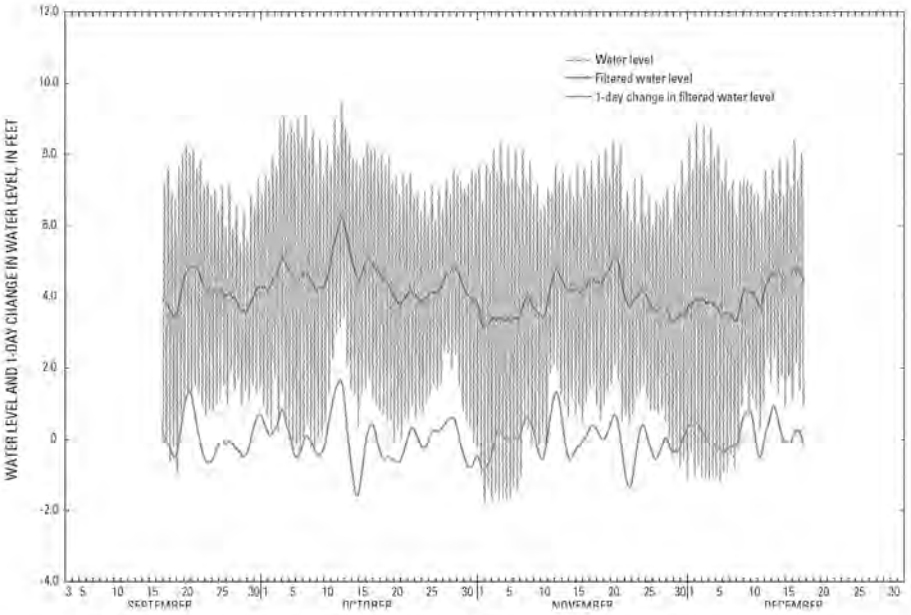


Figure 19. Hourly water levels at Fort Pulaski (station 02198980), low-pass filtered water levels, and 1-day change in filtered water levels for the 90-day period September 13 to December 13, 1994.

Averages and running averages are commonly used to remove the variability of measurements and to represent prevailing behaviors of the system. To capture the effect of the extended low-flow condition as a result of the extended drought, time derivatives of running average flow conditions were computed. The 14-day difference (time derivative) of the 14-day running average flow conditions can capture the change in average flow conditions over a 28-day period. For example, if the 14-day running average for June 28, 2002 (June 15–28) is 4,743 ft^3/s and the 14-day running average for June 15, 2002 (June 2–15) is 4,900 ft^3/s, then the 14-day difference (time derivative) for June 28, 2002 is –157 ft^3/s. The daily streamflow at Clyo, Ga., the 14-day average streamflow, and the 14-day difference in 14-day average flows are shown in figure 20. The time derivative signal shows the 14-day trend of the change in 14-day average streamflow conditions. There is a significant difference in the time derivative signal for the extended drought after the high flows of the El Niño in 1998. Prior to the drought, 14-day differences in 14-day average flows fluctuate by more than 10,000 ft^3/s. During the drought, fluctuations were less than 5,000 ft^3/s.

Correlation Analysis

The relations between the many variables and their various components are ascertained through correlation analyses to provide deeper understanding of system dynamics. For example, salinity intrusion is dependent on streamflow and tides, and correlation analysis provides a measure of relative contribution of each variable. Sensitivity analysis quantifies the relations between a dependent variable of interest and causal variables. Computing sensitivities requires defining the relation between variables through modeling.

Using statistical and(or) ANN software, the computer systematically correlates factors that most influence parameters of interest (for example, specific conductance) to candidate combinations of controlled and uncontrolled variables (for example, streamflow and tidal conditions). Correlation methods based on statistics and ANNs are applied in combination. Promising results identified by the analysis are validated by comparing them to known patterns of behavior.

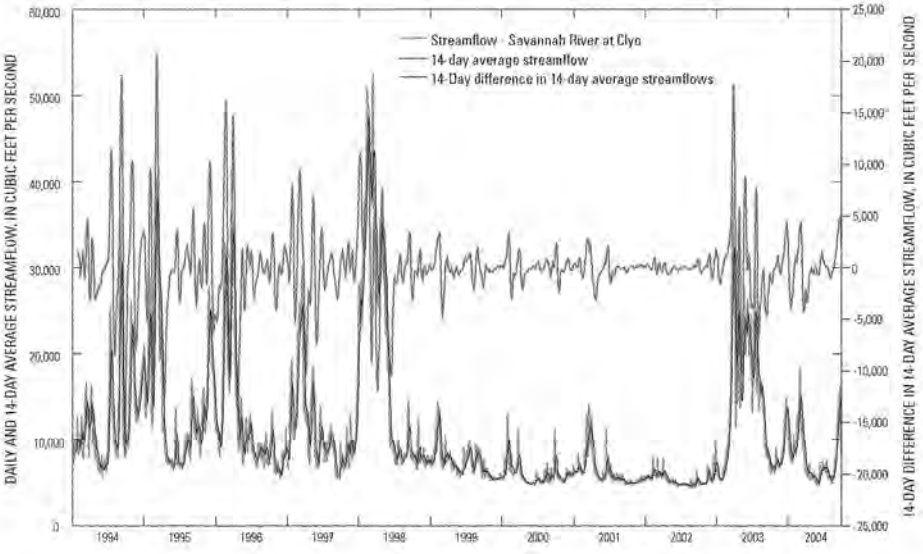


Figure 20. Daily flows, 14-day average flows, and 14-day differences in 14-day average flows for the Savannah River at Clyo, Ga., for the period 1994–2004. Note the scale for the 14-day differences in 14-day average flows is on the right.

State-Space Reconstruction

Chaos theory provides a conceptual framework called "state-space reconstruction" (SSR) for representing dynamic relations. Data collected at a point in time can be organized as a vector of measurements; for example, element one of the vector might be the water level, element two the streamflow, and so on. Engineers say that a process evolves from one state to another, in time, and that a vector of measurements, also referred to as a "state vector," represents the process state at the moment the measurements were taken. A sequence of state vectors represents a "state history." Mathematicians say that the state vector is a point in a "state space" having a number of dimensions equal to the number of elements in the vector. For example, eight vector elements equates to eight dimensions. Empirical modeling is the fitting of a multidimensional surface to the points arrayed in state space.

Chaos theory proposes that a process can be optimally represented (reconstructed) by a collection of state vectors, Y(t), using an optimal number of measurements equal to "local dimension" d_L that are spaced in time by integer multiples of an optimal time delay, τ_d (Abarbanel, 1996)[1]. For a multivariate process of k independent variables:

$$Y(t) = \{[x_1(t), x_1(t-\tau_{d1}), \ldots, x_1(t-(d_{L1}-1)\tau_{d1})], \ldots, [x_k(t), x_k(t-\tau_{dk}), \ldots, x_k(t-(d_{Lk}-1)\tau_{dk})]\} \quad (1)$$

where each $x(t,\tau_{di})$ represents a different dimension in state space, and therefore, a different element in a state vector. Values of d_{Li} and τ_{di} are estimated analytically or experimentally from the data. The mathematical formulations for models are derived from those for state vectors. To predict a dependent variable of interest y(t) from prior measurements (forecasting) of k independent variables (Roehl and others, 2000):

$$y(t) = F\{[x_1(t-\tau_{p1}), x_1(t-\tau_{p1}-\tau_{d1}), \ldots, x_1(t-\tau_{p1}-(d_{M1}-1)\tau_{d1})], \ldots, [x_k(t-\tau_{pk}), x_k(t-\tau_{pk}-\tau_{dk}), \ldots, x_k(t-\tau_{pk}-(d_{Mk}-1)\tau_{dk})]\} \quad (2)$$

where F is an empirical function such as an ANN, each $x(t,\tau_{pi},\tau_{di})$ is a different input to F, and τ_{pi} is yet another time delay. For each variable, τ_{pi} is specified according to one of the following constraints: time delay at which an input variable becomes uncorrelated to all other inputs, but can still provide useful information about y(t); time delay of the most recent available measurement of x_i; or time delay at which an input variable is most highly correlated to y(t). Here, the state space local dimension d_{Li} of Equation 1 is replaced with a model

[1] In Chaos theory, d_{Li} and τ_{di} are called "dynamical invariants," and are analogous to the amplitude, frequency, and phase angle of periodic time series.

input variable dimension d_M, which is determined experimentally. It is noted that $d_M \leq d_T$ and tends to decrease with increasing k.

Input-Output Mapping and Problem Representation

The development of ANN models to predict the water level and pore-water salinity of the tidal marsh was undertaken in two phases. The first phase was to train the ANN models to simulate the water level and specific conductance at the USGS and the GPA riverine sites. Inputs to the ANN models of the USGS river network include time series, or signals, of streamflow, tidal water level, and tidal range. Because of the limited data set, the GPA river network sites were modeled using differences in water level and specific conductance with the USGS river network stations. Outputs from these models are water level and salinity at the river network stations. Simulated specific-conductance values are post-processed to salinity values using the equation documented by Miller and others (1988). The second phase was to train the ANN models to simulate water level and pore-water specific conductance at the USGS and the GPA marsh sites. Inputs for these models include the water-level and specific-conductance signals from the USGS and GPA river networks near the marsh gaging sites. Outputs from these models are water level and salinity at the marsh network stations.

One of the ultimate applications of the ANN models will be to simulate the change in water level and specific conductance in the marsh likely to result from a potential harbor deepening. As discussed previously, a 3D model, EFDC, has been applied and will be used to simulate water-level and salinity changes in the river resulting from geometric changes expected from proposed physical changes to the harbor. Using the USGS river network time series as input for the marsh, the ANN models can accommodate the integration of output from other models of the river. Rather than use the ANN river predictions as input to the ANN marsh models, EFDC predictions were used. The final application of the ANN models can be run under two different modes. Mode 1 uses the streamflow and tidal condition inputs and evaluates the effects of changing hydrologic conditions on water level and specific conductance of the river and marsh sites. Mode 2 uses EFDC predictions of changes from a base-case scenario at the USGS river network as inputs to evaluate the effects of changes in the channel geometry on water level and specific conductance of the marsh sites.

Decorrelation of Variables

Often, explanatory variables share information about the behavior of a response variable. It is difficult, if not impossible, to understand the individual effects of these variables (sometimes known as confounded or correlated variables), on a response variable. Empirical models have no notion of process physics, nor the nature of interrelations between input variables. To be able to clearly analyze the effects of confounded variables, the unique informational content of each variable must be determined by "de-correlating" the confounded variables. For the Savannah River application, the boundary input data, streamflow from Clyo, Ga., and water levels from Fort Pulaski, are both distant from the river and marsh gaging network near the SNWF. The Pearson correlation coefficient, R, between Clyo streamflows and the Savannah Harbor water level is -0.03, indicating very little correlation between the two time series.

The only variables in the application that needed to be decorrelated were data from the GPA specific-conductance stations (GPA10S, GPA11, GPA11R, and GPA12) used as inputs for the USGS marsh salinity models. Decorrelation is accomplished by generating an empirical correlation function and computing its residual error by subtracting the function's predicted values from the actual measurement. The residual error is the "unshared" information between the two signals. Single Input Single Ouput (SISO) ANN models were built to decorrelate data from GPA11, GPA11R, and GPA12 from GPA10S. The residual error signal was then used in the USGS marsh salinity models as the decorrelated inputs for those stations.

Artificial Neural Network Models

Models generally fall into one of two categories, deterministic (or mechanistic) or empirical. Deterministic models are created from first-principles equations, whereas empirical modeling adapts generalized mathematical functions to fit a line or surface through data from two or more variables. The most common empirical approach is OLS, which relates variables using straight lines, planes, or hyper-planes, whether the actual relations are linear or not. Calibrating either type of model attempts to optimally synthesize a line or surface through the observed data. Calibrating models is made difficult when data have substantial measurement error or are incomplete, and the variables for which data are available may only be able to provide a partial explanation of the causes of variability. The principal advantages that empirical models have over deterministic models are that they can be developed much faster and are often more accurate when the modeled systems are well characterized by data. Empirical models, however, are prone to problems when poorly applied. Overfitting and multicollinearity caused by correlated input variables can lead to invalid mappings between input and output variables (Roehl and others, 2003).

An ANN model is a flexible mathematical structure capable of describing complex nonlinear relations between input and output data sets. The architecture of ANN models is loosely based on the biological nervous system (Hinton, 1992). Although there are numerous types of ANNs, the most commonly used type is the multilayer perceptron (MLP) (Rosenblatt, 1958). As shown in figure 21, MLP ANN's are constructed from layers of interconnected processing elements called neurons, each executing a simple "transfer function."

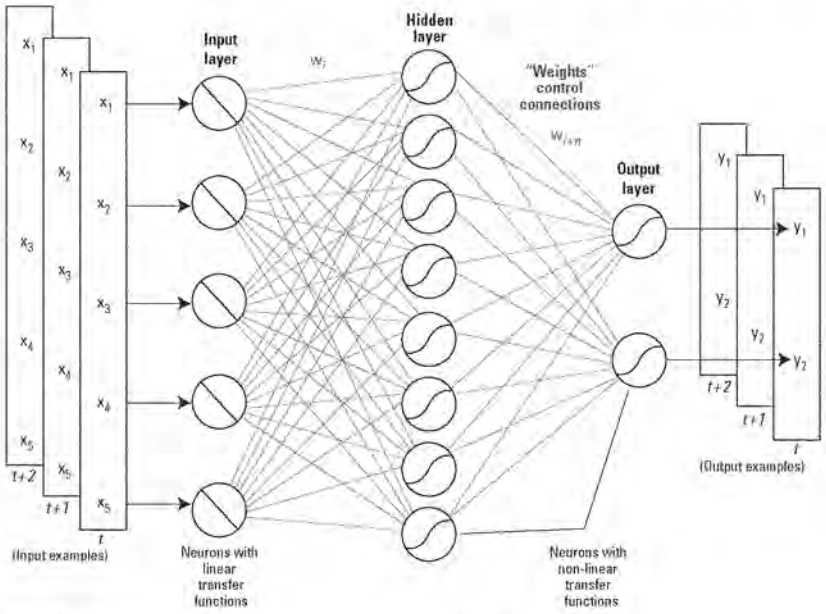


Figure 21. Multilayer perceptron artificial neural network architecture.

All input layer neurons are connected to every hidden layer neuron, and every hidden layer neuron is connected to every output neuron. There can be multiple hidden layers, but a single layer is sufficient for most problems.

Typically, linear transfer functions are used to simply scale input values to fall within the range that corresponds to the most linear part of the s-shaped sigmoid transfer functions used in the hidden and output layers. Each connection has a "weight," w_i, associated with it that scales the output received by a neuron from a neuron in an antecedent layer. The output of a neuron is a simple combination of the values it receives through its input connections and their weights, and the neuron's transfer function.

An ANN is "trained" by iteratively adjusting its weights to minimize the error by which it maps inputs to outputs for a data set comprising "input/output vector pairs." Simulation accuracy during and after training can be measured by a number of metrics, including coefficient of determination (R^2) and root mean square error (RMSE). An algorithm that is commonly used to train MLP ANNs is the back error propagation (BEP) training algorithm (Rumelhart and others, 1986). Jensen (1994) describes the details of the MLP ANN, the type of ANN used in this study. MLP ANNs can synthesize functions to fit high-dimension, nonlinear multivariate data. Devine and others (2003) and Conrads and Roehl (2005) describe their use of MLP ANN in multiple applications to model and control combined man-made and natural systems including disinfection byproduct formation, industrial air emissions monitoring, and surface-water systems affected by point and nonpoint source contaminants.

Experimentation with a number of ANN architectural and training parameters is a normal part of the modeling process. For correlation analysis or predictive modeling applications, a number of candidate ANNs are trained and evaluated for both their statistical accuracy and their representation of process physics. Interactions between combinations of variables also are considered. Finally, a satisfactory model can be exported for end-user deployment. In general, a high-quality predictive model can be obtained when:

- the data are well distributed throughout the state space (historical range of conditions) of interest,
- the input variables selected by the modeler share "mutual information" about the output variables, and
- the form "prescribed" or "synthesized" for the model used to "map" (correlate) input variables to output variables is a good one. Techniques such as OLS and physics-based finite-difference models prescribe the functional form of the model's fit of the calibration data. Machine learning techniques like ANN's synthesize a best fit to the data.

Subdividing a complex modeling problem into subproblems and then addressing each is a means to achieving the best possible results. A collection of submodels whose calculations are coordinated by a computer program constitutes a "super-model." For the Savannah study, individual ANN models (submodels) were developed for the river and marsh water level and salinity at each continuous station. These submodels were then incorporated into a "super-model" application that integrates the model controls, model database, and model outputs. The "super-model" for the project is the Model-to-Marsh (M2M) DSS described later in this report. The ANN models and plots described herein were developed using the iQuest™ data-mining software[2] (Version 2.03C DM Rev31). The ANN models were deployed in the DSS using the Visual Basic run-time library of the iQuest R/T™ software.

Statistical Measures of Prediction Accuracy

The R^2, the mean error (ME), root mean square error (RMSE), and percent model error (PME) have been computed for the training and testing data sets for each model and are listed in Appendix I. Model accuracy usually is reported in terms of R^2 and commonly is interpreted as the "goodness of the fit" of a model. A second interpretation is one of answering the question, "How much information does one variable or a group of variables have about the behavior of another variable?" In the first context, an $R^2 = 0.6$ might be disappointing, whereas in the latter, it is merely an accounting of how much information is shared by the variables being used. The developers believe that the river and marsh water-level and salinity models are unusually accurate relative to one-dimensional, two-dimensional, and three-dimensional finite-difference models developed for comparably complex estuaries and tidal marsh systems.

The ME and RMSE statistics provide a measure of the prediction accuracy of the ANN models. The ME is a measure of the bias of model predictions—whether the model over or under predicts the measured data. The ME is presented as the adjustment to the simulated values to equal the measured values. Therefore, a negative ME indicates an over simulation by the model and a positive ME indicates an under prediction by the ANN model. Mean errors near zero may be misleading because negative and positive discrepancies in the simulations can cancel each other. RMSE addresses the limitations of ME by computing the magnitude, rather than the direction (sign) of the discrepancies. The units of the ME and RMSE statistic are the same as the simulated variable of the model.

The minimum and maximum values of the measured output are listed in Appendix I. The accuracy of the models, as given by RMSE, should be evaluated with respect to the range of the output variable. A model may have a low RMSE, but if the range of the output variable is small, the model may only be accurate for a small range of conditions and the model error may be a relatively large percentage of the model response. Likewise, a model may have a large RMSE, but if the range of the output variable is large, the model error may be a relatively small percentage of the total model response. The PME was computed by dividing the RMSE by the range of the measured data. The models of the USGS river and marsh networks have the greatest range of the output variables.

Generally, the USGS river water-level and specific-conductance models have R^2 values in the 0.95 to 0.99 and 0.57 to 0.90 ranges, respectively, and PME values of 1.5 to 4.1 percent and 1.0 to 6.3 percent, respectively. (The statistics for the river models are based on the test data sets of the hourly models.) The USGS marsh water-level and specific-conductance models' range of R^2 values are 0.72 to 0.87 for water levels, 0.74 to 0.93 for specific conductance, and 3.4 to 5.4 percent and 4.0 to 10.6 percent, respectively, for PME. (Statistics for the marsh water level are based on the test data set of the hourly models, and statistics for the marsh specific-conductance predictions are based on all measured data.)

Development of Artificial Neural Network Models

The following sections describe how the water-level and salinity models were developed for the river and marsh sites. All the stations from the USGS and the GPA river and marsh networks were modeled. The river stations used to model the marshes were generally limited to the USGS river stations because their long period of record covers the largest range of hydrologic conditions. The model developments for each type of station—river water level, river salinity, marsh water level, and marsh pore-water salinity—follow a similar approach. One example is given for each type of model and is followed by a general description of the performance of all the stations of that particular type. Figures are shown for each type of model. A graph of measured and simulated data for a short period (1 to 2 months) is shown for the example station to show model performance. The graph of the example station is followed by graphs showing the performance of the daily river water-level and specific-conductance models for the period of record to show how well the models simulate the long-term trends of the system. The graphs of measured and simulated daily data are followed by graphs showing the performance of the hourly models for a short period (2 to 3 months). For the marsh models, the graph of the measured and simulated values for the example station is followed by graphs showing the performance of the hourly models. Model summaries for the example models (the input and output variables, size of training and testing data sets, and their respective R^2s) are given in table 3, and model summaries of all the models can be found in Appendix II. Summary statistics for all the models can be found in Appendix I.

[2] The iQuest™ software is exclusively distributed by Advanced Data Mining, LLC, 3620 Pelham Road, PMB 351, Greenville, SC 29615-5044 Phone: 864-201-8679, email: info@advdatamining.com; *http://www.advdatamining.com*.

The river models were developed in two stages. The first stage simulated the low-pass filtered daily water-level or specific-conductance signals to capture the long-term dynamics of the system. The second stage simulated the higher-frequency hourly water level or specific conductance, using the simulated water level and specific conductance as a carrier signal. Each river water-level model uses three general types of input signals, or time series: streamflow signal(s), water-level signal(s), and tidal range signal(s). The signals may be of the measured series values, filtered values, and/or a time derivative of the signals. The specific-conductance (salinity) models use an additional streamflow input: a time derivative of a moving window average, such as the 14-day difference in the 14-day average streamflows (fig. 19). The available data set for developing the models was randomly bifurcated into training and testing data sets. For the large data sets, such as the USGS riverine network stations dating back to 1994, a zone averaging, or box, filter of the data, was used to separate the data into training and testing data sets. Using the zone average filter, all the data are used in the test data set and a small selected sample of the data is used for the training data set. The filter separates the data set into user-specified number of zones or boxes and determines the input vectors with the highest information content and reserves these vectors for the training data set. The percentage of training and testing data depended on the length of the data set and the range of hydrologic conditions in the data set. Typically, the zone averaging filter uses a small percentage of the data (less than 10 percent) for the training data set. Model development summaries and variable descriptions can be found in Appendixes II and III.

Riverine Water-Level Model at Little Back River near Limehouse

The daily water-level model (wl8979a-2005-1) for Little Back River near Limehouse (station 02198979) uses streamflow, water-level, and tidal range inputs (table 3). The streamflow inputs are daily average streamflow (Q8500A) and the 1-day derivative of streamflow (DQ8500A). The water-level data inputs are daily water level from Fort Pulaski (FWL8980A) and the 1-day time derivative of daily water level lagged 1 day (DWLAD1). Gaps in the time series for Savannah River at Fort Pulaski (station 02198980) were filled by correlating to upstream water levels such as Front River at Broad Street (station 02198920). The tidal range inputs are daily tidal range (XWL8980A) and a 1-day time derivative of daily tidal range lagged 1 day (DXWLAD1). For testing and training the daily model, there were 78,980 data values available. Ten percent of the data was used for training and 90 percent was used for testing. The coefficient of determination, R^2, for the training and testing were 0.95 and 0.96, respectively (table 3, Appendices I and II). The daily model used two hidden-layer neurons.

The hourly water-level model (wl8979h-2005-1) uses the simulated daily water level from the daily model and Fort Pulaski water-level inputs. The simulated daily water-level input (PWL8979A) captures the long-term movement of the water level that is characterized by the streamflow and tidal range data in the daily model. The six water-level inputs; LG1NWL, LG1D3NWL, LG4D3NWL, LG7D3NWL, LG10D3NWL, LG13D3NWL, are the 1-hour lagged water level (LG1NWL), and 3-hour time derivatives of the water level lagged 1, 4, 7, 10, and 13 hours, respectively. The lagged water-level inputs capture the periodic semidiurnal tidal signal. For testing and training the hourly model, there were 79,216 data values available (approximately 11 years of hourly data from 1994 to 2005). The data set was bifurcated into training and testing data sets. Ten percent of the data was used for training and 90 percent was used for testing. The R^2 for the training and testing data were 0.98 and 0.98, respectively (table 3, Appendices I and II). The hourly model used two hidden-layer neurons.

The measured and simulated hourly water levels are shown in figure 22 for the first quarter of 2002. The model simulates the measured data well, but does not capture the full range of the tide and slightly under simulates the maximum and minimum water levels. The PME for the period of record is less than 3 percent (Appendix I).

The daily water levels represent the chaotic portion of the water-level signal and the long-term trend of the system. The models are able to simulate this portion of the signal quite well (R^2 from 0.88 to 0.96) but miss the extreme high and low water levels (figs. 23 and 24). The simulations for the Front River at Houlihan Bridge (station 02198920, fig. 23*B*), under simulates the daily water levels more in the first half of the record than the second half. This may be the result of either a systematic change in the data collection or a change in the water-level behavior at the station. The under simulation for the first half of the time series explained the lower R^2 for the daily water-level model as compared to the other sites. The hourly water levels represent the periodic portion of the water-level signal and, generally, the models are able to simulate this portion of the signal quite well (R^2 from 0.98 to 0.995, figure 24).

Riverine Specific-Conductance Model at Little Back River at USFW Dock

The daily salinity model (sc89791a-2005-2) for Little Back River at USFW Dock uses six streamflow, three water-level, and three tidal range inputs. The streamflow inputs are daily average streamflow (Q8500A), the 1-day derivative of streamflow (D8500A), daily streamflow lagged 2 days (LAQ2), the 2-day change in streamflow (DAQ2), the 16-day change in streamflow (DAQ16), and the 30-day change in streamflow (DAQ30). The water-level data inputs are filtered daily water level from Fort Pulaski (FWL8980A), the 1-day time derivative of filtered daily water level (DWLA), and the 1-day time derivative of filtered daily water level lagged 2 days (LG2DWL). The tidal range daily inputs are daily tidal range (XWL8980A), the 1-day time derivative of daily tidal range (DXWLA), and the 1-day time derivative of daily tidal range lagged 2 days (LG2DXWLA). For testing and training

Table 3. Model name and model summary for four types of models used in the study.

[WL, water level; SC, specific conductance; XWL, tidal range; MWA, moving window average]

Model name	Model type	Input variables	Variable description	Training/testing data points	Hidden layer neurons
wl8979a-2005-1	Daily	Q8500A	daily average flow	7,987/70,993	2
		DQ8500A	1-day change in daily average flow		
		FWL8980A	filled, filtered daily WL		
		XWL8980A	daily tidal range		
		DXWLAD1	1-day change in tidal range, lagged 1 day		
		DWLAD1	1-day change in WL, lagged 1 day		
wl8979h-2005-1	Hourly	LG1NWL	1-hour lag in the in WL	8,029/71,187	2
		LG1D3NWL	1-hour lag in the 3-hour change in WL		
		LG4D3NWL	4-hour lag in the 3-hour change in WL		
		LG7D3NWL	7-hour lag in the 3-hour change in WL		
		LG10D3NWL	10-hour lag in the 3-hour change in WL		
		LG13D3NWL	13-hour lag in the 3-hour change in WL		
		PWL8979A	Predicted daily WL at 02198979		
sc89791a-2005-1	Daily	Q8500A	daily average flow	9,660/75,782	3
		DQ8500A	1-day change in daily average flow		
		LAQ2	2-day lag of the daily flow		
		DAQ2	2-day change in daily flow		
		DAQ16	16-day change in daily flow		
		DAQ30	30-day change in daily flow		
		FWL8980A	filled, filtered daily WL		
		XWL8980A	daily tidal range		
		DWLA	1-day change in WL		
		DXWLA	1-day change in tidal range		
		LG2DWLA	1-day change in WL, lagged 2 days		
		LG2DXWLA	1-day change in XWL, lagged 2 days		
		LG2DXWLA	1-day change in tidal range, lagged 2 days		
sc89791h-2005-1	Hourly	FWL8980A	filled, filtered daily WL	9,736/76,366	3
		XWL8980A	daily tidal range		
		NXWL	hourly WL		
		LG1NWL	1-hour lag in the in hourly WL		
		LG1D3NWL	1-hour lag in the 3-hour change in WL		
		LG4D3NWL	4-hour lag in the 3-hour change in WL		
		LG7D3NWL	7-hour lag in the 3-hour change in WL		
		LG10D3NWL	10-hour lag in the 3-hour change in WL		
		LG13D3NWL	13-hour lag in the 3-hour change in WL		
		PSC89791A	Predicted daily SC at 021989791		

Table 3. Model name and model summary for four types of models used in the study.—Continued

[WL, water level; SC, specific conductance; XWL, tidal range; MWA, moving window average]

Model name	Model type	Input variables	Variable description	Training/testing data points	Hidden layer neurons
pb2mwl-2005	Hourly	FWL8840	WL at station 02198840	3,284/18,228	2
		DFWL8840	difference with WL at 02198840		
		LG3DFWL8840	difference with WL at 02198840 lagged 3 days		
		LG6DFWL8840	difference with WL at 02198840 lagged 6 days		
		FWLDIF8977	WL at station 02198977		
		FWLDIF8979	WL at station 02198979		
		FWLDIF8920	WL at station 02198920		
pb2msc-2005-2	Hourly	SCDIF8840A	difference with SC between 02198840 and 021989791	2,142/18,770	1
		SCDIF8920A	difference with SC with difference with SC between 021988920 and 021989791		
		FSC89791A4WK	4-week MWAs of SC at 021989791		
		LG672FSC89791A4WKD4WK	difference between 4-week and lagged 4-week MWAs of SC at 021989791		
		FSC89791A2WKD4WK	difference between 2- and 4-week and lagged MWAs of SC at 021989791		
		FSC89791A1WKD2WK	difference between 1- and 2-week and lagged MWAs of SC at 021989791		
		FSC89791A48D1WK	difference between 2-day and 1-week and lagged MWAs of SC at 021989791		
		FSC89791DA48	difference between hourly and 2-day MWA of SC at 021989791		
		DFSC89791DA48	3-hour time derivative of SC at 021989791		
		LG3DFSC89791DA48	time derivative lagged 3 hours of SC at 021989791		
prb2msc	Hourly	RSC10S_12RS_A1WK	residual error of predicted weekly average SCGPA12RS (for decorrelation)	4,176/16,736	1
		RSC10S_11RB_A1WK	residual error of predicted weekly average SCGPA11RB (for decorrelation)		
		RSC10S_11B_A1WK	residual error of predicted weekly average SCGPA11B (for decorrelation)		
		PSCGPA10S_FLR_A1WK	1-week MWA of predicted hourly SC at GPA10S		

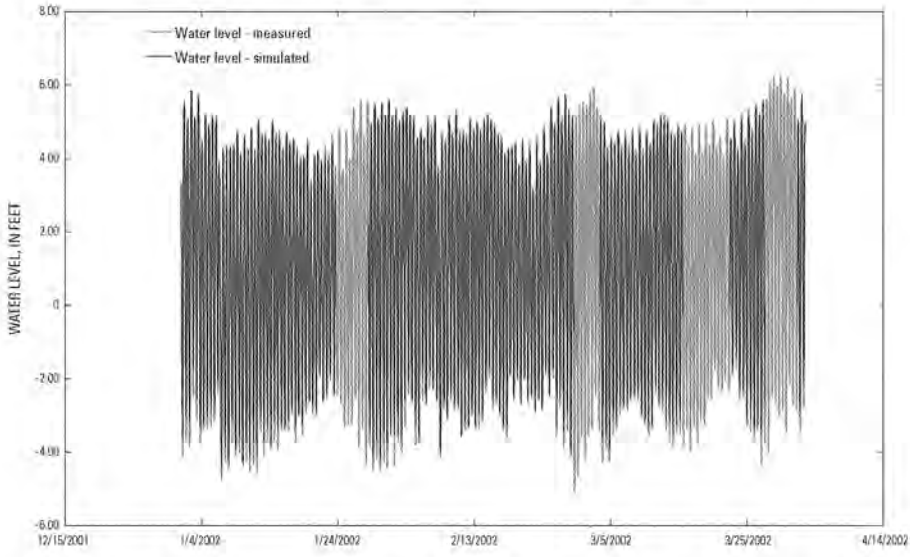


Figure 22. Measured and simulated hourly water levels at Little Back River near Limestone (station 02198979) for the period January 1 to March 31, 2002. Breaks in the prediction time series are caused by incomplete time series for one or more of the model inputs.

the daily model, there were 85,442 data values available. Eleven percent of the data was used for training, and 89 percent was used for testing. The R^2 for the training and testing were 0.89 and 0.87, respectively. The daily model used three hidden-layer neurons.

The hourly salinity model (sc89791h) uses simulated daily specific-conductance values from the daily model, two tidal range inputs, and six water-level inputs. The simulated daily specific-conductance input (PSC8979A) captures the long-term movement of the specific conductance that is characterized by the streamflow and tidal range data in the daily model. The two tidal range inputs are the daily tidal range (XWL8980A) and hourly tidal range (NXWL). The six water-level inputs—LG1NWL, LG1D3NWL, LG4D3NWL, LG7D3NWL, LG10D3NWL, LG13D3NWL—are 1-hour lagged water level, and 3-hour time derivatives of the water level lagged 1, 4, 7, 10, and 13 hours, respectively. The lagged water-level inputs capture the periodic semidiurnal tidal cycle signal. For testing and training the hourly model, there were 86,102 data values. Eleven percent of the data was used for training, and 89 percent was used for testing. The R^2 for the training and testing were 0.89 and 0.83, respectively. The hourly model used three hidden-layer neurons. A summary of the input variables, size of the training and testing data sets, number of hidden-layer neurons, and coefficient of determination for the hourly model can be found in table 3 and Appendix I.

The measured and simulated hourly salinities are shown in figure 25 for the summer of 2002. This period was the end of the 5-year drought that began in 1998 and had the highest salinity intrusions of the drought. The model simulates the measured data and captures the salinity intrusions occurring on a 14- and 28-day cycle. The model also is able to simulate the full range of the large salinity intrusion on about August 10, 2002.

The measured and simulated daily and hourly specific conductances for 1994 to 2005 for the four USGS river water-level gages are shown in figures 26 and 27. As with the water-level models, the daily specific conductance represents the chaotic portion of the signal, and the models are able to simulate this portion of the signal well (R^2 from 0.85 to 0.87, fig. 26) but do not capture the variability as well as the daily water-level models. The quality of hourly models, in terms of the coefficient of determination, vary from a R^2 of 0.57 at Savannah River at I-95 (station 02198840, fig. 27) to 0.87 at Front River at Houlihan Bridge (station 02198920, fig. 27). Although the specific-conductance model for I-95 explains only 57 percent of the variability, the results are quite satisfactory, in terms of timing and magnitude of response, for a station on the leading edge of the saltwater-freshwater interface where the salinity response is less than 0.5 psu.

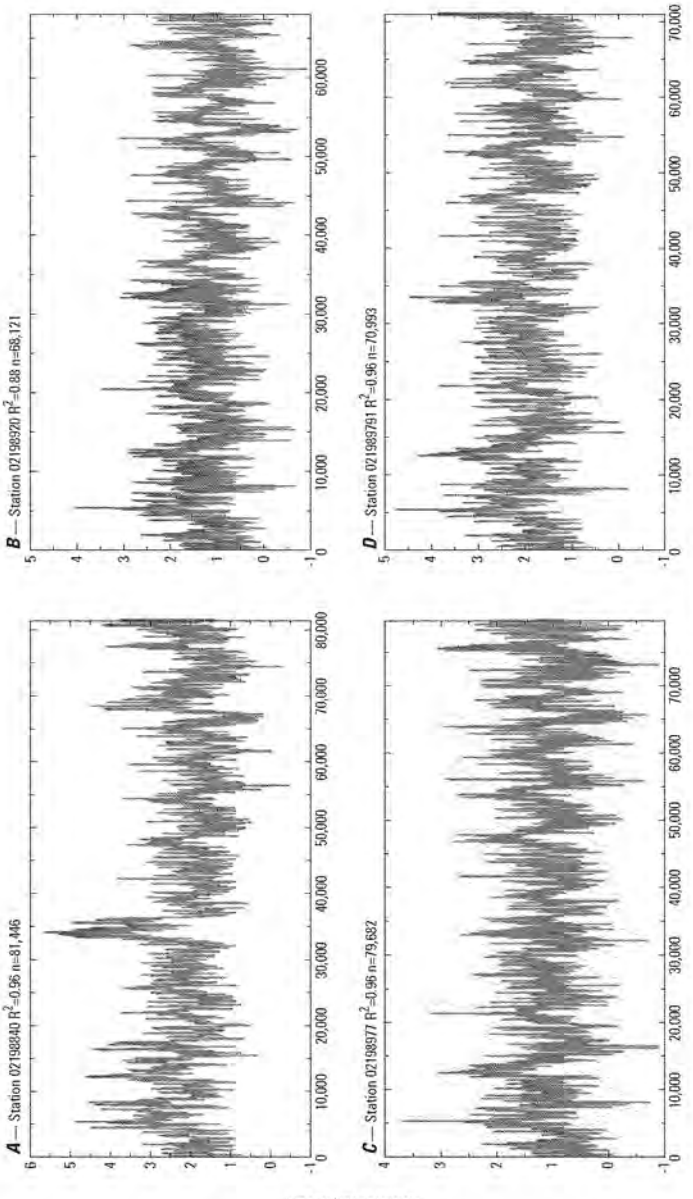


Figure 23. Measured (blue trace) and simulated (red trace) daily water levels for four USGS river gages for the period 1994 to 2004. Data to train the ANN models were bifurcated into training and testing sets. Graphs show data from the testing data set along with the coefficient of determination (R^2) and number (n) of data points.

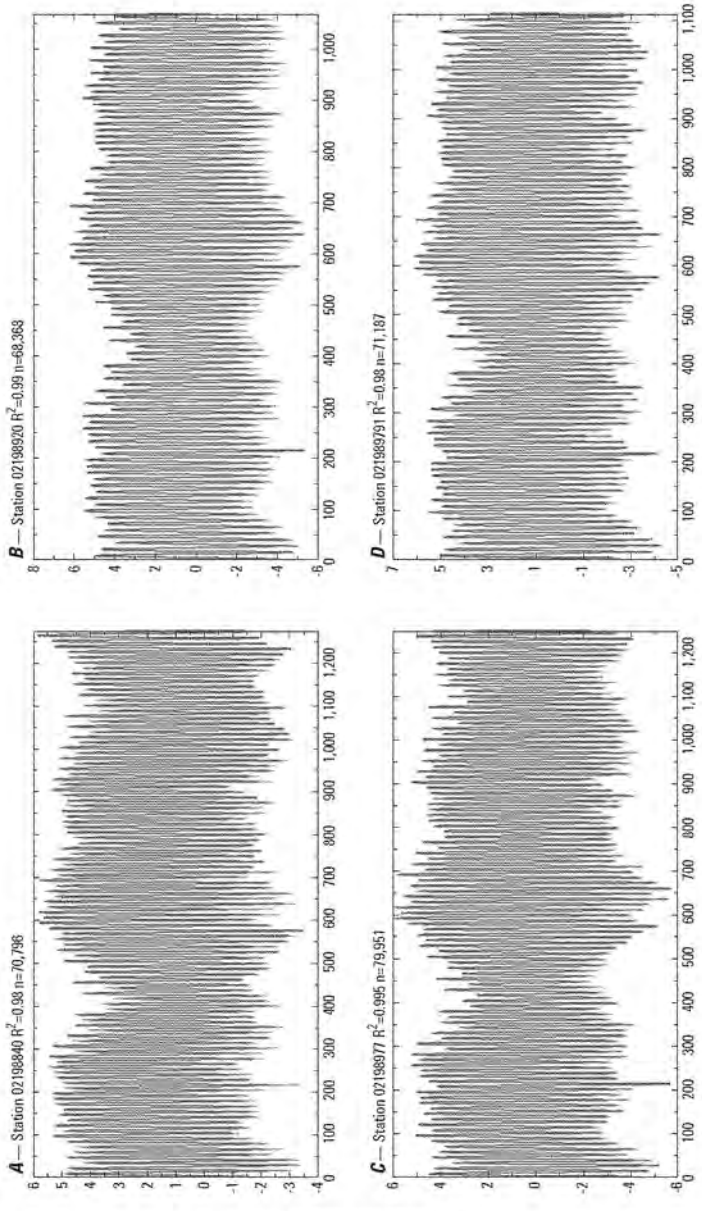


Figure 24. Measured (blue trace) and simulated (red trace) hourly water levels for four USGS river gages. Models were trained and tested on data from the period 1994 to 2004. Data to train the ANN models were bifurcated into training and testing sets. For clarity, only 1,100 observations (approximately 50 days) are shown from the testing data set along with the coefficient of determination (R^2) and number (n) of data points for the testing data set.

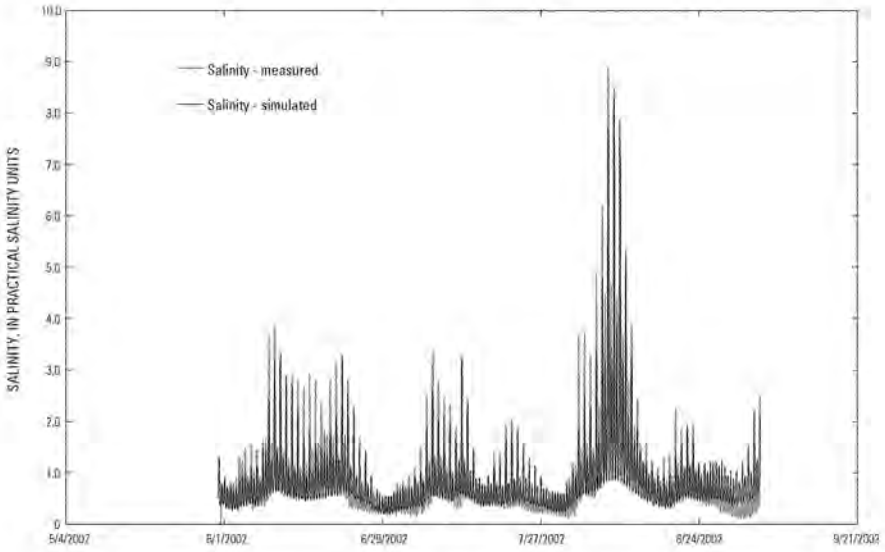


Figure 25. Measured and simulated hourly salinity at Little Back River at U.S. Fish and Wildlife Service Dock (station 02198979) for the period June 1 to August 31, 2002.

Marsh Water-Level Model at Little Back River at Site B2

The hourly water-level model (pb2mwl-2005) for Little Back River at Site B2 uses seven water-level inputs and differences in water levels from the four USGS riverine gages in the vicinity of SNWF. The water-level inputs include the water level at I-95 (station 02198840), 1-day change in water level, 1-day change in water level lagged 3 days, and 1-day change in water level lagged 6 days (variables FWL8840, DFWL8840, LG3DFWL8840, and LG6DFWL8840, respectively). Differences in water level at Site B2 and the USGS riverine gages are also used for inputs. These inputs include the difference in water level with stations 02198977, 02198979, and 02198920 (variables FWLDIF8977, FWLDIF8979, and FWLDIF8920, respectively). For testing and training the daily model, there were 21,512 data values available (approximately 2.5 years of hourly data from 1999 to 2005). Fifteen percent of the data was used for training and 85 percent was used for testing. The R^2 for the training and testing were 0.80 and 0.77, respectively. The daily model used two hidden-layer neurons.

The measured and simulated hourly water levels are shown in figure 28 for the first quarter of 2002. The model simulates the measured data well but does not capture the full range of the tide and slightly under simulates the maximum and minimum water levels.

The measured and simulated hourly water levels for the seven USGS marsh stations are shown in figures 29 and 30. The quality of marsh water-level models, in terms of the coefficient of determination, varies from a R^2 of 0.72 to 0.87. Generally, the models for the stations closer to the harbor (Sites B3, B4, and F1) explain more of the water-level variability (R^2 vary from 0.84 to 0.87) than the models for the stations farther from the harbor (R^2 vary from 0.72 to 0.79).

Marsh Specific-Conductance Model at Site B2

A potential mitigation scenario to ameliorate an increase in salinity in the vicinity of the SNWR would be to divert additional streamflow to the Middle and Little Back Rivers. One concern with using only the long-term USGS riverine gages to simulate the pore-water salinity in the marsh is that there would not be any data on the Middle Back River that may be important for evaluating mitigation alternatives. Data in this area are available from the GPA river networks. Although the data from these stations are limited to conditions from either the summer of 1997 or 1999, data from GPA10, GPA11, GPA11R, and GPA12 were used as inputs to

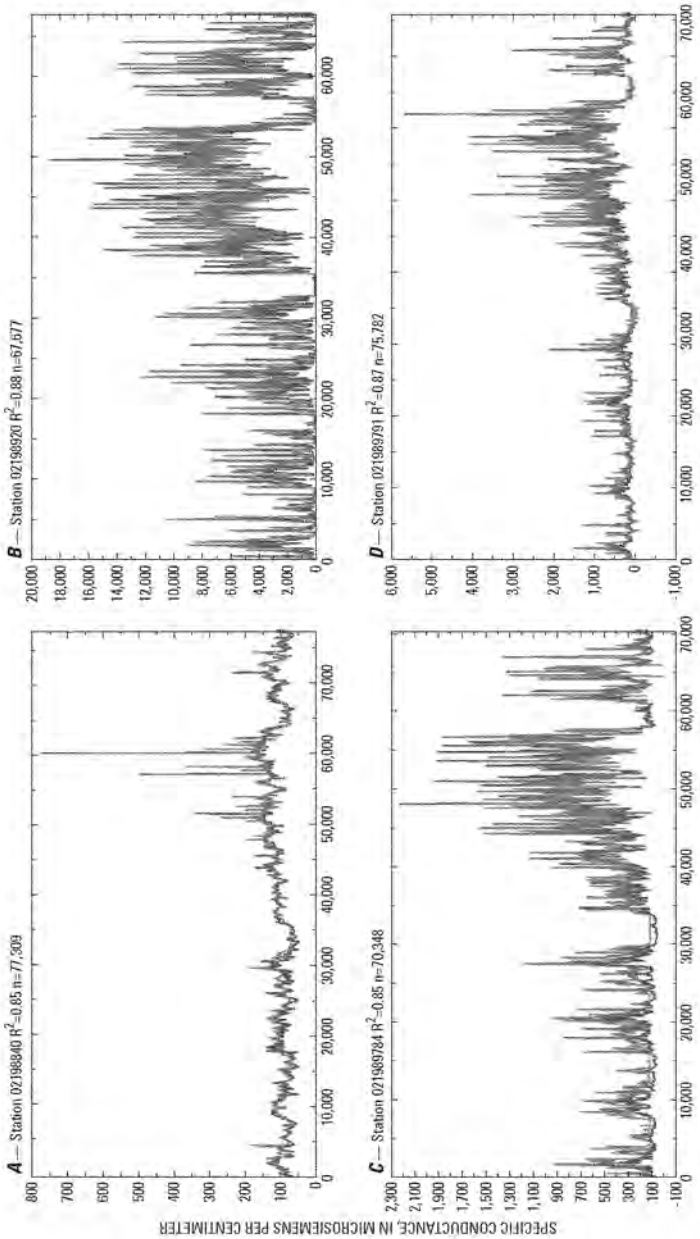


Figure 26. Measured and simulated daily specific conductance for four USGS river gages for the period 1994 to 2004. Data to train the ANN models were bifurcated into training and testing sets. Graphs show data from the testing data set along with the coefficient of determination (R^2) and number (n) of data points.

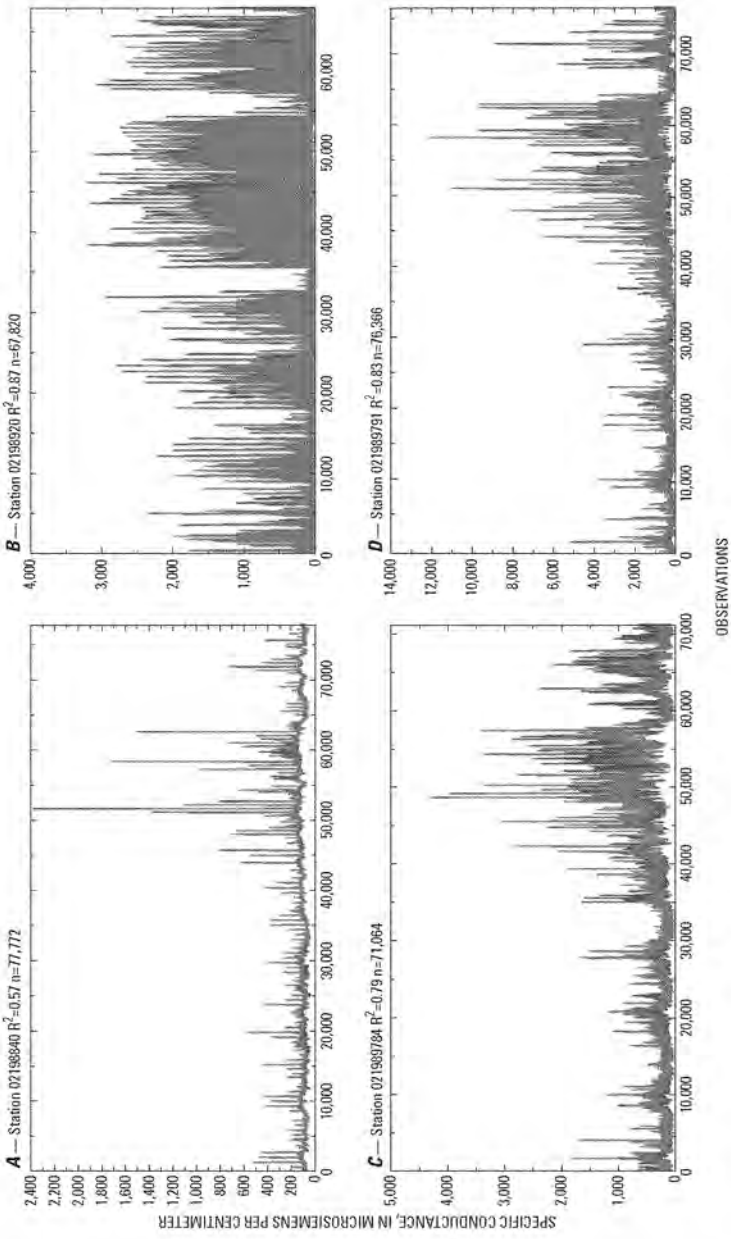


Figure 27. Measured (blue trace) and simulated (red trace) hourly specific conductance for four USGS river gages for the period 1994 to 2004. Data to train the ANN models were bifurcated into training and testing sets. Graphs show data from the testing data set along with the coefficient of determination (R^2) and number (n) of data points.

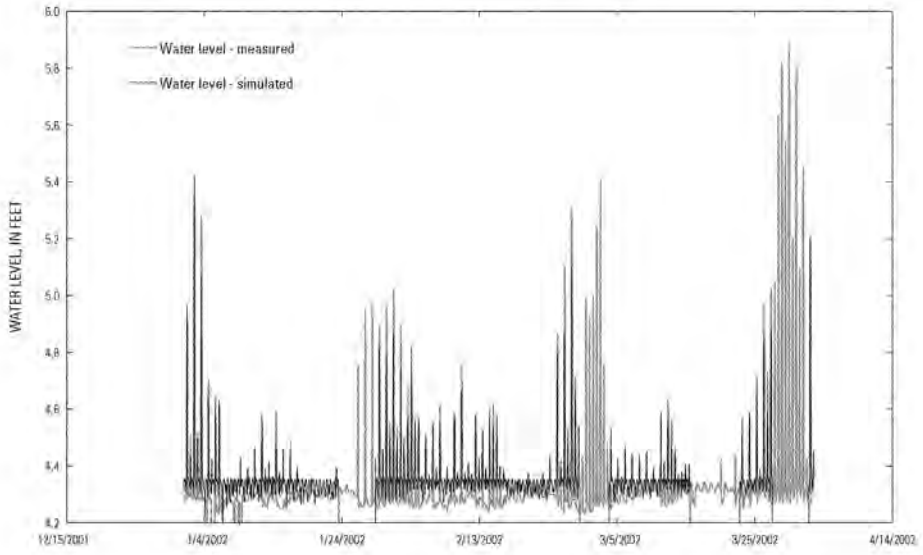


Figure 28. Measured and simulated hourly water levels at Site B2 on the Little Back River for the period January 1 to March 31, 2002. Breaks in the prediction time series are caused by incomplete time series for one or more of the model inputs.

the marsh salinity models to address spatial distribution of the river salinity inputs for the marsh salinity models.

There are two technical issues with using the short-term GPA data that need to be addressed. The first technical issue is that the GPA data are not concurrent with the USGS marsh data (summers of 1997 and 1999 compared to 2000–2005). The models for the four GPA stations were used to simulate the time series of specific conductance for the period 2000–2005. To generate the data for this period, the GPA models were used to make salinity predictions for a range of streamflow conditions much larger than measured during the summers of 1997 and 1999 (fig. 18A). The second issue is that the GPA data are highly correlated. To ensure that the data from the GPA site inputs unique information for the marsh predictions, the data for stations GPA11, GPA11R, and GPA12 were systematically decorrelated from GPA10.

The marsh pore-water salinities were modeled in two stages. The first stage used the USGS river data to simulate the marsh salinity. The second stage used the GPA river data to simulate the residual error (difference between the simulated and measured marsh salinity) from the first stage model. The final marsh salinity predictions are the sum of the predictions from the two models.

The first stage pore-water salinity model (pb2msc-2005-2) for Little Back River at Site B2 uses 10 specific-conductance inputs and differences in specific conductance from two USGS riverine gages in the vicinity of SNWF. Two inputs are the difference in specific conductance at the Little Back River at USFW Dock (021989791) and the Savannah River at I-95 (station 02198840) and Front River at Houlihan Bridge (station 02198920), variables SCDIF8840A and SCDIF8920A, respectively. There are four moving window average inputs of 48 hours, 1-, 2-, and 4-weeks (variables FSC89791A48, FSC89791D1WK, FSC89791D2WK, FSC89791D4WK) and four time derivative inputs (variables LG672FSC89791A4WKD4WK, FSC89791DA48, DFSC89791DA48, and LG3DFSC89791DA48). For testing and training the daily model, there were 20,912 data values available (approximately 5 years of hourly data from 1999 to 2005). Ten percent of the data was used for training, and 90 percent was used for testing. The R^2 for the training and testing were 0.83. The model used one hidden layer neuron.

The second stage model (prb2msc) simulates the residual error from the first stage marsh pore-water salinity model. Four inputs used to simulate the residual error included weekly averages of the decorrelated specific-conductance variable from each GPA site and a 1-week moving window average of specific conductance at GPA10 (variables RSC10S_11B_A1WK, RSC10S_11BR_A1WK, RSC10S_12RS_A1WK, and PSCGPA10S_FLR_A1WK, respectively). A summary of the

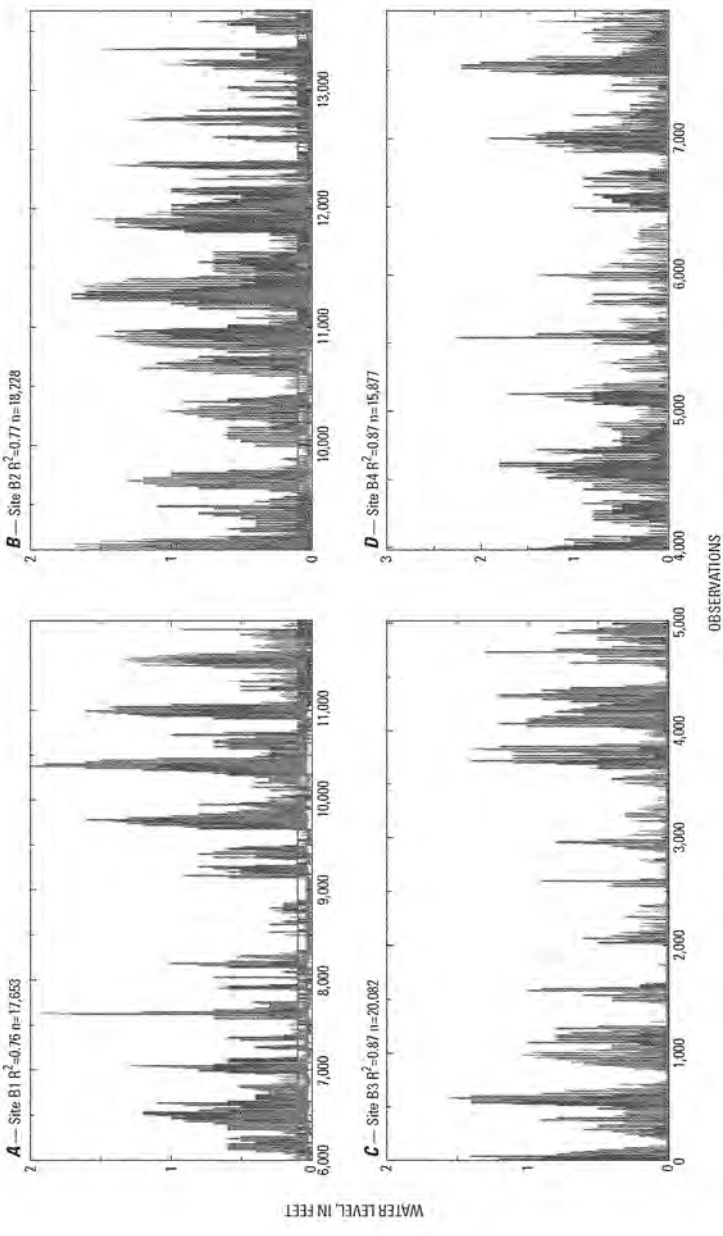


Figure 29. Measured (blue trace) and simulated (red trace) hourly water levels for four USGS marsh gages along the Little Back and Back Rivers for the period June 2000 to May 2005. Data to train the ANN models were bifurcated into training and testing sets. For clarity, only 4,500 to 5,000 observations (approximately 180 days) are shown from the testing data set along with the coefficient of determination (R^2) and number (n) of data points for the testing data set.

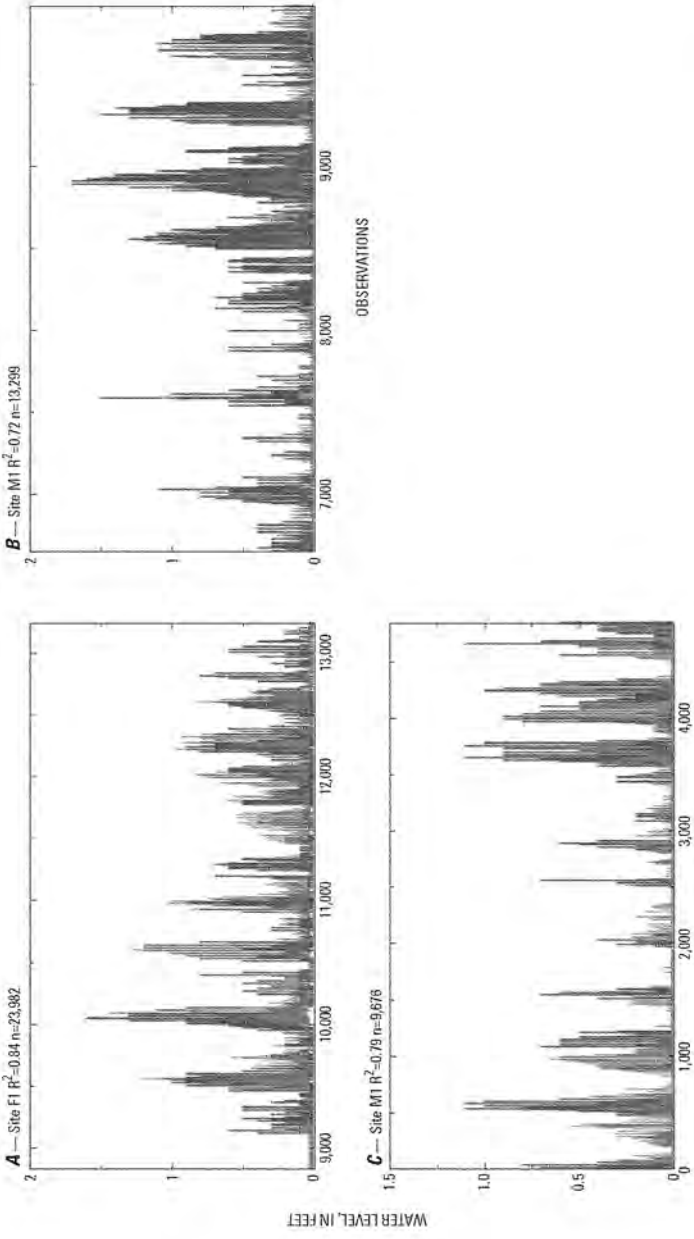


Figure 30. Measured (blue trace) and simulated (red trace) hourly water levels for the three USGS gages along the Middle Back and Front Rivers for the period June 2000 to May 2005. Data to train the ANN models were bifurcated into training and testing sets. For clarity, only 4,500 to 5,000 observations (approximately 180 days) are shown from the testing data set along with the coefficient of determination (R^2) and number (n) of data points for the testing data set.

input variables, size of the training and testing data sets, number of hidden-layer neurons, and coefficient of determination for the daily model can be found in table 3 and Appendix I.

The measured and simulated hourly pore-water salinities are shown in figure 31 for summer 2002. This period was the end of the 5-year drought that began in 1998 and had the highest salinity intrusions of the drought. The model simulates the salinity intrusions occurring on a 14- and 28-day cycle and generally under simulates the salinity concentrations.

The measured and simulated hourly salinity for the seven USGS marsh stations are shown in figures 32 and 33. The quality of marsh water-level models, in term of the coefficient of determination, varies from a R^2 of 0.74 to 0.93. Generally, the models follow the trend of the measured data, as reflected in the high R^2, but miss the variability over short time periods.

Analysis of Estuary Dynamics Using Three-Dimensional Response Surfaces

The river and marsh ANN models can be used to examine the effect of water level and tidal range in the harbor, Savannah River streamflow at Clyo on water levels, and specific conductance in the primary and secondary river channels and the marshes. Three-dimensional response surfaces can be generated to display two explanatory variables (water level, tidal range, or streamflow) with a response variable (specific-conductance or water level). The data for the surface are computed by the ANN model across the full range of the displayed input variables, while the "unshown" inputs (all the models have more than two inputs) are set to a constant value, such as a historical mid-range or mean value. Response surfaces are a valuable tool for understanding the dynamics of an estuary and for comparing how variable interactions differ throughout the system.

The conceptual model of salinity intrusion occurring during de-stratified conditions during neap tides (fig. 13) can be seen in the plot of the time series at GPA04 for summer 1999 (fig. 14). Salinity intrusion dynamics can also be seen in the response surfaces showing the interaction of daily streamflow, water level, and specific conductance for neap and spring tidal conditions (fig. 34). For example, the salinity intrusion on the Front River at Houlihan Bridge site (station 02198920) is shown in figure 34. The response surfaces show increasing streamflow along the x-axis (horizontal, out of the page), increasing water level along the y-axis (horizontal, into

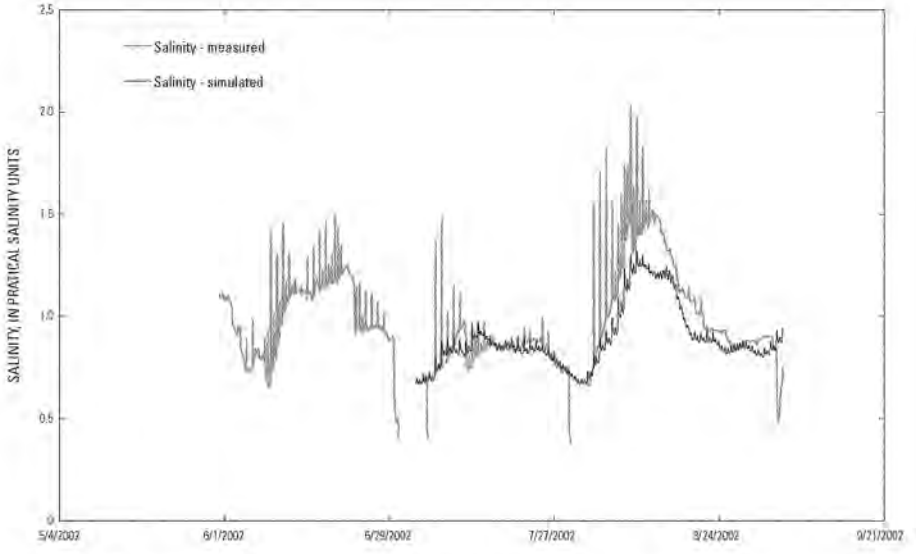


Figure 31. Measured and simulated hourly salinities at Little Back River at Site B2 for the period June 1 to August 31, 2002. Breaks in the prediction time series are caused by incomplete time series for one or more of the model inputs.

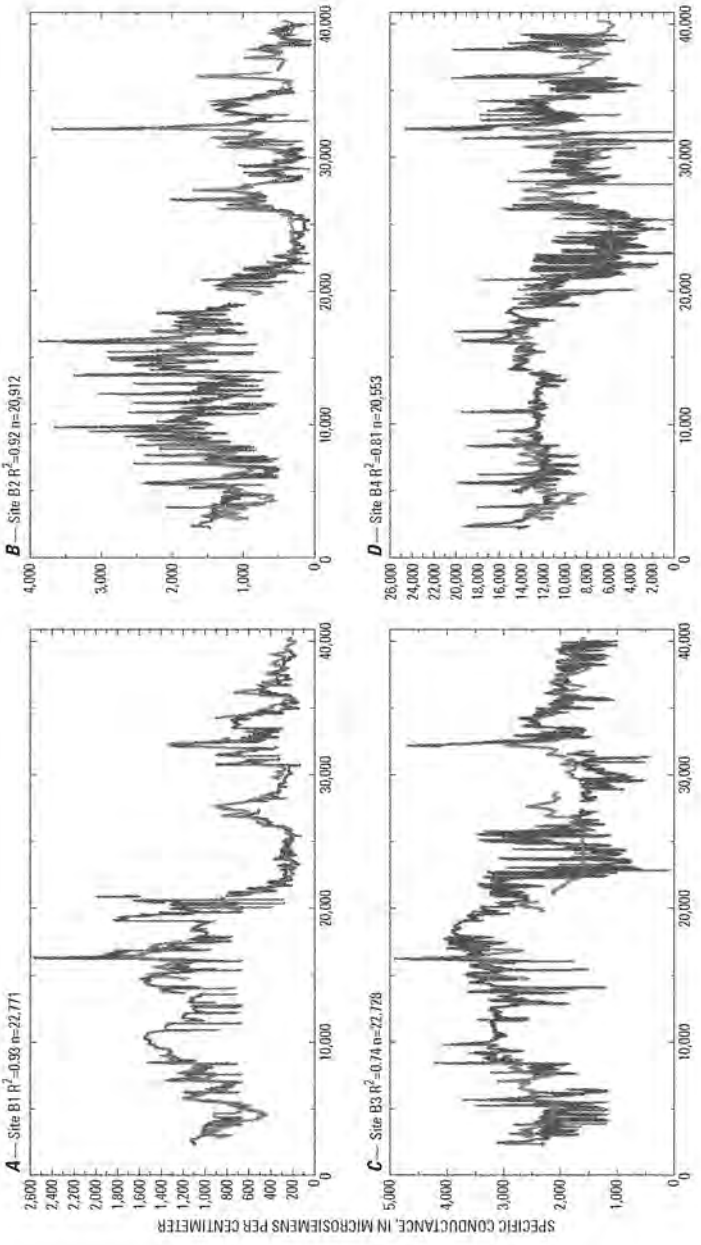


Figure 32. Measured (blue trace) and simulated (red trace) hourly specific conductance for four USGS gages along the Little Back and Back Rivers for the period June 2000 to May 2005. Data to train the ANN models were bifurcated into training and testing sets. Graphs show the complete data set along with the coefficient of determination (R^2) and number (n) of data points. Breaks in the simulated values are caused by one or more missing input values.

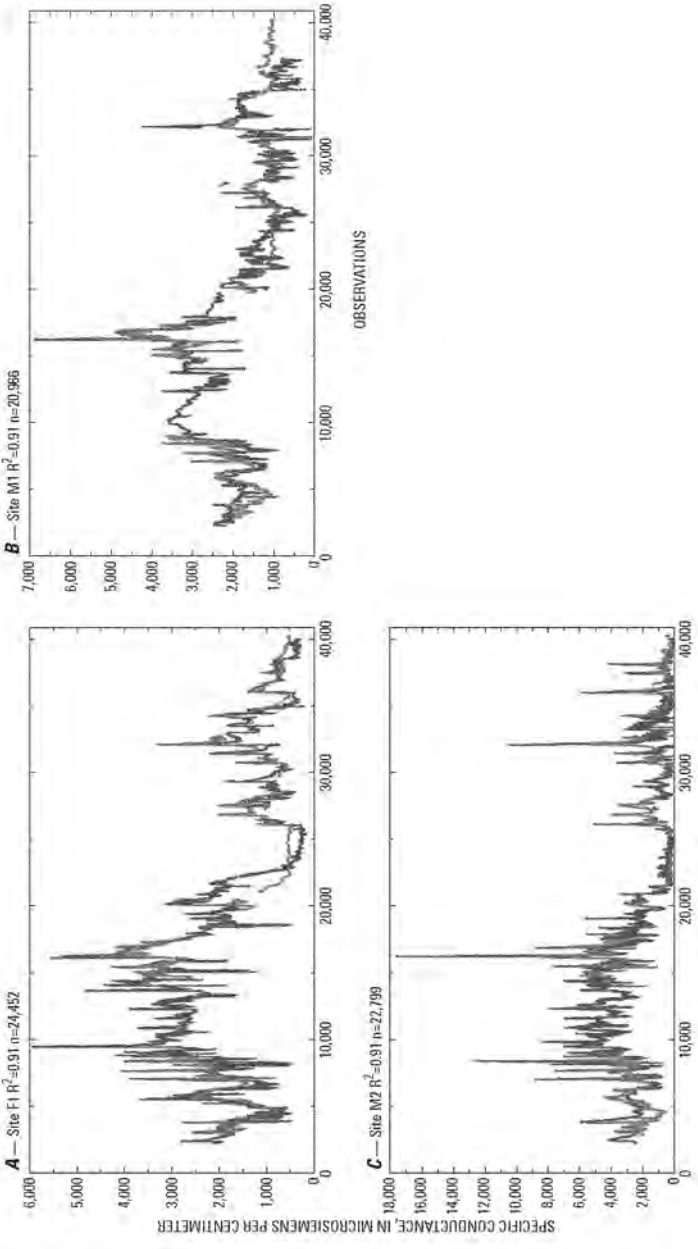


Figure 33. Measured (blue trace) and simulated (red trace) hourly specific conductance for four USGS gages along the Front and Middle Back Rivers for the period June 2000 to May 2005. Data to train the ANN models were bifurcated into training and testing sets. Graphs show data from the testing data set along with the coefficient of determination (R^2) and number (n) of data points. Breaks in the simulated values are caused by one or more missing input values.

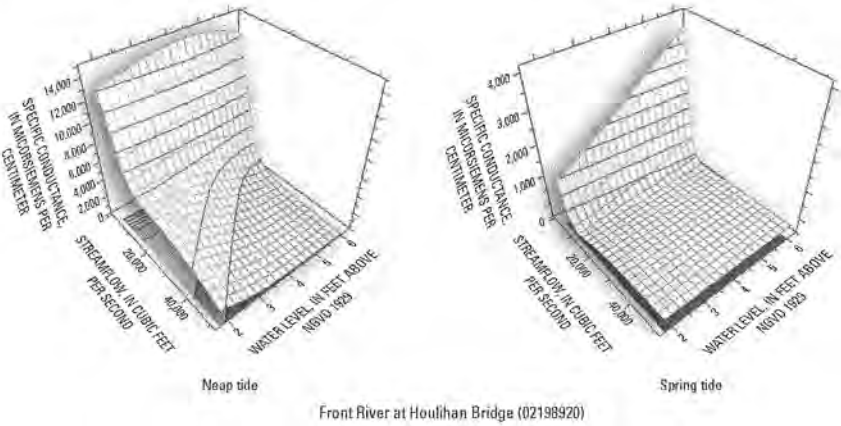


Figure 34. The interaction of water level (FWL8980A) and streamflow (Q8500A) on specific conductance for Front River at Houlihan Bridge (station 02198920) for neap and spring tide conditions. The response surface on the left shows specific conductance response at the gage under neap tide conditions (all other input values set to the mean historical condition for both response surfaces). The response surface on the right shows the gage response under spring tide conditions. Note differences in the z-axis (vertical) scale. During neap tides, salinity intrusion at Front Street is greatest during low-flow conditions through the full range of Harbor water-level conditions. During spring tides, salinity intrusion is greatest during low-flow conditions and increasing water-level conditions in the Harbor.

the page), and increasing specific-conductance (salinity) along the z-axis (vertical) for neap and spring tides (left and right response surfaces, respectively). All other variables were set to their historical means. In figure 34, the neap tide surface on the left shows that salinity intrusion occurs during low-flow conditions for the entire range of water levels in the harbor. Note the change across the response surface when flows are below 10,000 ft^3/s. The spring tide surface on the right in figure 34 shows that salinity intrusion during spring tides occurs only during low flow and increasing harbor water-level conditions. Note the slope of the edge of the response surface at low flows as water levels increase and specific conductance increases from 1,000 to 4,000 µS/cm.

The response surfaces at the I-95 Bridge (station 02198840) show different salinity intrusion dynamics (fig. 35), with the greatest salinity intrusions occurring on spring tides. The response surface at left shows that during neap tides, increases in salinity occur during low-flow conditions and all water-level conditions in the harbor. The response surface at right shows that during spring tides, similar specific-conductance levels occur during low-flow conditions and for most water levels. During very high harbor water-level conditions, salinity intrusion can be more than twice as high as during neap tides. The increased salinity intrusion is possibly due to decreased stratification and fully mixed conditions during neap and spring tides in the upper reaches of the river, which would limit intrusion to periods with increased volumes of saltwater (high water-level conditions), high mixing energy (spring tides), and limited upstream flow resistance to intruding saltwater (low-flow conditions). It should be remembered that the response surfaces show daily values. Maximum hourly specific-conductance intrusions during the drought ranged from 100 to 8,000 µS/cm.

The increased daily specific-conductance, or salinity, values during spring tides at I-95 (station 02198840) can also be seen by plotting streamflows, tidal ranges, and specific conductance with the other inputs set to their historical means. Figure 36 shows that during low flow and historical mean harbor water levels, daily specific conductance can increase as much as 100 µS/cm from neap to spring tides.

Figure 37 shows specific-conductance response surfaces for two sites on the Little Back River. The response surface at left for Little Back River at the USFW Dock (Station 021989791) shows that at mean harbor water levels, salinity intrusion is greatest during low flows and spring tides. Downstream at Little Back River near the Lucknow Canal (Station 021989784), higher specific conductance under similar water-level conditions occurs during low flows and neap tides. Although neither response surfaces show dramatic changes in specific-conductance response under different tidal

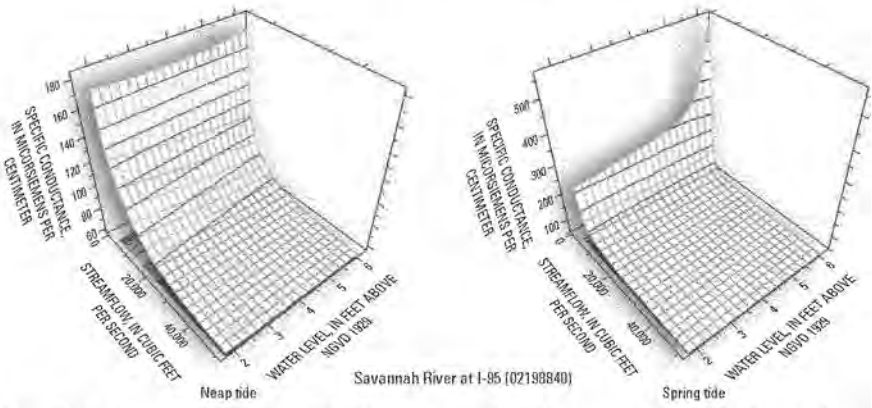


Figure 35. The interaction of water level (FWL8980A) and streamflow (Q8500A) on specific conductance at Savannah River at I-95 (station 02198840) for neap and spring tide conditions. The response surface on the left shows specific conductance response at the gage under neap tide conditions (all other input values set to the mean historical condition for both response surfaces). The response surface on the right shows the specific conductance response under spring tide conditions. Note differences in the z-axis (vertical) scale. During neap tides, salinity intrusion at I-95 is greatest during low-flow conditions through the full range of water-level conditions. During spring tides, salinity intrusion can be over twice as high as neap tide during low-flow and high water-level conditions.

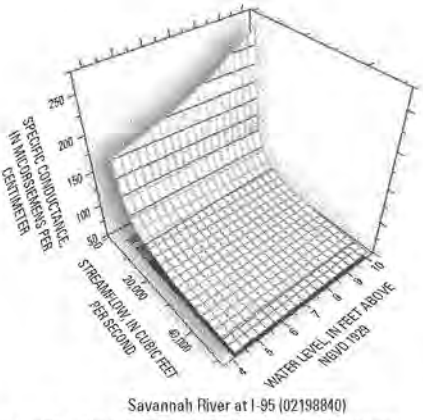


Figure 36. The interaction of tidal range (XWL8980A) and streamflow (Q8500A) on specific conductance at Savannah River at I-95 (station 02198840). The response surface shows the specific conductance response at the gage under mean water-level conditions (all other input values set to the mean historical condition for both surfaces). During mean water-level conditions, specific conductance intrusion at I-95 is greatest during low-flow and spring-tide conditions.

range conditions, they do indicate a gradual change in salinity intrusion behavior from the I-95 Bridge to the station near Lucknow Canal.

Response surfaces can also be used to analyze the influence of Savannah River streamflow and harbor water levels on the local water level in the vicinity of the SNWR. As noted above, streamflow at Clyo, Ga., (station 02198500) and harbor water levels (station 02198980) are virtually uncorrelated (R=-0.03). The effect of streamflow and water level on local water levels depends on their proximity to the harbor. Water levels in the upper reaches exhibit more riverine influence than the downstream stations. The riverine influence diminishes farther downstream, and the influence of the tide is more prominent. Figures 38 and 39 show response surfaces for four water-level gages. The upstream station, Savannah River at I-95 (fig. 38, left response surface), shows a significant contribution of streamflow to the local water level. The downstream station, the Front River at Broad Street (fig. 39, right response surface), shows that streamflow has a negligible influence on its water level. The other two stations, Front River at the Houlihan Bridge (station 02198920, fig. 38, right response surface) and Little Back River at Limehouse (station 02198979, fig. 39, left response surface), show large contributions of harbor water level and small contributions of streamflow to the local water levels.

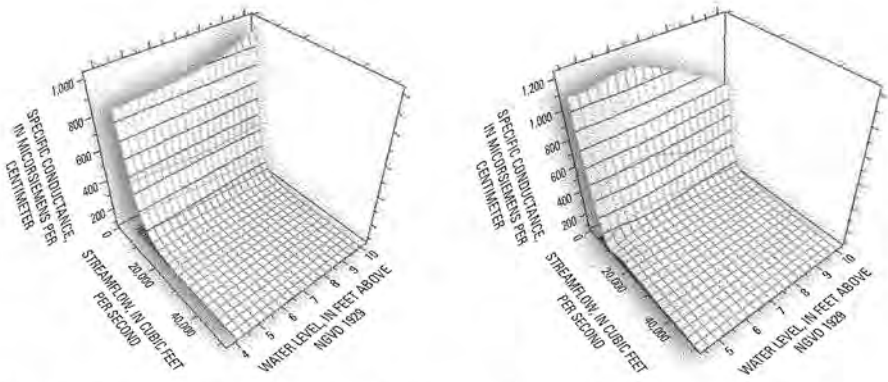


Figure 37. The interaction of tidal range (XWL8980A) and streamflow (Q8500A) on specific conductance at Little Back River at U.S. Fish and Wildlife Service Dock (station 021989791, left response surface) and for Little Back River at Lucknow Canal (station 021989784, right response surface). The response surface on the left shows higher salinity intrusion at the upstream station occurs during spring tides. The response surface on the right shows that high salinity intrusions occur during neap tides.

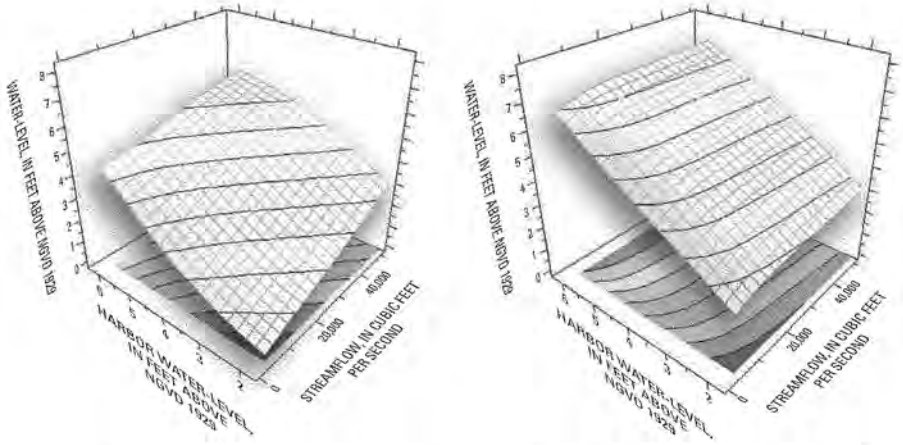


Figure 38. The interaction of harbor water level (FWL8980A) and streamflow (Q8500A) on local water levels at Savannah River at I-95 (station 02198840, left response surface) and for Front River at Houlihan Bridge (station 02198920, right response surface). The response surface of water levels on the left shows higher contribution of streamflow than the downstream station on the right.

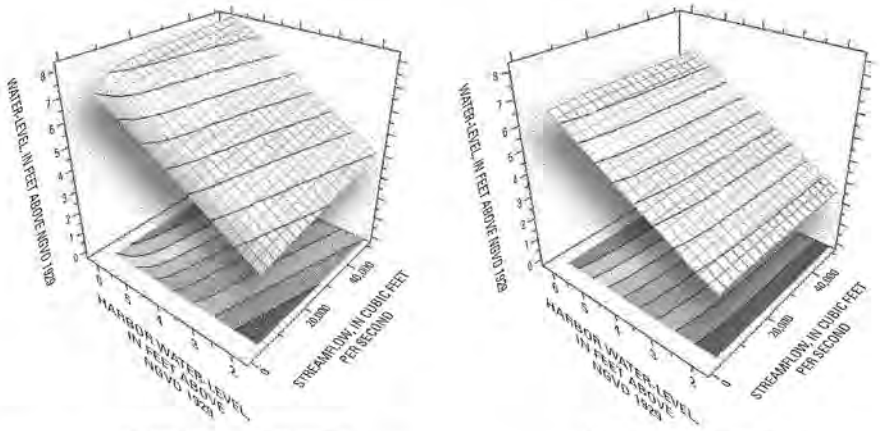


Figure 39. The interaction of harbor water level (FWL8980A) and streamflow (Q8500A) on local water levels at Little Back River at Limehouse (station 02198979, left response surface) and at Front River at Broad Street (station 02198977, right response surface). Both response surfaces show larger contributions of harbor water levels than streamflow on local water-level conditions. The response surface on the right shows negligible influence of streamflow on local water levels.

Development of a Model-to-Marsh Decision Support System

Dutta and others (1997) define DSSs as, "systems helping decision-makers to solve various semistructured and unstructured problems involving multiple attributes, objectives, and goals .... Historically, the majority of DSSs have been either computer implementations of mathematical models or extensions of database systems and traditional management information systems." Environmental resource managers commonly use complex mathematical (mechanistic) models based on first principles physical equations to evaluate options for using the resource without damage. While there appears to be no strict criteria that distinguish a DSS from other types of programs, Dutta and others (1997) suggest that artificial intelligence (AI) is a characteristic of more advanced DSSs, "With the help of AI techniques DSSs have incorporated the heuristic models of decision-makers and provided increasingly richer support for decision-making. AI systems have also benefited from DSS research as they have scaled down their goal from replacing to supporting decision makers."

The authors have previously developed a DSS to support the permitting of three water-reclamation facilities that discharge into South Carolina's Beaufort River estuary (Conrads and others, 2002b; Conrads and others, 2003; Conrads and Roehl, 2005). The Beaufort DSS incorporated a water-quality model comprising several dozen ANN "submodels" that simulated both point and nonpoint source effects on water quality throughout the system. ANN execution speeds were also found to be much faster than mechanistic models, greatly reducing the turn-around time for users performing waste load allocation scenarios. The Beaufort DSS was a spreadsheet application that connected the ANN super-model to a database storing time series of the area's rainfall and riverine water level, specific conductance, water temperature, and dissolved oxygen from seven different USGS gaging stations. The DSS could run 3-year simulations under different point and nonpoint loading scenarios while providing users with streaming tabular output and graphics to provide situational awareness. Its graphical user interface (GUI) requires no typing. These features make the DSS easily distributed and immediately usable by all stakeholders. The development, performance, and features of the Savannah DSS are described below.

The development of a DSS for the Savannah River Estuary and surrounding wetlands, called the Model-to-Marsh DSS (M2M), required a number of steps (described previously), including (1) merging all the data into a single comprehensive database, (2) developing water-level and salinity ANN submodels, and (3) developing of a spreadsheet application that integrates the new database, output from an existing 3D hydrodynamic model, and ANN submodels into a single package that is easy to use and readily disseminated.

Architecture

Figure 40 shows the basic architectural elements of the DSS. The DSS reads and writes files for the various run-time options that can be selected by the user through the system's GUI. A historical database contains 11 years of hydrodynamic data that are read into the simulator along with the ANN submodels at the start of a simulation. Using GUI controls, the user can evaluate alternative flow scenarios, or load specially formatted output files from the 3D hydrodynamic model that adjust historical riverine water level and specific conductance to evaluate alternative channel geometries and "replumbing" scenarios. The outputs generated by the simulator are written to files for post processing a spreadsheet application used by the DSS's "2D Color-Gradient Visualization Program". The DSS also provides streaming graphics during simulations, visually representing historical and simulated behaviors side-by-side. These features are described in more detail below.

Historical Database

The measured data required extensive clean up for a variety of problems, including erroneous and missing values and phase shifts. The locations of the gaging stations are shown in figures 1 and 5. The resulting database comprises 11 years of half-hourly data (≈160,000 time stamps) for 110 variables. A summary of the historical databases stored in the DSS is described below.

- Clyo streamflow (Q_{clyo}) and harbor water levels—11 years of half-hourly water-level measurements in Savannah Harbor at Fort Pulaski, Ga., and river flows measured inland at Clyo, Ga., by the USGS.
- USGS riverine water level and specific conductance—11 years of half-hourly measurements collected from four stations in the Savannah River Estuary by the USGS.
- GPA riverine water level and specific conductance—half-hourly measurements collected on behalf of the GPA from 14 stations over 3 months each in 1997 and 1999. Some stations recorded both surface and bottom specific-conductance measurements.
- USGS marsh water level and specific conductance—71 months (June 1999 to May 2005) of half-hourly measurements from seven stations.
- GPA marsh water level and specific conductance—40 months (June 1999 to October 2002) of half-hourly specific conductance and water-level measurements from 10 stations.

Linkage to the Three-Dimensional Hydrodynamic Model

The ANN super-model comprises 127 submodels that are configured as follows. Simulation models of water level and specific conductance at four USGS stations in the main channel of the river were developed using Savannah River streamflow data and Savannah Harbor water-level data for inputs, incorporating multiple time delays, moving window averages, and time derivatives to capture the system's dynamic behavior. The simulations were then used as inputs to model the much shorter time series of water level and specific conductance at the many remaining riverine and marsh stations. This provided one set of ANN models that link the river's main channel behavior to tidal forcing and fresh water flowing down the river, and a second set that links main channel behaviors to backwater riverine and marsh behaviors.

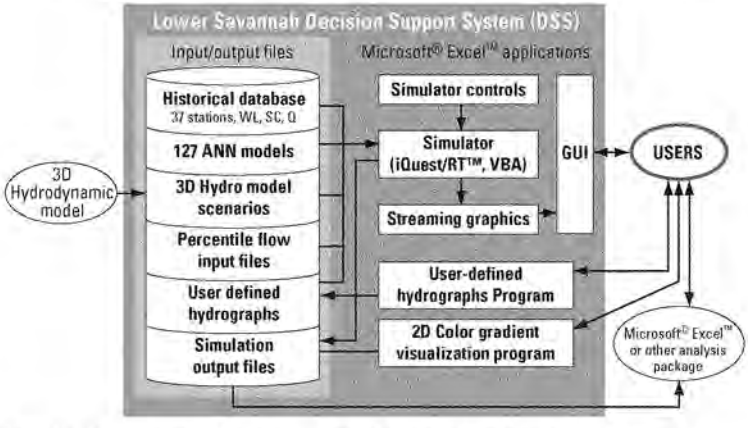


Figure 40. Architecture of the lower Savannah River Estuary Decision Support System (DSS).

Linking the 3D hydrodynamic model to the simulator is accomplished by reading in a file of simulated differences in water-level and specific-conductance values for the river, which reflect hypothetical channel geometry and replumbing scenarios run in the hydrodynamic model, to drive the riverine and marsh ANN models.

Much of the continuous data was collected during a record-setting 5-year drought, raising concerns that the relatively short time series from the riverine and marsh stations was not representative of "typical" hydrodynamic conditions. River flows had been at record lows, leading to unprecedented salinity intrusion, even without a deepened harbor (fig. 12). This concern was mitigated by the fact that the main channel ANNs were able to "learn" the full range of behaviors exhibited over 11 years, starting long before the onset of the drought. Therefore, ANNs could both "hindcast" the riverine and marsh behaviors to nondrought conditions, and be retrained on post-drought conditions as new data become available.

Model Simulation Control, User-Defined Hydrographs Program, Streaming Graphics, and Two-Dimensional Color-Gradient Visualization Program

The Simulator in the M2M DSS integrates the historical database with the 127 ANN models. The Date/Time Controls on the User Controls panel (fig. 41) are used to adjust start and end dates and time-step size for a simulation. The Simulator allows the user to run "What-if?" simulations by varying the streamflow from its historical values. The user has five Simulation Input Variable Options:

- Percent of historical Clyo streamflows,
- User-set Clyo streamflow to constant value,
- Percentile hydrograph of daily Clyo streamflow,
- User-defined daily hydrograph for Clyo streamflow, and
- 3D-model inputs at the USGS river stations and selected GPA river stations.

Explanations of how to use each of the options in the M2M can be found in the User's Manual in Appendix IV.

Streaming graphics display output while a simulation is running for any four simulated variables selected by the user (fig. 42). Each graph displays the historical time series, the simulated output using the measured streamflow (to show model accuracy), and the simulated output using streamflow set by the user using the GUI controls or an input file.

To spatially visualize the marsh salinity response, the DSS is distributed with the "2D Color-Gradient Visualization Program" (fig. 43) that interpolates and extrapolates simulator output to fill and color a grid of the study area. The program provides a qualitative view of the large-scale, longitudinal gradients of the marsh parallel to the river, rather than a quantitative view of small-scale lateral gradients in the marsh perpendicular to the river. For the application, the seven USGS marsh gages were used because of the large range of measured hydrologic conditions, especially nondrought conditions, compared with the GPA marsh sites.

Although the marsh data time series provides a temporally detailed description of changing salinity conditions, the seven sites provide only information on large-scale, longitudinal gradients in the system rather than small-scale, lateral variations in the marsh. Ecological interest in marsh salinity response typically is on seasonal and annual time scales rather than the smaller time scales of riverine responses of hours and days. For the color-gradient visualization program, users can select moving window averages of 1–12 months from the M2M simulator results.

Spatial visualization is based on a 100 meter (m) (107.6 square feet) grid of the study area. The 29,000-cell grid covers the tidal marshes from I-95 to the Highway 17 bridges on the Back and Front Rivers (fig. 2). Interpolation is performed using a simple ratio of linear distances between nearest USGS marsh gages and distance from a cell to the nearest stations. To enlarge the areal extent of measured marsh data (see

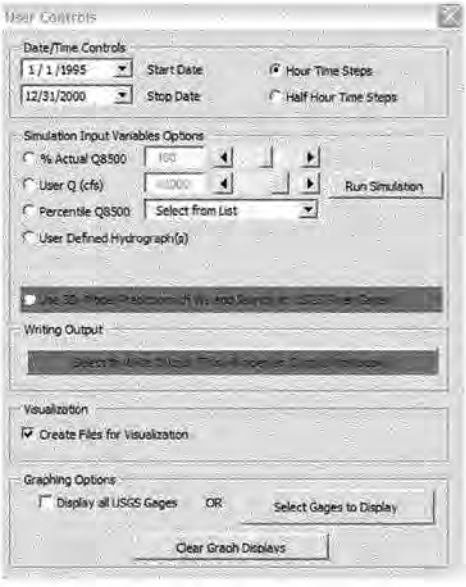


Figure 41. Simulator controls used to set parameters and run a simulation.

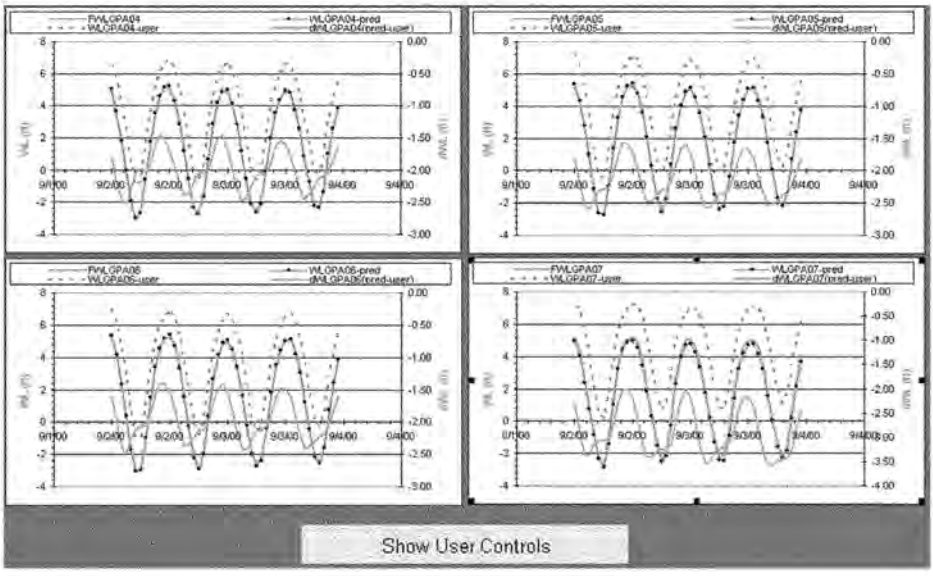


Figure 42. Streaming graphics displayed during simulation.

USGS marsh network, fig. 5*C*), riverine gages on the Savannah River at I-95 (Station 02198840, fig. 5*A*) and Back River upstream from the Tide Gate (GPA05, fig. 5*B*) were added to interpolate and extrapolate cells above Sites M1 and M2 and below Site B4.

The program allows the user to configure the color scale and export all salinity values and grid parameters, i.e., cell size, and corner coordinates, as an ASCII file for input into a mapping package such as ArcView™. In addition to the 100-m grid, a 10-m (107.6 square feet) grid (2,900,000 cells) was developed to minimize numerical computation errors when overlaying the grid data and irregular polygons in GIS applications.

Application of the Model-to-Marsh Decision Support System

The development of the ANN models and the DSS application for the Savannah River Estuary had two objectives. The first was to provide the ecologists responsible for developing marsh succession models of the tidal marshes with a predictive tool that could simulate riverine water-level and salinity responses to changes in hydrologic conditions, and to simulate marsh water-level and pore-water salinity responses to changing river conditions. The models allow ecologists to evaluate the system under different hydrologic conditions to better understand the relation between riverine and marsh water-level and salinity dynamics. The second objective was to integrate predictions from the 3D EFDC model with the predictive marsh succession models. Ultimately, the M2M is a tool to assist in understanding the complex Savannah River Estuary system, and to evaluate alternative scenarios for the potential harbor deepening. The following sections describe the application of the M2M to various hydrologic scenarios.

User-Defined Hydrology

As discussed previously, salinity dynamics result from three large-scale forcing factors: (1) harbor tidal range; (2) water levels at Fort Pulaski; and (3) Savannah streamflows. Tidal range and water-level variability depend on orbital mechanics and meteorological conditions, and are not regulated. The streamflow depends on meteorological conditions, the hydrologic cycle, and a combination of regulated streamflow upstream from Augusta and unregulated streamflow downstream from Augusta. The M2M allows the user to set the input streamflow conditions to evaluate river and marsh dynamics, and alternative regulated streamflow conditions.

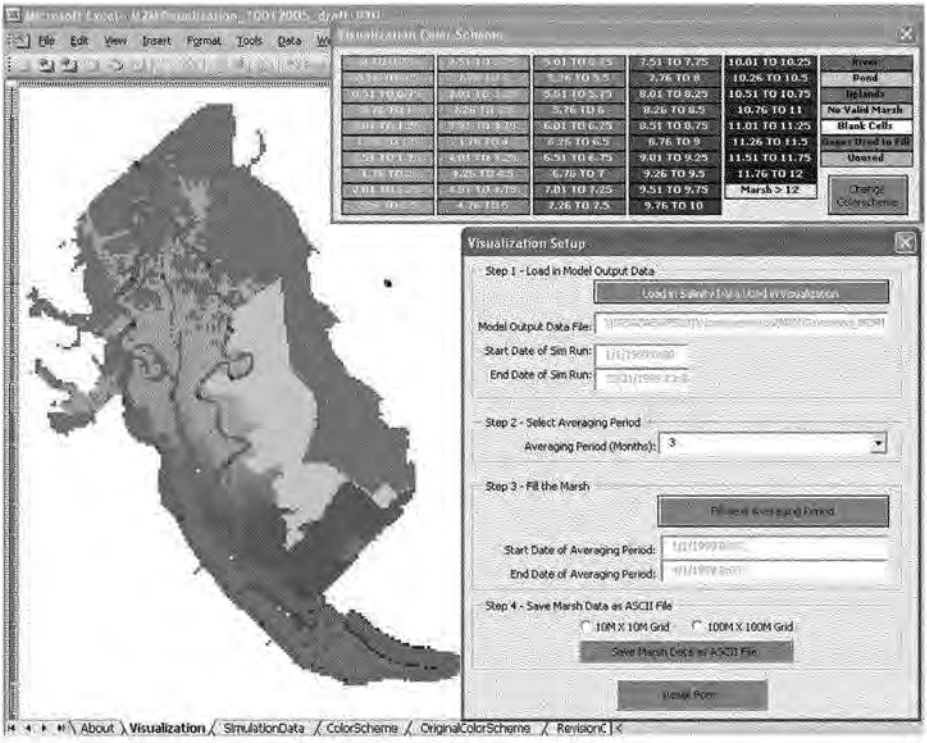


Figure 43. Screen capture of the Two-Dimensional Color-Gradient Visualization Program. Left image shows spatial distribution of marsh salinity based on data from the seven USGS marsh stations. Panel in the upper right of the screen shows the user-specified color scheme. Panel in the lower right shows the user's controls of the visualization program.

Percentile and Constant Streamflow

It is instructive to analyze riverine and estuarine systems under extreme conditions. Often the critical dynamics of a system manifest themselves during these periods rather than during average hydrologic conditions. The 5-year drought (1998–2002) in South Carolina and Georgia provides an opportunity to analyze salinity dynamics and hydrologic conditions during the worst extended drought on record. To evaluate the state of the hydrology of the Savannah River for a particular year, an actual daily streamflow hydrograph can be compared to a percentile flow hydrograph. During the last year of the drought, 2002, the daily streamflow recorded at Clyo, Ga., was at or below the 5th percentile flow for the entire historical record. Figure 44 shows the actual daily 2002 streamflow at Clyo, Ga., with selected percentile flow hydrographs. During the first 5 months of the year, the streamflow was establishing new record lows. During the summer, flows generally were between the 5th percentile and the historical minimum flows. It was not until early fall that streamflows increased consistently above the 5th percentile. During the summer, large salinity intrusions were recorded throughout the USGS river and marsh gaging networks.

To evaluate the effect of low-flow conditions on the salinity response in the system, the M2M was set up to simulate a constant streamflow of 6,000 ft^3/s during 2002. The salinity response to the constant flows on the Little Back River at the USFW Dock (station 021989791) is shown in figure 45 along with the measured and constant streamflows, and harbor tidal range. Constant flow does not manifest the high streamflow

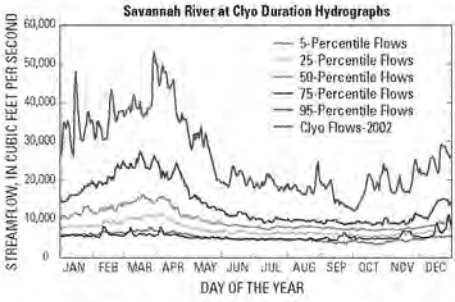


Figure 44. Duration hydrographs for Savannah River near Clyo, Ga., and daily hydrograph for the calendar year 2002 streamflows. Percentile flows are based on streamflow data from 1929 to 2003.

pulses, which exceeded 8,000 ft³/s, in February through April and December. During the summer low-flow period, the constant 6,000 ft³/s flow was substantially greater than the measured 2002 conditions.

The constant streamflow did not significantly affect the salinity intrusions during the first 4 months (January to April) of 2002 when the average measured streamflow was approximately 6,000 ft³/s. During this period, the greatest intrusions occur on 14- and 28-day cycles that are co-incident with the spring tides. The three higher-flow pulses during this period did not occur during the spring tides. During the low-flow period after May, the constant flow is above the actual flow and did substantially affect salinity levels. For the actual flow conditions, the salinity intrusions (blue line) were approximately 3.0 psu, with the greatest intrusion of 8.0 psu occurring in early August. The salinity response to the constant 6,000 ft³/s (red line) shows that the difference in the flows decreases the early salinity intrusions to approximately 1.5 to 2.0 psu, and the high intrusion in August fell to approximately 4.0 psu.

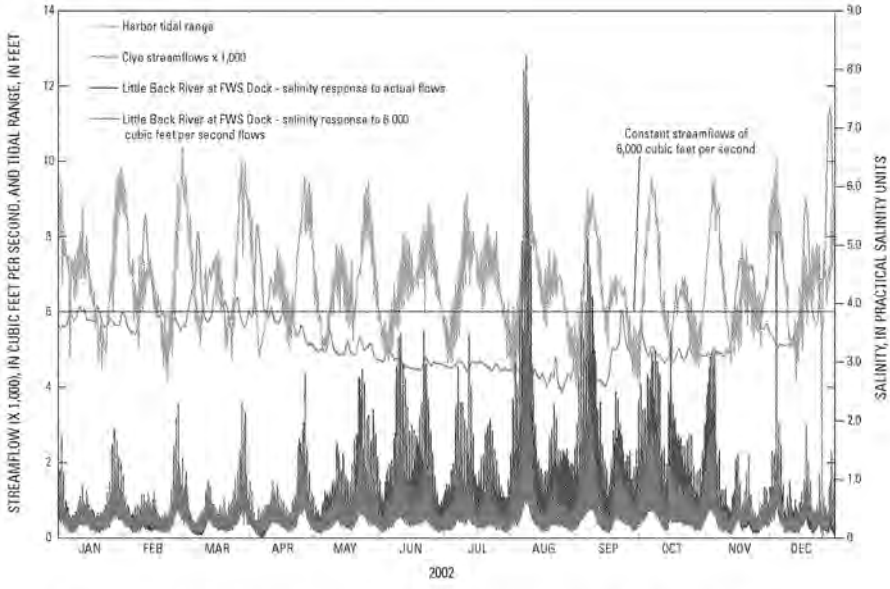


Figure 45. Salinity response at Little Back River at U.S. Fish and Wildlife Service Dock (station 021989791) for calendar year 2002 streamflows and constant 6,000 ft³/s streamflows. Tidal range for Savannah River at Fort Pulaski (station 02198980) also are shown.

The reduction in the salinity intrusion by constant streamflow also had a substantial effect on the pore-water salinity in the tidal marshes. Figure 46 shows the pore-water salinity response to the actual and constant 6,000 ft³/s streamflows. Some of the input data for the marsh ANN models were missing during the first 3 months of the year, and predictions are not shown. For Site B1, the salinity response to the measured streamflow is between 0.5 and 1.0 psu, with the large intrusion in August being approximately 1.2 psu. The constant streamflow decreased the pore-water salinity by approximately 50 percent to 0.5 psu or less. The response to the increased streamflow virtually changed Site B1 from an oligohaline marsh to a tidal freshwater marsh (fig. 15). Downstream at Site B2, there is a similar substantial decrease in the salinity for the measured and constant 6,000 ft³/s streamflows. Note the similarities in the responses in the marsh pore-water salinity at Site B1 for measured flow conditions and Site B2 for the constant flow conditions. The slight increase in the streamflow of the constant input changed the marsh response at Site B2 to one that is equivalent to the marsh upstream during measured conditions.

Percent of Historical Streamflow

Another user-specified streamflow option is percent of historical streamflow. This allows the DSS user to modify the measured streamflow from 50 to 200 percent of the historical value. The salinity response on the Little Back River at USFW Dock (station 021989781) for a 25-percent increase in streamflow during 2002 is shown in figure 47. There is an overall decrease in salinity with high streamflow. In the constant flow simulation above, during the first 4 months the three flow pulses were decreased substantially but there was little response in salinity owing to the timing of the 28-day spring tide cycle (fig. 45). With the 25-percent increase in streamflow (fig. 47), there is a consistent reduction in the salinity, with the largest percentage reduction occurring during spring tides. During the low flows in August, the 25-percent increase in streamflows was not as great a difference over the actual streamflow as the constant 6,000 ft³/s simulation; therefore the large salinity intrusion values were reduced to 5 psu, rather than the 4 psu with the 6,000 ft³/s constant flow.

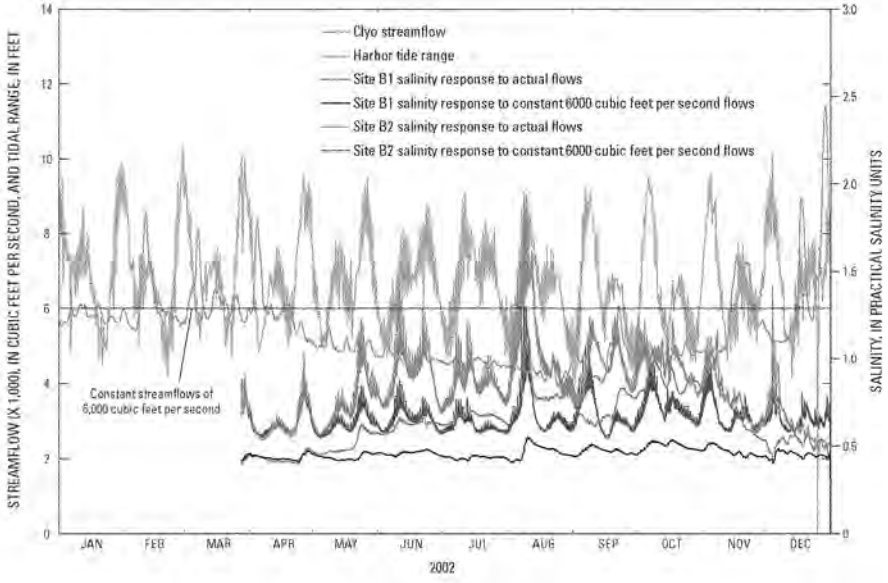


Figure 46. Hourly salinity response for two tidal marsh sites (B1 and B2) off the Little Back River for calendar year 2002 streamflows and constant 6,000 ft³/s streamflows. Tidal range for Savannah River at Fort Pulaski (station 02198980) also are shown.

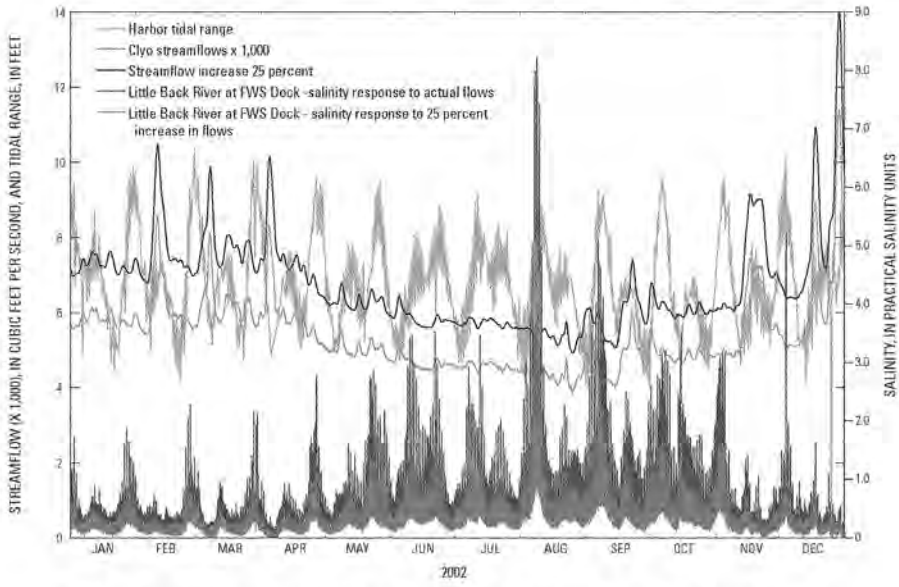


Figure 47. Hourly salinity response at Little Back River at U.S. Fish and Wildlife Service Dock (station 021989791) for calendar year 2002 streamflows and a 25-percent increase in streamflows. Tidal range for Savannah River at Fort Pulaski (station 02198980) also are shown.

The marsh response to the 25-percent higher streamflow during 2002 is shown in figure 48 for marsh sites B1, B2, and B3. The three sites have similar and different responses to higher streamflow. Generally, the three sites respond more to the higher streamflow beginning in June, with Site B3 showing the greatest response. For the 14-day period around the large salinity intrusion in August 2002, Site B2 had the greatest percentage change (approximately 300 percent) of the three sites. For 2002, Site B3 showed the largest overall response (to 0.8 psu). The different responses at the marsh sites show that percentage change in flow does not yield a consistent, proportional change in salinity.

The marsh responses to a 25-percent increase in streamflow can also be displayed as frequency distributions to reveal the changes in the occurrence of salinity in the pore-water. The cumulative percent distribution of salinity occurrences for the three marsh sites at a 25-percent increase in streamflow is shown in figure 49. For all three sites, the increase in streamflow shifts the frequency distribution to the left as pore-water salinity concentrations decrease. The differences in the slopes and the shapes of the frequency response curves show that the marshes are responding differently to marsh and river salinity dynamics. The 25-percent increase shifted the salinity frequency at Site B2 to conditions that are similar to the actual flow conditions at Site B1 upstream.

Percentile Hydrograph of Daily Streamflow

Percentile hydrographs can be used as inputs to the M2M to estimate riverine and marsh water-level and salinity responses for these graduated streamflow conditions. The user selects the time period to simulate and the percentile hydrograph to use as input. The M2M DSS will simulate the water-level and salinity responses using the measured harbor water level and tidal range data from the selected time period. The percentile flow hydrograph option allows, "normalized" water-level and salinity conditions to be determined. For example, for a period when the system is experiencing extreme low-flow conditions, a percentile flow hydrograph (for example the 25th to 75th percentile) will allow "normal" salinities and water levels to be estimated. Figure 50 shows the salinity response at the USFW Dock on the Little Back River (station 021989791) during 2002. The response for the 25th percentile flow hydrograph can be considered the "normal" response to

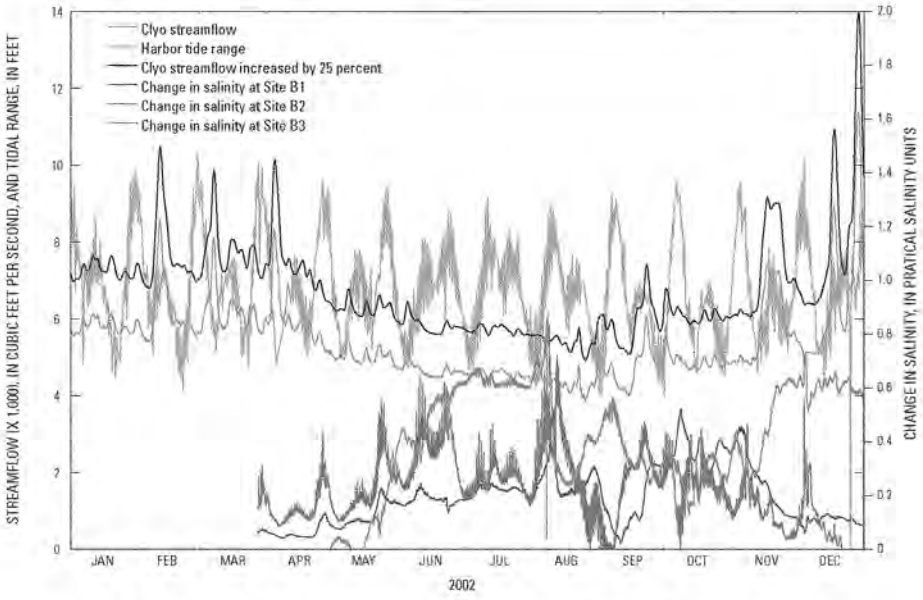


Figure 48. Hourly salinity response for three tidal marsh sites (B1, B2, and B3) along the Little Back River for a 25-percent increase in calendar year 2002 streamflows. Salinity response is the difference between salinity response for actual streamflows and a 25-percent increase in streamflows. Tidal range for Savannah River at Fort Pulaski (station 02198980) also are shown.

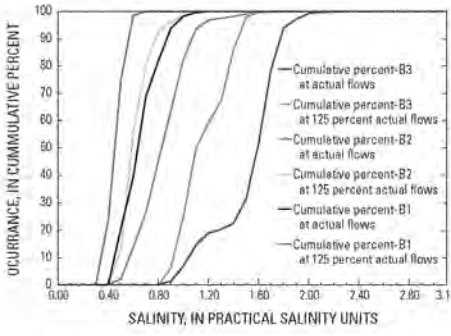


Figure 49. Frequency-distribution curves of salinity occurrence for three tidal marsh sites (B1, B2, and B3) along the Little Back River for 2002 streamflow conditions and a 25-percent increase in streamflow conditions.

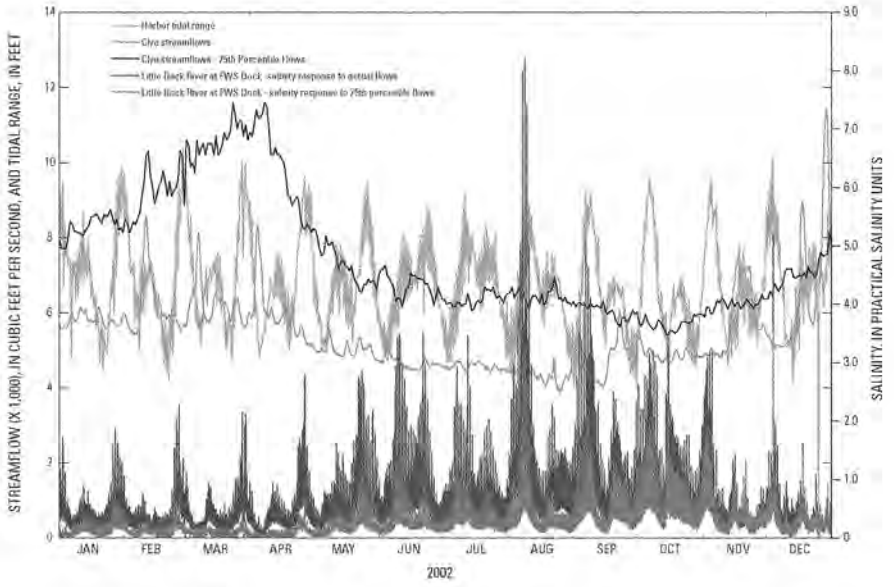


Figure 50. Hourly salinity response at U.S. Fish and Wildlife Service Dock (station 021989791) for calendar year 2002 streamflows and the 25th percentile duration hydrograph. Percentile flows based on streamflows from 1929 to 2003. Tidal range for Savannah River at Fort Pulaski (station 02198980) also are shown.

statistically derived streamflow conditions. The effect of the drought in 2002 is the difference between the salinity response to the actual flows and the 25th percentile hydrograph. During the seasonally high flows in the spring, the salinity intrusion in April is reduced from about 2.0 psu to less than 0.5 psu. During the extreme low flows during the summer, salinity intrusions of 3.0 psu are reduced to 1.0 to 1.5 psu, and 8.0 psu is reduced to 3.0 psu. With the return of slightly higher flows in the fall and winter, the reductions of the intrusions are lower.

The pore-water salinity response at three marsh sites for three different percentile flow conditions were simulated for the 2002 calendar year (fig. 51). When the streamflow is reduced to the 15th percentile, the pore-water salinities increase and the frequency distributions are shifted to the right. The frequency distribution for 15th percentile at Site B1 is similar to the 25th frequency distribution for Site B2. Further reduction in the streamflows to the 5th percentile shifts the frequency distributions even farther to the right. Sites B1 and B2 are shifted from freshwater tidal marsh to oligohaline marsh conditions.

User-Defined Streamflow Hydrograph

The fourth option for user-defined streamflow input M2M is a user-defined hydrograph. With this option, a half-hourly flow hydrograph is created outside of the M2M DSS. A simulation period is selected and the M2M uses the user-defined hydrograph and tidal conditions for the simulation period as inputs. Two scenarios were simulated using this option. In the first scenario, a hydrograph for the 2002 calendar year was created with the minimum flow set to 5,000 ft^3/s. The actual and user-defined hydrographs for 2002 and the salinity response at USFW Dock on the Little Back River (station 021989791) are shown in figure 52. During 2002, flows did not drop below 5,000 ft^3/s until May. From May to September, the minimum 5,000 ft^3/s streamflow usually is greater than the actual flow. The minimum streamflows decreased the salinity level but not as much as the constant 6,000 ft^3/s shown in figure 45. The large salinity intrusion in August was decreased by less than 1.5 psu. The apparent difference in actual and user-defined streamflow salinity responses in early

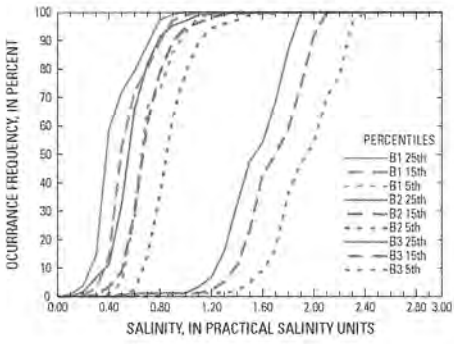


Figure 51. Frequency-distribution curves of salinity occurrence for three tidal marsh sites (B1, B2, and B3) along the Little Back River for 5th, 15th, and 25th percentile duration hydrographs.

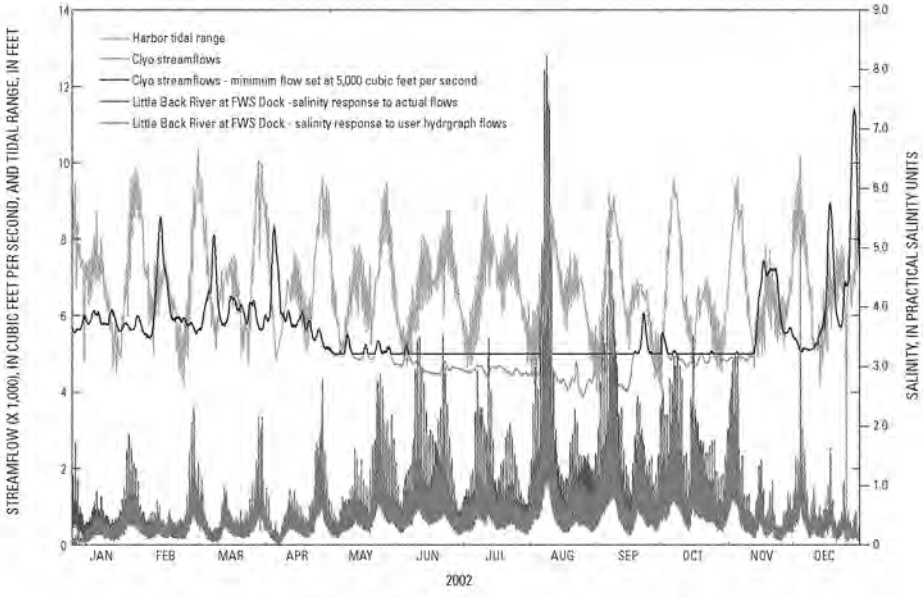


Figure 52. Hourly salinity response at U.S. Fish and Wildlife Service Dock (station 021989791) for calendar year 2002 streamflows and minimum flows set at 5,000 ft^3/s. Tidal range for Savannah River at Fort Pulaski (station 02198980) also are shown.

January are an artifact of missing 2001 values in the user-defined hydrograph for computing model inputs such as long-term time derivatives and moving window averages.

In the second user-defined hydrograph scenario (fig. 53), a hydrograph was created that shifted the higher streamflow pulses that occurred during the first 4 months of 2002 to coincide with the spring tides to evaluate whether the salinity intrusion would be substantially reduced. In addition to shifting the three pulses early in the year, a pulse of approximately 8,500 ft³/s was inserted to coincide with the August spring tide and the coincident large salinity intrusion. The results of the simulation are shown in figure 54. The shifting of the pulses did decrease the salinity intrusions at the end of January, February, and March. The intrusion in January had the largest reduction and may be due to the larger magnitude and duration of this streamflow pulse compared to the subsequent two pulses. The timed flow pulse inserted to reduce the August salinity intrusion reduced the magnitude of the salinity intrusion by more than 4 psu.

Inputs to Model-to-Marsh from Three-Dimensional Model Output

The fifth option for user-defined inputs to the M2M DSS is output from the 3D hydrodynamic EFDC model of the Savannah River Estuary. Using this option, the differences between a historical baseline simulation and alternative harbor geometry are used for input to the M2M simulator. Inputs for the USGS marsh models include the differences from the EFDC simulations generated at the USGS river stations and at the decorrelated GPA river stations (GPA11, GPA11R, and GPA12).

One scenario was run using the historical streamflow and tidal conditions of the 1999 calendar year and a hypothetical deepening of the harbor. Two simulations were generated with the EFDC model. The first was the actual historical conditions from 1999. The second simulation was using the same boundary input conditions but a different channel geometry file representing a 4-ft deepening of the harbor. The difference between the two EFDC simulations are post-processed for the specified USGS and GPA river stations for input to the M2M simulator.

The two-dimensional color-gradient visualization program was used to display the results from the scenario. Four visualization files are generated by the M2M simulator as input to the marsh visualization program: actual conditions, simulated actual conditions, user-defined conditions, and the difference between simulated actual conditions and user-defined conditions. The user-defined conditions represent the simulated salinity values resulting from the EFDC deepening scenario. The difference between the simulated actual conditions and user-defined conditions show the effects of the scenario. Figure 55 shows the baseline simulation on the left and the user-defined condition on the right. The darker shades of green on the right panel (fig. 55*B*) indicate the increased marsh salinity concentrations resulting from a deepening of the harbor for a 2-month period in 1999.

The same deepening scenario is displayed in figure 56 as the difference between the historical condition and the deepened condition. The marsh salinity concentrations show the effect of a deepening. Figures 55 and 56 do not use the same color gradient. As expected, the effect is more evident closer to the harbor and diminishes farther upstream.

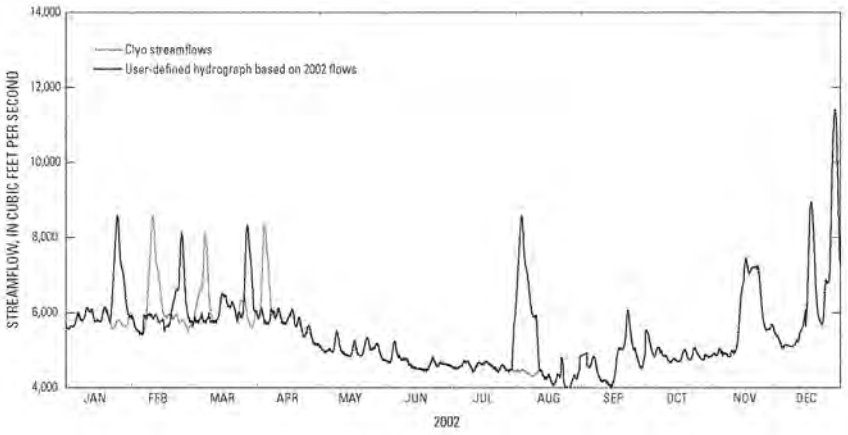


Figure 53. The 2002 streamflow hydrograph and a user-defined hydrograph for input into the Model-to-Marsh application. Hydrograph generated to time streamflow pulses to occur during spring tides and reduce salinity intrusion.

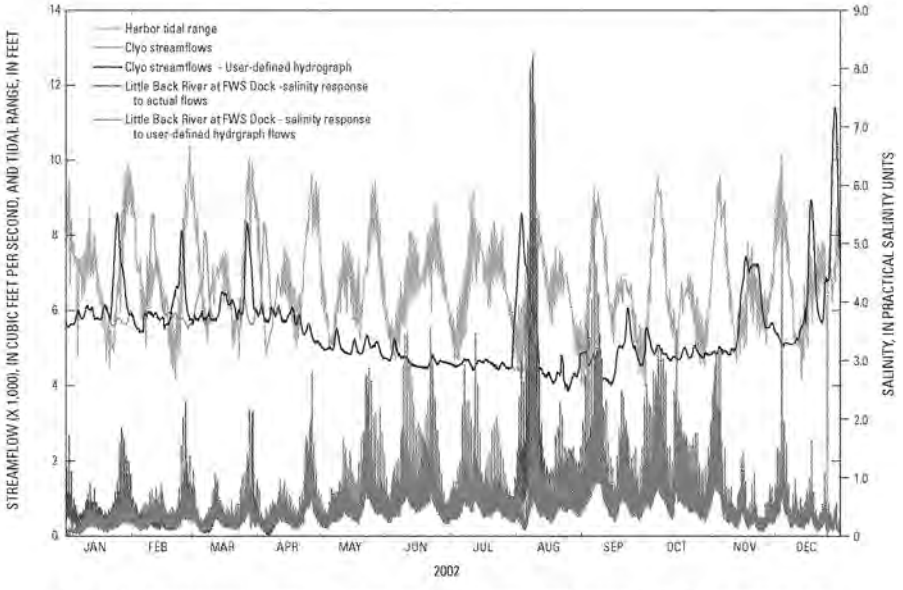


Figure 54. Hourly salinity response at U.S. Fish and Wildlife Service Dock (station 021989791) for calendar year 2002 streamflows and user-defined hydrograph with streamflow pulses inserted to occur during spring tides to reduce salinity intrusion. Tidal range for Savannah River at Fort Pulaski (station 02198980) also are shown.

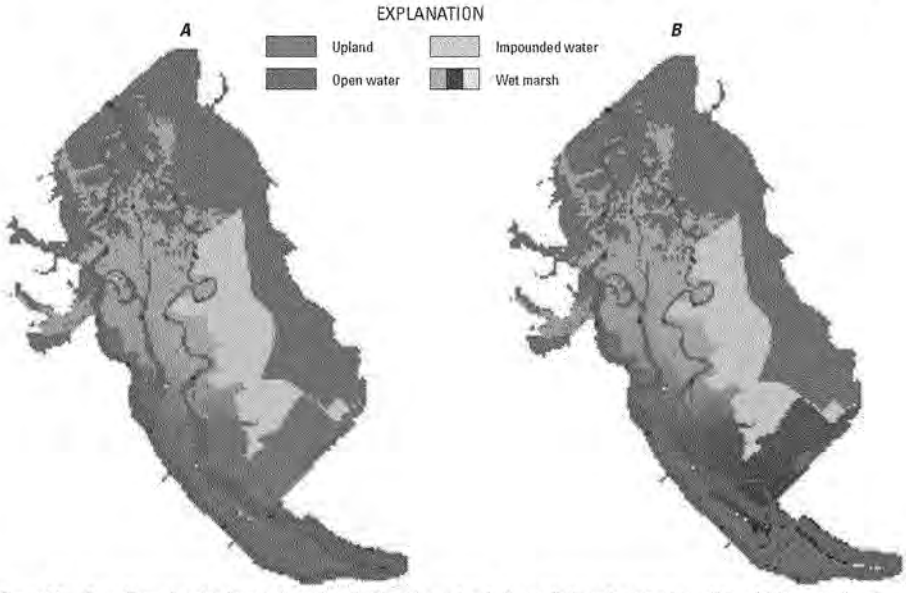


Figure 55. Two-dimensional color-gradient visualization of marsh salinity predictions for actual conditions (*A*, left panel) and a deepened condition (*B*, right panel) for the period July 1 to August 31, 1999. Both panels use the same green color gradient (values from 0.0–12 psu) to represent average marsh pore-water salinity concentrations. The panel on the right shows slightly higher (darker green) marsh pore-water salinity concentrations due to the deepening of the harbor.

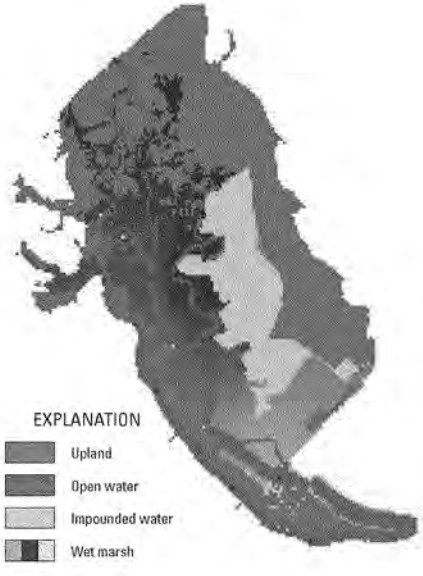


Figure 56. Two-dimensional color-gradient visualization of differences in average marsh salinity prediction for actual conditions and a deepened condition for the period July 1 to August 31, 1999. The panel uses a green color gradient (values from –3.0 to 0 psu). Lighter green color shades indicate greater differences between the two simulations.

Summary

To evaluate potential effects of a proposed deepening of the Savannah Harbor, the Georgia Ports Authority (GPA) has undertaken hydrodynamic and ecological studies of the river and marshes in the vicinity of the SNWR. The freshwater tidal marshes support a diversity of plants and wildlife and were formerly one of the largest freshwater tidal marshes along the East Coast. The potential deepening of the harbor will alter the salinity dynamics of the system and could adversely affect the freshwater tidal marshes. Two models have been developed to evaluate effects and simulate possible mitigation scenarios to minimize potential deepening effects. The GPA and the U.S. Army Corps of Engineers funded the development of hydrodynamic and ecological models to evaluate the potential effects of a proposed deepening of Savannah Harbor. A three-dimensional (3D) hydrodynamic and water-quality model was developed that simulates water levels and salinity throughout the riverine network for anticipated changes in shipping channel geometry. The other models are marsh succession models that predict the changes in marsh plant communities as a result of changes in marsh pore-water salinity. To link the predictive capacity of the two modeling efforts, artificial neural network (ANN) models were developed using data-mining techniques to simulate riverine and marsh water-level and salinity dynamics.

The river and marsh ANN models, historical database, model simulation controls, streaming graphics, and model output were integrated into a decision support system (DSS) named the Model-to-Marsh (M2M). The M2M can be run under two different modes. One mode allows the user to manipulate the streamflow inputs to the system. Four options are available: constant streamflows, percent of historical streamflows, percentile streamflow hydrographs, and user-defined hydrograph. The other mode allows users to input the simulated change in riverine conditions from the 3D hydrodynamic model. Output from the M2M includes tabular time series of measured data, predictions of the measured data, predictions of the user-specified conditions, and differences in simulated and user-specified values. A two-dimensional (2D) plan view visualization routine was also developed that displays marsh salinity conditions. The visualization routine uses marsh predictions at seven locations and interpolates and extrapolates values across the marsh on either a 10- or 100-meter grid. The 2D grid is formatted to be compatible with geographic information system (GIS) applications. The M2M is a spreadsheet application that facilitates the dissemination and utility of the DSS.

The empirical ANN models were developed using data-mining techniques. Data mining is a powerful tool for converting large databases into knowledge to solve problems that are otherwise imponderable because of the large numbers of explanatory variables or poorly understood process physics. Since the last harbor modification in 1994, there are four databases of time series of river and marsh water level and specific conductance (field measurement for salinity). The USGS has maintained a network of continuous streamflow, water-level, and specific-conductance river gages since the 1980s and a network of continuous tidal marsh water-level and salinity gages since 1999. To support the 3D hydrodynamic model development, the GPA collected continuous water-level and water-quality data during the summers of 1997 and 1999. The GPA also collected continuous tidal marsh water-level and specific-conductance data from 1999 to 2002.

Development of models with good predictive ability through the full range of historical conditions is dependent on the availability of measured data covering the full range of conditions in the system. Depending on the period of time when these data collection networks were active, each data set covered different ranges of Savannah River streamflow conditions. For the river networks, the USGS stations recorded water level and specific conductance for the full range of historical streamflow conditions from 4,320 to 52,600 ft^3/s. The GPA network measured conditions for a flow range of 5,440 to 11,600 ft^3/s, which represents median flow conditions (the 25th and 75th percentiles for the period of record). For the tidal marsh networks, the USGS gaging network measured hydrologic conditions of 4,320 to 39,600 ft^3/s, which represents a low- to high-flow condition (from minimum flow to greater than 95th percentile flows for the period of record). The GPA network measured conditions from 4,320 to 14,100 ft^3/s, which like the GPA river network, represents median flow conditions.

For the application of the ANN models to the Savannah River, data-mining methods are applied to maximize the information content in raw data. Signal processing techniques included signal decomposition, digital filtering, time derivatives, time delays, running averages, and differences between stations. Signal inputs to the ANN model used "state space reconstruction" (SSR) for representing dynamic relations of the system. The development of ANN models to simulate the water level and pore-water salinity of the tidal marsh was undertaken in two phases. The first phase was to train ANN models to simulate the water level and specific conductance at the USGS and the GPA riverine sites. Inputs to the ANN models of the USGS river network include time series, or signals, of streamflow, tidal water level, and tidal range. The second phase was to train ANN models to simulate water level and pore-water specific conductance at the USGS and the GPA marsh sites. Inputs for these models include the water-level and specific-conductance signals from the USGS river network at the marsh gaging sites.

For a complex system like the Savannah River Estuary and tidal marshes, the statistical accuracy of the models and predictive capability are satisfactory. The salinity models are able to simulate the 14- and 28-day salinity intrusion cycles in the rivers and capture the salinity dynamics responses in the marshes. The models of the USGS river and marsh networks have the greatest range of the output variables. Generally, the river water-level models have coefficient of determination (R^2) values ranging from 0.88 to 0.99 and the specific-conductance

models have R^2 values ranging from 0.57 to 0.87. The marsh water-level models have R^2 values ranging from 0.72 to 0.87 and the specific-conductance models have R^2 values ranging from 0.53 to 0.85.

The M2M application was used to simulate four user-specified flow options in the applications. The first scenario simulated the 2002 conditions using a constant streamflow of 6,000 ft^3/s. During the low-flow conditions in the summer when the actual flows were less than 6,000 ft^3/s, there was a reduction in the salinity intrusion into the Little Back River. The constant 6,000 ft^3/s reduced the amount of streamflow for three higher streamflow pulses that occurred in the spring of 2002. The reductions in the streamflow did not cause an increase in the salinity intrusion for these three events related to the timing with the 28-day spring tidal cycle. For the Little Back River, salinity intrusion is greatest during spring tides, and the three higher streamflow pulses did not occur during the optimal tidal phase. The constant streamflow also had a significant effect on the pore-water salinity response in the tidal marshes. The response to the increased streamflow during the low-flow conditions of the summer essentially changed Site B1 from an oligohaline marsh to a tidal freshwater marsh.

A second option for user-specified inflows for the M2M application is percent of historical streamflows. A 25-percent increase in streamflow for 2002 was simulated, and there was an overall decrease in the salinity with the increase in flow. With the 25-percent increase in streamflows, salinity intrusion is reduced during these periods due to the increase in streamflow with the largest percentage reductions occurring during spring tides.

Percentile hydrographs can be used as a third option as inputs to the M2M to estimate riverine and marsh water-level and salinity response for these streamflow conditions. Using the percentile flow hydrograph option, "normalized" water-level and salinity conditions can be determined for a particular time period. Three percentile streamflow conditions, the 5th, 15th, and 25th percentile hydrographs, were simulated with the M2M application for the 2002 calendar year. The marsh response for these conditions showed Sites B1 and B2 shifting from freshwater tidal marsh conditions to oligohaline marsh conditions as flow conditions were reduced from the 25th to the 5th percentile.

The fourth option for streamflow inputs to the M2M application is a user-defined hydrograph. For this scenario, a hydrograph was created that shifted the higher streamflow pulses that occurred during the first 4 months of 2002 to coincide with the spring tides to evaluate whether the salinity intrusion would be significantly reduced. The shifting of the three pulses to coincide with the spring tides did decrease the salinity intrusions at the end of January, February, and March 2002.

The final option for inputs to the M2M application is output from the 3D EFDC model. For this scenario, the EFDC model was used to simulate the effects of a hypothetical 4-ft deepening of the harbor based on the historical hydrologic and tidal conditions for calendar year 1999. The differences at selected USGS and GPA river gages were post-processed and used as input to the M2M. The 2-month average marsh salinities for the period July through August 1999 showed the highest effects in the marshes closest to the harbor and proximal to the Front River with diminishing increases farther upstream.

References

Abarbanel, H.D.I., 1996, Analysis of observed chaotic data: Springer-Verlag New York, Inc., NewYork, p. 4–12, 39.

Ambrose, R.B., Wool, T.A., and Martin, J.L., 1993, The water quality analysis simulation program, WASP5, part A—model documentation: U.S. Environmental Protection Agency, Athens, Ga., 210 p.

Applied Science Associates and Applied Technology and Management, 1998, Hydrodynamic and water quality modeling of the Lower Savannah River estuary, engineering report prepared for the Georgia Ports Authority, Savannah, Ga.: Applied Technology and Management, Inc., Atlanta, Ga., variously paged.

Applied Technology and Management, 1998, Hydrodynamics and water quality modeling of the Lower Savannah River estuary, engineering report prepared for Georgia Ports Authority, Savannah, Ga.: Applied Technology and Management, Inc., Charleston, S.C., May 1998, variously paged.

Applied Technology and Management, 2000, Hydrodynamic and water quality monitoring of the Lower Savannah River estuary, August 2 through October 9, 1999: Applied Technology and Management, Inc., April 2000, variously paged.

Applied Technology and Management, 2003, Savannah Harbor deepening project tidal marsh studies data report, volume 1, Report submitted to Georgia Ports Authority, March 2003, variously paged.

Barber, H.E., and Gann, A.R., 1989, A history of the Savannah District U.S. Army Corps of Engineers, 1829–1989: Savannah District, U.S. Army Corps of Engineers, Savannah, Ga., 554 p.

Bossart, J., Kitchens, W.M., and Dusek, M.L., 2001, Assessing salinity induced changes to tidal freshwater and oligohaline marsh habitats in the lower Savannah River: Watershed 2002 Specialty Conference, Fort Lauderdale, 2002.

Conrads, P.A., and Roehl, E.A., 1999, Comparing physics-based and neural network models for predicting salinity, water temperature, and dissolved oxygen concentration in a complex tidally affected river basin: South Carolina Environmental Conference, Myrtle Beach, March 1999.

Conrads, P.A., and Roehl, E.A., 2005, Integration of data mining techniques with mechanistic models to determine the impacts of non-point source loading on dissolved oxygen in tidal waters: South Carolina Environmental Conference, Myrtle Beach, March 2005.

Conrads, P.A., Roehl, E.A., and Cook, J.B., 2002a, Estimation of tidal marsh loading effects in a complex estuary: American Water Resources Association Annual Conference, New Orleans, May 2002.

Conrads, P.A., Roehl, E.A., and Martello, W.P., 2002b, Estimating point-source impacts on the Beaufort River using neural network models: American Water Resources Association Annual Conference, New Orleans, May 2002.

Conrads, P.A., Roehl, E.A., and Martello, W.P., 2003, Development of an empirical model of a complex, tidally affected river using artificial neural networks: Water Environment Federation TMDL 2003 Specialty Conference, Chicago, Illinois, November 2003.

Cowardin, L.M., Carter, V.M., Golet, F.C., and LaRoe, E.T., 1979, Classification of wetlands and deepwater habitats of the United States: U.S. Fish and Wildlife Service, FWS/OBS-79/31.

Devine, T.W., Roehl, E.A., and Busby, J.B., 2003, Virtual sensors—cost effective monitoring: Air and Waste Management Association Annual Conference, June 2003.

Dusek, M.L., 2003, Multi-scale spatial and temporal change in the tidal marshes of the Lower Savannah River Delta: Thesis presented to the graduate school of the University of Florida.

Dutta, Soumitra, Wierenga, Berend, Dalebout, Arco, 1997, Case-based reasoning systems: from automation to decision-aiding and stimulation: Knowledge and Data Engineering, IEEE Transactions on, v. 9, no. 6, p. 911–922.

Dyer, K.R., 1997, Estuaries—A physical introduction, 2nd ed.: John Wiley and Sons, Ltd, West Sussex, England, p. 4.

Georgia Environmental Protection Division, 1988, Savannah River classification study: Environmental Protection Division, Georgia Department of Natural Resources, Atlanta, Ga., January 1988 (revised).

Georgia Ports Authority, 1998, Environmental impact statement—Savannah Harbor expansion feasibility study: Prepared by Lockwood Greene and Applied Technology and Management, 1998, variously paged.

Gough, Laura, and Grace, J.B., 1998, Effects of flooding, salinity, and herbivory on coastal plant communities, Louisiana, United States: Oecologia, v. 117, no. 4, p. 527–535.

Granger, M.L., 1968, History of the Savannah District, 1829–1968: Savannah District, U.S. Army Corps of Engineers, Savannah District, 114 p.

Hamrick, J.M., 1992, A three-dimensional environmental fluid dynamics computer code: theoretical and computational aspects: The College of William and Mary, Virginia Institute of Marine Science, Special Report 317, 63 p.

Harleman, D.R.F., 1977, User's manual for the M.I.T. transient water quality network model—including nitrogen-cycle dynamics for rivers and estuaries: U.S. Environmental Protection Agency, EPA-600/3-77-010, Corvallis, Oreg., January 1977, 229 p.

Hinton, G.E., 1992, How neural networks learn from experience: Scientific American, September 1992, p. 145–151.

Howard, R.J., and Mendelsson, I.A., 1999, Salinity as a constraint on growth of oligohaline marsh macrophytes—Salt pulses and recovery potential: American Journal of Botany 86, p. 795–806.

Huvel, C.J., Muller, R.H., Senter, P.K., and Boyd, M.S., 1979, Savannah Harbor investigation and model study—volume IV reanalysis of freshwater control plan numerical model study, technical report 2-550: U.S. Army Corps of Engineers, Waterways Experiment Stations, September 1979.

Hydroscience, Inc., 1970, Water quality analysis of the Savannah River Estuary: Westwood, New Jersey, June 1970, 115 p. plus Addendum.

Jensen, B.A., 1994, Expert Systems—Neural networks, instrument engineers' handbook (3d ed.): Chilton, Radnor, Pa., p. 48–54.

Lamar, W.L., 1942, Industrial quality of the public water supplies in Georgia, 1940: U.S. Geological Survey, Water-Supply Paper 912, 83 p.

Latham, P.J., 1990, Plant distributions and competitive interactions along a gradient of tidal freshwater and brackish marshes: Dissertation presented to the graduate school of the University of Florida.

Latham, P.J., and Kitchens, W.M., 1995, Changes in vegetation and interstitial salinities following tide gate removal on the lower Savannah River, 1986–1994: Florida Cooperative Fish and Wildlife Research Unit, Gainesville, Fla., 16 p.

Lawler, Matusky, and Skelly Engineers, 1983, Development and application of a transport-dispersion water quality model for the Savannah River estuary—volume I application report: Pearl River, N.Y., 158 p.

Lawler, Matusky, and Skelly Engineers, 1986, Evaluation of the Savannah River estuary model, Letter Report: Pearl River, N.Y., March 4, 1986, 10 p. plus attachments.

Loftin, C.S., McCloskey, J.R., Kitchens, W.M., and Dusek, M.L., 2003, Changes in vegetation distributions in the Lower Savannah River tidal marsh following removal of a tidal flap gate, *in* W.M. Kitchens and others, 2003, Tidal wetland studies and tidal wetland resource utilization studies, Final Report: U.S. Geological Survey Florida Cooperative Fish and Wildlife Research Unit, 42 p.

Miller, R.L., Bradford, W.L., and Peters, N.E., 1988, Specific conductance: theoretical considerations and application to analytical quality control: U.S. Geological Survey Water-Supply Paper 2311, 16 p.

Muin, M., and Spauling, M.L., 1997, Three-dimensional boundary fitted circulation model: Journal of Hydraulic Engineering, January 1997, American Society of Civil Engineering, p. 2–12.

Odum, W.E., Smith, T.J., III, Hoover, J.K., and McIvor, C.C., 1984, The ecology of tidal freshwater marshes of the United States east coast—A community profile: U.S. Fish and Wildlife Service, FWS/OBS-83/17, Washington, D.C., 177 p.

Olinger, L.W., 1970, Procedure for evaluating the pollution assimilative capacity of the Savannah estuary: Federal Water Pollution Control Administration, Athens, Ga., April 1970, 30 p.

Pearlstine, L.G., Kitchens, W.M., Latham, P.J., and Bartleson, R.D., 1993, Tide gate influences on a tidal marsh: American Water Resources Association, Water Resources Bulletin, v. 29, no. 6, December 1993, p. 1009–1019.

Pearlstine, L.G., Latham, P.J., Kitchens, W.M., and Bartleson, R.D., 1990, Development and application of a habitat succession model for the wetland complex of the SNWR, volume II, final report, Submitted to the U.S. Fish and Wildlife Service, Savannah Coast Refuges, by the Florida Cooperative Fish and Wildlife Research Unit, Gainesville, Fla.

Pennington, C.H., and Bond, C.L., 1981, Savannah River estuary study—volume 1: water quality data report, miscellaneous paper EL-81, U.S. Army Corps of Engineers Waterways Experiment Studies, Vicksburg, Miss., April 1981, 85 p.

Press, W.H., Teukolsky, S.A., Vetterling, W.T., and Flannery, B.P., 1993, Numerical recipes in C: The art of scientific computing, Cambridge University Press, 1007 p.

Rhodes, R.F., 1949, The hydraulics of a tidal river as illustrated by the Savannah Harbor, Georgia: U.S. Army Corps of Engineers, Savannah District, Savannah, Ga., January 1949.

Risley, J.C., Roehl, E.A., and Conrads, P.A., 2002, Estimating water temperatures in small streams in western Oregon using neural network models: U.S. Geological Survey Water-Resources Investigations Report 02-4218, 59 p.

Roehl, E.A., and Conrads, P.A., 1999, Near real-time control for matching wastewater discharges to the assimilative capacity of a complex, tidally affected river basin: 1999 South Carolina Environmental Conference, Myrtle Beach, March 15–16, 1999.

Roehl, E.A., Conrads, P.A., and Cook, J.B., 2003, Discussion of using complex permittivity and artificial neural networks for contaminant prediction: Journal of Environmental Engineering, Nov. 2003, p. 1069–1071.

Roehl, E.A., Conrads, P.A., Roehl, T.A.S., 2000, Real-time control of the salt front in a complex tidally affected river basin: Smart Engineering System Design: Volume 10, Proceedings of the Artificial Neural Networks In Engineering Conference: ASME Press, New York, p. 947–954.

Rosenblatt, Frank, 1958, The perceptron: a probabilistic model for information storage and organization in the brain: Psychological Review, 65, 1958, p. 386–408.

Rumelhart, D.E., Hinton, G.E., and Williams, R.J., 1986, Learning internal representations by error Propagation, Parallel Distributed Processing—Explorations in the Microstructure of Cognition, Volume 1, Cambridge, Mass.: The MIT Press, p. 318–362.

Sanders, C.L., Kubik, H.E., Hoke, J.T., and Kirby, W.H., 1990, Flood frequency of the Savannah River at Augusta, Georgia: U.S. Geological Survey Water-Resources Investigations Report 90-4024, 87 p.

Shingler, J.H.C., 1981, Savannah River Estuary Study—volume II hydrodynamic data report, Miscellaneous Paper EL-81, U.S. Army Corps of Engineers Waterways Experiment Studies, Vicksburg, Miss., August 1981, 226 p.

Spaulding, M.L., 1984, A vertically averaged circulation model using boundary-fitted coordinates: Journal of Physical Oceanography, v. 14, no. 5, p. 973–982.

Streeter, H.W., and Phelps, E.B., 1925, A study of the pollution and natural purification of the Ohio River, Illinois—factors concerned in the phenomena of oxidation and reaeration: U.S. Public Health Service Bulletin 146, Washington, D.C.

Swanson, J.C., 1986, A three-dimensional numerical model system of coastal circulation and water quality, PhD dissertation, University of Rhode Island, Kingston, R.I.

Tetra Tech, 2005, Development of the EFDC hydrodynamic model for the Savannah Harbor, Prepared for the U.S. Army Corps of Engineers—Savannah District: Tetra Tech, Inc., Atlanta, Ga.

Tiner, R.W., 1977, An inventory of South Carolina's coastal marshes: Office of Conservation and Management, South Carolina Wildlife and Marine Resources Department, Charleston, S.C., Technical Report Number 23, 33 p.

U.S. Army Corps of Engineers, 1991, Tidal hydraulics—engineering manual: U.S. Army Corps of Engineers Technical Report No. EM 1110-2-1607, Washington, D.C.

U.S. Army Corps of Engineers Waterways Experiment Station, 1961a, Savannah Harbor investigations and model study: volume III—results of model investigation, section 1—model verification and results of general studies, Technical Report No. 2-580, Vicksburg, Miss.

U.S. Army Corps of Engineers Waterways Experiment Station, 1961b, Savannah Harbor investigations and model study: volume III—results of model investigation, section 2—test of improvement plans, Technical Report No. 2-580, Vicksburg, Miss.

U.S. Army Corps of Engineers Waterways Experiment Station, 1963, Savannah Harbor investigations and model study: volume III—results of model investigation, section 3—results of supplemental tests, Technical Report No. 2-580, Vicksburg, Miss.

U.S. Environmental Protection Agency, 2004, Draft total maximum daily load (TMDL) for dissolved oxygen in Savannah Harbor, Savannah River Basin, Chatham and Effingham Counties, Georgia: U.S. Environmental Protection Agency, Region 4, Atlanta, Ga., 20 p.

Weiss, S.M., and Indurkhya, Nitin, 1998, Predictive data mining—a practical guide: Morgan Kaufmann Publishers, Inc., San Francisco, p. 1.

Wool, T.A., Ambrose, R.B., Martin, J.L., and Comer, E.A., 2001, Water quality analysis simulation program (WASP) version 6.0 draft, user's manual: U.S. Environmental Protection Agency, Region 4, Atlanta, Ga., 259 p.

Appendices I–IV

Appendix I. Summary statistics for the water-level and specific-conductance models used in the study.

[WL, water level; SC, specific conductance; Min, minimum; Max, maximum; n, number of data points; R^2, coefficient of determination; SSE, sum of squared error; ME, mean error; RMSE, root mean square error; PME, percent model error]

Model name	Gage number	Output variable	Range of output variable		Training		SSE	ME	RMSE	PME	Range of output variable		Testing					
			Min	Max	n	R^2					Min	Max	n	R^2	SSE	ME	RMSE	PME
USGS river network water-level models																		
wl8840a-2005-1	2198840	WL-daily	−0.31	4.46	11051	0.969	165.57	0.000	0.12	2.6%	−0.48	5.66	81446	0.964	1911	0.022	0.15	2.5%
wl8840h-2005-1	2198840	WL-hourly	−3.98	6.87	2303	0.987	199.33	0.000	0.29	2.7%	−4.32	7.09	70296	0.993	7935	0.025	0.33	2.9%
wl8920a-2005-1	2198920	WL-daily	−0.94	3.07	10482	0.977	84.06	−0.000	0.09	2.2%	−0.95	4.05	68121	0.885	2803	0.183	0.20	4.1%
wl8920h-2005-1	2198920	WL-hourly	−7.08	6.73	10538	0.995	467.38	0.000	0.21	1.5%	−6.46	7.34	68368	0.991	5492	0.186	0.28	2.1%
wl8977a-2005-1	2198977	WL-daily	−0.91	3.07	10612	0.980	137.193	0.000	0.11	2.9%	−0.91	3.68	79682	0.965	857	0.028	0.10	2.3%
wl8977h-2005-1	2198977	WL-hourly	−7.20	6.85	10717	0.994	524.459	−0.000	0.22	1.6%	−6.65	7.13	79951	0.995	3422	0.029	0.21	1.5%
wl8979a-2005-1	2198979	WL-daily	−0.30	3.86	7987	0.952	141.946	−0.000	0.13	3.2%	−0.32	4.75	70993	0.961	1153	0.043	0.13	2.5%
wl8979h-2005-1	2198979	WL-hourly	−4.70	6.88	8029	0.984	980.854	−0.000	0.35	3.0%	−4.86	7.13	71187	0.981	10071	0.034	0.38	3.1%
USGS river network specific-conductance models																		
sc8840a-2005-1	2198840	SC-daily	60	773	10056	0.887	1763591.2	0.047	13	1.9%	45.95	773.40	77309	0.851	12414716	−3.254	13	1.7%
sc8840h-2005-1	2198840	SC-hourly	59	8370	10197	0.879	21846887	0.056	46	0.6%	30.00	2374.60	77772	0.567	42270460	−3.236	23	1.0%
sc8920a-2005-1	2198920	SC-daily	68	18667	9836	0.897	1.41E+10	0.864	1198	6.4%	50.48	18725.80	67677	0.883	8.80E+10	−367.667	1141	6.1%
sc8920h-2005-1	2198920	SC-hourly	6	31169	9900	0.900	3.84E+10	−0.732	1971	6.3%	30.00	31934.70	67820	0.867	2.32E+11	−308.104	1850	5.8%
sc89784a-2005-1	21989784	SC-daily	79	2198	8534	0.880	1.62E+8	0.160	138	6.5%	50.45	2229.85	70348	0.853	1.02E+9	−60.755	121	5.5%
sc89784h-2005-1	21989784	SC-hourly	72	5821	8600	0.825	2.92E+8	0.006	184	3.2%	40.00	4286.00	71064	0.793	1.62E+9	−56.100	151	3.6%
sc89791a-2005-1	21989791	SC-daily	78	5693	9660	0.887	5.97E+8	0.870	249	4.4%	51.64	5689.54	75782	0.870	2.89E+9	−65.833	195	3.5%
sc89791h-2005-1	21989791	SC-hourly	75	15200	9736	0.888	1.10E+9	0.336	336	2.2%	50.00	10972.59	76366	0.826	5.42E+9	−63.386	266	2.4%
USGS marsh network water-level models																		
pb1mwl-2005	B1	WL-hourly	−0.10	1.50	3143	0.770	12.88	0.000	0.06	4.0%	−0.10	1.60	17653	0.762	67.48	−0.001	0.06	3.6%
pb2mwl-2005	B2	WL-hourly	0.00	1.80	3284	0.797	37.00	0.000	0.11	5.9%	0.00	2.20	18228	0.768	229.15	−0.002	0.11	5.1%
pb3mwl-2005	B3	WL-hourly	0.00	1.80	3558	0.858	19.22	−0.000	0.07	4.1%	0.00	2.10	20082	0.886	105.25	−0.000	0.07	3.4%
pb4mwl-2005	B4	WL-hourly	0.00	2.00	2879	0.887	19.31	−0.002	0.08	4.1%	0.00	2.30	15877	0.872	127.81	0.000	0.09	3.9%
pf1mwl-2005	F1	WL-hourly	0.00	1.50	4243	0.839	19.61	0.000	0.07	4.5%	0.00	2.00	24981	0.835	113.20	−0.001	0.07	3.4%
pm1mwl-2005	M1	WL-hourly	0.00	1.40	2424	0.694	22.38	0.000	0.10	6.9%	0.00	1.70	13299	0.722	111.83	0.001	0.09	5.4%
pm2mwl-2005	M2	WL-hourly	0.00	1.40	1751	0.808	12.22	0.000	0.08	6.0%	0.00	1.80	9676	0.778	73.91	−0.002	0.09	4.9%
USGS marsh network specific-conductance models																		
pb1msc-2005-2	B1	SC-hourly	117	2433	2333	0.857	6.56E+7	−0.050	168	7.2%	53.60	2561.60	20555	0.849	5.98E+8	0.207	171	6.8%
pb2msc-2005-2	B2	SC-hourly	52	3055	2142	0.826	1.41E+8	−0.684	257	8.5%	50.50	3881.00	18770	0.832	1.22E+9	0.823	255	6.7%
pb3msc-2005-2	B3	SC-hourly	619	4478	2326	0.549	6.17E+8	0.657	515	13.4%	98.50	4921.80	20519	0.532	5.48E+9	−4.510	517	10.7%
pb4msc-2005-2	B4	SC-hourly	131	21845	2093	0.654	9.59E+9	−2.247	2142	9.9%	50.00	24624.80	18577	0.641	9.66E+10	14.870	2209	9.0%

Appendix I. Summary statistics for the water-level and specific-conductance models used in the study.—Continued

[WL, water level; SC, specific conductance; Min, minimum; Max, maximum; n, number of data points; R^2, coefficient of determination; SSE, sum of squared error; ME, mean error; RMSE, root mean square error; PME, percent model error]

Model name	Gage number	Output variable	Range of output variable		Training					Range of output variable		Testing				
			Min	Max	n	R^2	SSE	ME	RMSE	PME	Min	Max	n	R^2	SSE	ME	RMSE	PME
USGS marsh network specific-conductance models—Continued																		
pf1mse-2005-2	F1	SC-hourly	165	5236	2496	0.816	4.77E+8	0.439	437	8.6%	161.90	5565.50	22073	0.820	4.14E+9	-14.661	433	8.0%
pm1mse-2005-2	M1	SC-hourly	56	6853	2147	0.809	3.83E+8	0.252	423	6.2%	50.30	6886.89	18927	0.808	3.27E+9	-2.905	416	6.1%
pm2mse-2005-2	M2	SC-hourly	67	12721	2323	0.841	1.03E+9	-0.078	666	5.3%	52.40	17588.40	20593	0.830	1.02E+10	10.560	704	4.0%
Decorrelation models																		
dc_gpa_a1wk_10s_11b	GPA11	SC-decorrelated-hourly	101	9825	7644	0.800	7.37E+9	-1.863	982	10.1%	100.51	9836.66	30459	0.804	2.85E+10	23.431	967	9.9%
dc_gpa_a1wk_10s_11b	GPA11	SC-decorrelated-hourly	101	9825	7750	0.947	1.62E+9	-1.837	457	4.7%	100.51	9836.66	30921	0.958	6.25E+9	-1.865	450	4.6%
dc_gpa_a1wk_10s_12b	GPA12	SC-decorrelated-hourly	101	9825	7750	0.881	4.48E+9	-0.273	760	7.8%	100.51	9836.66	30921	0.880	1.79E+10	0.863	761	7.8%
Residual models																		
prb1mse	B1	SC-residual-hourly	-543	780	4547	0.080	1.16E+8	0.005	160	12.1%	-610.27	797.10	18224	0.087	4.90E+8	1.615	164	11.7%
prb2mse	B2	SC-residual-hourly	-895	1291	4176	0.067	2.49E+8	-0.158	244	11.2%	-931.97	1652.73	16736	0.059	1.03E+9	0.915	248	9.6%
prb3mse	B3	SC-residual-hourly	-1422	1889	4519	0.020	1.18E+9	0.089	510	15.4%	-1505.04	1920.47	18209	0.018	4.80E+9	-6.018	513	15.0%
prb4mse	B4	SC-residual-hourly	-7437	9515	4097	0.020	1.96E+10	0.213	2185	12.9%	-10521.66	11200.50	16456	0.020	7.83E+10	-41.183	2182	10.0%
pr1mse	F1	SC-residual-hourly	-2214	2046	4873	0.055	9.10E+8	2.199	432	10.1%	-2213.96	2946.15	19579	0.050	3.47E+9	9.212	421	9.9%
pm1mse	M1	SC-residual-hourly	-1411	2029	4163	0.073	6.80E+8	0.169	404	11.8%	-1434.29	1575.44	15803	0.065	2.71E+9	1.600	402	13.3%
pm2mse	M2	SC-residual-hourly	-2721	5548	4539	0.034	2.16E+9	0.138	691	8.4%	-3576.68	8438.79	18260	0.016	8.87E+9	3.267	697	5.8%
USGS marsh network final specific-conductance predictions																		
pb1mse+pr1mse	B1	SC-hourly	54	2562	22771	0.930	6.06979116053	146	165	6.5%								
pb2mse+pr2mse	B2	SC-hourly	51	3881	20912	0.920	12799314936574	189	247	6.5%								
pb3mse+pr3mse	B3	SC-hourly	99	4932	22728	0.740	59760212783970	204	513	10.6%								
pb4mse+pr4mse	B4	SC-hourly	50	24625	20553	0.810	9790248450142?	863	2183	8.9%								
pf1mse+pr1mse	F1	SC-hourly	162	5045	24452	0.910	438128478159?	314	423	7.3%								
pm1mse+pr1mse	M1	SC-hourly	50	6887	20666	0.906	3391670991851	350	402	5.9%								
pm2mse+pr2mse	M2	SC-hourly	50	17588	22799	0.915	1103136904835?	497	696	4.0%								

Appendix I. Summary statistics for the water-level and specific-conductance models used in the study.—Continued

[WL, water level; SC, specific conductance; Min, minimum; Max, maximum; n, number of data points; R^2, coefficient of determination; SSE, sum of squared error; ME, mean error; RMSE, root mean square error; PME, percent model error]

Model name	Gage number	Output variable	Range of output variable		Training		SSE	ME	RMSE	PME	Range of output variable		Testing					
			Min	Max	n	R^2					Min	Max	n	R^2	SSE	ME	RMSE	PME
GPA river network water-level models																		
wlgpa04d-2005	GPA04	WL-hourly	-1.22	1.27	4215	0.640	134.44	-0.024	0.18	7.2%	-0.79	1.35	1079	0.626	35.47	-0.023	0.18	8.5%
wlgpa05d-2005	GPA05	WL-hourly	-1.12	3.71	4344	0.638	148.27	0.070	0.18	3.8%	-1.00	0.72	1133	0.676	36.01	0.067	0.18	10.4%
wlgpa06d-2005	GPA06	WL-hourly	-0.64	0.88	4305	0.176	166.61	-0.037	0.20	12.9%	-0.65	0.92	1124	0.152	45.26	-0.045	0.20	12.8%
wlgpa07d-2005	GPA07	WL-hourly	-1.31	1.10	1606	0.641	85.52	-0.031	0.23	7.9%	-1.34	1.06	416	0.638	23.15	-0.035	0.24	9.9%
wlgpa08d-2005	GPA08	WL-hourly	-0.77	0.97	4614	0.238	153.87	0.029	0.18	10.5%	-0.78	0.74	1175	0.216	36.88	0.021	0.18	11.7%
wlgpa09d-2005	GPA09	WL-hourly	-1.39	1.59	4642	0.338	877.16	0.019	0.43	14.6%	-1.36	1.43	1192	0.310	230.22	0.027	0.44	15.8%
wlgpa10d-2005	GPA10	WL-hourly	-2.18	1.79	2187	0.230	138.00	-0.125	0.25	6.3%	-1.07	3.34	587	0.233	42.88	-0.112	0.27	6.1%
wlgpa11d-2005	GPA11	WL-hourly	-1.27	1.94	1578	0.534	180.26	-0.037	0.34	10.5%	-1.49	1.97	434	0.570	46.47	-0.021	0.33	9.5%
wlgpa11rd-2005	GPA11R	WL-hourly	-1.53	0.86	1617	0.863	57.56	-0.012	0.19	7.9%	-1.57	0.79	399	0.855	15.06	-0.015	0.19	8.3%
wlgpa12d-2005	GPA12	WL-hourly	-3.08	1.92	2846	0.272	1733.72	-0.045	0.78	15.6%	-2.93	1.61	749	0.242	461.76	-0.033	0.79	17.3%
wlgpa13d-2005	GPA13	WL-hourly	-3.52	1.91	2123	0.917	301.34	-0.008	0.38	6.9%	-3.48	1.75	561	0.926	72.48	-0.022	0.36	6.9%
wlgpa14d-2005	GPA14	WL-hourly	-0.95	1.63	1630	0.914	54.32	-0.016	0.18	7.1%	-0.86	1.56	424	0.909	14.23	-0.022	0.18	7.6%
wlgpa21d-2005	GPA21	WL-hourly	-0.71	0.84	2227	0.030	117.57	0.006	0.23	14.8%	-0.68	0.76	551	0.004	29.40	0.004	0.23	16.1%
wlgpa22d-2005	GPA22	WL-hourly	-1.04	1.36	1502	0.884	57.72	0.012	0.20	8.2%	-1.01	1.40	384	0.867	15.60	0.011	0.20	8.4%
wlgpa23d-2005	GPA23	WL-hourly	-0.77	1.43	2754	0.816	98.93	0.013	0.19	8.6%	-0.90	1.31	696	0.798	27.75	0.006	0.20	9.0%
wlgpa24md-2005	GPA24M	WL-hourly	-0.89	1.24	2755	0.760	126.14	0.089	0.21	10.0%	-0.86	1.28	697	0.741	35.18	0.088	0.22	10.5%
wlgpa25md-2005	GPA25M	WL-hourly	-0.97	1.44	2750	0.653	158.93	0.001	0.24	10.0%	-1.10	1.14	697	0.645	39.98	0.002	0.24	10.7%
wlgpa26d-2005	GPA26	WL-hourly	-1.19	1.29	2210	0.788	85.62	-0.008	0.20	7.9%	-0.92	1.19	553	0.786	23.05	0.003	0.20	9.7%
GPA river network specific-conductance models																		
scgpa04bd-2005	GPA04B	SC-hourly	-39814	-8970	4284	0.522	4.04E+10	1124	3072	10.0%	-37572	-10000	1090	0.491	1.12E+10	1264	3202.85	11.6%
scgpa04sd-2005	GPA04S	SC-hourly	27602	2556	4511	0.650	2.93E+10	901	2549	8.5%	-26373	-775	1145	0.666	7.30E+9	796	2527	9.9%
scgpa05bd-2005	GPA05B	SC-hourly	-21759	1084	3901	0.714	1.87E+10	-2161	2190	9.6%	-21367	-178	1021	0.702	5.13E+9	-2082	2244	10.6%
scgpa06bd-2005	GPA06B	SC-hourly	-37739	-502	4155	0.676	5.80E+10	2127	3737	10.0%	-37573	621	1090	0.678	1.46E+10	1960	3663	9.9%
scgpa06sd-2005	GPA06S	SC-hourly	-20801	11578	4131	0.641	1.68E+10	497	2017	6.2%	-19027	9616	1044	0.630	4.20E+9	428	2008	7.0%
scgpa07bd-2005	GPA07B	SC-hourly	-15830	147	2042	0.806	3.14E+9	175	1241	7.8%	-15880	41	555	0.808	9.45E+8	140	1307	8.2%
scgpa07sd-2005	GPA07S	SC-hourly	-16314	100	2376	0.857	2.65E+9	-388	1057	6.4%	-15529	97	598	0.861	7.79E+8	-471	1343	7.3%
scgpa08bd-2005	GPA08B	SC-hourly	-30232	5712	4792	0.402	5.98E+10	672	3533	9.8%	-30249	592	1216	0.428	1.35E+10	799	3335	10.8%
scgpa08sd-2005	GPA08S	SC-hourly	-6751	19219	4112	0.419	8.33E+9	-320	1424	5.5%	-4379	15676	1030	0.409	1.72E+9	-331	1294	6.4%
scgpa09bd-2005	GPA09B	SC-hourly	-23857	9668	4611	0.260	1.31E+10	400	1686	5.0%	-21042	3490	1178	0.295	3.07E+9	369	1616	6.6%
scgpa09sd-2005	GPA09S	SC-hourly	-10331	13666	1641	0.546	1.93E+9	49	1085	4.5%	-9256	10335	410	0.568	3.98E+8	71	973	5.0%

Appendix I. Summary statistics for the water-level and specific-conductance models used in the study.—Continued

[WL, water level; SC, specific conductance; Min, minimum; Max, maximum; n, number of data points; R^2, coefficient of determination; SSE, sum of squared error; ME, mean error; RMSE, root mean square error; PME, percent model error]

Model name	Gage number	Output variable	Range of output variable		Training		SSE	ME	RMSE	PME	Range of output variable		Testing					
			Min	Max	n	R^2					Min	Max	n	R^2	SSE	ME	RMSE	PME
GPA river network specific-conductance models—Continued																		
scgpa10bd-2005	GPA10B	SC-hourly	-5530	19498	2335	0.919	1.75E+9	-84	866	3.8%	-4965	13953	625	0.908	4.30E+8	-113	831	4.4%
scgpa10sd-2005	GPA10S	SC-hourly	-3999	16271	1609	0.899	1.15E+9	-366	846	4.2%	-4321	13949	410	0.887	3.20E+8	-410	886	4.8%
scgpa11bd-2005	GPA11B	SC-hourly	-6645	1386	1777	0.534	2.53E+8	-66	378	4.7%	-6422	1237	470	0.430	7.57E+7	-77	402	5.3%
scgpa11rbd-2005	GPA11RB	SC-hourly	-13115	16987	1288	0.662	3.98E+9	-633	1750	5.8%	-12878	15785	326	0.743	7.36E+8	-733	1507	5.3%
scgpa12bd-2005	GPA12B	SC-hourly	-569	21688	3003	0.986	6.51E+8	-66	466	2.1%	-298	20393	787	0.985	1.65E+8	-76	458	2.2%
scgpa12rsd-2005	GPA12RS	SC-hourly	-4958	20297	1455	0.847	2.63E+9	-384	1345	5.3%	-4131	18648	367	0.861	5.21E+8	-532	1304	5.7%
scgpa13bd-2005	GPA13B	SC-hourly	-1769	2620	2120	0.408	8.06E+7	-84	195	4.4%	-1411	2212	561	0.502	2.06E+7	-83	192	5.3%
scgpa14bd-2005	GPA14B	SC-hourly	-53	36	4502	0.662	2.55E+5	-5	8	8.4%	-45	31	1169	0.657	6.84E+4	-5	8	10.2%
scgpa15sd-2005	GPA15S	SC-hourly	-5267	769	5540	0.555	3.90E+8	-2	265	4.4%	-5180	560	1359	0.518	1.00E+8	-4	271	4.7%
scgpa21bd-2005	GPA21B	SC-hourly	-39880	-9982	1759	0.577	2.03E+10	-56	3399	11.3%	-39856	-10000	427	0.503	5.19E+9	-149	3495	11.7%
scgpa21sd-2005	GPA21S	SC-hourly	-20970	8773	2396	0.606	1.03E+10	-927	2074	7.0%	-21397	5406	597	0.594	2.57E+9	-1063	2078	7.7%
scgpa22bd-2005	GPA22B	SC-hourly	-28249	-660	1328	0.329	1.45E+10	-99	3307	12.0%	-25199	-1255	334	0.269	3.81E+9	-415	3388	14.1%
scgpa22sd-2005	GPA22S	SC-hourly	-11036	18858	1602	0.627	4.29E+9	212	1637	5.5%	-12626	14317	393	0.627	1.09E+9	217	1670	6.2%
GPA marsh network water-level models																		
ps1canalwl-2005	Site 1	WL-hourly	-0.80	6.01	815	0.983	59.48	0.000	0.27	4.0%	0.8	6.27	7911	0.983	680.61	-0.007	0.29	4.1%
ps1marshwl-2005	Site 1	WL-hourly	4.88	5.57	1726	0.648	2.17	0.000	0.04	5.1%	4.86	5.66	7208	0.610	13.02	-0.001	0.04	5.3%
[1]ps1marshwl1at-2005	Site 1	WL-hourly	4.73	5.89	1371	0.672	8.09	-0.000	0.08	6.7%								
ps2canalwl-2005	Site 2	WL-hourly	0.56	5.70	613	0.922	96.17	-0.001	0.40	7.7%	0.56	5.76	2398	0.936	390.11	0.004	0.40	7.8%
ps2marshwl-2005	Site 3	WL-hourly	5.55	4.65	796	0.741	3.67	0.000	0.07	6.2%	3.47	4.78	2306	0.740	13.30	-0.002	0.08	5.8%
ps3canalwl-2005	Site 3	WL-hourly	-0.50	6.29	877	0.976	78.46	-0.000	0.30	4.4%	-0.5	6.56	12699	0.961	2004.13	-0.015	0.40	5.6%
ps3marshwl-2005	Site 4	WL-hourly	3.89	5.32	2077	0.891	3.87	0.000	0.04	3.0%	3.85	5.32	12595	0.806	43.74	-0.002	0.06	4.0%
ps4canalwl-2005	Site 4	WL-hourly	-2.78	5.94	809	0.986	68.59	0.001	0.29	3.3%	-2.79	6.12	7784	0.985	818.92	-0.012	0.32	3.6%
ps4marshwl-2005	Site 5	WL-hourly	4.06	5.16	1764	0.902	1.76	-0.000	0.03	2.9%	4.06	5.25	7762	0.858	12.98	-0.001	0.04	3.4%
ps5canalwl-2005	Site 5	WL-hourly	-0.35	6.36	4805	0.989	226.77	0.000	0.22	3.2%	-0.22	8.59	5784	0.619	10029.90	1.632	1.32	14.9%
ps5marshwl-2005	Site 6	WL-hourly	4.62	5.60	1965	0.911	1.61	-0.000	0.03	2.9%	4.61	5.61	10219	0.891	10.16	-0.003	0.03	3.2%
ps6canalwl-2005	Site 6	WL-hourly	0.18	6.13	791	0.990	22.32	-0.000	0.17	2.8%	0.18	6.78	7408	0.983	441.83	-0.003	0.24	3.7%
ps6marshwl-2005	Site 6	WL-hourly	4.83	5.47	1647	0.804	1.31	0.000	0.03	4.4%	4.83	5.6	6637	0.763	7.89	-0.002	0.03	4.5%
[1]ps6marshwl1at-2005	Site 6	WL-hourly	4.67	5.84	1720	0.960	1.65	-0.000	0.03	2.6%								
ps7canalwl-2005	Site 7	WL-hourly	-0.93	5.69	572	0.924	177.69	0.000	0.56	8.4%	-0.93	6	2739	0.933	881.28	-0.024	0.57	8.2%
[1]ps7marshwl-2005	Site 7	WL-hourly	4.19	5.28	2822	0.701	13.81	-0.000	0.07	6.4%								

Appendix I. Summary statistics for the water-level and specific-conductance models used in the study.—Continued

[WL, water level; SC, specific conductance; Min, minimum; Max, maximum; n, number of data points; R^2, coefficient of determination; SSE, sum of squared error; ME, mean error; RMSE, root mean square error; PME, percent model error]

Model name	Gage number	Output variable	Range of output variable		Training		SSE	ME	RMSE	PME	Range of output variable		Testing					
			Min	Max	n	R^2					Min	Max	n	R^2	SSE	ME	RMSE	PME
GPA marsh network water-level models—Continued																		
[1]ps8canalwl-2005	Site 8	WL-hourly	0.18	5.74	430	0.996	6.54	0.000	0.12	2.2%								
ps9canalwl-2005	Site 9	WL-hourly	1.00	5.68	805	0.991	14.87	0.000	0.14	2.9%	0.99	6.18	7829	0.988	213.29	−0.001	0.17	3.2%
ps9marshwl-2005	Site 9	WL-hourly	3.89	5.13	1801	0.827	8.63	0.000	0.07	5.6%	3.89	5.27	7882	0.762	55.80	0.000	0.08	6.1%
ps10canalwl-2005	Site 10	WL-hourly	−0.26	6.29	694	0.982	45.82	0.000	0.26	3.9%	−0.26	6.68	5982	0.980	513.02	−0.010	0.29	4.2%
ps10marshwl-2005	Site 10	WL-hourly	3.99	5.09	1530	0.906	1.73	0.000	0.03	3.1%	3.98	5.19	5985	0.904	9.32	−0.005	0.04	3.3%
GPA marsh network specific-conductance models																		
ps1canalsc-2005	Site 1	SC-hourly	0	22990	750	0.926	1.51E+9	1.3	1420.82	6.2%	0	23690	7559	0.885	1.34E+10	−179	1331.61	5.6%
ps1marshsc-2005	Site 1	SC-hourly	0	16740	1441	0.726	1.29E+9	0.3	946.81	5.7%	0	16740	3990	0.722	2.11E+9	−45.0	727.38	4.3%
ps2canalsc-2005	Site 2	SC-hourly	694	25157	1301	0.913	3.27E+9	9.0	1586.61	6.5%	0	25869	6355	0.897	1.54E+10	−110	1556.94	6.0%
ps2marshsc-2005	Site 2	SC-hourly	5	21870	902	0.882	4.00E+9	2.4	2107.13	9.6%	0	21870	2733	0.876	8.97E+9	45.7	1812.32	8.3%
ps3canalsc-2005	Site 3	SC-hourly	0	19750	2118	0.812	3.88E+9	0.0	1354.12	6.9%	0	23010	11954	0.813	1.28E+10	−75.0	1034.87	4.5%
ps3marshsc-2005	Site 3	SC-hourly	0	13320	2062	0.845	1.84E+9	1.7	945.09	7.1%	0	13320	11025	0.826	5.25E+9	−34.5	690.13	5.2%
ps4canalsc-2005	Site 4	SC-hourly	0	13535	1798	0.865	9.28E+8	4.3	718.82	5.3%	0	14330	7463	0.839	2.85E+9	0.8	618.05	4.3%
ps4marshsc-2005	Site 4	SC-hourly	0	9590	1658	0.897	3.11E+8	0.0	433.36	4.5%	0	9890	5535	0.861	7.44E+8	−14.5	366.70	3.7%
ps5canalsc-2005	Site 5	SC-hourly	0	11600	1509	0.814	8.42E+8	2.8	749.72	6.5%	0	45780	4312	0.000	3.22E+11	19536	8643.49	18.9%
ps5marshsc-2005	Site 5	SC-hourly	0	21300	4108	0.630	1.78E+10	−2.4	2082.09	9.8%	0	21300	12677	0.548	3.99E+10	6.6	1774.24	8.3%
ps6canalsc-2005	Site 6	SC-hourly	0	20930	1617	0.834	3.17E+9	−1.1	1401.02	6.7%	0	22290	6115	0.825	7.58E+9	3.1	1113.54	5.0%
ps6marshsc-2005	Site 6	SC-hourly	0	19170	1673	0.859	1.50E+9	1.0	947.45	4.9%	0	20940	5953	0.814	3.62E+9	−40.7	779.94	3.7%
ps7canalsc-2005	Site 7	SC-hourly	0	24710	3665	0.875	1.18E+10	3.1	1794.83	7.3%	0	22260	3040	0.000	1.70E+11	1214	7469.44	33.6%
prs7marshpwc	Site 7	SC-hourly	88	6089	1539	0.150	3.26E+9	1.0	1456.37	24.3%	0	8180.38	6136	0.141	1.28E+10	14.1	1444.55	17.7%
ps7marshpwsc-2005-2	Site 7	SC-hourly	0	20180	4270	0.650	1.11E+10	−1.0	1612.68	8.0%	0	22180	4260	0.679	1.07E+10	21.0	1585.22	7.1%
ps8canalsc-2005	Site 8	SC-hourly	0	5797	1458	0.871	7.40E+7	0.3	225.48	3.9%	0	5797	4752	0.831	2.73E+8	24.1	239.74	4.1%
ps9canalsc-2005	Site 9	SC-hourly	0	16240	1805	0.847	1.10E+9	−10.6	780.87	4.8%	0	16240	6905	0.826	2.58E+9	−11.1	611.35	3.8%
prs9marshpwc	Site 9	SC-hourly	88	3729	1519	0.098	2.20E+8	−0.0	380.82	10.5%	0	3781.08	6052	0.097	8.34E+8	−1.5	371.28	9.8%
ps9marshpwsc-2005-2	Site 9	SC-hourly	0	6002	4221	0.518	7.95E+8	−0.1	434.09	7.2%	0	6002	4205	0.556	7.27E+8	−20.5	415.90	6.9%
prs10marshpwc	Site 10	SC-hourly	88	2184	1460	0.100	8.41E+9	0.4	2401.70	114.6%	0	2188.51	5797	0.101	3.17E+10	77.0	2338.85	106.9%
ps10marshpwsc-2005-2	Site 10	SC-hourly	0	17400	3195	0.851	2.42E+9	1.1	870.58	5.0%	0	17370	4917	0.324	3.70E+10	−1834	2743.72	15.8%

[1] Sum of results from marsh and residual models. Statistics for period of record for each USGS marsh site.

[2] Models predicted differences from one of the USGS river gages. Observed minimum conductance is difference with USGS river gage and may be negative.

[3] Due to data quality concerns, data set was not bifurcated into training and testing datasets.

Appendix II. Model summary of artificial neural network models used in the Model-to-Marsh application.

[R^2, coefficient of determination]

Model	Input variables	Output variable	Number of hidden neurons	Training matrix size	Testing matrix size	R^2 training	R^2 testing
USGS river network water-level models							
wl8840a-2005-1	Q8500A DQ8500A FWL8980A XWL8980A DXWLAD1 DWLAD1	WL8840A	3	11051	81446	0.969	0.964
wl8840h-2005-1	LG1NWL LG1D3NWL LG4D3NWL LG7D3NWL LG10D3NWL LG13D3NWL PWL8840A	WL8840	3	2303	70796	0.987	0.983
wl8920a-2005-1	Q8500A DQ8500A FWL8980A XWL8980A DXWLAD1 DWLAD1	WL8920A	3	10482	68121	0.977	0.883
wl8920h-2005-1	LG1NWL LG1D3NWL LG4D3NWL LG7D3NWL LG10D3NWL LG13D3NWL PWL8920A	WL8920	2	10538	68368	0.995	0.991
wl8977a-2005-1	Q8500A DQ8500A FWL8980A XWL8980A DXWLAD1 DWLAD1	WL8977A	2	10612	79682	0.960	0.965
wl8977h-2005-1	LG1NWL LG1D3NWL LG4D3NWL LG7D3NWL LG10D3NWL LG13D3NWL PWL8977A	WL8977	2	10717	79951	0.994	0.995

Appendix II. Model summary of artificial neural network models used in the Model-to-Marsh application.—Continued

[R^2, coefficient of determination]

Model	Input variables	Output variable	Number of hidden neurons	Training matrix size	Testing matrix size	R^2 training	R^2 testing
USGS river network water-level models—Continued							
wl8979a-2005-1	Q8500A DQ8500A FWL8980A XWL8980A DXWLAD1 DWLAD1	WL8979A	2	7987	70993	0.952	0.961
wl8979h-2005-1	LG1NWL LG1D3NWL LG4D3NWL LG7D3NWL LG10D3NWL LG13D3NWL PWL8979A	WL8979	2	8029	71187	0.984	0.981
USGS river network specific-conductance models							
sc8840a-2005-1	Q8500A DQ8500A LAQ2 DAQ2 DAQ16 DAQ30 FWL8980A XWL8980A DWLA DXWLA	SC8840A	3	10056	77309	0.887	0.851
sc8840h-2005-1	LG1NWL LG1D3NWL LG4D3NWL LG7D3NWL PSC8840A NXWL	SC8840	2	10197	77772	0.879	0.567
sc8920a-2005-1	Q8500A DQ8500A LAQ2 DAQ2 DAQ16 DAQ30 FWL8980A XWL8980A DWLA DXWLA LG2DWLA LG2DXWLA	SC8920A	2	9836	67677	0.897	0.883

Appendix II. Model summary of artificial neural network models used in the Model-to-Marsh application.—Continued

[R^2, coefficient of determination]

Model	Input variables	Output variable	Number of hidden neurons	Training matrix size	Testing matrix size	R^2 training	R^2 testing
USGS river network specific-conductance models—Continued							
sc8920h-2005-1	FWL8980A XWL8980A NXWL LG1NWL LG1D3NWL LG4D3NWL LG7D3NWL LG10D3NWL LG13D3NWL PSC8920A	SC8920	2	9900	67820	0.900	0.867
sc89784a-2005-1	Q8500A DQ8500A LAQ2 DAQ2 DAQ16 DAQ30 FWL8980A XWL8980A DWLA DXWLA LG2DWLA LG2DXWLA	SC89784A	3	8534	70348	0.880	0.853
sc89784b-2005-1	PSC89784A FWL8980A XWL8980A NXWL LG1NWL LG1D3NWL LG4D3NWL LG7D3NWL LG10D3NWL LG13D3NWL	SC89784	3	8600	71064	0.825	0.793
sc89791a-2005-1	Q8500A DQ8500A LAQ2 DAQ2 DAQ16 DAQ30 FWL8980A XWL8980A	SC89791A	3	9660	75782	0.887	0.870

Appendix II. Model summary of artificial neural network models used in the Model-to-Marsh application.—Continued

[R^2, coefficient of determination]

Model	Input variables	Output variable	Number of hidden neurons	Training matrix size	Testing matrix size	R^2 training	R^2 testing
USGS river network specific-conductance models—Continued							
sc89791a-2005-1 (cont.)	DWLA DXWLA LG2DWLA LG2DXWLA						
sc89791b-2005-1	FWL8980A XWL8980A NXWL LG1NWL LG1D3NWL LG4D3NWL LG7D3NWL LG10D3NWL LG13D3NWL PSC89791A	SC89791	3	9736	76366	0.888	0.826
USGS marsh network water-level models							
pb1mwl-2005	FWL8840 DFWL8840 LG3DFWL8840 LG6DFWL8840 FWLDIF8977 FWLDIF8979 FWLDIF8920	B1MWL	2	3143	17653	0.770	0.762
pb2mwl-2005	FWL8840 DFWL8840 LG3DFWL8840 LG6DFWL8840 FWLDIF8977 FWLDIF8979 FWLDIF8920	FB2MWL	2	3284	18228	0.797	0.768
pb3mwl-2005	FWL8840 DFWL8840 LG3DFWL8840 LG6DFWL8840 FWLDIF8977 FWLDIF8979 FWLDIF8920	FB3MWL	2	3558	20082	0.858	0.866
pb4mwl-2005	FWL8840 DFWL8840 LG3DFWL8840 LG6DFWL8840	FB4MWL-0P1	2	2879	15877	0.887	0.883

Appendix II. Model summary of artificial neural network models used in the Model-to-Marsh application.—Continued

[R^2, coefficient of determination]

Model	Input variables	Output variable	Number of hidden neurons	Training matrix size	Testing matrix size	R^2 training	R^2 testing
USGS marsh network water-level models—Continued							
pb4mwl-2005 (cont.)	FWLDIF8977 FWLDIF8979 FWLDIF8920						
pf1mwl-2005	FWL8840 DFWL8840 LG3DFWL8840 LG6DFWL8840 FWLDIF8977 FWLDIF8979 FWLDIF8920	FF1MWL	2	4243	23982	0.839	0.836
pm1mwl-2005	FWL8840 DFWL8840 LG3DFWL8840 LG6DFWL8840 FWLDIF8977 FWLDIF8979 FWLDIF8920	FM1MWL	2	2424	13299	0.694	0.722
pm2mwl-2005	FWL8840 DFWL8840 LG3DFWL8840 LG6DFWL8840 FWLDIF8977 FWLDIF8979 FWLDIF8920	M2MWL	2	1751	9676	0.808	0.778
USGS marsh network specific-conductance models							
pb1msc-2005-2	SCDIF8840A SCDIF8920A FSC89791A4WK LG672FSC89791A4WKD4WK FSC89791A2WKD4WK FSC89791A1WKD2WK FSC89791A48D1WK FSC89791DA48 DFSC89791DA48 LG3DFSC89791DA48	B1MSC	1	2333	20555	0.857	0.849
pb2msc-2005-2	SCDIF8840A SCDIF8920A FSC89791A4WK LG672FSC89791A4WKD4WK FSC89791A2WKD4WK	B2MSC	1	2142	18770	0.827	0.832

Appendix II. Model summary of artificial neural network models used in the Model-to-Marsh application.—Continued

[R^2, coefficient of determination]

Model	Input variables	Output variable	Number of hidden neurons	Training matrix size	Testing matrix size	R^2 training	R^2 testing
USGS marsh network specific-conductance models—Continued							
pb2msc-2005-2 (cont.)	FSC89791A1WKD2WK FSC89791A48D1WK FSC89791DA48 DFSC89791DA48 LG3DFSC89791DA48						
pb3msc-2005-2	SCDIF8840A SCDIF8920A FSC89791A4WK LG672FSC89791A4WKD4WK FSC89791A2WKD4WK FSC89791A1WKD2WK FSC89791A48D1WK FSC89791DA48 DFSC89791DA48 LG3DFSC89791DA48	B3MSC	1	2326	20519	0.549	0.532
pb4msc-2005-2	SCDIF8840A SCDIF8920A FSC89791A4WK LG672FSC89791A4WKD4WK FSC89791A2WKD4WK FSC89791A1WKD2WK FSC89791A48D1WK FSC89791DA48 DFSC89791DA48 LG3DFSC89791DA48	B4MSC	1	2093	18577	0.654	0.641
pf1msc-2005-2	SCDIF8840A SCDIF8920A FSC89791A4WK LG672FSC89791A4WKD4WK FSC89791A2WKD4WK FSC89791A1WKD2WK FSC89791A48D1WK FSC89791DA48 DFSC89791DA48 LG3DFSC89791DA48	F1MSC	1	2496	22073	0.816	0.820
pm1msc-2005-2	SCDIF8840A SCDIF8920A FSC89791A4WK LG672FSC89791A4WKD4WK FSC89791A2WKD4WK	M1MSC	1	2147	18927	0.809	0.808

Appendix II. Model summary of artificial neural network models used in the Model-to-Marsh application.—Continued

[R^2, coefficient of determination]

Model	Input variables	Output variable	Number of hidden neurons	Training matrix size	Testing matrix size	R^2 training	R^2 testing
USGS marsh network specific-conductance models—Continued							
pm1msc-2005-2 (cont.)	FSC89791A1WKD2WK FSC89791A48D1WK FSC89791DA48 DFSC89791DA48 LG3DFSC89791DA48						
pm2msc-2005-2	SCDIF8840A SCDIF8920A FSC89791A4WK LG672FSC89791A4WKD4WK FSC89791A2WKD4WK FSC89791A1WKD2WK FSC89791A48D1WK FSC89791DA48 DFSC89791DA48 LG3DFSC89791DA48	M2MSC	1	2323	20593	0.841	0.830
GPA river specific-conductance decorrelation models							
dc_gpa_a1wk_10s_11b	PSCGPA11B_FLR_A1WK	PSCGPA10S_FLR_A1WK	1	7644	30459	0.800	0.804
dc_gpa_a1wk_10s_11rb	PSCGPA11RB_FLR_A1WK	PSCGPA10S_FLR_A1WK	1	7750	30921	0.957	0.958
dc_gpa_a1wk_10s_12rs	PSCGPA12RS_FLR_A1WK	PSCGPA10S_FLR_A1WK	1	7750	30921	0.881	0.880
Residual USGS marsh models							
prb1msc	RSC10S_12RS_A1WK RSC10S_11RB_A1WK RSC10S_11B_A1WK PSCGPA10S_FLR_A1WK	RB1MSC	1	4547	18224	0.080	0.087
prb2msc	RSC10S_12RS_A1WK RSC10S_11RB_A1WK RSC10S_11B_A1WK PSCGPA10S_FLR_A1WK	RB2MSC	1	4176	16736	0.067	0.059
prb3msc	RSC10S_12RS_A1WK RSC10S_11RB_A1WK RSC10S_11B_A1WK PSCGPA10S_FLR_A1WK	RB3MSC	1	4519	18209	0.020	0.018
prb4msc	RSC10S_12RS_A1WK RSC10S_11RB_A1WK RSC10S_11B_A1WK PSCGPA10S_FLR_A1WK	RB4MSC	1	4097	16456	0.020	0.020
prf1msc	RSC10S_12RS_A1WK RSC10S_11RB_A1WK RSC10S_11B_A1WK PSCGPA10S_FLR_A1WK	RF1MSC	1	4873	19579	0.042	0.050

Appendix II. Model summary of artificial neural network models used in the Model-to-Marsh application.—Continued

[R^2, coefficient of determination]

Model	Input variables	Output variable	Number of hidden neurons	Training matrix size	Testing matrix size	R^2 training	R^2 testing
Residual USGS marsh models—Continued							
prm1msc	RSC10S_12RS_A1WK RSC10S_11RB_A1WK RSC10S_11B_A1WK PSCGPA10S_FLR_A1WK	RM1MSC	1	4163	16803	0.073	0.065
prm2msc	RSC10S_12RS_A1WK RSC10S_11RB_A1WK RSC10S_11B_A1WK PSCGPA10S_FLR_A1WK	RM2MSC	1	4539	18260	0.034	0.016
GPA river network water-level models							
wlgpa04d-2005	WL8977 D3WL8977 D3WL8977(006) D3WL8977(012) D3WL8977(018) D3WL8977(024)	DWL8977GPA04	2	4215	1079	0.640	0.626
wlgpa05d-2005	WL8977 D3WL8977 D3WL8977(006) D3WL8977(012) D3WL8977(018) D3WL8977(024)	DWL8977GPA05	2	4344	1133	0.638	0.676
wlgpa06d-2005	WL8977 D3WL8977 D3WL8977(006) D3WL8977(012) D3WL8977(018) D3WL8977(024)	DWL8977GPA06	2	4305	1124	0.176	0.152
wlgpa07d-2005	WL8920 D3WL8920 D3WL8920(006) D3WL8920(012) D3WL8920(018) D3WL8920(024)	DWL8920GPA07	2	1606	416	0.641	0.639
wlgpa08d-2005	WL8920 D3WL8920 D3WL8920(006) D3WL8920(012) D3WL8920(018) D3WL8920(024)	DWL8920GPA08	2	4614	1175	0.238	0.216

Appendix II. Model summary of artificial neural network models used in the Model-to-Marsh application.—Continued

[R^2, coefficient of determination]

Model	Input variables	Output variable	Number of hidden neurons	Training matrix size	Testing matrix size	R^2 training	R^2 testing
GPA river network water-level models—Continued							
wlgpa09d-2005	WL8920 D3WL8920 D3WL8920(006) D3WL8920(012) D3WL8920(018) D3WL8920(024)	DWL8920GPA09	3	4642	1192	0.338	0.310
wlgpa10d-2005	WL8920 D3WL8920 D3WL8920(006) D3WL8920(012) D3WL8920(018) D3WL8920(024)	DWL8920GPA10	2	2187	587	0.230	0.233
wlgpa11d-2005	WL8979 D3WL8979 D3WL8979(006) D3WL8979(012) D3WL8979(018) D3WL8979(024)	DWL8979GPA11	2	1578	434	0.534	0.570
wlgpa11rd-2005	WL8920 D3WL8920 D3WL8920(006) D3WL8920(012) D3WL8920(018) D3WL8920(024)	DWL8920GPA11R	2	1617	399	0.863	0.855
wlgpa12d-2005	WL8920 D3WL8920 D3WL8920(006) D3WL8920(012) D3WL8920(018) D3WL8920(024)	DWL8920GPA12	2	2846	749	0.272	0.242
wlgpa13d-2005	WL8979 D3WL8979 D3WL8979(006) D3WL8979(012) D3WL8979(018) D3WL8979(024)	DWL8979GPA13	2	2123	561	0.917	0.926
wlgpa14d-2005	WL8840 D3WL8840 D3WL8840(006) D3WL8840(012) D3WL8840(018) D3WL8840(024)	DWL8840GPA14	2	1630	424	0.914	0.909

Appendix II. Model summary of artificial neural network models used in the Model-to-Marsh application.—Continued

[R^2, coefficient of determination]

Model	Input variables	Output variable	Number of hidden neurons	Training matrix size	Testing matrix size	R^2 training	R^2 testing
GPA river network water-level models—Continued							
wlgpa21d-2005	WL8977 D3WL8977 D3WL8977(006) D3WL8977(012) D3WL8977(018) D3WL8977(024)	DWL8977GPA21	2	2227	551	0.030	0.004
wlgpa22d-2005	WL8920 D3WL8920 D3WL8920(006) D3WL8920(012) D3WL8920(018) D3WL8920(024)	DWL8920GPA22	2	1502	384	0.884	0.867
wlgpa23d-2005	WL8977 D3WL8977 D3WL8977(006) D3WL8977(012) D3WL8977(018) D3WL8977(024)	DWL8977GPA23	2	2754	696	0.816	0.798
wlgpa24md-2005	WL8977 D3WL8977 D3WL8977(006) D3WL8977(012) D3WL8977(018) D3WL8977(024)	DWL8977GPA24M	2	2755	697	0.760	0.741
wlgpa25md-2005	WL8977 D3WL8977 D3WL8977(006) D3WL8977(012) D3WL8977(018) D3WL8977(024)	DWL8977GPA25M	2	2750	697	0.653	0.645
wlgpa26d-2005	WL8977 D3WL8977 D3WL8977(006) D3WL8977(012) D3WL8977(018) D3WL8977(024)	DWL8977GPA26	2	2210	553	0.788	0.786
GPA river network specific-conductance models							
scgpa04bd-2005	SC8920 D3SC8920 D3SC8920(006)	DSC8920GPA04B	3	4284	1090	0.522	0.491

Appendix II. Model summary of artificial neural network models used in the Model-to-Marsh application.—Continued

[R^2, coefficient of determination]

Model	Input variables	Output variable	Number of hidden neurons	Training matrix size	Testing matrix size	R^2 training	R^2 testing
GPA river network specific-conductance models—Continued							
scgpa04bd-2005 (cont.)	D3SC8920(012) D3SC8920(018) D3SC8920(024) WL8977 D3WL8977 D3WL8977(006) D3WL8977(012) D3WL8977(018) D3WL8977(024)						
scgpa04sd-2005	SC8920 D3SC8920 D3SC8920(006) D3SC8920(012) D3SC8920(018) D3SC8920(024) WL8977 D3WL8977 D3WL8977(006) D3WL8977(012) D3WL8977(018) D3WL8977(024)	DSC8920GPA04S	2	4511	1145	0.650	0.666
scgpa05bd-2005	SC8920 D3SC8920 D3SC8920(006) D3SC8920(012) D3SC8920(018) D3SC8920(024) WL8977 D3WL8977 D3WL8977(006) D3WL8977(012) D3WL8977(018) D3WL8977(024)	DSC8920GPA05B	3	3901	1021	0.714	0.702
scgpa06bd-2005	SC8920 D3SC8920 D3SC8920(006) D3SC8920(012) D3SC8920(018) D3SC8920(024) WL8977	DSC8920GPA06B	3	4155	1090	0.676	0.678

Appendix II. Model summary of artificial neural network models used in the Model-to-Marsh application.—Continued

[R^2, coefficient of determination]

Model	Input variables	Output variable	Number of hidden neurons	Training matrix size	Testing matrix size	R^2 training	R^2 testing
GPA river network specific-conductance models—Continued							
scgpa06bd-2005 (cont.)	D3WL8977						
	D3WL8977(006)						
	D3WL8977(012)						
	D3WL8977(018)						
	D3WL8977(024)						
scgpa06sd-2005	SC8920	DSC8920GPA06S	2	4131	1044	0.641	0.630
	D3SC8920						
	D3SC8920(006)						
	D3SC8920(012)						
	D3SC8920(018)						
	D3SC8920(024)						
	WL8977						
	D3WL8977						
	D3WL8977(006)						
	D3WL8977(012)						
	D3WL8977(018)						
	D3WL8977(024)						
scgpa07bd-2005	SC89791	DSC89791GPA07B	2	2042	555	0.806	0.808
	D3SC89791						
	D3SC89791(006)						
	D3SC89791(012)						
	D3SC89791(018)						
	D3SC89791(024)						
	WL8979						
	D3WL8979						
	D3WL8979(006)						
	D3WL8979(012)						
	D3WL8979(018)						
	D3WL8979(024)						
scgpa07sd-2005	SC89791	DSC89791GPA07S	2	2376	598	0.857	0.861
	D3SC89791						
	D3SC89791(006)						
	D3SC89791(012)						
	D3SC89791(018)						
	D3SC89791(024)						
	WL8979						
	D3WL8979						
	D3WL8979(006)						
	D3WL8979(012)						
	D3WL8979(018)						
	D3WL8979(024)						

Appendix II. Model summary of artificial neural network models used in the Model-to-Marsh application.—Continued

[R^2, coefficient of determination]

Model	Input variables	Output variable	Number of hidden neurons	Training matrix size	Testing matrix size	R^2 training	R^2 testing
GPA river network specific-conductance models—Continued							
scgpa08bd-2005	DSC89791GPA07S SC8920 D3SC8920 D3SC8920(006) D3SC8920(012) D3SC8920(018) D3SC8920(024) WL8920 D3WL8920 D3WL8920(006) D3WL8920(012) D3WL8920(018) D3WL8920(024)	DSC8920GPA08B	2	4792	1216	0.402	0.428
scgpa08sd-2005	SC8920 D3SC8920 D3SC8920(006) D3SC8920(012) D3SC8920(018) D3SC8920(024) WL8920 D3WL8920 D3WL8920(006) D3WL8920(012) D3WL8920(018) D3WL8920(024)	DSC8920GPA08S	2	4112	1030	0.419	0.409
scgpa09bd-2005	SC8920 D3SC8920 D3SC8920(006) D3SC8920(012) D3SC8920(018) D3SC8920(024) WL8920 D3WL8920 D3WL8920(006) D3WL8920(012) D3WL8920(018) D3WL8920(024)	DSC8920GPA09B	2	4611	1178	0.260	0.295
scgpa09sd-2005	SC8920 D3SC8920 D3SC8920(006)	DSC8920GPA09S	2	1640	410	0.546	0.568

Appendix II. Model summary of artificial neural network models used in the Model-to-Marsh application.—Continued

[R^2, coefficient of determination]

Model	Input variables	Output variable	Number of hidden neurons	Training matrix size	Testing matrix size	R^2 training	R^2 testing
GPA river network specific-conductance models—Continued							
scgpa09sd-2005 (cont.)	D3SC8920(012) D3SC8920(018) D3SC8920(024) WL8920 D3WL8920 D3WL8920(006) D3WL8920(012) D3WL8920(018) D3WL8920(024)						
scgpa10bd-2005	SC8920 D3SC8920 D3SC8920(006) D3SC8920(012) D3SC8920(018) D3SC8920(024) WL8920 D3WL8920 D3WL8920(006) D3WL8920(012) D3WL8920(018) D3WL8920(024)	DSC8920GPA10B	2	2335	625	0.919	0.908
scgpa10sd-2005	SC8920 D3SC8920 D3SC8920(006) D3SC8920(012) D3SC8920(018) D3SC8920(024) WL8920 D3WL8920 D3WL8920(006) D3WL8920(012) D3WL8920(018) D3WL8920(024)	DSC8920GPA10S	2	1609	410	0.899	0.887
scgpa11bd-2005	SC89791 D3SC89791 D3SC89791(006) D3SC89791(012) D3SC89791(018) D3SC89791(024) WL8979	DSC89791GPA11B	2	1777	470	0.534	0.430

Appendix II. Model summary of artificial neural network models used in the Model-to-Marsh application.—Continued

[R^2, coefficient of determination]

Model	Input variables	Output variable	Number of hidden neurons	Training matrix size	Testing matrix size	R^2 training	R^2 testing
GPA river network specific-conductance models—Continued							
scgpa11bd-2005 (cont.)	D3WL8979						
	D3WL8979(006)						
	D3WL8979(012)						
	D3WL8979(018)						
	D3WL8979(024)						
scgpa11rbd-2005	SC8920	DSC8920GPA11RB	2	1288	326	0.662	0.743
	D3SC8920						
	D3SC8920(006)						
	D3SC8920(012)						
	D3SC8920(018)						
	D3SC8920(024)						
	WL8920						
	D3WL8920						
	D3WL8920(006)						
	D3WL8920(012)						
	D3WL8920(018)						
	D3WL8920(024)						
scgpa12bd-2005	SC8920	DSC8920GPA12B	2	3003	787	0.986	0.985
	D3SC8920						
	D3SC8920(006)						
	D3SC8920(012)						
	D3SC8920(018)						
	D3SC8920(024)						
	WL8920						
	D3WL8920						
	D3WL8920(006)						
	D3WL8920(012)						
	D3WL8920(018)						
	D3WL8920(024)						
scgpa12rsd-2005	SC8920	DSC8920GPA12RS	2	1455	367	0.847	0.861
	D3SC8920						
	D3SC8920(006)						
	D3SC8920(012)						
	D3SC8920(018)						
	D3SC8920(024)						
	WL8920						
	D3WL8920						
	D3WL8920(006)						
	D3WL8920(012)						
	D3WL8920(018)						
	D3WL8920(024)						

Appendix II. Model summary of artificial neural network models used in the Model-to-Marsh application.—Continued

[R^2, coefficient of determination]

Model	Input variables	Output variable	Number of hidden neurons	Training matrix size	Testing matrix size	R^2 training	R^2 testing
GPA river network specific-conductance models—Continued							
scgpa13bd-2005	SC89791 D3SC89791 D3SC89791(006) D3SC89791(012) D3SC89791(018) D3SC89791(024) WL8979 D3WL8979 D3WL8979(006) D3WL8979(012) D3WL8979(018) D3WL8979(024)	DSC89791GPA13B	2	2120	561	0.408	0.502
scgpa14bd-2005	SC8840 D3SC8840 D3SC8840(006) D3SC8840(012) D3SC8840(018) D3SC8840(024) WL8840 D3WL8840 D3WL8840(006) D3WL8840(012) D3WL8840(018) D3WL8840(024)	DSC8840GPA14B	2	4502	1169	0.662	0.657
scgpa15sd-2005	SC89791 D3SC89791 D3SC89791(006) D3SC89791(012) D3SC89791(018) D3SC89791(024) WL8979 D3WL8979 D3WL8979(006) D3WL8979(012) D3WL8979(018) D3WL8979(024)	DSC89791GPA15S	2	5540	1359	0.555	0.518
scgpa21bd-2005	SC8920 D3SC8920 D3SC8920(006) D3SC8920(012)	DSC8920GPA21B	2	1759	427	0.577	0.503

Appendix II. Model summary of artificial neural network models used in the Model-to-Marsh application.—Continued

[R^2, coefficient of determination]

Model	Input variables	Output variable	Number of hidden neurons	Training matrix size	Testing matrix size	R^2 training	R^2 testing
GPA river network specific-conductance models—Continued							
scgpa21bd-2005 (cont.)	D3SC8920(018) D3SC8920(024) WL8977 D3WL8977 D3WL8977(006) D3WL8977(012) D3WL8977(018) D3WL8977(024)						
scgpa21sd-2005	SC8920 D3SC8920 D3SC8920(006) D3SC8920(012) D3SC8920(018) D3SC8920(024) WL8977 D3WL8977 D3WL8977(006) D3WL8977(012) D3WL8977(018) D3WL8977(024)	DSC8920GPA21S	3	2396	597	0.606	0.594
scgpa22bd-2005	SC8920 D3SC8920 D3SC8920(006) D3SC8920(012) D3SC8920(018) D3SC8920(024) WL8920 D3WL8920 D3WL8920(006) D3WL8920(012) D3WL8920(018) D3WL8920(024)	DSC8920GPA22B	2	1328	334	0.329	0.269
scgpa22sd-2005	SC8920 D3SC8920 D3SC8920(006) D3SC8920(012) D3SC8920(018) D3SC8920(024) WL8920 D3WL8920	DSC8920GPA22S	2	1602	393	0.627	0.627

Appendix II. Model summary of artificial neural network models used in the Model-to-Marsh application.—Continued

[R^2, coefficient of determination]

Model	Input variables	Output variable	Number of hidden neurons	Training matrix size	Testing matrix size	R^2 training	R^2 testing
GPA river network specific-conductance models—Continued							
scgpa22sd-2005 (cont.)	D3WL8920(006)						
	D3WL8920(012)						
	D3WL8920(018)						
	D3WL8920(024)						
GPA marsh network water-level models							
ps1canalwl-2005	FWL8840	S1CANALWL	2	815	7911	0.983	0.983
	DFWL8840						
	LG3DFWL8840						
	LG6DFWL8840						
	FWLDIF8977						
	FWLDIF8979						
	FWLDIF8920						
ps1marshwl-2005	FWL8840	S1MARSHWL	3	1726	7208	0.648	0.610
	DFWL8840						
	LG3DFWL8840						
	LG6DFWL8840						
	FWLDIF8977						
	FWLDIF8979						
	FWLDIF8920						
1ps1marshwlat-2005	FWL8840	S1MARSHWLAT	2	1371		0.672	
	DFWL8840						
	LG3DFWL8840						
	LG6DFWL8840						
	FWLDIF8977						
	FWLDIF8979						
	FWLDIF8920						
ps2canalwl-2005	FWL8840	S2CANALWL	2	613	2398	0.922	0.936
	DFWL8840						
	LG3DFWL8840						
	LG6DFWL8840						
	FWLDIF8977						
	FWLDIF8979						
	FWLDIF8920						
ps2marshwl-2005	FWL8840	S2MARSHWL	2	796	2306	0.741	0.740
	DFWL8840						
	LG3DFWL8840						
	LG6DFWL8840						
	FWLDIF8977						
	FWLDIF8979						
	FWLDIF8920						

Appendix II. Model summary of artificial neural network models used in the Model-to-Marsh application.—Continued

[R^2, coefficient of determination]

Model	Input variables	Output variable	Number of hidden neurons	Training matrix size	Testing matrix size	R^2 training	R^2 testing
GPA marsh network water-level models—Continued							
ps3canalwl-2005	FWL8840 DFWL8840 LG3DFWL8840 LG6DFWL8840 FWLDIF8977 FWLDIF8979 FWLDIF8920	S3CANALWL	2	877	12699	0.976	0.961
ps3marshwl-2005	FWL8840 DFWL8840 LG3DFWL8840 LG6DFWL8840 FWLDIF8977 FWLDIF8979 FWLDIF8920	S3MARSHW	2	2077	12595	0.891	0.806
ps4canalwl-2005	FWL8840 DFWL8840 LG3DFWL8840 LG6DFWL8840 FWLDIF8977 FWLDIF8979 FWLDIF8920	S4CANALWL	2	809	7784	0.986	0.985
ps4marshwl-2005	FWL8840 DFWL8840 LG3DFWL8840 LG6DFWL8840 FWLDIF8977 FWLDIF8979 FWLDIF8920	S4MARSHWL	3	1764	7762	0.902	0.858
ps5canalwl-2005	FWL8840 DFWL8840 LG3DFWL8840 LG6DFWL8840 FWLDIF8977 FWLDIF8979 FWLDIF8920	S5CANALWL	1	4805	5784	0.989	0.619
ps5marshwl-2005	FWL8840 DFWL8840 LG3DFWL8840 LG6DFWL8840 FWLDIF8977 FWLDIF8979 FWLDIF8920	S5MARSHWL	3	1965	10219	0.911	0.891

Appendix II. Model summary of artificial neural network models used in the Model-to-Marsh application.—Continued

[R^2, coefficient of determination]

Model	Input variables	Output variable	Number of hidden neurons	Training matrix size	Testing matrix size	R^2 training	R^2 testing
GPA marsh network water-level models—Continued							
ps6canalwl-2005	FWL8840 DFWL8840 LG3DFWL8840 LG6DFWL8840 FWLDIF8977 FWLDIF8979 FWLDIF8920	S6CANALWL	3	791	7408	0.990	0.983
ps6marshwl-2005	FWL8840 DFWL8840 LG3DFWL8840 LG6DFWL8840 FWLDIF8977 FWLDIF8979 FWLDIF8920	S6MARSHWL	3	1647	6637	0.804	0.763
1ps6marshwlat-2005	FWL8840 DFWL8840 LG3DFWL8840 LG6DFWL8840 FWLDIF8977 FWLDIF8979 FWLDIF8920	S6MARSHWLAT	2	1720		0.960	
ps7canalwl-2005	FWL8840 DFWL8840 LG3DFWL8840 LG6DFWL8840 FWLDIF8977 FWLDIF8979 FWLDIF8920	S7CANALWL	3	572	2739	0.924	0.933
1ps7marshwl-2005	FWL8840 DFWL8840 LG3DFWL8840 LG6DFWL8840 FWLDIF8977 FWLDIF8979 FWLDIF8920	S7MARSHWL	2	2822		0.701	
1ps8canalwl-2005	FWL8840 DFWL8840 LG3DFWL8840 LG6DFWL8840 FWLDIF8977 FWLDIF8979 FWLDIF8920	S8CANALWL	1	430		0.996	

Appendix II. Model summary of artificial neural network models used in the Model-to-Marsh application.—Continued

[R^2, coefficient of determination]

Model	Input variables	Output variable	Number of hidden neurons	Training matrix size	Testing matrix size	R^2 training	R^2 testing
GPA marsh network water-level models—Continued							
ps9canalwl-2005	FWL8840 DFWL8840 LG3DFWL8840 LG6DFWL8840 FWLDIF8977 FWLDIF8979 FWLDIF8920	S9CANALWL	2	805	7829	0.991	0.988
ps9marshwl-2005	FWL8840 DFWL8840 LG3DFWL8840 LG6DFWL8840 FWLDIF8977 FWLDIF8979 FWLDIF8920	S9MARSHWL	3	1801	7882	0.827	0.762
ps10canalwl-2005	FWL8840 DFWL8840 LG3DFWL8840 LG6DFWL8840 FWLDIF8977 FWLDIF8979 FWLDIF8920	S10CANALWL	2	694	5982	0.982	0.980
ps10marshwl-2005	FWL8840 DFWL8840 LG3DFWL8840 LG6DFWL8840 FWLDIF8977 FWLDIF8979 FWLDIF8920	S10MARSHWL	3	1530	5985	0.906	0.904
GPA marsh network specific-conductance models							
ps1canalsc-2005	FWL8840 DFWL8840 LG3DFWL8840 LG6DFWL8840 FSC89791 DFSC89791 LG3DFSC89791 LG6DFSC89791 FSCDIF8840 FSCDIF8920	S1CANALSC	3	750	7559	0.926	0.885

Appendix II. Model summary of artificial neural network models used in the Model-to-Marsh application.—Continued

[R^2, coefficient of determination]

Model	Input variables	Output variable	Number of hidden neurons	Training matrix size	Testing matrix size	R^2 training	R^2 testing
GPA marsh network specific-conductance models—Continued							
ps1marshsc-2005	FWL8840 DFWL8840 LG3DFWL8840 LG6DFWL8840 FSC89791 DFSC89791 LG3DFSC89791 LG6DFSC89791 FSCDIF8840 FSCDIF8920	S1MARSHSC	2	1441	3990	0.726	0.722
ps2canalsc-2005	FWL8840 DFWL8840 LG3DFWL8840 LG6DFWL8840 FSC89791 DFSC89791 LG3DFSC89791 LG6DFSC89791 FSCDIF8840 FSCDIF8920	S2CANALSC	3	1301	6355	0.913	0.897
ps2marshsc-2005	FWL8840 DFWL8840 LG3DFWL8840 LG6DFWL8840 FSC89791 DFSC89791 LG3DFSC89791 LG6DFSC89791 FSCDIF8840 FSCDIF8920	S2MARSHSC	3	902	2733	0.882	0.876
ps3canalsc-2005	FWL8840 DFWL8840 LG3DFWL8840 LG6DFWL8840 FSC89791 DFSC89791 LG3DFSC89791 LG6DFSC89791 FSCDIF8840 FSCDIF8920	S3CANALSC	3	2118	11954	0.812	0.813

Appendix II. Model summary of artificial neural network models used in the Model-to-Marsh application.—Continued

[R^2, coefficient of determination]

Model	Input variables	Output variable	Number of hidden neurons	Training matrix size	Testing matrix size	R^2 training	R^2 testing
GPA marsh network specific-conductance models—Continued							
ps3marshsc-2005	S3CANALSC FWL8840 DFWL8840 LG3DFWL8840 LG6DFWL8840 FSC89791 DFSC89791 LG3DFSC89791 LG6DFSC89791 FSCDIF8840 FSCDIF8920	S3MARSHSC	3	2062	11025	0.845	0.826
ps4canalsc-2005	FWL8840 DFWL8840 LG3DFWL8840 LG6DFWL8840 FSC89791 DFSC89791 LG3DFSC89791 LG6DFSC89791 FSCDIF8840 FSCDIF8920	S4CANALSC	3	1798	7463	0.865	0.839
ps4marshsc-2005	FWL8840 DFWL8840 LG3DFWL8840 LG6DFWL8840 FSC89791 DFSC89791 LG3DFSC89791 LG6DFSC89791 FSCDIF8840 FSCDIF8920	S4MARSHSC	2	1658	5535	0.897	0.861
ps5canalsc-2005	FWL8840 DFWL8840 LG3DFWL8840 LG6DFWL8840 FSC89791 DFSC89791 LG3DFSC89791 LG6DFSC89791 FSCDIF8840 FSCDIF8920	S5CANALSC	2	1500	4312	0.814	0.000

Appendix II. Model summary of artificial neural network models used in the Model-to-Marsh application.—Continued

[R^2, coefficient of determination]

Model	Input variables	Output variable	Number of hidden neurons	Training matrix size	Testing matrix size	R^2 training	R^2 testing
GPA marsh network specific-conductance models—Continued							
ps5marshsc-2005	FWL8840 DFWL8840 LG3DFWL8840 LG6DFWL8840 FSC89791 DFSC89791 LG3DFSC89791 LG6DFSC89791 FSCDIF8840 FSCDIF8920	S5MARSHSC	3	4108	12677	0.630	0.548
ps6canalsc-2005	FWL8840 DFWL8840 LG3DFWL8840 LG6DFWL8840 FSC89791 DFSC89791 LG3DFSC89791 LG6DFSC89791 FSCDIF8840 FSCDIF8920	S6CANALSC	3	1617	6115	0.834	0.825
ps6marshsc-2005	FWL8840 DFWL8840 LG3DFWL8840 LG6DFWL8840 FSC89791 DFSC89791 LG3DFSC89791 LG6DFSC89791 FSCDIF8840 FSCDIF8920	S6MARSHSC	3	1673	5953	0.859	0.814
ps7canalsc-2005	FWL8840 DFWL8840 LG3DFWL8840 LG6DFWL8840 FSC89791 DFSC89791 LG3DFSC89791 LG6DFSC89791 FSCDIF8840 FSCDIF8920	S7CANALSC	3	3665	3049	0.873	0.000

Appendix II. Model summary of artificial neural network models used in the Model-to-Marsh application.—Continued

[R^2, coefficient of determination]

Model	Input variables	Output variable	Number of hidden neurons	Training matrix size	Testing matrix size	R^2 training	R^2 testing
GPA marsh network specific-conductance models—Continued							
prs7marshpwc	RSC10S_12RS_A1WK RSC10S_11RB_A1WK RSC10S_11B_A1WK PSCGPA10S_FLR_A1WK	RS7MARSHPWC	1	1539	6136	0.150	0.141
ps7marshpwsc-2005-2	FSC89791A4WK FSC89791A24DA4WK AQ8500A168L72	S7MARSHPWSC	1	4270	4260	0.650	0.679
ps7marshsc-2005	FWL8840 DFWL8840 LG3DFWL8840 LG6DFWL8840 FSC89791 DFSC89791 LG3DFSC89791 LG6DFSC89791 FSCDIF8840 FSCDIF8920	S7MARSHSC	2	3386	3118	0.685	0.000
ps8canalsc-2005	FWL8840 DFWL8840 LG3DFWL8840 LG6DFWL8840 FSC89791 DFSC89791 LG3DFSC89791 LG6DFSC89791 FSCDIF8840 FSCDIF8920	S8CANALSC	2	1458	4752	0.871	0.831
ps9canalsc-2005	FWL8840 DFWL8840 LG3DFWL8840 LG6DFWL8840 FSC89791 DFSC89791 LG3DFSC89791 LG6DFSC89791 FSCDIF8840 FSCDIF8920	S9CANALSC	3	1806	6905	0.847	0.826
prs9marshpwc	RSC10S_12RS_A1WK RSC10S_11RB_A1WK RSC10S_11B_A1WK PSCGPA10S_FLR_A1WK	RS9MARSHPWC	1	1519	6052	0.098	0.097

Appendix II. Model summary of artificial neural network models used in the Model-to-Marsh application.—Continued

[R^2, coefficient of determination]

Model	Input variables	Output variable	Number of hidden neurons	Training matrix size	Testing matrix size	R^2 training	R^2 testing
GPA marsh network specific-conductance models—Continued							
ps9marshpwsc-2005-2	FSC89791A4WK FSC89791A24DA4WK AQ8500A168L72	S9MARSHPWSC	1	4221	4205	0.518	0.556
prs10marshpwc	RSC10S_12RS_A1WK RSC10S_11RB_A1WK RSC10S_11B_A1WK PSCGPA10S_FLR_A1WK	RS10MARSHPWC	1	1460	5797	0.100	0.101
ps10marshswsc-2005	FWL8840 DFWL8840 LG3DFWL8840 LG6DFWL8840 FSC89791 DFSC89791 LG3DFSC89791 LG6DFSC89791 FSCDIF8840 FSCDIF8920	S10MARSHSWSC	3	1810	6718	0.896	0.855

[1] Due to data quality concerns, data set was not bifurcated into training and testing datasets.

Appendix III. Variables used in artifical neural network models.

[SC, specific conductance; USGS, U.S. Geological Survey; WL, water level; GPA, Georgia Ports Authority; XWL, tidal range; MWA, moving window average]

Variable	Description
AQ8500A168L72	168-hour average flow at station 02198500—lagged 72 hours
B1MSC	Hourly SC at USGS marsh site B1
B1MWL	SC at station B1—hourly
B2MSC	Hourly SC at USGS marsh site B2
B3MSC	Hourly SC at USGS marsh site B3
B4MSC	Hourly SC at USGS marsh site B4
D3SC8840	3-hour difference in SC at station 02198840
D3SC8840(006)	3-hour difference in SC at station 02198840—lagged 6 hours
D3SC8840(012)	3-hour difference in SC at station 02198840—lagged 12 hours
D3SC8840(018)	3-hour difference in SC at station 02198840—lagged 18 hours
D3SC8840(024)	3-hour difference in SC at station 02198840—lagged 24 hours
D3SC8920	3-hour difference in SC at station 02198920
D3SC8920(006)	3-hour difference in SC at station 02198920—lagged 6 hours
D3SC8920(012)	3-hour difference in SC at station 02198920—lagged 12 hours
D3SC8920(018)	3-hour difference in SC at station 02198920—lagged 18 hours
D3SC8920(024)	3-hour difference in SC at station 02198920—lagged 24 hours
D3SC89791	3-hour difference in SC at station 021989791
D3SC89791(006)	3-hour difference in SC at station 021989791—lagged 6 hours
D3SC89791(012)	3-hour difference in SC at station 021989791—lagged 12 hours
D3SC89791(018)	3-hour difference in SC at station 021989791—lagged 18 hours
D3SC89791(024)	3-hour difference in SC at station 021989791—lagged 24 hours
D3WL8840	3-hour difference in WL at station 02198840
D3WL8840(006)	3-hour difference in WL at station 02198840—lagged 6 hours
D3WL8840(012)	3-hour difference in WL at station 02198840—lagged 12 hours
D3WL8840(018)	3-hour difference in WL at station 02198840—lagged 18 hours
D3WL8840(024)	3-hour difference in WL at station 02198840—lagged 24 hours
D3WL8920	3-hour difference in WL at station 02198920
D3WL8920(006)	3-hour difference in WL at station 02198920—lagged 6 hours
D3WL8920(012)	3-hour difference in WL at station 02198920—lagged 12 hours
D3WL8920(018)	3-hour difference in WL at station 02198920—lagged 18 hours
D3WL8920(024)	3-hour difference in WL at station 02198920—lagged 24 hours
D3WL8977	3-hour difference in WL at station 02198977
D3WL8977(006)	3-hour difference in WL at station 02198977—lagged 6 hours
D3WL8977(012)	3-hour difference in WL at station 02198977—lagged 12 hours
D3WL8977(018)	3-hour difference in WL at station 02198977—lagged 18 hours

Appendix III. Variables used in artifical neural network models.—Continued

[SC, specific conductance; USGS, U.S. Geological Survey; WL, water level; GPA, Georgia Ports Authority; XWL, tidal range; MWA, moving window average]

Variable	Description
D3WL8977(024)	3-hour difference in WL at station 0219897—lagged 24 hours
D3WL8979	3-hour difference in WL at station 02198979
D3WL8979(006)	3-hour difference in WL at station 02198979—lagged 6 hours
D3WL8979(012)	3-hour difference in WL at station 02198979—lagged 12 hours
D3WL8979(018)	3-hour difference in WL at station 02198979—lagged 18 hours
D3WL8979(024)	3-hour difference in WL at station 02198979—lagged 24 hours
DAQ16	16-day change in daily flow at station 02198500
DAQ2	2-day change in daily flow at station 02198500
DAQ30	30-day change in daily flow at station 02198500
DFSC89791	1-day difference in filtered SC at station 021989791
DFSC89791DA48	1-day difference in filtered 48-hour differences of SC at station 021989791
DFWL8840	1-day difference in filtered WL at station 02198840
DQ8500A	1-day difference in daily average flow at station 02198500
DSC8840GPA14B	Difference in SC between 02198840 and GPA14b
DSC8920GPA04B	Difference in SC between 02198920 and GPA04s
DSC8920GPA04S	Difference in SC between 02198920 and GPA04b
DSC8920GPA05B	Difference in SC between 02198920 and GPA05b
DSC8920GPA06B	Difference in SC between 02198920 and GPA06b
DSC8920GPA06S	Difference in SC between 02198920 and GPA06s
DSC8920GPA08B	Difference in SC between 02198920 and GPA08b
DSC8920GPA08S	Difference in SC between 02198920 and GPA08s
DSC8920GPA09B	Difference in SC between 02198920 and GPA09b
DSC8920GPA09S	Difference in SC between 02198920 and GPA09s
DSC8920GPA10B	Difference in SC between 02198920 and GPA10b
DSC8920GPA10S	Difference in SC between 02198920 and GPA10s
DSC8920GPA11RB	Difference in SC between 02198920 and GPA11b
DSC8920GPA12B	Difference in SC between 02198920 and GPA12b
DSC8920GPA12RS	Difference in SC between 02198920 and GPA12rs
DSC8920GPA21B	Difference in SC between 02198920 and GPA21b
DSC8920GPA21S	Difference in SC between 02198920 and GPA21s
DSC8920GPA22B	Difference in SC between 02198920 and GPA22b
DSC8920GPA22S	Difference in SC between 02198920 and GPA22s
DSC89791GPA07B	Difference in SC between 021989791 and GPA07b
DSC89791GPA07S	Difference in SC between 021989791 and GPA07s
DSC89791GPA11B	Difference in SC between 021989791 and GPA11b

Appendix III. Variables used in artifical neural network models.—Continued

[SC, specific conductance; USGS, U.S. Geological Survey; WL, water level; GPA, Georgia Ports Authority; XWL, tidal range; MWA, moving window average]

Variable	Description
DSC89791GPA13B	Difference in SC between 02198791 and GPA15s
DSC89791GPA15S	Difference in SC between 02198791 and GPA13b
DWL8840GPA14	Difference in WL between 02198840 and GPA14
DWL8920GPA07	Difference in WL between 02198920 and GPA07
DWL8920GPA08	Difference in WL between 02198920 and GPA08
DWL8920GPA09	Difference in WL between 02198920 and GPA09
DWL8920GPA10	Difference in WL between 02198920 and GPA10
DWL8920GPA11R	Difference in WL between 02198920 and GPA11r
DWL8920GPA12	Difference in WL between 02198920 and GPA12
DWL8920GPA22	Difference in WL between 02198920 and GPA22
DWL8977GPA04	Difference in WL between 02198977 and GPA04
DWL8977GPA05	Difference in WL between 02198977 and GPA05
DWL8977GPA06	Difference in WL between 02198977 and GPA06
DWL8977GPA21	Difference in WL between 02198977 and GPA21
DWL8977GPA23	Difference in WL between 02198977 and GPA23
DWL8977GPA24M	Difference in WL between 02198977 and GPA24m
DWL8977GPA25M	Difference in WL between 02198977 and GPA25m
DWL8977GPA26	Difference in WL between 02198977 and GPA26
DWL8979GPA11	Difference in WL between 02198979 and GPA11
DWL8979GPA13	Difference in WL between 02198979 and GPA13
DWLA	1-day change in WL
DWLAD1	1-day change in WL, lagged 1 day
DXWLA	1-day change in tidal range (XWL)
DXWLAD1	1-day change in tide range, lagged 1 day
F1MSC	Hourly SC at USGS marsh site F1M
FB2MWL	Filtered WL at station B2—hourly
FB3MWL	Filtered WL at station B3—hourly
FB4MWL-0P1	Filtered WL at station B4—hourly
FF1MWL	Filtered WL at station F1—hourly
FM1MWL	Filtered WL at station M1—hourly
FSC89791	Filtered SC at station 021989791
FSC89791A1WKD2WK	Difference between 1- and 2-week lagged MWAs of FSC89791
FSC89791A24DA4WK	Difference between 24-day and 2-week lagged MWAs of FSC89791
FSC89791A48D1WK	Difference between 2-day and 1-week and lagged MWAs of FSC89791
FSC89791A4WK	4-week MWA of FSC89791

Appendix III. Variables used in artifical neural network models.—Continued

[SC, specific conductance; USGS, U.S. Geological Survey; WL, water level; GPA, Georgia Ports Authority; XWL, tidal range; MWA, moving window average]

Variable	Description
FSC89791DA48	Difference between hourly and 2-day MWA of FSC89791
FSCDIF8840	Difference with SC at station 02198840 and station 021989791
FSCDIF8920	Difference with SC station 02198840 and station 02198920
FWL8840	Filled WL at station 02198840
FWL8980A	Filled, filtered daily WL
FWLDIF8920	Filled WL difference between station 02198840 and station 02198920
FWLDIF8977	Filled WL difference between station 02198840 and station 02198977
FWLDIF8979	Filled WL difference between station 02198840 and station 02198979
LAQ2	2-day lag of the daily flow at station 02198500
LG10D3NWL	10-hour lag in the 3 hour change in WL at station 02198980
LG13D3NWL	13-hour lag in the 3 hour change in WL at station 02198980
LG1D3NWL	1-hour lag in the 3 hour change in WL at station 02198980
LG1NWL	1-hour lag in the in hourly WL at station 02198980
LG2DWLA	1-day change in WL, lagged 2 day at station 02198980
LG2DXWLA	1-day change in tidal range, lagged 2 days at station 02198980
LG3DFSC89791	1-day change in SC at station 021989791 lagged 3 hours
LG3DFSC89791DA48	48-hour average of 1-day change in SC at station 021989791 lagged 3 hours
LG3DFWL8840	Difference with WL at station 02198840 lagged 3 days
LG4D3NWL	4-hour lag in the 3 hour change in WL
LG672FSC89791A4WKD4WK	Difference between 4-week and lagged 4-week MWAs of SC at station 021989791
LG6DFSC89791	SC difference at 021989791 lagged 6 hours
LG6DFWL8840	WL difference at 02198840 lagged 6 days
LG7D3NWL	7-hour lag in the 3 hour change in WL at station 02198980
M1MSC	Hourly SC at marsh site M1
M2MSC	Hourly SC at marsh site M2
M2MWL	Hourly WL at marsh site M2
NXWL	Tidal range at station 02198980
PSC8840A	Predicted daily SC at station 02198840
PSC8920A	Predicted daily SC at station 02198920
PSC89784A	Predicted daily SC at station 021989784
PSC89791A	Predicted daily SC at station 021989791
PSCGPA10S_FLR_A1WK	1-week MWA of floored predicted hourly SC at GPA10S
PSCGPA11B_FLR_A1WK	1-week MWA of floored predicted hourly SC at GPA11B
PSCGPA11RB_FLR_A1WK	1-week MWA of floored predicted hourly SC at GPA11RB
PSCGPA12RS_FLR_A1WK	1-week MWA of floored predicted hourly SC at GPA12RS

Appendix III. Variables used in artifical neural network models.—Continued

[SC, specific conductance; USGS, U.S. Geological Survey; WL, water level; GPA, Georgia Ports Authority; XWL, tidal range; MWA, moving window average]

Variable	Description
PWL8840A	Predicted daily WL at station 02198840
PWL8920A	Predicted daily WL at station 02198920
PWL8977A	Predicted daily WL at station 02198977
PWL8979A	Predicted daily WL at station 02198979
Q8500A	Daily average flow at station 02198500
RB1MSC	Residual error of predicted hourly SC at USGS marsh site B1
RB2MSC	Residual error of predicted hourly SC at USGS marsh site B2
RB3MSC	Residual error of predicted hourly SC at USGS marsh site B3
RB4MSC	Residual error of predicted hourly SC at USGS marsh site B4
RF1MSC	Residual error of predicted hourly SC at USGS marsh site F1
RM1MSC	Residual error of predicted hourly SC at USGS marsh site M1
RM2MSC	Residual error of predicted hourly SC at USGS marsh site M2
RS10MARSHPWC	Residual error of predicted hourly SC at USGS marsh site S10
RS7MARSHPWC	Residual error of predicted hourly SC at USGS marsh site S7
RS9MARSHPWC	Residual error of predicted hourly SC at USGS marsh site S9
RSC10S_11B_A1WK	Residual error of predicted weekly average floored SCGPA11B (for decorrelation)
RSC10S_11B_A1WK	Residual error of predicted weekly average floored SCGPA11B (for decorrelation)
RSC10S_11RB_A1WK	Residual error of predicted weekly average floored SCGPA11RB (for decorrelation)
RSC10S_11RB_A1WK	Residual error of predicted weekly average floored SCGPA11RB (for decorrelation)
RSC10S_12RS_A1WK	Residual error of predicted weekly average floored SCGPA12RS (for decorrelation)
S10CANALWL	Hourly WL at GPA marsh site S10 canal porewater
S10MARSHSWSC	Hourly SC at GPA marsh site S10 surface water
S10MARSHWL	Hourly WL at GPA marsh site S10
S1CANALSC	Hourly SC at GPA marsh site S1 canal
S1CANALWL	Hourly WL at GPA marsh site S1 canal
S1MARSHSC	Hourly SC at GPA marsh site S1
S1MARSHWL	Hourly WL at GPA marsh site S1
S1MARSHWLAT	Hourly WL at GPA marsh site S1 aquatapo
S2CANALSC	Hourly SC at GPA marsh site S2 canal
S2CANALWL	Hourly WL at GPA marsh site S2 canal
S2MARSHSC	Hourly SC at GPA marsh site S2 canal
S2MARSHWL	Hourly WL at GPA marsh site S2
S3CANALSC	Hourly SC at GPA marsh site S3
S3CANALWL	Hourly WL at GPA marsh site S3 canal
S3MARSHSC	Hourly SC at GPA marsh site S3

Appendix III. Variables used in artifical neural network models.—Continued

[SC, specific conductance; USGS, U.S. Geological Survey; WL, water level; GPA, Georgia Ports Authority; XWL, tidal range; MWA, moving window average]

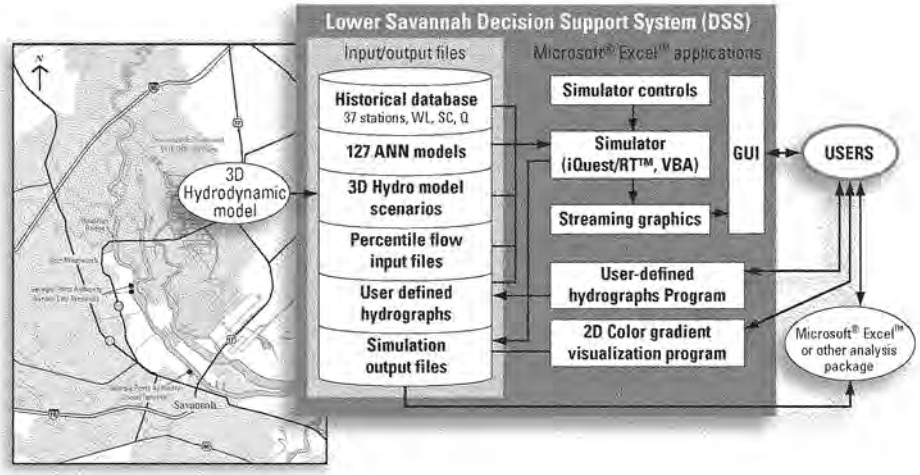
Variable	Description
S3MARSHWL	HourlyWL at GPA marsh 3
S4CANALSC	Hourly SC at GPA marsh site S4 canal
S4CANALWL	Hourly WL at GPA marsh site S4 canal
S4MARSHSC	Hourly SC at GPA marsh site S4
S4MARSHWL	Hourly WL at GPA marsh site S4
S5CANALSC	Hourly SC at GPA marsh site S5 canal
S5CANALWL	Hourly WL at GPA marsh site S5 canal
S5MARSHSC	Hourly SC at GPA marsh site S5
S5MARSHWL	Hourly WL at GPA marsh site S5 canal
S6CANALSC	Hourly SC at GPA marsh site S6 canal
S6CANALWL	Hourly WL at GPA marsh site S6 canal
S6MARSHSC	Hourly SC at GPA marsh site S6 canal
S6MARSHWL	Hourly WL at GPA marsh site S6 canal
S6MARSHWLAT	Hourly WL at GPA marsh site S6 aquatapv
S7CANALSC	Hourly SC at GPA marsh site S7 canal
S7CANALWL	Hourly WL at GPA marsh site S7 canal
S7MARSHPWSC	Hourly SC at GPA marsh site S7 porewatpr
S7MARSHSC	Hourly SC at GPA marsh site S7
S7MARSHWL	Hourly WL at GPA marsh site S7
S8CANALSC	Hourly SC at GPA marsh site S8 canal
S8CANALWL	Hourly WL at GPA marsh site S8 canal
S9CANALSC	Hourly SC at GPA marsh site S9 canal
S9CANALWL	Hourly WL at GPA marsh site S9 canal
S9MARSHPWSC	Hourly SC at GPA marsh site S9 porewatpr
S9MARSHWL	Hourly WL at GPA marsh site S9
SC8840	SC at station 02198840—hourly data
SC8840A	SC at 02198840—daily data
SC8920	SC at station 02198920—hourly data
SC8920A	SC at station 02198920—daily data
SC89784	SC at station 021989784—hourly data
SC89784A	SC at station 021989784—daily data
SC89791	SC at station 021989791—hourly data
SC89791A	SC at station 021989791—daily data
SCDIF8840A	Difference between daily (filtered) SC at gages 89791 and 8840
WL8840	WL at station 02198840—hourly data

Appendix III. Variables used in artifical neural network models.—Continued

[SC, specific conductance; USGS, U.S. Geological Survey; WL, water level; GPA, Georgia Ports Authority; XWL, tidal range; MWA, moving window average]

Variable	Description
WL8840A	WL at station 02198840—daily data
WL8920	WL at station 02198920—hourly data
WL8920A	WL at station 02198920—daily data
WL8977	WL at station 02198977—hourly data
WL8977A	WL at station 02198977—daily data
WL8979	WL at station 02198979—daily data
WL8979A	WL at station 02198979—hourly data
XWL8980A	Daily tidal range

Appendix IV. User's Manual for Model-to-Marsh Decision Support System



Contents

1. Introduction 107
2. Installation and System Requirements 107
3. Removal 107
4. Operation 107
4.1. ***About*** Worksheet 107
4.2. ***Controls*** Worksheet 107
4.2.1. Date/Time Controls 109
4.2.2. Simulation Input Variable Options 109
4.2.3. Writing Output 109
4.2.4. Visualization 109
4.2.5. Graphing Options 109
4.2.6. Savannah Map 110
4.3. ***AllUSGSGraphs*** Worksheet 110
4.4. ***SelectedGraphs*** Worksheet 110
4.5. ***RiverOutputTemplate*** and ***MarshOutputTemplate*** Worksheets 110
4.6. ***RevisionControl*** Worksheet 110
5. Running the Models Using 3D Hydrodynamic Model Predictions (EFDC) as Inputs 113
6. Creating a UserHydrograph 113
6.1. ***About*** Worksheet 113
6.2. ***UserHydrographtemplate*** Worksheet 113

Contents—continued

6.2.1. Creating a UserHydrograph using the Cut and Paste Option....114
6.2.2. Creating a UserHydrograph using the Set Points Option....115
6.2.2.1. Create *UserHydrograph* Worksheet....115
6.3. ***Revision Control*** Worksheet....116
7. Marsh Filling and Visualization....116
7.1. ***About*** Worksheet....116
7.2. ***Visualization*** Worksheet....116
7.2.1. Visualization Grid....116
7.2.2. ***Visualization Setup*** UserForm....116
7.2.2.1. Step 1—Load in Model Output Data....116
7.2.2.2. Step 2—Select Averaging Period....118
7.2.2.3. Step 3—Fill the Marsh....118
7.2.2.4. Step 4—Save Marsh Data as ASCII File....118
7.2.3. *Visualization Color Scheme* UserForm....118
7.3. ***ColorScheme*** Worksheet....118
7.3.1. Color Values for the Marsh Salinity Levels....119
7.3.2. Color Values for Constant Values....119
7.3.3. Maximum Salinity Setting....119
7.3.4. Reset the Color Scheme....119
7.4. ***Simulation Data*** Worksheet....119
7.5. Original Colorscheme Worksheet....119
7.6. ***Revision Control*** Worksheet....119
Appendix A....121

Figures

A1. *About* worksheet....108
A2. *Controls* worksheet....108
A3. Graph selection form....110
A4. Output workbook—river output....111
A5. Output workbook—marsh output....111
A6. *AllUSGSGraphs* worksheet....112
A7. *SelectedGraphs* worksheet....112
A8. *About* worksheet....113
A9. *UserHydrographtemplate* worksheet....114
A10. OptionForm with "Cut and Paste" option....114
A11. OptionForm with "Generate a Hydrograph" option selected....115
A12. Create UserHydrograph form....115
A13. Saving the UserHydrograph....116
A14. *About* worksheet for M2M visualization application....117
A15. *Visualization* worksheet from M2M application....117
A16. Color gradient of marsh area....118
A17. *Visualization Setup* UserForm....119
A18. Visualization color scheme UserForm....119
A19. *ColorScheme* worksheet....120
A20. *Simulation data* worksheet....120

1. Introduction

This document describes how to install and operate the Model-to-Marsh (M2M) application hereafter called the M2M DSS. This M2M DSS predicts how the flow rate (Q) down the Savannah River, as measured at a USGS gage at Clyo, Ga. (station 02198500), and tidal forces, as measured by the water level (WL) at a gage in Savannah Harbor at Fort Pulaski, Ga. (station 02198890), impact the water levels and specific conductivities (SC) at a number of gages on the Savannah, Back, and Little Back Rivers (fig. 1). In turn, the predictions made at these locations will be used to predict the water level and specific conductance of the tidal marshes. The model is an Excel™/VBA (Visual Basic for Applications)[1] program that integrates a large data set, artificial neural network (ANN) models, streaming graphics, and a graphical user-interface. The data set is composed of half-hour samples of Q, WL, and SC covering the period from March 1994 to May 2005. Data through May 2005 were used to develop the ANNs, and are included as separate files, one file for each year of data. This allows the user to run long-term simulations to evaluate permutations of the actual historical record.

2. Installation and System Requirements

Copy the folder titled SavannahM2M to your computer's hard drive. You may place this folder anywhere on your system. The only requirement is that all the files stay in the same directory.

Copy the following files to your computer's System32 directory:

admquestrt.dll
mscomct2.ocx

For example: on a Microsoft XP or Windows 2000 system, the path would be C:\Windows\System32\.

If present, you should delete the file NE32.dll from the System32 directory (you would have this if you loaded an earlier version of the Savannah Phase II application).

Register the above files by typing the following at the Run Prompt (usually accessed from the start menu). This assumes the path is c:\windows\system32.

Regsvr32 c:\windows\system32\admquestrt.dll
Regsvr32 c:\windows\system32\mscomct2.ocx

The program was developed and tested using Microsoft Excel™ 2002. This version or any later version should be used to run the program.

3. Removal

When the M2M DSS is no longer needed, delete the folder containing the applications and its contents.

[1] Any use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

4. Operation

Three Excel™ programs make up the application. In each program the latest release date is included in the file name in the format mmddyyyy (month/day/year). The three programs are:

SavannahM2M_mmddyyyy.xls
This is the main program from which all simulations are run. This program is hereafter referred to as the model.

CreateUserHydrograph_mmddyyyy.xls
This program is used to create user-defined hydrographs which can be used to run simulations. This is described in greater detail in section 6.

M2MVisualization_mmddyyyy.xls
This program is used to interpolate salinity levels throughout the marsh and visualize the results. This is described in greater detail in section 7.

The remainder of this section will describe how to use the M2M DSS.

The M2M DSS is opened like a standard Excel™ workbook. Simply open the .xls file. Depending on the security settings you have set up for Excel™, you may have to Enable Macros.

The model workbook consists of the following worksheets: *About*, *Controls*, *AllUSGSGraphs*, *SelectedGraphs*, *RiverOutputTemplate*, *MarshOutputTemplate*, and *RevisionControl*.

A description of each worksheet and its use/function follows.

4.1. *About* Worksheet

When the workbook opens, the *About* worksheet (fig. A1) is automatically displayed for 5 seconds. This sheet contains the version number of the M2M DSS and contact information for the program's developers. After displaying for 5 seconds, the user is automatically taken to the *Controls* worksheet. The user may return to the *About* worksheet at any time for contact/version information.

4.2. *Controls* Worksheet

The *Controls* worksheet (fig. A2) contains a map of the Savannah River Basin and a *User Controls* user form, which is used to control each simulation run. This form can be moved, closed, and reopened as needed. If closed (by selecting the X in the upper right corner of the form), it is reopened by selecting the "Show User Controls" command button which appears when the form is closed. Figure A2 shows the worksheet divided into six sections which are described next.

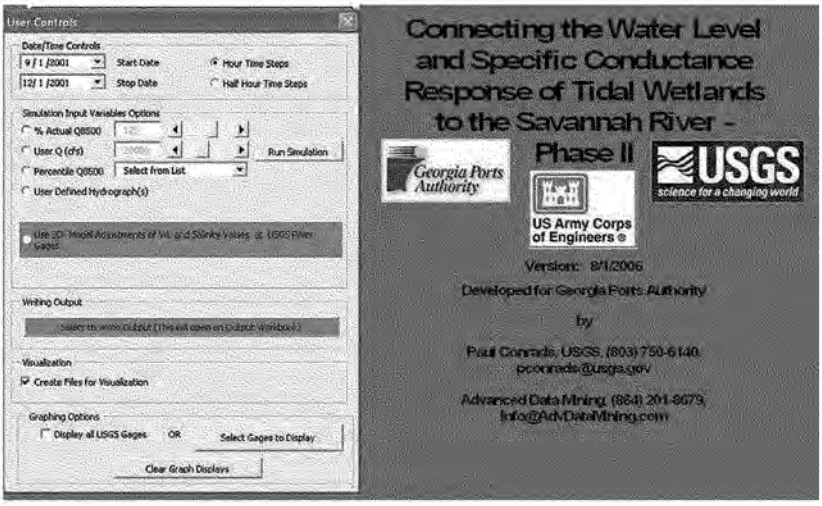


Figure A1. *About* worksheet.

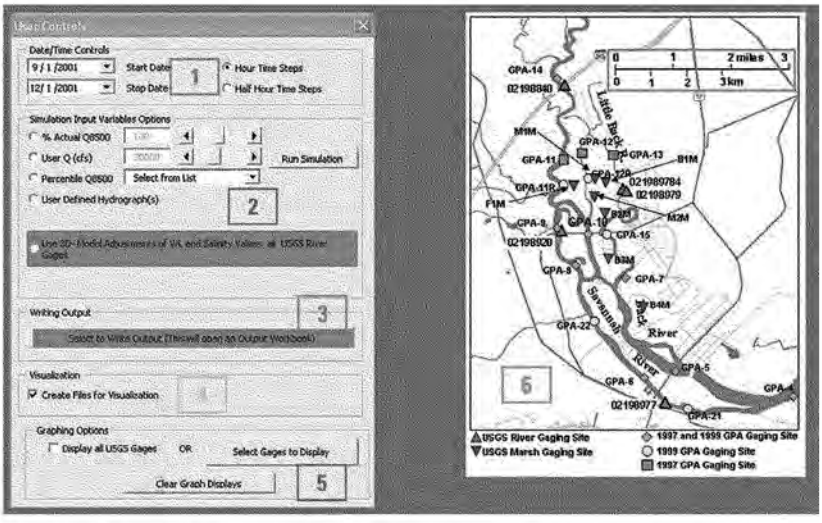


Figure A2. *Controls* worksheet.

4.2.1. Date/Time Controls

This section is used to set the start date, end date, and step size of a simulation run. The start and end dates are set using the calendar combo boxes. Dates selected must be between 3/1/1994 and 5/1/2005. The step size is selected by choosing either the "Hour" or "Half-Hour Time Step" option button. Suggested maximum simulation run if saving output is 2 years.

4.2.2. Simulation Input Variable Options

This section is used to select the model inputs used in modeling the WL and salinity at the various river and marsh gages. The user can opt to set the flow at Clyo(Q) in one of four ways, or the user can input adjustments made by the EFDC hydrodynamic model of WL and salinity at the USGS river gages to predict the effects in the marsh. The five options are described below.

- Percent of Actual Q8500: This sets the user Q as a percentage of the actual historical Q. The percentage is varied using the scroll bar. The setting will display in the text box to the left of the scroll bar. Allowable range is 1–200 percent.
- User Q: This sets the user Q to a fixed value. The value is varied using the scroll bar to select a value. The setting displays in the text box to the left of the scroll bar. Allowable range is 100 to 53,000 cfs.
- Percentile File: Select one of the percentile files (5–95%) from the drop-down box. These files consist of a percentile of the daily mean value from 1929 to 2002.
- User-Defined Hydrograph: This allows the user to select hydrograph file(s) created using the CreateUserhydrographmmddyyyy.xls application from a browser window. The user will be prompted to select the UserHydrograph files(s). Up to 2 years (2 yearly files) may be selected. To select multiple files (the files must cover successive years), simply hold down the <Ctl> key when picking files. Each UserHydrograph file spans 1 year. Instructions for creating the files are provided in detail in this manual in section 6. The user must make sure that the simulation dates selected are not outside the dates spanned by the UserHydrograph file(s).
- 3D-Model Adjustments of WL and Salinity Values at USGS River Gages: The user will be prompted to select the data file(s) containing the adjustments from a browser window. The format requirements for the data file(s) are provided in section 4.2.5. The program will use these values to make predictions in the marsh.

This section also contains the "Run Simulation" command button. When all simulation controls are set, selecting this button will begin the simulation run. There will be some delay while the data files needed for the simulations are loaded.

4.2.3. Writing Output

Select the "Select to Write Output" button to have the outputs written to a workbook. You will be prompted for the name of the workbook that will be created to hold the output. Once the simulation run is complete, the file will be saved and closed. The output file consists of 2 worksheets—one containing river data and the other marsh data (figs. A4, A5). Data written to the output file include flow at Clyo (Q), WL in the Savannah Harbor (WL8980), and for each modeled gaging location:

- historical data,
- predicted value based on actual data or predicted USGS riverine (pred),
- the change predicted due to the user settings (pred-user), and
- the new prediction.

Gages measuring water level are preceded by "WL," and those measuring salinity are preceded by "Sal." Appendix A lists the measured and modeled data in the output file.

4.2.4. Visualization

Checking the box labeled "Create Files for Visualization" will save four files to the VisualizationFiles directory. The files will contain the data for the gages needed by the M2MVisualization program (described in this manual in section 7).

The files saved are:

- SavVisActual_m_dd_yyyy_h_mm.cvs (where m=month, dd=day, yyyy=year, h=hour, mm=minutes) will contain the actual data for the gages;
- SavVisPred_m_dd_yyyy_h_mm.cvs will contain the predicted values based on actual Q;
- SavVisUser_m_dd_yyyy_h_mm.cvs will contain the predicted values based on user settings; and
- SavVisDelta_m_dd_yyyy_h_mm.cvs will contain the changes due to user settings.

4.2.5. Graphing Options

This section controls what the user views while the simulation is running. The user can opt to view all USGS river and Back River gage values or the user may select any of four gages to display (recommended). Selecting the "Select Gages to Display" button will pop up a window showing all the graphing options (fig. A3). Select any four and then click "Done." For each gage selected, the graph will display actual values, predicted values (of historical conditions), predicted values of user-defined conditions, and differences between actual and user-defined conditions. Clearing the graphing displays will clear all data from the graphs.

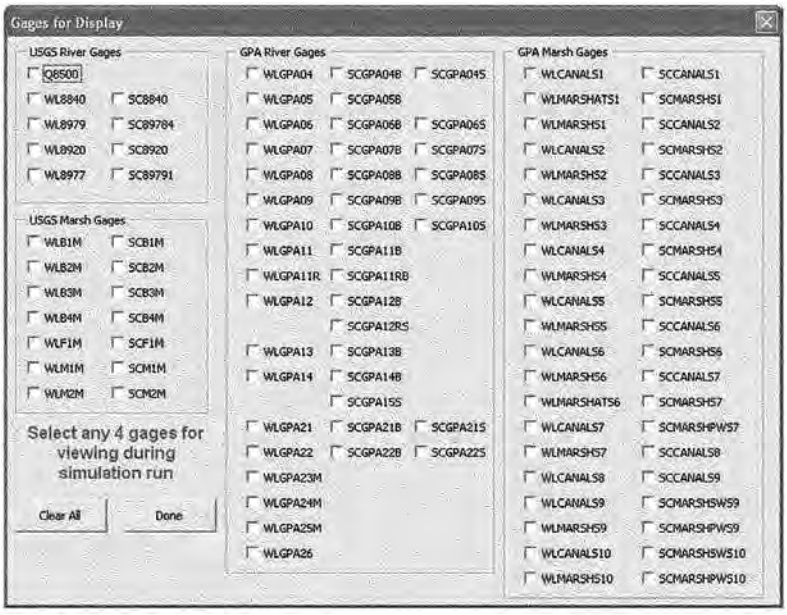


Figure A3. Graph selection form.

4.2.6. Savannah Map

This map displays the locations of most of the gages modeled in the application.

4.3. *AllUSGSGraphs* Worksheet

The *AllUSGSGraphs* worksheet (fig. A6) displays the WL and salinity for the USGS river gages as well as the flow at Clyo (section 1 of fig. A6). This worksheet automatically displays during a simulation run if the user has chosen the option to "Display All USGS Gages" on the *Controls* worksheet. Once the simulation run is complete, the user can return to the *Controls* worksheet by clicking on the "Show User Controls" command button (section 2 of fig. A6).

4.4. *SelectedGraphs* Worksheet

The *SelectedGraphs* worksheet (fig. A7) displays the WL and salinity for any four gages selected on the Graph Selection Form (fig. A3). This worksheet automatically displays during a simulation run if the user has chosen the "Select Gages to Display" option. Once the simulation run is complete, the user can return to the *Controls* worksheet by clicking on the "Show User Controls" command button.

4.5. *RiverOutputTemplate* and *MarshOutputTemplate* Worksheets

The two output template worksheets show the format of the output files created when "Select to Write Output" is selected (fig. A2).

4.6. *RevisionControl* Worksheet

The *RevisionControl* worksheet shows a brief description of changes made to the program with each revision.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	DATETIME	ROW	Q8500	Q8500A	Q8500-us	WL8980	XWL8980	Sal8840	Sal8840-p	dSal8840(	Sal8840-u	WL8840	WL8840-p	dWL8840(	WL8840-u
2	1/1/2002	1	5670	5713.71	7740	-0.28	8.127501	0.051247	0.062449	0.009117	0.04213	3.3	3.097175	-0.18067	3.480675
3	1/1/2002 1:00	3	5662	5706.1	7733.75	-2.11	8.240001	0.048619	0.057799	0.00951	0.039109	1.64	1.288404	-0.2386	1.879589
4	1/1/2002 2:00	5	5662	5698.62	7727.5	-3.63	8.352501	0.048619	0.053164	0.009473	0.039147	-0.06	-0.25676	-0.24833	0.188325
5	1/1/2002 3:00	7	5647	5691.29	7721.25	-4.4	8.465001	0.048182	0.053761	0.00934	0.038843	-1.6	-1.52403	-0.22498	-1.37502
6	1/1/2002 4:00	9	5647	5684.12	7715	-3.56	8.577501	0.048182	0.056107	0.009061	0.039121	-2.86	-2.88022	-0.18029	-2.67971
7	1/1/2002 5:00	11	5647	5677.12	7708.75	-1.77	8.690001	0.047746	0.05759	0.008887	0.038859	-3.69	-3.39974	-0.15333	-3.53667
8	1/1/2002 6:00	13	5640	5670.29	7702.5	0.37	8.802502	0.048182	0.057491	0.0089	0.039282	-2.08	-1.85648	-0.18015	-1.88985
9	1/1/2002 7:00	15	5632	5663.65	7696.25	2.6	8.915002	0.048182	0.056533	0.009018	0.039165	0.2	0.746222	-0.1836	0.383597
10	1/1/2002 8:00	17	5625	5657.19	7690	4.09	9.027502	0.049932	0.057085	0.008958	0.040974	2.41	3.050076	-0.13427	2.54427
11	1/1/2002 9:00	19	5617	5650.92	7683.75	4.74	9.14	0.058088	0.059284	0.008706	0.047382	4.09	4.501727	-0.08364	4.173638
12	1/1/2002 10:00	21	5609	5644.85	7677.5	4.85	9.04	0.063622	0.060857	0.008537	0.055084	4.84	5.158915	-0.06232	4.902317
13	1/1/2002 11:00	23	5602	5638.99	7671.25	3.51	8.94	0.071663	0.061461	0.009221	0.062442	5.15	5.330165	-0.07354	5.223638
14	1/1/2002 12:00	25	5602	5633.35	7665	2.01	8.839999	0.067188	0.079688	0.014295	0.052892	4.99	4.888905	-0.12189	5.111892
15	1/1/2002 13:00	27	5594	5627.93	7658.75	0.21	8.739999	0.064765	0.091489	0.018285	0.03648	4.07	3.80399	-0.19267	4.26267
16	1/1/2002 14:00	29	5587	5622.74	7652.5	-1.75	8.639998	0.049613	0.061447	0.012018	0.038601	2.55	2.508562	-0.25856	2.808584
17	1/1/2002 15:00	31	5587	5617.8	7646.25	-3.27	8.539998	0.049057	0.053247	0.009621	0.039435	0.85	0.840478	-0.27484	1.124841
18	1/1/2002 16:00	33	5579	5613.1	7640	-3.95	8.439998	0.049494	0.056432	0.009164	0.04033	-0.8	-0.49439	-0.26719	-0.54281
19	1/1/2002 17:00	35	5579	5608.67	7633.75	-3.09	8.339997	0.049494	0.059557	0.008824	0.04067	-2.23	-1.93862	-0.21882	-2.01118
20	1/1/2002 18:00	37	5571	5604.51	7627.5	-1.07	8.239997	0.049932	0.059798	0.008841	0.041091	-3.13	-2.79886	-0.18494	-2.94506
21	1/1/2002 19:00	39	5571	5600.62	7621.25	1.01	8.139997	0.049932	0.057196	0.009214	0.040718	-1.43	-1.02367	-0.20428	-1.22572
22	1/1/2002 20:00	41	5571	5597.02	7615	2.91	8.039996	0.049932	0.055658	0.00947	0.040483	0.97	1.287558	-0.1856	1.155596
23	1/1/2002 21:00	43	5564	5593.7	7608.75	3.99	7.94	0.054324	0.056458	0.009451	0.044873	3.05	3.328842	-0.12868	3.178576
24	1/1/2002 22:00	45	5564	5590.68	7602.5	3.85	8.057693	0.060512	0.060363	0.00805	0.051462	4.32	4.630055	-0.08066	4.400562
25	1/1/2002 23:00	47	5556	5587.98	7596.25	2.93	8.175385	0.067188	0.063844	0.008701	0.058487	4.76	4.651083	-0.07883	4.838835
26	1/2/2002	49	5556	5585.58	7590	1.54	8.293077	0.062288	0.064135	0.008977	0.05331	4.4	4.3282	-0.12197	4.521968
27	1/2/2002 1:00	51	5556	5583.52	7586.792	-0.09	8.410769	0.052125	0.063214	0.010252	0.041873	3.2	3.20384	-0.1937	3.393702
28	1/2/2002 2:00	53	5556	5581.78	7583.584	-1.77	8.528461	0.05037	0.056677	0.010526	0.039844	1.58	1.572192	-0.2444	1.824404
29	1/2/2002 3:00	55	5556	5580.38	7580.376	-3.28	8.646152	0.049932	0.053299	0.010529	0.039403	-0.04	0.033229	-0.25374	0.21374
30	1/2/2002 4:00	57	5548	5579.32	7577.168	-4.02	8.763844	0.049494	0.055528	0.010284	0.03921	-1.49	-1.28279	-0.23262	-1.25738
31	1/2/2002 5:00	59	5556	5578.6	7573.96	-3.04	8.881536	0.049057	0.05958	0.00985	0.039206	-2.73	-2.56155	-0.19236	-2.53764
32	1/2/2002 6:00	61	5556	5578.23	7570.752	-1.29	8.998228	0.048619	0.061012	0.009737	0.038882	-3.37	-2.93386	-0.168	-3.202
33	1/2/2002 7:00	63	5556	5578.18	7567.544	0.99	9.11692	0.049057	0.060315	0.009902	0.039154	-1.63	-1.33812	-0.18699	-1.44301
34	1/2/2002 8:00	65	5564	5578.45	7564.336	3.13	9.234612	0.049057	0.05781	0.010302	0.038755	0.71	1.380634	-0.17637	0.886372
35	1/2/2002 9:00	67	5564	5579.04	7561.128	4.71	9.352304	0.052564	0.059269	0.010278	0.042287	2.92	3.463959	-0.12308	3.043079
36	1/2/2002 10:00	69	5571	5579.92	7557.92	5.45	9.47	0.059182	0.06034	0.01001	0.049173	4.44	4.783649	-0.07476	4.514781
37	1/2/2002 11:00	71	5571	5581.08	7554.712	5.16	9.257692	0.067635	0.062272	0.009769	0.057886	5.14	5.404792	-0.08623	5.19623
38	1/2/2002 12:00	73	5571	5582.49	7551.504	4.14	9.045384	0.083383	0.064426	0.010864	0.072519	5.46	5.522354	-0.07231	5.53231
39	1/2/2002 13:00	75	5571	5584.12	7548.296	2.33	8.833076	0.100705	0.101306	0.021147	0.079558	5.4	5.29962	-0.11774	5.517737
40	1/2/2002 14:00	77	5564	5585.96	7545.088	0.62	8.620769	0.065849	0.120748	0.027224	0.038525	4.7	4.384307	-0.20123	4.90123

RiverOutputTemplate / MarshOutputTemplate / Sheet3

Figure A4. Output workbook—river output.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	DATETIME	ROW	S1CANAL	S1CANAL	dS1CANA	S1CANAL	S1MARSH	S1MARSH	dS1MARS	S1MARSH	S1MARSH	S1MARSH	dS1MARS	S1MARSH	S2CANAL	S2CANAL	dS2CANA	S2CANAL
11	1/1/2002 9:00	19	4.4	4.233431	-0.04097	4.440975	?	4.86155	-0.01203	4.873581	5.1	5.053614	-0.00387	5.103888	?	5.080873	0.105447	4.975526
12	1/1/2002 10:00	21	4.9	4.810073	-0.02321	4.923213	?	4.890724	-0.01833	4.909056	5.1	5.084976	-0.00909	5.109094	?	5.079346	0.024129	5.055217
13	1/1/2002 11:00	23	5.2	5.010074	-0.02428	5.224277	?	4.96892	-0.02066	4.989582	5.2	5.150697	-0.0167	5.216703	?	4.263006	-0.10815	4.371156
14	1/1/2002 12:00	25	4.7	4.817895	-0.05272	4.75272	?	4.974326	-0.00915	4.983475	5.1	5.120988	-0.01221	5.112212	?	2.795732	-0.20741	3.003144
15	1/1/2002 13:00	27	3.2	3.741564	-0.1238	3.303802	?	4.897757	-0.01043	4.908188	5.1	5.063102	-0.0094	5.100403	?	1.498792	0.028499	1.470293
16	1/1/2002 14:00	29	1.3	1.688833	-0.18884	1.490639	?	4.930774	-0.00716	4.937922	5.1	5.093496	-0.00861	5.108613	?	0.737882	0.002835	0.735027
17	1/1/2002 15:00	31	-0.6	-0.12386	-0.10917	-0.49083	?	4.963968	-0.004	4.967988	5.1	5.098568	0.000279	5.098726	?	0.585311	-0.00808	0.594689
18	1/1/2002 16:00	33	-0.6	-0.83829	-0.04574	-0.75426	?	4.98242	-0.00243	4.984848	5.1	5.089063	0.003103	5.098897	?	0.580467	0.000713	0.559764
19	1/1/2002 17:00	35	-0.6	-0.93102	-0.0108	-0.7834	?	4.959907	-0.00279	4.962695	5.1	5.084057	0.001818	5.098182	?	0.56253	-0.00152	0.564048
20	1/1/2002 18:00	37	-0.8	-0.83865	-0.0169	-0.7831	?	4.923231	-0.00668	4.929914	5.1	5.065787	-0.00226	5.102295	?	0.66039	-0.03139	0.691778
21	1/1/2002 19:00	39	-0.9	-0.53186	-0.07385	-0.72805	?	4.895179	-0.01262	4.906213	5.1	5.057617	-0.00653	5.106532	?	0.331233	0.060319	0.671914
22	1/1/2002 20:00	41	1.6	1.019562	-0.13864	1.738644	?	4.885207	-0.01456	4.899863	5.1	5.081142	-0.01113	5.111131	?	2.774626	-0.2212	2.99683
23	1/1/2002 21:00	43	3.5	3.153306	-0.08600	3.586092	?	4.89736	-0.01033	4.907882	5.1	5.086211	-0.00533	5.105328	?	4.553693	0.119133	4.43466
24	1/1/2002 22:00	45	4.5	4.309094	-0.04049	4.540488	?	4.904096	-0.01036	4.914458	5.1	5.06497	-0.00367	5.103673	?	4.629604	0.120087	4.509617
25	1/1/2002 23:00	47	4.6	4.592369	-0.03604	4.635037	?	4.893066	-0.01402	4.907068	5.1	5.073677	-0.00507	5.105089	?	4.078264	0.068793	4.00947
26	1/2/2002	49	4	4.230497	-0.0681	4.068103	?	4.81532	-0.01547	4.830786	5.1	5.068043	-0.00512	5.10512	?	2.602628	-0.1669	2.769526
27	1/2/2002 1:00	51	2.4	2.672258	-0.13757	2.537589	?	4.839892	-0.01671	4.858602	5.1	5.049404	-0.00389	5.103826	?	1.1507	-0.09708	1.24778
28	1/2/2002 2:00	53	0.5	0.686228	-0.14778	0.647775	?	4.895675	-0.01342	4.909093	5.1	5.051389	-0.00491	5.10491	?	0.602999	-0.05871	0.661713
29	1/2/2002 3:00	55	-0.8	-0.44104	-0.08607	-0.71393	?	4.926700	-0.00849	4.936194	5.1	5.054903	-0.00325	5.108254	?	0.486011	-0.10845	0.594466
30	1/2/2002 4:00	57	-0.8	-0.86472	-0.03161	-0.76899	?	4.946338	-0.00433	4.950669	5.1	5.069738	-0.00181	5.10181	?	0.496727	-0.03327	0.529999
31	1/2/2002 5:00	59	-0.8	-0.87336	-0.00709	-0.79291	?	4.947193	-0.00393	4.951127	5.1	5.073103	-0.00066	5.10066	?	0.522936	-0.01221	0.535147
32	1/2/2002 6:00	61	-0.8	-0.82511	-0.0135	-0.7865	?	4.902864	-0.00822	4.911087	5.1	5.061223	-0.00489	5.104887	?	0.612459	-0.04533	0.657793
33	1/2/2002 7:00	63	-0.8	-0.6193	-0.0619	-0.7381	?	4.877658	-0.01539	4.893052	5.1	5.049888	-0.00827	5.108265	?	0.984927	-0.00407	0.988996
34	1/2/2002 8:00	65	1.4	0.783406	-0.13106	1.531089	?	4.856405	-0.01633	4.872731	5.1	5.049603	-0.0081	5.108097	?	2.833343	0.139266	2.694077
35	1/2/2002 9:00	67	3.6	3.174683	-0.07985	3.679848	?	4.858972	-0.01199	4.871958	5.1	5.051253	-0.00604	5.106036	?	5.019635	0.134763	4.884871
36	1/2/2002 10:00	69	4.8	4.612719	-0.0302	4.803206	?	4.901367	-0.01318	4.914538	5.1	5.061014	-0.0051	5.1051	?	5.238348	0.071357	5.16699
37	1/2/2002 11:00	71	5.3	5.099253	-0.01846	5.318465	?	5.066316	-0.02741	5.093727	5.3	5.129875	-0.01514	5.315139	?	5.209116	-0.0022	5.211315
38	1/2/2002 12:00	73	5.6	5.260937	-0.0212	5.521206	?	5.367211	-0.0205	5.387707	5.4	5.279876	-0.02193	5.42193	?	4.286773	-0.18948	4.476256
39	1/2/2002 13:00	75	6.2	5.139106	-0.04147	5.241475	?	5.26933	0.004903	5.264426	5.2	5.196799	-0.01916	5.219164	?	2.974406	-0.39365	3.367962
40	1/2/2002 14:00	77	4	4.382848	-0.11587	4.115875	?	4.949241	-0.00604	4.955279	5.1	5.08622	-0.01034	5.110335	?	1.60978	0.088332	1.521448
41	1/2/2002 15:00	79	2.2	2.549571	-0.18924	2.389237	?	4.943667	-0.00631	4.947973	5.1	5.082737	-0.00436	5.104365	?	0.863025	0.053775	0.80925
42	1/2/2002 16:00	81	0.3	0.501779	-0.15703	0.457051	?	4.95913	-0.00301	4.952142	5.1	5.098497	0.00275	5.09725	?	0.852722	0.016289	0.836433
43	1/2/2002 17:00	83	-0.8	-0.56907	-0.06824	-0.73176	?	4.964196	-0.00243	4.966627	5.1	5.09756	0.003681	5.096319	?	0.597647	0.00533	0.592317
44	1/2/2002 18:00	85	-0.9	-0.01966	-0.03684	-0.76316	?	4.967023	-0.00356	4.960593	5.1	5.093638	0.00146	5.09854	?	0.650096	-0.00022	0.650319
45	1/2/2002 19:00	87	-0.8	-0.73886	-0.04698	-0.75302	?	4.917243	-0.00677	4.924013	5.1	5.070680	-0.00245	5.102451	?	0.764779	0.008533	0.756246
46	1/2/2002 20:00	89	0.2	-0.02465	-0.11451	0.314807	?	4.910738	-0.01043	4.921171	5.1	5.07709	-0.00614	5.106138	?	2.077451	0.170385	1.907066
47	1/2/2002 21:00	91	2.2	1.770216	-0.13066	2.300684	?	4.918291	-0.00915	4.927445	5.1	5.082406	-0.00567	5.106067	?	3.568931	0.220033	3.345098
48	1/2/2002 22:00	93	3.7	3.427089	-0.07546	3.775461	?	4.927451	-0.007	4.934453	5.1	5.078259	-0.00398	5.103985	?	4.237403	0.189918	4.047485
49	1/2/2002 23:00	95	4.4	4.33588	-0.04121	4.441215	?	4.944885	-0.01011	4.954892	5.1	5.077634	-0.00436	5.104063	?	4.659252	0.1108	4.548652

RiverOutputTemplate / MarshOutputTemplate / Sheet3

Figure A5. Output workbook—marsh output.

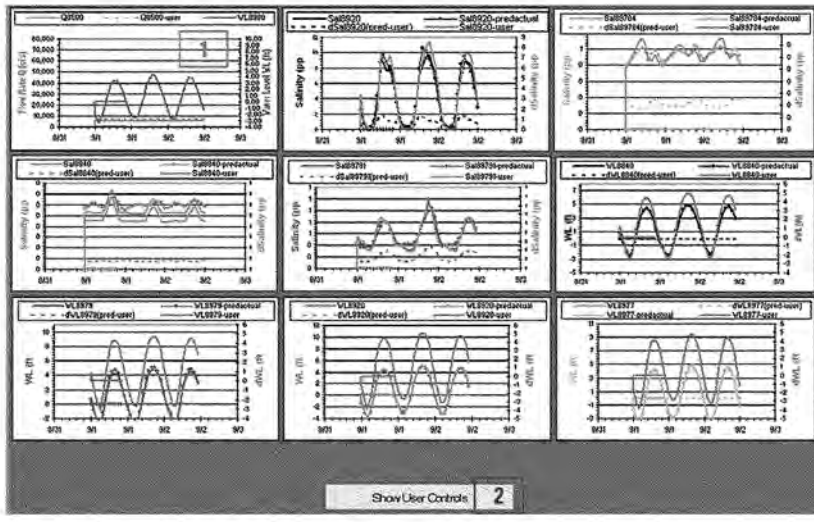


Figure A6. *AllUSGSGraphs* worksheet.

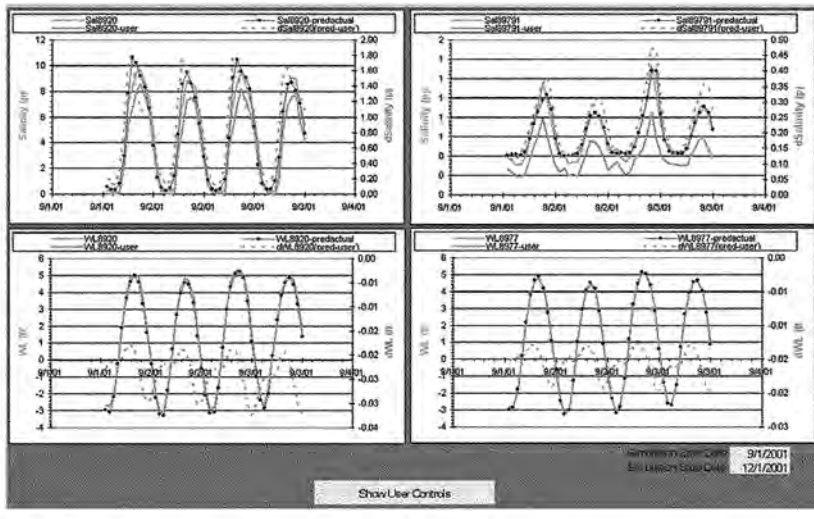


Figure A7. *SelectedGraphs* worksheet.

5. Running the Models Using 3D Hydrodynamic Model Predictions (EFDC) as Inputs

The 3D hydrodynamic model predictions datafile must have a specific format to be used by the M2M. The file format requirements can be found in the file 3DHydroModel_fileformat.csv located in the application directory and also are mentioned below:

- Comma-delimited file.
- First row is a header row.
- Subsequent rows contain the data values. In the year column, put the time stamp (in standard Excel™ number format, for example, 1/1/1900 0:00 = 1; 1/1/1994 0:00 = 34335; 1/1/1994 0:30 = 34335.02083). The first row of data is row 1. Data increments must be in half-hour steps; therefore, a non-leap year would contain 17,520 rows and a leap year 17,568 rows of data.
- A "?" indicates no data available.
- A sample file with instructions is located in \EFDCHydroModelSimData\EFDC_fileformat_r3.

6. Creating a UserHydrograph

A separate Excel™ program called Createuserhydrograph_mmddyyyy.xls is used to generate a UserHydrograph file. Each UserHydrograph created must include 1 year of half-hour values. This application is contained in the same folder as the model.

Three worksheets are in the workbook: *About*, *UserHydrographtemplate*, and *Userformsheet*.

6.1. *About* Worksheet

The *About* Worksheet (fig. A8) contains the contact and revision information for the application. It will display for 5 seconds and then the *UserHydrographtemplate* worksheet will display.

6.2. *UserHydrographtemplate* Worksheet

The *UserHydrographtemplate* worksheet (fig. A9 and hereafter referred to as the template) contains your choices for generating a hydrograph. This application can be used in two ways. The user can cut and paste in flow values and then save the values to the file, or the user can generate a hydrofile from scratch by setting setpoints for flow values. The program will then fill in the remaining values by interpolating between setpoints.

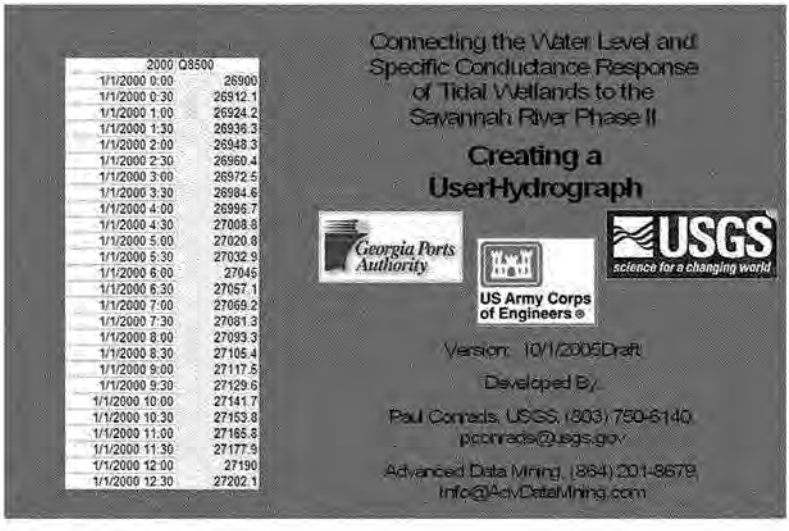


Figure A8. *About* worksheet.

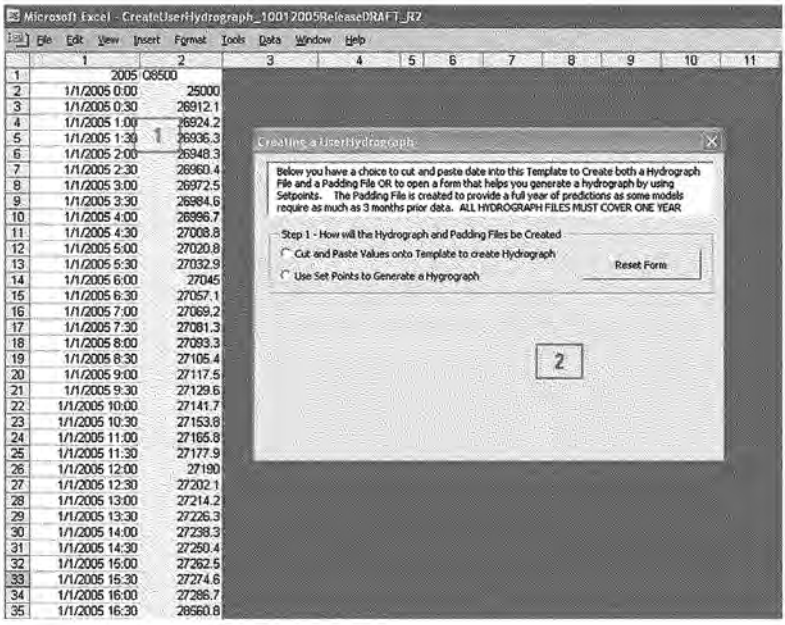


Figure A9. *UserHydrographtemplate* worksheet.

Found on the *Template* worksheet is the *Creating a UserHydrograph* UserForm (hereafter called OptionForm) which steps the user through the process of creating a UserHydrograph (section 2 of fig. A9 shows the opened OptionForm).

6.2.1. Creating a UserHydrograph using the Cut and Paste Option

The cut and paste option allows the user to use flow values created outside of this program. The user pastes flow values into the specified location on the *Template* worksheet. Figure A10 shows the OptionForm with the cut and paste option selected. The steps to perform are:

- Select the option to cut and paste values onto the template.
- Select the year using the year combo box. Any year between 1994 and 2002 is allowed.

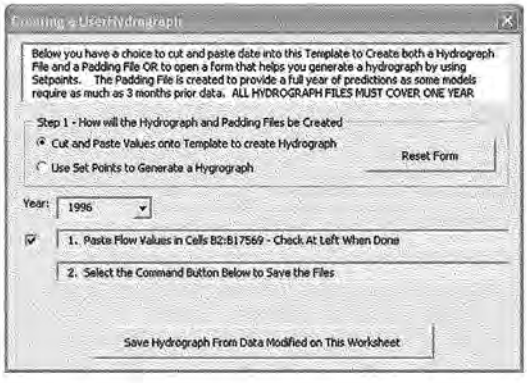


Figure A10. OptionForm with "Cut and Paste" option.

- Paste the flow values in the specified cells on the worksheet. The user must supply 1 full year of half-hour values. If the year selected is a leap year, the user must provide 366 days of values.
- Save the hydrograph values to file by selecting the "Save Hydrograph" command button.

6.2.2. Creating a UserHydrograph using the Set Points Option

The set points option allows the user to set values for specific dates. Once all set points are selected, the program will interpolate between set points to generate the remaining flow values. Figure A11 shows details of the OptionForm when the "use set points to generate a hydrograph" option is selected. The steps to perform are:

- Select the "Use Set Points" option.
- Select the "Generate Hydrograph Flows" command button. This will open the UserForm worksheet and the Create UserHydrograph Form (hereafter called SetPointForm).

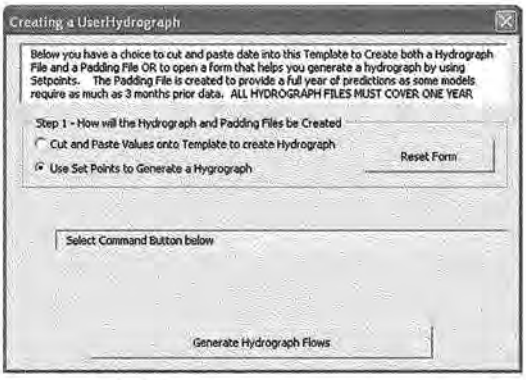


Figure A11. OptionForm with "Generate a Hydrograph" option selected.

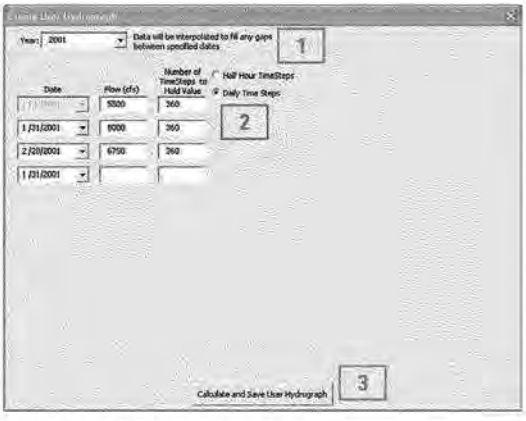


Figure A12. Create UserHydrograph form.

6.2.2.1. Create *UserHydrograph* Worksheet

The Create UserHydrograph form (fig. A12) allows the user to specify set points for the UserHydrograph. The program will then interpolate between the specified set points to create a UserHydrograph. The steps are as follows:

- Select any year between 1994 and 2005 (section 1 of fig. A12) for the UserHydrograph.
- Enter a flow for the first set point. The first set point is automatically set to January 1 of the specified year.
- Enter a hold time for the value. The user has two choices for units in setting a hold time. The user may select that the hold time be specified in half-hour time steps or daily time steps using the provided option buttons (section 2 of fig. A12). For example, if the user has specified a hold time of 1 and selected daily time steps, the flow value specified will stay constant for 1 day. If the user has selected half-hour time steps, the flow value specified will stay constant for 1 half hour.
- A user may specify up to 24 set points. After a set point has been entered, a new blank set point will become visible.
- After all set points have been entered, select the "Calculate and Save UserHydrograph" command button (section 3 of fig. A12). This will interpolate values between setpoints, holding any given value for the specified hold time. If the last set point is not at year's end, the program will hold the last set point value to year's end.
- The user will be prompted for the name of the UserHydrograph file. A workbook will open with the UserHydrograph data and the file saved. Figure A13 shows the user windows which pop up for choosing the file name and saving of the file.

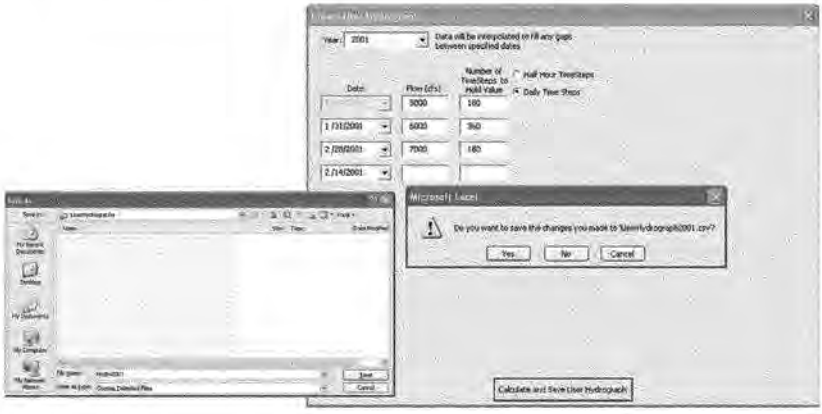


Figure A13. Saving the UserHydrograph.

6.3. *Revision Control* Worksheet

The *Revision Control* worksheet notes each revision and its changes.

7. Marsh Filling and Visualization

The application ***M2MVisualization_mmddyyy.xls*** (hereafter referred to as M2M) is used to fill salinity values for the entire marsh area using salinity values from various gages. The program uses output from the model program to fill the marsh values. To create these files, the user must select "Save Visualization Files" when running a simulation using the model. The files are saved in the VisualizationFiles folder.

The M2M application consists of seven worksheets which are described below.

7.1. *About* Worksheet

The ***About*** worksheet (fig. A14) contains contact and revision information.

7.2. *Visualization* Worksheet

The ***Visualization*** worksheet (fig. A15) contains the visualization of the marsh and all controls for handling the filling and colorization of the marsh. The controls for filling the marsh are contained on the *Visualization Setup* UserForm (section 2 of fig. A15). Controls for changing the color scheme of the visualization grid are contained in the *Visualization Color Scheme* UserForm (section 3 of fig. A15).

7.2.1. Visualization Grid

The visualization grid (section 1 of fig. A15) displays the Savannah River, Back River, marsh, and surrounding areas. The river, upland area, and pond are displayed in blue, brown, and light blue, respectively. These remain fixed. The marsh areas shown in figure A15 are displayed in various shades of green depending on the salinity. An example of this is shown in figure A16.

7.2.2. ***Visualization Setup*** UserForm

The *Visualization Setup* UserForm is used to control the filling of the marsh for visualization (fig. A17). The form is divided into four steps which are described below.

7.2.2.1. Step 1—Load in Model Output Data

Here the user selects the file containing the salinity data which will be used to fill the marsh. Selecting the "Load in Salinity Data Used in Visualization" command button will open a browser window from which the user can select the desired file. The only data which can be read into this program is the visualization data created by the model program during the simulation run. The next three text boxes are for display only (no user input allowed) and will display the name of the data file selected, the start date of the simulation run for the selected file, and the end date of the simulation run for the selected file.

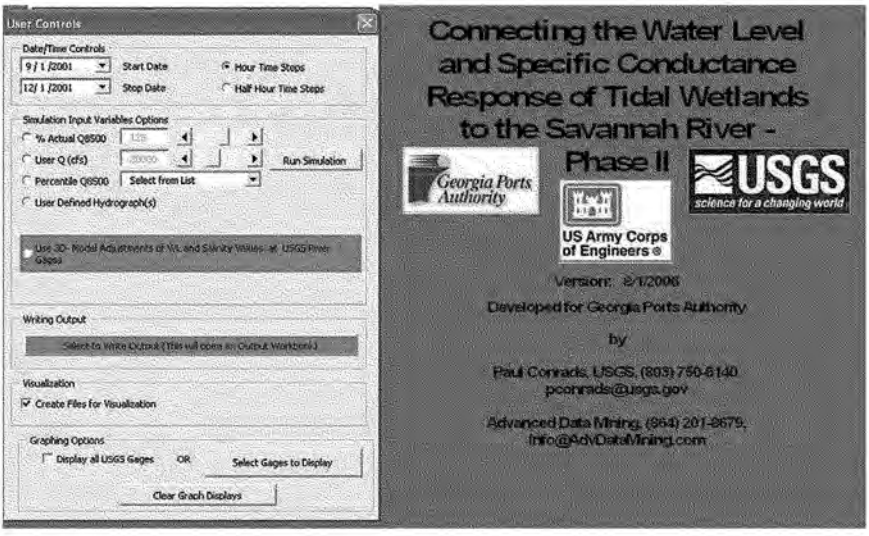


Figure A14. *About* worksheet for M2M visualization application.

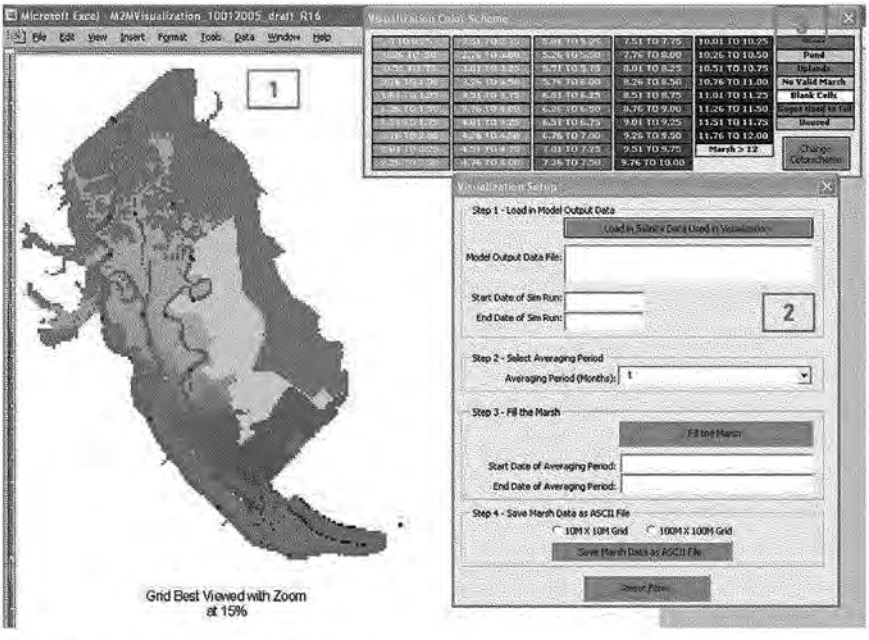


Figure A15. *Visualization* worksheet from M2M application.

Figure A16. Color gradient of marsh area. Darker shades of green represent increasing salinity concentrations.

7.2.2.2. Step 2—Select Averaging Period

The visualization data contains half-hourly or hourly data created by the model program. This data can be averaged in increments of 1 month up to 1 year or over 2 years. The averaging period to be used for filling is selected using the combo box in step 2.

7.2.2.3. Step 3—Fill the Marsh

Selecting the "Fill the Marsh" command button will compute averages for the gage locations given the selected averaging period. These averages will be used to interpolate the marsh salinity values. The marsh will then be filled with the colorization based on the color scheme used. In the color scheme used in figure A16, the darker green values correlate to higher salinity values. The two text boxes below the "Fill the Marsh" command button are for display only and show the start and end dates of the averaging period.

7.2.2.4. Step 4—Save Marsh Data as ASCII File

To save the marsh data to file, first select either "10M X 10M Grid" or "100M X 100M Grid." Selecting the "Save Marsh Data as ASCII File" command button will then save the filled marsh data. The data can then serve as input for other applications. The format of the saved marsh data is a space-delimited file with six rows of header information defining the grid followed by the data. The header below is for a 10M X 10M grid:

```
ncols,1490
nrows,1950
xllcorner, 957290.6875
yllcorner, 757059.0625
cellsize, 32.80839895
NODATA_value,-9999
<data>
```

Also note that the following constant values are used: 888 = river; 777 = impounded water; 222 = upriver.

7.2.3. *Visualization Color Scheme* UserForm

The *Visualization Color Scheme* UserForm (hereafter called ColorForm) displays the current color scheme for the colorization of the marsh. The values superimposed on the colored cells indicate the use of the color (fig. A18). For example, salinity values of 0–0.25 are colored the lightest green. Any salinity value greater than 12 is colored yellow. The colored cells on the far right indicate the constant colors used in the grid. This color scheme can be changed by selecting the "Change Colorscheme" command button. Selecting this button will take the user to the *ColorScheme* worksheet.

7.3. *ColorScheme* Worksheet

The *ColorScheme* worksheet (fig. A19) is used to change the colors used in the visualization of the marsh pore-water salinity. Excel™ allows 56 colors. The user can assign any desired RGB values to a particular color index.

- Column 2 of the ColorScheme worksheet indicates the color index being assigned. The user cannot change these values.
- Columns 3, 4, and 5 have the red, green, and blue components of the color, respectively. The values used can range from 0 to 255. The user changes these values to change the color scheme.
- Column 6 shows the color setting based on the user RGB values selected.
- Cell 7:2 contains the user-set maximum salinity value. The user enters this value.

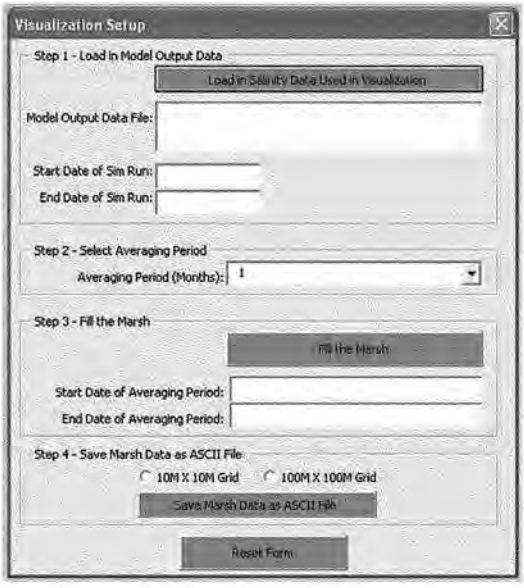


Figure A17. *Visualization Setup* UserForm.

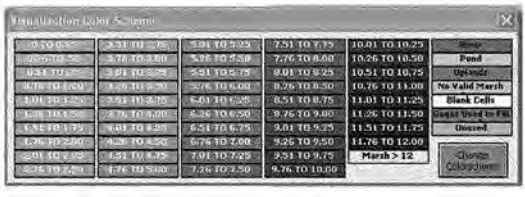


Figure A18. Visualization color scheme UserForm.

7.3.1. Color Values for the Marsh Salinity Levels

In section 1 of figure A19, the user can alter the RGB values for the 49 color indexes used in coloring the marsh. Color index 1 is for the lowest salinity value, and color index 48 is for the maximum salinity value. Any salinity value greater than the maximum set will be colored using color index 49. To determine the salinity values used for color index 2 to color index 47, the total range is divided into 48 equal parcels.

7.3.2. Color Values for Constant Values

In section 2 of figure A19, the colors are selected for constant areas. These defined areas are:

- river, pond (imprisoned water), uplands, no valid marsh data, blank cells, gages used to fill marsh, and 1 unused.

7.3.3. Maximum Salinity Setting

In section 3 of figure A19—specifically cell 7:2 of the worksheet—the user sets the maximum salinity value which is used in creating the color gradients.

7.3.4. Reset the Color Scheme

Selecting the "Reset Color Scheme" command button will update the color index to match the new user settings. The new colors will display in column 6 of the worksheet.

7.4. *Simulation Data* Worksheet

The *Simulation Data* worksheet (fig. A20) contains the data read in from the visualization file.

7.5. Original Colorscheme Worksheet

This worksheet contains the original colorscheme and is read only. To restore the original scheme, the user can copy and paste the values from this worksheet onto the *ColorScheme* worksheet.

7.6. *Revision Control* Worksheet

The *Revision Control* worksheet notes each revision and its changes.

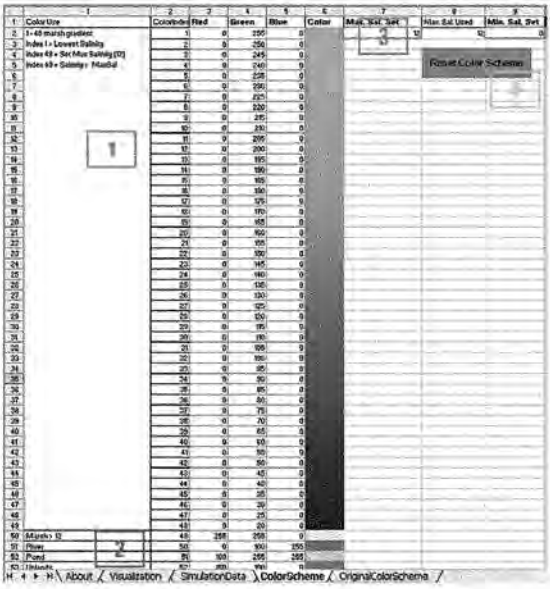


Figure A19. *ColorScheme* worksheet.

	1	2	3	4	5	6	7	8	9	10	11
1	DATETIME	ROW	Q8500	Q8500A	Q8500-user	WL8380	WL8380	Sal8840	Sal8840-predactualactual	dSal8840(pred-user)	Sal8840-user
2	1/1/2002	1	5570	5713.708961	7740	-0.280000001	8.127500534	0.051247172	0.052448699	0.009117066	0.042130105
3	1/1/2002 1:00	3	5682	5706.1	7733.75	-2.109999895	8.240000725	0.048619405	0.057799461	0.009509897	0.039109416
4	1/1/2002 2:00	5	5682	5698.62	7727.5	-3.830000114	8.352500916	0.048619405	0.053164087	0.009472896	0.03914652
5	1/1/2002 3:00	7	5647	5691.29	7721.25	-4.400000095	8.465001106	0.048162335	0.053761111	0.009339521	0.038842812
6	1/1/2002 4:00	9	5647	5684.12	7715	-3.559999943	8.577501297	0.048162335	0.056109812	0.009061083	0.039121252
7	1/1/2002 5:00	11	5647	5677.12	7708.75	-1.769999981	8.690001488	0.047745524	0.057589566	0.008868621	0.038876905
8	1/1/2002 6:00	13	5640	5670.29	7702.5	0.370000005	8.802501678	0.048162335	0.057490681	0.008900477	0.039261858
9	1/1/2002 7:00	15	5632	5663.65	7696.25	2.599999905	8.915001869	0.048162335	0.056632614	0.009017611	0.039164726
10	1/1/2002 8:00	17	5625	5657.19	7690	4.090000153	9.02750206	0.049832165	0.057064997	0.008958422	0.040973734
11	1/1/2002 9:00	19	5617	5650.92	7683.75	4.739999771	9.140000343	0.056067506	0.059284067	0.008705749	0.047361755
12	1/1/2002 10:00	21	5609	5644.85	7677.5	4.650000095	9.039999962	0.063821584	0.068957221	0.008537164	0.055084415
13	1/1/2002 11:00	23	5602	5638.99	7671.25	3.59999999	8.939999959	0.071663164	0.081457733	0.009221225	0.062441939
14	1/1/2002 12:00	25	5602	5633.35	7665	2.009999999	8.839999199	0.067167854	0.079663316	0.014295464	0.052892591
15	1/1/2002 13:00	27	5594	5627.93	7658.75	0.209999993	8.739999817	0.054764591	0.091489297	0.01828481	0.036479782
16	1/1/2002 14:00	29	5587	5622.74	7652.5	-1.75	8.639999436	0.048619405	0.061446846	0.012018203	0.036801201

Figure A20. *Simulation data* worksheet.

Appendix A

The Output workbook will consist of two or more worksheets (*RiverOutput* worksheet and *MarshOutput* worksheet. The USGS and GPA river data are found on the *RiverOutput* worksheet and the USGS and GPA Marsh Data on the *MarshOutput* worksheet. If more data is collected than will fit on one worksheet (limit is 65,536 rows of data), additional worksheets will be created as needed.

The Output workbook will contain the following information for each gage modeled:

- actual (or historical) value,
- predicted actual value (predicted output using historical Clyo flow),
- predicted-user (predicted delta due to user set flows or EFDC adjustments), and
- user value (predicted user value calculated by offsetting the historical value [or predicted actual if historical not available] by the delta calculated by taking the difference of actual and user predictions).

***RiverOutput* worksheet**

Color Explanation	
Actual (historical) data	
Predicted (predicted using actual flow conditions)	
Difference (predicted actual – predicted user)	
User (predicted using user flow conditions or EFDC deltas)	

Column heading	Heading description
DATETIME	Simulation Date and Time
ROW	Row Number in Historical Data File
Q8500	Actual flow at Clyo
Q8500A	Filtered Actual Flow at Clyo
Q8500-user	User Set Flow
WL8980	Water Level at Fort Pulaski
XWL8980	Tidal Range
Sal8840	Actual Salinity
Sal8840-predactualactual	Predicted Salinity Using Actual Flow
dSal8840(pred-user)	Difference Between Predicted and User Values
Sal8840-user	Predicted Salinity Using User Set Flow
WL8840	Actual Water Level
WL8840-predactualactual	Predicted Water Level Using Actual Flow
dWL8840(pred-user)	Predicted Water Level Using User Set Flow
WL8840-user	Difference Between Predicted and User Values
Sal8920	Actual Salinity
Sal8920-predactual	Predicted Salinity Using Actual Flow
dSal8920(pred-user)	Difference Between Predicted and User Values
Sal8920-user	Predicted Salinity Using User Set Flow
WL8920	Actual Water Level
WL8920-predactual	Predicted Water Level Using Actual Flow
dWL8920(pred-user)	Predicted Water Level Using User Set Flow
WL8920-user	Difference Between Predicted and User Values
Sal89784	Actual Salinity
Sal89784-predactual	Predicted Salinity Using Actual Flow

***RiverOutput* worksheet—Continued**

Color Explanation	
Actual (historical) data	
Predicted (predicted using actual flow conditions)	
Difference (predicted actual – predicted user)	
User (predicted using user flow conditions or EFDC deltas)	

Column heading	Heading description
dSal89784(pred-user)	Difference Between Predicted and User Values
Sal89784-user	Predicted Salinity Using User Set Flow
Sal89791	Actual Salinity
Sal89791-predactual	Predicted Salinity Using Actual Flow
dSal89791(pred-user)	Difference Between Predicted and User Values
Sal89791-user	Predicted Salinity Using User Set Flow
WL8979	Actual Water Level
WL8979-predactual	Predicted Water Level Using Actual Flow
dWL8979(pred-user)	Predicted Water Level Using User Set Flow
WL8979-user	Difference Between Predicted and User Values
WL8977	Actual Water Level
WL8977-predactual	Predicted Water Level Using Actual Flow
dWL8977(pred-user)	Predicted Water Level Using User Set Flow
WL8977-user	Difference Between Predicted and User Values
WLGPA04	Actual Water Level
WLGPA04-predactual	Predicted Water Level Using Actual Flow
dWLGPA04(pred-user)	Predicted Water Level Using User Set Flow
WLGPA04-user	Difference Between Predicted and User Values
WLGPA05	Actual Water Level
WLGPA05-predactual	Predicted Water Level Using Actual Flow
dWLGPA05(pred-user)	Predicted Water Level Using User Set Flow
WLGPA05-user	Difference Between Predicted and User Values
WLGPA06	Actual Water Level
WLGPA06-predactual	Predicted Water Level Using Actual Flow
dWLGPA06(pred-user)	Predicted Water Level Using User Set Flow
WLGPA06-user	Difference Between Predicted and User Values
WLGPA07	Actual Water Level
WLGPA07-predactual	Predicted Water Level Using Actual Flow
dWLGPA07(pred-user)	Predicted Water Level Using User Set Flow
WLGPA07-user	Difference Between Predicted and User Values
WLGPA08	Actual Water Level
WLGPA08-predactual	Predicted Water Level Using Actual Flow
dWLGPA08(pred-user)	Predicted Water Level Using User Set Flow
WLGPA08-user	Difference Between Predicted and User Values

RiverOutput worksheet—Continued

Color Explanation	
Actual (historical) data	
Predicted (predicted using actual flow conditions)	
Difference (predicted actual – predicted user)	
User (predicted using user flow conditions or EFDC deltas)	

Column heading	Heading description
WLGPA09	Actual Water Level
WLGPA09-predactual	Predicted Water Level Using Actual Flow
dWLGPA09(pred-user)	Predicted Water Level Using User Set Flow
WLGPA09-user	Difference Between Predicted and User Values
WLGPA10	Actual Water Level
WLGPA10-predactual	Predicted Water Level Using Actual Flow
dWLGPA10(pred-user)	Predicted Water Level Using User Set Flow
WLGPA10-user	Difference Between Predicted and User Values
WLGPA11	Actual Water Level
WLGPA11-predactual	Predicted Water Level Using Actual Flow
dWLGPA11(pred-user)	Predicted Water Level Using User Set Flow
WLGPA11-user	Difference Between Predicted and User Values
WLGPA11R	Actual Water Level
WLGPA11R-predactual	Predicted Water Level Using Actual Flow
dWLGPA11R(pred-user)	Predicted Water Level Using User Set Flow
WLGPA11R-user	Difference Between Predicted and User Values
WLGPA12	Actual Water Level
WLGPA12-predactual	Predicted Water Level Using Actual Flow
dWLGPA12(pred-user)	Predicted Water Level Using User Set Flow
WLGPA12-user	Difference Between Predicted and User Values
WLGPA13	Actual Water Level
WLGPA13-predactual	Predicted Water Level Using Actual Flow
dWLGPA13(pred-user)	Predicted Water Level Using User Set Flow
WLGPA13-user	Difference Between Predicted and User Values
WLGPA14	Actual Water Level
WLGPA14-predactual	Predicted Water Level Using Actual Flow
dWLGPA14(pred-user)	Predicted Water Level Using User Set Flow
WLGPA14-user	Difference Between Predicted and User Values
WLGPA21	Actual Water Level
WLGPA21-predactual	Predicted Water Level Using Actual Flow
dWLGPA21(pred-user)	Predicted Water Level Using User Set Flow
WLGPA21-user	Difference Between Predicted and User Values
WLGPA22	Actual Water Level
WLGPA22-predactual	Predicted Water Level Using Actual Flow

***RiverOutput* worksheet—Continued**

Color Explanation	
Actual (historical) data	
Predicted (predicted using actual flow conditions)	
Difference (predicted actual – predicted user)	
User (predicted using user flow conditions or EFDC deltas)	

Column heading	Heading description
dWLGPA22(pred-user)	Predicted Water Level Using User Set Flow
WLGPA22-user	Difference Between Predicted and User Values
WLGPA23M	Actual Water Level
WLGPA23M-predactual	Predicted Water Level Using Actual Flow
dWLGPA23M(pred-user)	Predicted Water Level Using User Set Flow
WLGPA23M-user	Difference Between Predicted and User Values
WLGPA24M	Actual Water Level
WLGPA24M-predactual	Predicted Water Level Using Actual Flow
dWLGPA24M(pred-user)	Predicted Water Level Using User Set Flow
WLGPA24M-user	Difference Between Predicted and User Values
WLGPA25M	Actual Water Level
WLGPA25M-predactual	Predicted Water Level Using Actual Flow
dWLGPA25M(pred-user)	Predicted Water Level Using User Set Flow
WLGPA25M-user	Difference Between Predicted and User Values
WLGPA26	Actual Water Level
WLGPA26-predactual	Predicted Water Level Using Actual Flow
dWLGPA26(pred-user)	Predicted Water Level Using User Set Flow
WLGPA26-user	Difference Between Predicted and User Values
SalGPA04B	Actual Salinity
SalGPA04B-predactual	Predicted Salinity Using Actual Flow
dSalGPA04B(pred-user)	Difference Between Predicted and User Values
SalGPA04B-user	Predicted Salinity Using User Set Flow
SalGPA04S	Actual Salinity
SalGPA04S-predactual	Predicted Salinity Using Actual Flow
dSalGPA04S(pred-user)	Difference Between Predicted and User Values
SalGPA04S-user	Predicted Salinity Using User Set Flow
SalGPA05B	Actual Salinity
SalGPA05B-predactual	Predicted Salinity Using Actual Flow
dSalGPA05B(pred-user)	Difference Between Predicted and User Values
SalGPA05B-user	Predicted Salinity Using User Set Flow
SalGPA06B	Actual Salinity
SalGPA06B-predactual	Predicted Salinity Using Actual Flow
dSalGPA06B(pred-user)	Difference Between Predicted and User Values
SalGPA06B-user	Predicted Salinity Using User Set Flow

RiverOutput worksheet—Continued

Color Explanation	
Actual (historical) data	
Predicted (predicted using actual flow conditions)	
Difference (predicted actual – predicted user)	
User (predicted using user flow conditions or EFDC deltas)	

Column heading	Heading description
SalGPA06S	Actual Salinity
SalGPA06S-predactual	Predicted Salinity Using Actual Flow
dSalGPA06S(pred-user)	Difference Between Predicted and User Values
SalGPA06S-user	Predicted Salinity Using User Set Flow
SalGPA07B	Actual Salinity
SalGPA07B-predactual	Predicted Salinity Using Actual Flow
dSalGPA07B(pred-user)	Difference Between Predicted and User Values
SalGPA07B-user	Predicted Salinity Using User Set Flow
SalGPA07S	Actual Salinity
SalGPA07S-predactual	Predicted Salinity Using Actual Flow
dSalGPA07S(pred-user)	Difference Between Predicted and User Values
SalGPA07S-user	Predicted Salinity Using User Set Flow
SalGPA08B	Actual Salinity
SalGPA08B-predactual	Predicted Salinity Using Actual Flow
dSalGPA08B(pred-user)	Difference Between Predicted and User Values
SalGPA08B-user	Predicted Salinity Using User Set Flow
SalGPA08S	Actual Salinity
SalGPA08S-predactual	Predicted Salinity Using Actual Flow
dSalGPA08S(pred-user)	Difference Between Predicted and User Values
SalGPA08S-user	Predicted Salinity Using User Set Flow
SalGPA09B	Actual Salinity
SalGPA09B-predactual	Predicted Salinity Using Actual Flow
dSalGPA09B(pred-user)	Difference Between Predicted and User Values
SalGPA09B-user	Predicted Salinity Using User Set Flow
SalGPA09S	Actual Salinity
SalGPA09S-predactual	Predicted Salinity Using Actual Flow
dSalGPA09S(pred-user)	Difference Between Predicted and User Values
SalGPA09S-user	Predicted Salinity Using User Set Flow
SalGPA10B	Actual Salinity
SalGPA10B-predactual	Predicted Salinity Using Actual Flow
dSalGPA10B(pred-user)	Difference Between Predicted and User Values
SalGPA10B-user	Predicted Salinity Using User Set Flow
SalGPA10S	Actual Salinity
SalGPA10S-predactual	Predicted Salinity Using Actual Flow

RiverOutput worksheet—Continued

Color Explanation	
Actual (historical) data	
Predicted (predicted using actual flow conditions)	
Difference (predicted actual – predicted user)	
User (predicted using user flow conditions or EFDC deltas)	

Column heading	Heading description
dSalGPA10S(pred-user)	Difference Between Predicted and User Values
SalGPA10S-user	Predicted Salinity Using User Set Flow
SalGPA11B	Actual Salinity
SalGPA11B-predactual	Predicted Salinity Using Actual Flow
dSalGPA11B(pred-user)	Difference Between Predicted and User Values
SalGPA11B-user	Predicted Salinity Using User Set Flow
SalGPA11RB	Actual Salinity
SalGPA11RB-predactual	Predicted Salinity Using Actual Flow
dSalGPA11RB(pred-user)	Difference Between Predicted and User Values
SalGPA11RB-user	Predicted Salinity Using User Set Flow
SalGPA12B	Actual Salinity
SalGPA12B-predactual	Predicted Salinity Using Actual Flow
dSalGPA12B(pred-user)	Difference Between Predicted and User Values
SalGPA12B-user	Predicted Salinity Using User Set Flow
SalGPA12RS	Actual Salinity
SalGPA12RS-predactual	Predicted Salinity Using Actual Flow
dSalGPA12RS(pred-user)	Difference Between Predicted and User Values
SalGPA12RS-user	Predicted Salinity Using User Set Flow
SalGPA13B	Actual Salinity
SalGPA13B-predactual	Predicted Salinity Using Actual Flow
dSalGPA13B(pred-user)	Difference Between Predicted and User Values
SalGPA13B-user	Predicted Salinity Using User Set Flow
SalGPA14B	Actual Salinity
SalGPA14B-predactual	Predicted Salinity Using Actual Flow
dSalGPA14B(pred-user)	Difference Between Predicted and User Values
SalGPA14B-user	Predicted Salinity Using User Set Flow
SalGPA15S	Actual Salinity
SalGPA15S-predactual	Predicted Salinity Using Actual Flow
dSalGPA15S(pred-user)	Difference Between Predicted and User Values
SalGPA15S-user	Predicted Salinity Using User Set Flow
SalGPA21B	Actual Salinity
SalGPA21B-predactual	Predicted Salinity Using Actual Flow
dSalGPA21B(pred-user)	Difference Between Predicted and User Values
SalGPA21B-user	Predicted Salinity Using User Set Flow

***RiverOutput* worksheet—Continued**

Color Explanation	
Actual (historical) data	
Predicted (predicted using actual flow conditions)	
Difference (predicted actual – predicted user)	
User (predicted using user flow conditions or EFDC deltas)	

Column heading	Heading description
SalGPA21S	Actual Salinity
SalGPA21S-predactual	Predicted Salinity Using Actual Flow
dSalGPA21S(pred-user)	Difference Between Predicted and User Values
SalGPA21S-user	Predicted Salinity Using User Set Flow
SalGPA22B	Actual Salinity
SalGPA22B-predactual	Predicted Salinity Using Actual Flow
dSalGPA22B(pred-user)	Difference Between Predicted and User Values
SalGPA22B-user	Predicted Salinity Using User Set Flow
SalGPA22S	Actual Salinity
SalGPA22S-predactual	Predicted Salinity Using Actual Flow
dSalGPA22S(pred-user)	Difference Between Predicted and User Values
SalGPA22S-user	Predicted Salinity Using User Set Flow

***MarshOutput* worksheet**

Color Explanation	
Actual (historical) data	
Predicted (predicted using actual flow conditions)	
Difference (predicted actual – predicted user)	
User (predicted using user flow conditions or EFDC deltas)	

Column heading	Heading description
DATETIME	Simulation Date and Time
ROW	Row Number in Historical Data File
S1CANALWL	Actual Water Level
S1CANALWL-predactualactual	Predicted Water Level Using Actual Flow
dS1CANALWL(pred-user)	Predicted Water Level Using User Set Flow
S1CANALWL-user	Difference Between Predicted and User Values
S1MARSHWLAT	Actual Water Level
S1MARSHWLAT-predactual	Predicted Water Level Using Actual Flow
dS1MARSHWLAT(pred-user)	Predicted Water Level Using User Set Flow
S1MARSHWLAT-user	Difference Between Predicted and User Values
S1MARSHWL	Actual Water Level

MarshOutput worksheet—Continued

Color Explanation	
Actual (historical) data	
Predicted (predicted using actual flow conditions)	
Difference (predicted actual – predicted user)	
User (predicted using user flow conditions or EFDC deltas)	

Column heading	Heading description
S1MARSHWL-predactual	Predicted Water Level Using Actual Flow
dS1MARSHWL(pred-user)	Predicted Water Level Using User Set Flow
S1MARSHWL-user	Difference Between Predicted and User Values
S2CANALWL	Actual Water Level
S2CANALWL-predactual	Predicted Water Level Using Actual Flow
dS2CANALWL(pred-user)	Predicted Water Level Using User Set Flow
S2CANALWL-user	Difference Between Predicted and User Values
S2MARSHWL	Actual Water Level
S2MARSHWL-predactual	Predicted Water Level Using Actual Flow
dS2MARSHWL(pred-user)	Predicted Water Level Using User Set Flow
S2MARSHWL-user	Difference Between Predicted and User Values
S3CANALWL	Actual Water Level
S3CANALWL-predactual	Predicted Water Level Using Actual Flow
dS3CANALWL(pred-user)	Predicted Water Level Using User Set Flow
S3CANALWL-user	Difference Between Predicted and User Values
S3MARSHWL	Actual Water Level
S3MARSHWL-predactual	Predicted Water Level Using Actual Flow
dS3MARSHWL(pred-user)	Predicted Water Level Using User Set Flow
S3MARSHWL-user	Difference Between Predicted and User Values
S4CANALWL	Actual Water Level
S4CANALWL-predactual	Predicted Water Level Using Actual Flow
dS4CANALWL(pred-user)	Predicted Water Level Using User Set Flow
S4CANALWL-user	Difference Between Predicted and User Values
S4MARSHWL	Actual Water Level
S4MARSHWL-predactual	Predicted Water Level Using Actual Flow
dS4MARSHWL(pred-user)	Predicted Water Level Using User Set Flow
S4MARSHWL-user	Difference Between Predicted and User Values
S5CANALWL	Actual Water Level
S5CANALWL-predactual	Predicted Water Level Using Actual Flow
dS5CANALWL(pred-user)	Predicted Water Level Using User Set Flow
S5CANALWL-user	Difference Between Predicted and User Values
S5MARSHWL	Actual Water Level
S5MARSHWL-predactual	Predicted Water Level Using Actual Flow
dS5MARSHWL(pred-user)	Predicted Water Level Using User Set Flow

***MarshOutput* worksheet—Continued**

Color Explanation	
Actual (historical) data	
Predicted (predicted using actual flow conditions)	
Difference (predicted actual – predicted user)	
User (predicted using user flow conditions or EFDC deltas)	

Column heading	Heading description
S5MARSHWL-user	Difference Between Predicted and User Values
S6CANALWL	Actual Water Level
S6CANALWL-predactual	Predicted Water Level Using Actual Flow
dS6CANALWL(pred-user)	Predicted Water Level Using User Set Flow
S6CANALWL-user	Difference Between Predicted and User Values
S6MARSHWL	Actual Water Level
S6MARSHWL-predactual	Predicted Water Level Using Actual Flow
dS6MARSHWL(pred-user)	Predicted Water Level Using User Set Flow
S6MARSHWL-user	Difference Between Predicted and User Values
S6MARSHWLAT	Actual Water Level
S6MARSHWLAT-predactual	Predicted Water Level Using Actual Flow
dS6MARSHWLAT(pred-user)	Predicted Water Level Using User Set Flow
S6MARSHWLAT-user	Difference Between Predicted and User Values
S7CANALWL	Actual Water Level
S7CANALWL-predactual	Predicted Water Level Using Actual Flow
dS7CANALWL(pred-user)	Predicted Water Level Using User Set Flow
S7CANALWL-user	Difference Between Predicted and User Values
S7MARSHWL	Actual Water Level
S7MARSHWL-predactual	Predicted Water Level Using Actual Flow
dS7MARSHWL(pred-user)	Predicted Water Level Using User Set Flow
S7MARSHWL-user	Difference Between Predicted and User Values
S8CANALWL	Actual Water Level
S8CANALWL-predactual	Predicted Water Level Using Actual Flow
dS8CANALWL(pred-user)	Predicted Water Level Using User Set Flow
S8CANALWL-user	Difference Between Predicted and User Values
S9CANALWL	Actual Water Level
S9CANALWL-predactual	Predicted Water Level Using Actual Flow
dS9CANALWL(pred-user)	Predicted Water Level Using User Set Flow
S9CANALWL-user	Difference Between Predicted and User Values
S9MARSHWL	Actual Water Level
S9MARSHWL-predactual	Predicted Water Level Using Actual Flow
dS9MARSHWL(pred-user)	Predicted Water Level Using User Set Flow
S9MARSHWL-user	Difference Between Predicted and User Values
S10CANALWL	Actual Water Level

***MarshOutput* worksheet—Continued**

Color Explanation	
Actual (historical) data	
Predicted (predicted using actual flow conditions)	
Difference (predicted actual – predicted user)	
User (predicted using user flow conditions or EFDC deltas)	

Column heading	Heading description
S10CANALWL-predactual	Predicted Water Level Using Actual Flow
dS10CANALWL(pred-user)	Predicted Water Level Using User Set Flow
S10CANALWL-user	Difference Between Predicted and User Values
S10MARSHWL	Actual Water Level
S10MARSHWL-predactual	Predicted Water Level Using Actual Flow
dS10MARSHWL(pred-user)	Predicted Water Level Using User Set Flow
S10MARSHWL-user	Difference Between Predicted and User Values
S1CANALSC	Actual Salinity
S1CANALSC-predactual	Predicted Salinity Using Actual Flow
dS1CANALSC(pred-user)	Difference Between Predicted and User Values
S1CANALSC-user	Predicted Salinity Using User Set Flow
S1MARSHSC	Actual Salinity
S1MARSHSC-predactual	Predicted Salinity Using Actual Flow
dS1MARSHSC(pred-user)	Difference Between Predicted and User Values
S1MARSHSC-user	Predicted Salinity Using User Set Flow
S2CANALSC	Actual Salinity
S2CANALSC-predactual	Predicted Salinity Using Actual Flow
dS2CANALSC(pred-user)	Difference Between Predicted and User Values
S2CANALSC-user	Predicted Salinity Using User Set Flow
S2MARSHSC	Actual Salinity
S2MARSHSC-predactual	Predicted Salinity Using Actual Flow
dS2MARSHSC(pred-user)	Difference Between Predicted and User Values
S2MARSHSC-user	Predicted Salinity Using User Set Flow
S3CANALSC	Actual Salinity
S3CANALSC-predactual	Predicted Salinity Using Actual Flow
dS3CANALSC(pred-user)	Difference Between Predicted and User Values
S3CANALSC-user	Predicted Salinity Using User Set Flow
S3MARSHSC	Actual Salinity
S3MARSHSC-predactual	Predicted Salinity Using Actual Flow
dS3MARSHSC(pred-user)	Difference Between Predicted and User Values
S3MARSHSC-user	Predicted Salinity Using User Set Flow
S4CANALSC	Actual Salinity
S4CANALSC-predactual	Predicted Salinity Using Actual Flow
dS4CANALSC(pred-user)	Difference Between Predicted and User Values

***MarshOutput* worksheet—Continued**

Color Explanation	
Actual (historical) data	
Predicted (predicted using actual flow conditions)	
Difference (predicted actual – predicted user)	
User (predicted using user flow conditions or EFDC deltas)	

Column heading	Heading description
S4CANALSC-user	Predicted Salinity Using User Set Flow
S4MARSHSC	Actual Salinity
S4MARSHSC-predactual	Predicted Salinity Using Actual Flow
dS4MARSHSC(pred-user)	Difference Between Predicted and User Values
S4MARSHSC-user	Predicted Salinity Using User Set Flow
S5CANALSC	Actual Salinity
S5CANALSC-predactual	Predicted Salinity Using Actual Flow
dS5CANALSC(pred-user)	Difference Between Predicted and User Values
S5CANALSC-user	Predicted Salinity Using User Set Flow
S5MARSHSC	Actual Salinity
S5MARSHSC-predactual	Predicted Salinity Using Actual Flow
dS5MARSHSC(pred-user)	Difference Between Predicted and User Values
S5MARSHSC-user	Predicted Salinity Using User Set Flow
S6CANALSC	Actual Salinity
S6CANALSC-predactual	Predicted Salinity Using Actual Flow
dS6CANALSC(pred-user)	Difference Between Predicted and User Values
S6CANALSC-user	Predicted Salinity Using User Set Flow
S6MARSHSC	Actual Salinity
S6MARSHSC-predactual	Predicted Salinity Using Actual Flow
dS6MARSHSC(pred-user)	Difference Between Predicted and User Values
S6MARSHSC-user	Predicted Salinity Using User Set Flow
S7CANALSC	Actual Salinity
S7CANALSC-predactual	Predicted Salinity Using Actual Flow
dS7CANALSC(pred-user)	Difference Between Predicted and User Values
S7CANALSC-user	Predicted Salinity Using User Set Flow
S7MARSHSC	Actual Salinity
S7MARSHSC-predactual	Predicted Salinity Using Actual Flow
dS7MARSHSC(pred-user)	Difference Between Predicted and User Values
S7MARSHSC-user	Predicted Salinity Using User Set Flow
S7MARSHPWSC	Actual Salinity
S7MARSHPWSC-predactual	Predicted Salinity Using Actual Flow
dS7MARSHPWSC(pred-user)	Difference Between Predicted and User Values
S7MARSHPWSC-user	Predicted Salinity Using User Set Flow
S8CANALSC	Actual Salinity

MarshOutput worksheet—Continued

Color Explanation	
Actual (historical) data	
Predicted (predicted using actual flow conditions)	
Difference (predicted actual – predicted user)	
User (predicted using user flow conditions or EFDC deltas)	

Column heading	Heading description
S8CANALSC-predactual	Predicted Salinity Using Actual Flow
dS8CANALSC(pred-user)	Difference Between Predicted and User Values
S8CANALSC-user	Predicted Salinity Using User Set Flow
S9CANALSC	Actual Salinity
S9CANALSC-predactual	Predicted Salinity Using Actual Flow
dS9CANALSC(pred-user)	Difference Between Predicted and User Values
S9CANALSC-user	Predicted Salinity Using User Set Flow
S9MARSHSWSC	Actual Salinity
S9MARSHSWSC-predactual	Predicted Salinity Using Actual Flow
dS9MARSHSWSC(pred-user)	Difference Between Predicted and User Values
S9MARSHSWSC-user	Predicted Salinity Using User Set Flow
S9MARSHPWSC	Actual Salinity
S9MARSHPWSC-predactual	Predicted Salinity Using Actual Flow
dS9MARSHPWSC(pred-user)	Difference Between Predicted and User Values
S9MARSHPWSC-user	Predicted Salinity Using User Set Flow
S10MARSHSWSC	Actual Salinity
S10MARSHSWSC-predactual	Predicted Salinity Using Actual Flow
dS10MARSHSWSC(pred-user)	Difference Between Predicted and User Values
S10MARSHSWSC-user	Predicted Salinity Using User Set Flow
S10MARSHPWSC	Actual Salinity
S10MARSHPWSC-predactual	Predicted Salinity Using Actual Flow
dS10MARSHPWSC(pred-user)	Difference Between Predicted and User Values
S10MARSHPWSC-user	Predicted Salinity Using User Set Flow
B1MWL	Actual Water Level
B1MWL-predactual	Predicted Water Level Using Actual Flow
dB1MWL(pred-user)	Predicted Water Level Using User Set Flow
B1MWL-user	Difference Between Predicted and User Values
B2MWL	Actual Water Level
B2MWL-predactual	Predicted Water Level Using Actual Flow
dB2MWL(pred-user)	Predicted Water Level Using User Set Flow
B2MWL-user	Difference Between Predicted and User Values
B3MWL	Actual Water Level
B3MWL-predactual	Predicted Water Level Using Actual Flow
dB3MWL(pred-user)	Predicted Water Level Using User Set Flow

***MarshOutput* worksheet—Continued**

Color Explanation	
Actual (historical) data	
Predicted (predicted using actual flow conditions)	
Difference (predicted actual – predicted user)	
User (predicted using user flow conditions or EFDC deltas)	

Column heading	Heading description
B3MWL-user	Difference Between Predicted and User Values
B4MWL	Actual Water Level
B4MWL-predactual	Predicted Water Level Using Actual Flow
dB4MWL(pred-user)	Predicted Water Level Using User Set Flow
B4MWL-user	Difference Between Predicted and User Values
F1MWL	Actual Water Level
F1MWL-predactual	Predicted Water Level Using Actual Flow
dF1MWL(pred-user)	Predicted Water Level Using User Set Flow
F1MWL-user	Difference Between Predicted and User Values
M1MWL	Actual Water Level
M1MWL-predactual	Predicted Water Level Using Actual Flow
dM1MWL(pred-user)	Predicted Water Level Using User Set Flow
M1MWL-user	Difference Between Predicted and User Values
M2MWL	Actual Water Level
M2MWL-predactual	Predicted Water Level Using Actual Flow
dM2MWL(pred-user)	Predicted Water Level Using User Set Flow
M2MWL-user	Difference Between Predicted and User Values
B1MSC	Actual Salinity
B1MSC-predactual	Predicted Salinity Using Actual Flow
dB1MSC(pred-user)	Difference Between Predicted and User Values
B1MSC-user	Predicted Salinity Using User Set Flow
B2MSC	Actual Salinity
B2MSC-predactual	Predicted Salinity Using Actual Flow
dB2MSC(pred-user)	Difference Between Predicted and User Values
B2MSC-user	Predicted Salinity Using User Set Flow
B3MSC	Actual Salinity
B3MSC-predactual	Predicted Salinity Using Actual Flow
dB3MSC(pred-user)	Difference Between Predicted and User Values
B3MSC-user	Predicted Salinity Using User Set Flow
B4MSC	Actual Salinity
B4MSC-predactual	Predicted Salinity Using Actual Flow
dB4MSC(pred-user)	Difference Between Predicted and User Values
B4MSC-user	Predicted Salinity Using User Set Flow
F1MSC	Actual Salinity

***MarshOutput* worksheet—Continued**

Color Explanation	
Actual (historical) data	
Predicted (predicted using actual flow conditions)	
Difference (predicted actual – predicted user)	
User (predicted using user flow conditions or EFDC deltas)	

Column heading	Heading description
F1MSC-predactual	Predicted Salinity Using Actual Flow
dF1MSC(pred-user)	Difference Between Predicted and User Values
F1MSC-user	Predicted Salinity Using User Set Flow
M1MSC	Actual Salinity
M1MSC-predactual	Predicted Salinity Using Actual Flow
dM1MSC(pred-user)	Difference Between Predicted and User Values
M1MSC-user	Predicted Salinity Using User Set Flow
M2MSC	Actual Salinity
M2MSC-predactual	Predicted Salinity Using Actual Flow
dM2MSC(pred-user)	Difference Between Predicted and User Values
M2MSC-user	Predicted Salinity Using User Set Flow

Dredging Operations Technical Support (DOTS) Program

Savannah District Request for Technical Assistance

Dredge Vertical Construction Accuracy

DOTS Response Number: 2006-011

26 March 2006

Background

Via e-mail communication of 15 February 2006, the U.S. Army Corps of Engineers, Savannah District (SAS) (Lyle Maciejewski SAS-OP-N), requested technical assistance from the U.S. Army Engineer Research and Development Center (ERDC), Environmental Laboratory (EL) (Douglas G. Clarke, CEERD-EE-W) through the DOTS program pertaining to the Savannah River Deepening Project. The request was subsequently forwarded to the ERDC Coastal and Hydraulics Laboratory (Tim Welp, CEERD-HN-CD) for analysis and response.

Savannah District (SAS) is developing a plan for deepening Savannah Harbor, Georgia. A shallow aquifer layer and pockets of soil enriched with cadmium lie in the channel to be deepened. Dredging will require tight vertical and horizontal control. SAS is familiar with the process of horizontal control, however, they have requested CEERD to conduct a DOTS request to gather more information about vertical dredging accuracies. Since the dredge type has not been selected, SAS requested CEERD to furnish information on what is the current state of vertical control of cutterhead and bucket (backhoe and clamshell) dredges. The sediments to be dredged are clay, so hopper dredges were not considered. Work conducted under this DOTS request consisted of a literature search and interviews with various dredging contractors, Corps employees, and instrumentation manufacturers.

The definition of vertical accuracy is very important in how the respective values are considered and applied. The different sources identified in this DOTS response have reported vertical accuracy in different ways (i.e., plus/minus (±) a value or in absolute numbers). Where available, the specific definitions from the various sources are presented in this report.

One of the more detailed accuracy definitions used by the International Association of Dredging Contractors (IADC) et al. (2001) to describe construction accuracy will be presented here to illustrate the various components that vertical accuracy is comprised of. In the document "Construction and Survey Accuracies for the Execution of Dredging and Stone Dumping Works"

construction accuracy is defined as the extent to which the completed work corresponds to design requirements. Various factors influence the selection of dredging plant and its respective inherent accuracy(ies), for a specific project:

(1) Physical characteristics of material to be dredged.

(2) Quantities and physical layout of material to be dredged.

(3) Dredging depth.

(4) Location of both the dredging and placement sites and distance between them.

(5) Physical environment (i.e., waves, tides, currents) of and between the dredging and disposal placement areas.

(6) Contamination level of sediments.

(7) Method of placement.

(8) Production required.

(9) Type of dredges available

Construction accuracy achieved during a project will not only depend on the selected dredge type and its inherent excavation accuracy, but also on:

(1) Accuracies of the support hydrographic and positioning (two-dimensional reference) systems used.

(2) Level of quality control used to continuously monitor data quality

(3) Experience level of crew

The total construction accuracy is therefore dependant upon reference accuracies, steering (operator) accuracy, and excavation point accuracy (IADC 2001). The reference accuracy relates to errors in determining vessel position relative to fixed reference (coordinate) system. Steering accuracy concerns those errors introduced manually by the operator (leverman, etc.). Excavation point accuracy is related to the dredge type selected (e.g., shape and adjustability of suction mouth, cutterhead/suction mouth geometry, use of a level cut bucket as opposed to conventional bucket, etc.) and "linkage between reference positioning and depth measurement" (EPA 2005). IADC (2001) concluded from environmental dredging trials in the Ketelmeer Project that the inaccuracies become greater in the order of: reference inaccuracies, excavation mouth inaccuracies, then total construction inaccuracies.

Vertical and horizontal excavation control for a significant number of the larger cutterheads and mechanical bucket (backhoe) dredges in America is provided by a positioning system that indicates (to the operator) the dredge excavation point referenced to the dredging template.

While the amount of material disturbance by the dredges below desired depth (to achieve the design depth) will be a factor in determining contract specifications, this aspect was not specifically considered under this DOTS request. Documentation addressing this issue is discussed in greater detail in attachments 2 and 3 that consist of previous DOTS requests addressing this issue. Dredging accuracies are primarily determined by excavation results (depths) indicated by hydrographic survey (before dredge (BD) and after dredge (AD) surveys) relative to the dredging template (aka grade, neatline, etc.). The AD depths do not necessarily indicate the maximum depth that the cutterhead or bucket had to penetrate to achieve the final grade. The accuracy of these hydrographic surveys that are used to determine dredging accuracy and results should also be considered when evaluating overall dredging accuracy. The following information (broken down by dredge type) was collected from the various references cited.

Cutterhead Dredge

As a starting point, the Dredging and Dredged Material Disposal Engineer Manual (EM) 1110-2-5025 (1983) states that the vertical accuracy of a cutterhead dredge on a navigation dredging project is generally within $\pm$ 1 foot

IHC's positioning system, the Dredged Profile Monitoring (DPM), gives the position of the "cutter" relative to the centerline of the design profile, and to the waterline and working depth set points. The stated accuracy for this system is 10 cm (0.3 ft). Personnel Communication with Ruud Ouwerkerk of Dredging Technology Corporation (a subsidiary of IHC), revealed that no U.S. dredges used in navigation projects were operating with the DPM. Because a system is possibly accurate to this tolerance, it does not necessarily mean that the dredge can achieve this accuracy limit given site specific conditions and operator efficiency considerations.

Various U.S. dredging companies have developed and use proprietary cutterhead positioning systems. Although no specific documented information on accuracies was identified for these proprietary positioning systems used on larger cutterhead dredge dredges in navigation dredging projects during the technical literature search, some information was available for cutterheads used for environmental dredging projects.

"Environmental dredging" is a term used in recent years to describe dredging that's conducted primarily to remove contaminated sediment, as opposed to navigation dredging to maintain waterways for commercial traffic, national defense, and recreation. The objective of environmental dredging is to remove sediment contaminated above certain action levels while minimizing the spread of contaminants to the surrounding environment NRC (1997). Dredges used for environmental dredging are typically smaller than those used on the larger (yardage) navigation dredging projects. More emphasis is placed on controlling operational parameters (i.e., slower cycle times) and vertical accuracy in environmental dredging projects to minimize overdredging and sediment resuspension due to the significantly higher cost per cubic yard related to contaminant disposal or treatment aspects.

Ellicott's new 8 inch (203 mm) "swinging ladder" cutterhead dredge with three (3) traveling spud carriages (uses no cables) is designed specifically for environmental dredging jobs. The manufacturer states that this swinging ladder dredge can dig to a depth of 22 ft and "has controls which tell the dredge operator exactly which layers the cutter is in. The cutter can dredge to tolerances of plus or minus one inch (25 mm) which is critical, especially for contaminated sediments. The operator controls keep re-suspension of the sediment back into the water column to an absolute minimum. All dredge functions are linked to global positioning systems." (http://www.mudcat.com/environmental/new-dredging-tech-4.htm).

In guidance provided by EPA (2005) for sediment remediation of hazardous waste sites, Table 1 presents some of the currently available general information that is intended to help project managers initially assess, in the context of environmental dredging, dredge capabilities, and screen and select equipment types for evaluation at the feasibility study stage or for pilot field testing. The table is not intended as a guide for final equipment selection for remedy implementation because there are many site-specific, sediment-specific, and project-specific circumstances that will indicate which equipment is most appropriate for any given situation, and each equipment type can be applied in different ways to adapt to site and sediment conditions (EPA 2005).

The most pertinent parameter in Table 1 relative to this DOTS request, vertical operating accuracy, is defined (footnote 16) as the ability to position the dredgehead at a desired depth or elevation for the cut and maintain or repeat that vertical position during the dredging operation (accuracy and precision). This document, compiled with input from the USACE and caveated as general information only, lists the vertical excavation accuracy for 15 to 30 cm (6 to 12 inch inside diameter discharge pipeline diameter) cutterhead dredges as 10 cm (4 inches). Footnote 16 also states that "although positioning instrumentation is accurate to within a few cm, the design of the dredge and the linkages between the dredgehead and the positioning system will affect the accuracy attainable in positioning the dredgehead. A vertical accuracy of cut of approximately 15 cm

(0.5 ft) is considered attainable for most project conditions. Fixed arm equipment holds some advantage over wire-supported in maintaining vertical operating accuracy. The accuracies achievable for sediment characterization should be considered in setting performance standards for environmental dredging operating accuracy (both vertical and horizontal)."

Another EPA remediation guidance document (Assessment and Remediation of Contaminated Sediments (ARCS) Program Remediation Guidance 1994) provides operational characteristics on larger-sized dredges. Table 2 presents the operational characteristics of cutterhead dredges ranging in size from 6 to 30 inches (15 – 76 cm) in which the vertical dredging accuracy (assumed to be synonymous to construction accuracy) is 30 cm (1 ft) for all these sized dredges. It is not known if these accuracies are presented as those attainable in navigation or environmental dredging projects, or both.

The remaining pertinent document identified for this DOTS request was entitled "Construction and Survey Accuracies for the Execution of Dredging and Stone Dumping Works" (IADC 2001). The objective of this document is to present information on the construction accuracies of dredging and stone dumping works to minimize "certain tension between the requirements that arise from the design, the requirements with which the contractor, even with the application of maximum effort, can comply and economic considerations" (IADC 2001). Table 3 from this document presents "practical achievable vertical accuracies in meters of various dredging equipment for different bed types and working circumstances" source CROW 2001. An English version of this source (CROW (2001) was not available.

	EQUIPMENT TYPE[2]									
	Mechanical Dredges (2 to 8 cubic meter buckets)			Hydraulic/Pneumatic Dredges (15 to 30 cm pump sizes)						Dry Excavation
	Conventional Clamshell (Wire)[3]	Enclosed Bucket (Wire)[3]	Articulated Mechanical (Fixed Arm)[3]	Cutterhead[3]	Horizontal Auger[3]	Plain Suction[3]	Pneumatic[3]	Specialty[3]	Diver[3]	Various Mechanical Excavators[3]
OPERATIONAL CHARACTERISTICS[1]										
Operating Production Rate (m^3/hr)[14]	48 (2 m^3 bucket) 95 (4 m^3 bucket) 143 (6 m^3 bucket) 193 (8 m^3 bucket)			23 (15 cm pump) 41 (20 cm pump) 64 (25 cm pump) 93 (30 cm pump)			Site Specific	Equipment Specific	10	Site Specific
Percent Solids (by weight)[13]	Near In-Situ	Near In-Situ	Near In-Situ	5	5	5	15 or Higher	Equipment Specific	<5	In-Situ or Greater
Vertical Operating Accuracy (cm)[16]	15	15	10	10	10	10	15	10	--	5
Horizontal Operating Accuracy (cm)[17]	10	10	10	10	10	10	10	10	--	5
Maximum Dredging Depth (m)[11]	Stability Limitations	Stability Limitations	15	15	5	15	45	15	30	Stability Limitations
Minimum Dredging Depth (m)[18]	--	--	--	1	0.5	1	5	1	0.5	--

Table 1. Sample Environmental Dredging Operational Characteristics and Selection Factors (Source EPA 2005)

1012

1	This table provides some of the currently available general information that can help project managers initially assess dredge capabilities, and screen and select equipment types for evaluation at the feasibility study stage or for pilot field testing. This table is NOT intended as a guide for final equipment selection for remedy implementation, and regions may find it useful to consider other sources of information for purposes of comparison. There are many site-specific, sediment-specific, and project-specific circumstances that will indicate which equipment is most appropriate for any given situation, and each equipment type can be applied in different ways to adapt to site and sediment conditions. In addition, because new equipment is being continuously developed, project managers should consult with experts who are familiar with the latest technologies.
2	Equipment types shown here are considered the most commonly used for environmental dredging in the U.S. Other dredge types are available. Equipment used for environmental dredging is usually smaller in size than that commonly used for navigation dredging. Information presented here is tailored for mechanical bucket sizes from 3 to 10 cubic yards (about 2 to 8 m^3), and hydraulic/pneumatic pump sizes from 6 to 12 inches (about 15 to 30 cm). Larger sizes are available for many equipment types.
3	Clamshell - conventional clamshell dredges, wire supported, conventional open clam bucket.
4	Enclosed Bucket - wire supported, near watertight or sealed bucket usually incorporating a level cut capability.
5	Articulated Mechanical - backhoe designs, clam-type enclosed buckets, hydraulic closing mechanisms, all supported by articulated fixed-arm.
6	Cutterhead - conventional hydraulic pipeline dredge, with conventional cutterhead.
7	Horizontal Auger - hydraulic pipeline dredge with horizontal auger dredgehead.
8	Plain Suction - hydraulic pipeline dredge using dredgehead design with no cutting action.
9	Pneumatic – air operated submersible pump, pipeline transport, either wire supported or fixed-arm supported.
10	Specialty Dredgeheads - other hydraulic pipeline dredges with specialty dredgeheads or pumping systems.
11	Diver Assisted - hand-held hydraulic suction with pipeline transport.
12	Dry Excavation - conventional excavation equipment operating within dewatered containments such as sheet-pile enclosures or cofferdams.
13	OPERATIONAL CHARACTERISTICS - quantitative entries, reflecting capabilities and limitations of dredge types, and are solely a function of the equipment itself.
14	Production Rate - in-situ volume of sediment removed per unit time. Rates shown are for production cuts as opposed to "cleanup passes" and are for active periods of operation under average conditions. Rates for two bucket or pump sizes are shown for comparison. For mechanical dredges, the rates were calculated assuming 80% bucket fill with a bucket cycle time of 2 minutes. For hydraulic dredges, the rates were calculated assuming in-situ sediment 35% solids by weight, 5% solids by weight for slurry, and pump discharge velocity of 10 ft/sec. The rate shown for diver-assisted assumes a maximum pump size of 15 cm and roughly 50% efficiency of diver effort while working. Production rate for dry excavation is would be largely dictated by the time required to isolate and dewater the areas targeted for excavation. A variety of factors may influence the effective operating time per day, week, or season, and should be considered in calculating times required for removal.
15	Percent Solids by Weight - ratio of weight of dry solids to total weight of the dredged material as removed, expressed as a percentage. Percent solids for mechanical dredging is a function of the in-situ percent solids and the effective bucket fill (expressed as a percentage of the bucket capacity filled by in-situ sediment as opposed to free water), and near in-situ percent solids is possible for production cuts. A wide range of percent solids for hydraulic dredges is reported, but 5% solids can be expected for most environmental dredging projects.

Table 1. Footnotes for Sample Environmental Dredging Operational Characteristics and Selection Factors (Source EPA 2005)

16	Vertical Operating Accuracy - the ability to position the dredgehead at a desired depth or elevation for the cut and maintain or repeat that vertical position during the dredging operation. Although positioning instrumentation is accurate to within a few cm, the design of the dredge and the linkages between the dredgehead and the positioning system will affect the accuracy attainable in positioning the dredgehead. A vertical accuracy of cut of approximately 15 cm (one-half foot) is considered attainable for most project conditions. Fixed arm equipment holds some advantage over wire-supported in maintaining vertical operating accuracy. The accuracies achievable for sediment characterization should be considered in setting performance standards for environmental dredging operating accuracy (both vertical and horizontal).
17	Horizontal Operating Accuracy - the ability to position and operate the dredgehead at a desired location or within a desired surface area. Considerations are similar to those for vertical accuracy.
18	Maximum Dredging Depth - physical limitation to reach below a given depth. Wire-supported buckets or pumps can be deployed at substantial depths, so the maximum digging depth generally is limited by stability of the excavation. Reach of fixed arm supported buckets or hydraulic dredges is limited by the length of the arm or ladder. Conventional backhoe equipment is generally limited to about 15 m reach. Smaller hydraulic dredges are usually designed for a maximum dredging depth of about 15 m. Hydraulic dredges usually also have a limiting depth of removal of about 50 ft due to the limitation of atmospheric pressure, but this limitation can often be overcome by addition of a submerged pump on the ladder. The table entries should NOT be considered as hard and fast limits. Larger dredge sizes and designs are available for deeper depths.
19	Minimum Dredging Depth - constraints on draft limitations of some floating dredges or potential loss of pump prime for hydraulic dredges. Such limitations can be managed if the dredge "digs its way into the area." For smaller dredges, these limitations typically are at approximately the 1m water depth. Pneumatic dredges require a minimum water depth of about 5 m for efficient pump operation.

Table 1. Footnotes for Sample Environmental Dredging Operational Characteristics and Selection Factors Continued (Source EPA 2005)

Dredge Type	Percent Solids by Weight[a]	Range of Production Rates (m^3/hr)	Dredging Accuracy		Operational Dredging Depth		Debris Removal[b]
			Vertical (cm)	Horizontal (m)	Minimum (m)	Maximum (m)	
Clamshell	*near in situ*	23–460	60	0.3	0[c]	48[d]	+
Suction	10–15	19–3,800	30	~1	2	16–19[e]	–
Dustpan	10–20	19–3,800	15	~1	2-5	16–19[e]	–
Cutterhead							–
6–8 in. (15–20 cm)	10–20	25–105	30	~1	1.2	4[e]	–
10–12 in. (25–30 cm)	10–20	60–540	30	~1	1.4	8[e]	–
14–16 in. (36–41 cm)	10–20	160–875	30	~1	1.5	12[e]	–
20–24 in. (51–61 cm)	10–20	310–1,615	30	~1	1.6	15[e]	–
30 in. (76 cm)	10–20	575–2,500	30	~1	1.7	15[e]	–
Hopper	10–20	380–1,500	60	~3	3–9	21[e]	–
Horizontal auger	10–30	46–120	15	0.15	0.5	5	–
PNEUMA®	25–40	46–300	30	0.3	0[c]	48[d]	–
Oozer	25–40	340–500	30	~1	0[c]	48[d]	–
Clean-up	30–40	380–1,500	30	~1	1–5	4–21	–
Refresher	30–40	150–990	30	~1	1–5	4–21	–
Backhoe	*near in situ*	20–150	30	~1	0[c]	7–15	+
Matchbox	5–15	18–60	30	~1	1–5	4–21	–
Airlift	25–40	NA	30	0.3	6	V[f]	–

Note: NA = not available

Source: Adapted from Hand et al. (1978) and Philips and Malek (1984), as cited in Palermo and Pankow (1988). Additional data from Averett et al. (in prep.) and USEPA (1985b).

[a] Typical solids concentration under optimal conditions. Percent solids may be lower if operational difficulties (e.g., excess debris) are encountered.

[b] Ratings for debris removal: (+) can remove debris; (–) debris removal is limited.

[c] Zero if used alongside of waterway; otherwise, draft of vessel will determine the operational depth.

[d] Demonstrated operational depth; theoretically could be used much deeper.

[e] With submerged dredge pumps, operational dredging depths have been increased to 30 m or more.

[f] V = theoretically unlimited.

Table 2. Operational characteristics of various dredges (Source EPA 1994)

The accuracy on a "cutter suction dredger" (aka cutterhead dredge) in clay is listed as 0.4 m (1.3 ft). As qualified in the IADC (2001) table's footnotes, "the given values have a 95% confidence value, so the probability they will be exceeded on one side is 2.5%. The tolerances are expressed in meters and are both positive and negative (for example : 0.10 = ± 0.10 meter). The values are indicative and depend upon, amongst others, the equipment aboard. The values above are the sum of the inaccuracies in construction and measurement, the inaccuracies of measurement can be an order of magnitude smaller than those during construction." This ±1.3 ft value is qualified in a bulk effort level (for bulk products) where "a higher priority is assigned to a production level than to accuracy" (e.g. in a navigation dredging project). In the max (for maximum) effort "with a higher priority assigned to the accuracy and production is sacrificed in the interests of accuracy" (e.g in an environmental dredging project), the construction accuracy is increased to ±0.3 m (±1 ft). The last footnote in Table 3 states that the "maximum (max) effort is a relative term. It is always possible, will yet more effort to reach a result that is even more better".

In Table 3, both the bulk and max accuracies are supplemented for specific working circumstances i.e., working in unsheltered waters (add 0.1 m (0.3 ft) to accuracy), currents 0.5 - 1.0 m/s (1.0 - 2.0 knots) (add 0.1 m (0.3 ft) to accuracy), and water depths 10 - 30 m (30 - 100 ft) (add 0.05 m (.15 ft to accuracy). For the Savannah River Deepening project, where currents can exceed 2.0 knots and the water depth will exceed 30 ft, an additional 0.45 ft is added to the ±1.3 ft accuracy value is qualified in a bulk effort, and ±1.0 ft accuracy qualified in a max effort, totaling ±1.75 ft and ±1.45 ft respectively.

Bucket (Clamshell) Dredge

The Dredging and Dredged Material Disposal Engineer Manual (EM) 1110-2-5025 (1983) states that the vertical accuracy of this type of dredge on a navigation dredging project is generally within ±1 foot.

bed	Dredging equipment: trailing suction dredger		cutter suction dredger		environmental suction dredger		hydraulic crane (backhoe)		crane ship/ crane pontoon		bucket dredger		plough (supported)	
	bulk	max	bulk	max	bulk	max	bulk	max	bulk	max	bulk	max	bulk	max
sludge	0.4	0.3	0.4	0.25	0.2	0.1	0.4	0.2	0.45	0.3	0.3	0.2	0.3	0.2
sand	0.5	0.4	0.4	0.3	0.2	0.1	0.5	0.25	0.5	0.4	0.3	0.2	0.3	0.2
gravel	0.5	0.4	0.4	0.3	n/a	n/a	0.5	0.25	0.5	0.4	0.3	0.2	0.3	0.2
clay	0.6	0.5	0.4	0.3	n/a	n/a	0.5	0.35	0.6	0.5	0.3	0.2	0.3	0.2
rocks	n/a	n/a	0.5	0.4	n/a	n/a	0.6	0.4	n/a	n/a	n/a	n/a	n/a	n/a
supplements for specific working circumstances														
unsheltered water	0.1	0.1	0.1	0.1	n/a	n/a	0.1	0.1	0.2	0.2	0.1	0.1	0.2	0.2
current 0.5 - 1.0 m/s	0.1	0.1	0.1	0.1	0.05	0.05	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
water depth 10 - 20 m	0.1	0.1	0.05	0.05	0.05	0.05	0.1	0.1	0.1	0.1	0.05	0.05	0.05	0.05

Explanation and comments:

- The given values have a 95% confidence value, so the probability they will be exceeded on one side is 2.5%. The tolerances are expressed in metres and are both positive and negative (for example:0.10= +/-0.10 metre);
- The values above are indicative and depend upon, amongst others, the equipment aboard;
- The values above are the sum of the inaccuracies in construction and measurement, the inaccuracies of measurement can be an order of magnitude smaller than those during construction;
- "bulk" is for bulk products, where a higher priority is assigned to the production level than to accuracy;
- "max" is for maximum effort, with a higher priority assigned to accuracy and production is sacrified in the interests of accuracy;
- Maximum effort is a relative term. It is always possible with yet more effort to reach a result that is even better.

Table 3. "Practical achievable vertical accuracies in meters of various dredging equipment for different bed types and working circumstances" IADC (2001) (Source: IADC 2001)

1016

Table 1 (EPA 2005) indicates that the vertical dredging accuracy of a clamshell dredge in an environmental dredging project is 15 cm (0.5 ft). Table 2 (EPA 1994) indicates that the vertical dredging accuracy of a clamshell dredge is 60 cm (2 ft). Table 3 (IADC 2001) lists the bulk construction accuracy of a "crane/pontoon" dredge in clay with currents and deeper water as ±2.6 ft (0.6 m (2 ft), plus 0.1 m (0.3 ft) for currents ranging from 0.5 - 1.0 m/s (1.0 - 2.0 knots), plus 0.1 m (0.3 ft) for water depths exceeding 30 ft. For the maximum effort project (max i.e., an environmental dredging project) the construction accuracy total (plus current and depth supplements) is ±1.8 ft.

A technical literature search by Scott et al. (2002) reports that the only one reference was found that verifies the tolerance of (environmental) clamshell dredging. This was a study conducted by ETV Canada using a Cable Arm environmental clamshell bucket. This bucket produces a level cut, as opposed to the "scalloped" cut of a conventional clamshell bucket. The report verified that dredging with an environmental clamshell bucket can "produce a sediment-surface profile with an average depth which has a maximum deviation of ± 20 cm (± 0.67 ft) from the specified depth for the project 95% of the time" Water Technology International Corporation (1998). Factors that may degrade the clamshell dredging tolerances include (Scott et al. 2002):

- "the presence of debris, preventing full closure of the bucket;
- high tide range, causing the operator to chase the resulting high rate of water level change per unit time;
- high waves, wakes, and currents, causing the bucket to sway and bounce and the barge to heave, pitch, and roll;
- scalloped and uneven cut of the bucket cutting edge during closure;
- stretch and wear of bucket lines;
- inaccurate dredge positioning; and
- accuracy of cable markings and rounding of depth marks during dredging."

Bucket (Backhoe) Dredge

Table 1 (EPA 2005) indicates that the vertical dredging accuracy of an articulated mechanical (backhoe) dredge in an environmental dredging project is 10 cm (0.3 ft). Table 2 (EPA 1994) indicates that the vertical dredging accuracy of a backhoe dredge is 30 cm (1 ft). Table 3 (IADC 2001) lists the bulk construction accuracy of a hydraulic crane backhoe dredge in clay with currents and deeper water as ±2.2 ft (0.5 m (1.6 ft), plus 0.1 m (0.3 ft) for currents ranging from 0.5 - 1.0 m/s (1.0 - 2.0 knots), plus 0.1 m (0.3 ft) for water depths exceeding 30 ft. For the maximum effort project (max i.e., an environmental dredging project) the construction accuracy total (plus current and depth supplements) is ±1.75 ft.

Similar to the DPM for cutterhead dredges, IHC has a positioning system for the backhoe dredge, called the Excavator Position Monitor (XPM). The following

Figure 1 describes the XPM onboard Great Lakes Dredge and Dock's dredge New York that an overall accuracy of < 10 cm (0.3 ft) is claimed (Mallee 2002).

Excavator "New York" work in progress

Recently, one of the largest excavators (LIEBHERR 996) on pontoon called " New York" owned by Great Lakes (U.S.A.) is equipped with a new Excavator Position Monitor (XPM) and the latest upgraded Dredge Track Presentation System.

IHC Systems has recently provided upgrades for the eXcavator Position Monitor (XPM) and Dredge Track Presentation System.
The DTPS system is extended with a conversion from standard metric values into feet's and fathoms. These overall systems, together with the owner supplied RTK positioning system, makes it possible to handle jobs with an overall accuracy of < 10 cm.

The DTPS system shows on-line the excavator in the Digital Terrain Model (DTM) with contours. The DTM or Bathymetric view with geographical co-ordinates can be rotated on-line by the operator and is also capable to store default views. The alphanumeric window shows all relevant data. The DTPS systems communicate bi-directional with the XPM. All XPM sensor data is converted to absolute position data and transferred back to the XPM.

The channel design with objects will be triangulated (max 300 triangles) and transferred on request to the XPM. The depth matrix of the working area will be continuously updated with bucket/clamshell dredge depth positions. The operator is able to see positions to be dredged, positions where dredging took be place or where digging is stopped. The DTPS system stores all time tagged data, such as RTK positions, gyro, bucket depth, angles, downtime and conversions. With the help of the replay function, the operator is able the make a scaled DTM and Bathymetric plots on a standard colour printer.

Figure 1. XPM onboard Great Lakes Dredge and Dock's dredge New York (Source Mallee 2002)

As per personnel communication with Ruud Ouwerkerk of Dredging Technology Corporation, the following U.S. backhoe dredges have an IHC XPM or IHC XPM Next Generation (NG):

XPM:
a. Great Lakes : NEW YORK (Liebherr 996)
b. Jay Cashman: A.J.FOURNIER (Liebherr 994)

XPM NG
c. Donjon Marine, Inc - J.R.BOISSEAU (Liebherr 995)
d. Jay Cashman: JAY CASHMAN (Liebherr 995)
e. J.E.McAmis, Inc - RENEE MEEGAN (Komatsu 3000)

In 1999, the EPA, USACE, and Foster Wheeler performed preliminary and detailed evaluations of current, available dredge technologies to meet the specific requirements of the full scale remediation project at the New Bedford Harbor Superfund Site. They decided to perform a Pre-Design Field Test (PDFT) of dredging systems that show potential for application on the New Bedford full scale cleanup, to acquire performance values for use in the final remediation design, and to select the final dredge system(s) to be used on the full scale cleanup (Lally and Ikalainen 2000). Dredging depths ranged from 1 to 5 ft deep.

"Bean Technical Excavation Corporation (Bean TEC) mechanical dredge Bonacavora with a 4.5 yd^3 horizontal grab bucket was trialed. This dredge used a Crane Monitoring System (CMS). The CMS, coupled with the RTK system provides bucket positioning in the x, y, and z planes.,,,,,, Over the course of the PDFT, the representative average production rate for the excavator was 80 cy/hr.,,,,,,,, Evaluation of dredging accuracy was carried out based on comparison of the post-dredge survey with the target depths. For dredge Cuts 5, 6, 7 and 8, where accuracy was a focus, 95% of the dredge area was within 6 in. of the target depth. In 90% of the dredge area the average vertical dredging accuracy was most nearly 4 in" Lally and Ikalainen (2000).

On Bean Dredging's website http://www.cfbean.com/beanenvi/defaultcont.htm it states that "using advanced positioning and control systems, Bean Environmental dredges can excavate material to vertical tolerances of 0.1 meters, or about 3 inches."

Summary

The various vertical dredging accuracies for cutterhead, clamshell, and backhoe dredges identified in this DOTS request are compiled in Table 4. As previously presented, the definition of vertical accuracy is very important in how the respective values are considered and applied. The different sources identified in this DOTS response have reported vertical accuracy in different ways (i.e., plus/minus (±) a value or in absolute numbers, incorporation of survey

accuracies, etc.). Where possible, the specific accuracy definitions from these various sources were presented in this report.

While the amount of material disturbance below desired depth (to achieve that desired depth) will be a factor in determining contract specifications, it was not specifically considered under this DOTS request (two separate DOTS requests addressing this issue that were previously prepared for SAS and SPD are included in this response as appendices 1 and 2). One of the differences between navigation and environmental dredging is the relative shift in focus from production to increased accuracy to reduce the amount of un-necessary sediment being treated and/or disposed. A critical decision in these types of projects is to determine the allowed over depth that the contractor can dig to in order to achieve final grade, because, after a certain minimum distance, the closer that the grade and allowable over depth lines are together, the more the contractor has to expend time and energy to meet these contract specifications (and its respective impacts on production and cost). Reducing the over dredge allowance tends to slow production rates and increase the time and cost to complete the dredging project (Scott et al. 2002).

Some of the lowest dredging accuracies (or largest inaccuracies) are presented by IADC (2001). These values are construction accuracies that include both construction and surveying inaccuracies. The values provided by IADC (2001), USACE 1983, EPA (2005), EPA 1994, and the various individuals cited in this report are all presented with numerous caveats. These values should be viewed as general information as there are many site-specific, sediment-specific, and project-specific circumstances that will indicate which equipment is most appropriate for any given situation, and each equipment type can be applied in different ways to adapt to site and sediment conditions (EPA 2005).
The range in accuracy values in Table 4 is, in part, due to the difference of accuracy emphasis (and respective dredging costs) between navigation and environmental dredging. During environmental dredging, additional time must be allowed for other factors, such as greater precision of cut (EPA 1994). Some of the quoted accuracies were also obtained in relatively shallow (1 to 5 ft) quiet waters. IADC (2001) concluded from environmental dredging trials in the Ketelmeer Project that the inaccuracies become greater in the order of: reference inaccuracies, excavation mouth inaccuracies, then total construction inaccuracies.

Tim Welp
Dredging Group
Coastal and Hydraulics Lab
Engineer Research and Development Center

	USACE EM 1110-2-5025 1983	IADC 2001[1] Bulk[2] Depth and Current Corrected	IADC 2001[1] MAX[3] Depth and Current Corrected	EPA 1994	EPA 2005	IHC 2005	Mallee 2002	Scott et al. 2002
Cutterhead Vertical Accuracy (ft)	± 1.0	±1.75	±1.45	1.0	0.5	0.3		
Clamshell Vertical Accuracy (ft)	± 1.0	±2.6	±2.25	2.0	0.5			±0.67
Backhoe Vertical Accuracy (ft)		±2.2	±1.75	1.0	0.3		<0.3	

Table 4. Compilation of various vertical excavation accuracies

[1] Includes construction and survey inaccuracies
[2] Bulk is for bulk products where a higher priority is assigned to the production level than to accuracy
[3] Max is for maximum effort, where a higher priority is assigned to accuracy, and production is sacrificed in the interests of accuracy

1021

References

CROW 1999. "Toleranties in RAW-bestekken bijgrondverzet in den natte en steenbestortingen onder water: beschouwingen rond nauwkeurigheden bij het maken en meten, CROW-werkgroep Maak-en meettoleranties in de waterbouw, versie 25 maart 1999

International Association of Dredging Contractors (IADC), Rotterdam Public Works Engineering Department, Port of Rotterdam, and The Netherlands Association of Dredging, Shore and Bank Protection Contractors (VBKO) 2001. "Construction and Survey Accuracies for the Execution of Dredging and Stone Dumping Works"

Lally, J., and Ikalainen, A. (2000). Final Pre Design Field Test Dredge Technology Evaluation Report New Bedford,Harbor Superfund Site New Bedford, Massachusetts August 2001" USACE Contract No. DACW33-94-D-0002 TASK ORDER NO. 017 Total Environmental Restoration Contract

Mallee, G., T., (2002) "State of the Art on Dredge Track Presentation System (DTPS) in conjunction with dredge related instruments/automation and sensors", Proceedings of Dredging '02, May 5-6, Orlando, FL, Track 4J

National Research Council (NRC). 1997. Contaminated Sediments in Ports and Waterways. National Research Council. National Academy of Press, Washington, DC. Available from the National Academies Press Web site at http://www.nap.edu/bookstore.html.

Scott, J., Carscadden, R., Lally, J., and Webb, R. 2002. "Specifying an Overdepth Allowance for Environmental Clamshell Dredging in Puget Sound", Proceedings of Dredging '02, May 5-6, Orlando, FL

USACE 1983. "Dredging and Dredged Material Disposal EM 1110-2-5025," U.S. Army Corps of Engineers, Washington, DC

US EPA 2005. "Contaminated Sediment Remediation Guidance for Hazardous Waste Sites, Washington DC.
http://www.epa.gov/superfund/resources/sediment/pdfs/ch6.pdf

US EPA 1994. "ARCS Remediation Guidance Document." EPA 905-B94-003. Great Lakes National Program Office, Chicago, IL.

Water Technology International Corporation 1998. Performance Claim Verification of the Cable Arm Dredge Bucket", Final Report for the Environmental Technology Verification Program prepared for ETV Canada, July, 1998

DEPARTMENT OF THE ARMY
ENGINEER RESEARCH AND DEVELOPMENT CENTER, CORPS OF ENGINEERS
COASTAL AND HYDRAULICS LABORATORY
WATERWAYS EXPERIMENT STATION, 3909 HALLS FERRY ROAD
VICKSBURG, MISSISSIPPI 39180-6199

CEERD-HN-ND

09 MAR 2010

MEMORANDUM FOR Commander, US Army Engineer District, Savannah (CESAS-EN-H/ Mr. Wilbur Wiggins), PO Box 889, Savannah, GA 31402-0889

SUBJECT: Savannah Harbor Entrance Channel Simulations 2010 Report

1. Introduction. During 2002 and 2003 the U.S. Army Engineers, Engineer Research and Development Center (ERDC) conducted a ship simulator based navigation study for the U.S. Army Corps of Engineers District, Savannah (SAS). In November 2009, SAS contacted ERDC to revisit that study and conduct additional simulations for two different alignments for the Entrance Channel (Figure 1). The alignment changes, or doglegs, were proposed so that when the Entrance Channel is deepened, it will reach naturally deep water in less distance. This will reduce dredging costs. Three doglegs were originally proposed. However, this study focused on alignments S-3 and S-8.

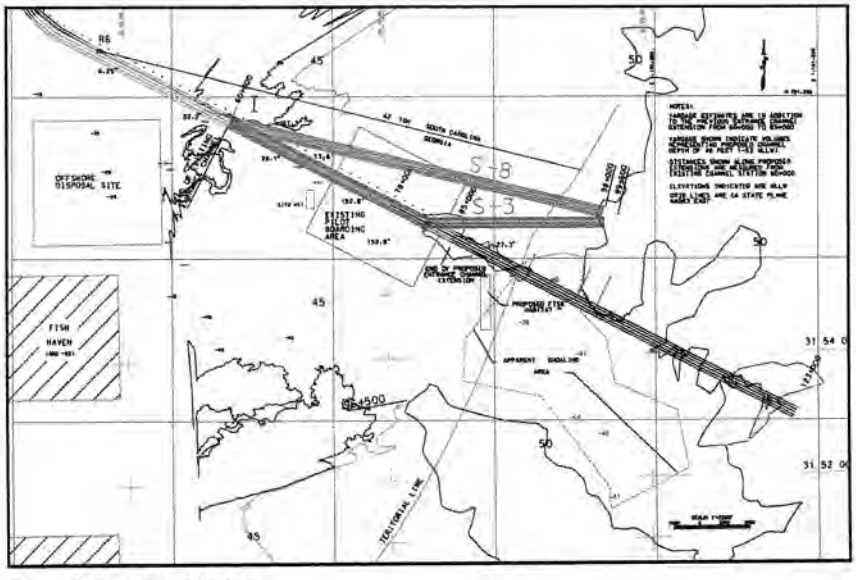


Figure 1. Entrance Channel

CEERD-HN-ND 09 MAR 2010
SUBJECT: Savannah Harbor Entrance Channel Simulations 2010 Report

2. Model Development. The simulation databases from the earlier study were modified to reflect alignments S-3 and S-8. Currents and waves for the proposed alignments were modeled in separate ERDC studies (Brown, in preparation and Briggs, in preparation). Maximum flood and ebb currents from the hydrodynamic model were added to the simulator database. Bend wideners were added to both alignments (Figure 2). The bend wideners were designed by setting the inside corner back 700 ft on each side and then connecting those endpoints. Inbound ranges were also built for each alignment in the visual scene and radar.

3. Model databases were developed for eight different configurations. They were:

a. S-3
b. S-3 with widener
c. S-3 with ranges
d. S-3 with widener and ranges
e. S-8
f. S-8 with widener
g. S-8 with ranges
h. S-8 with widener and ranges

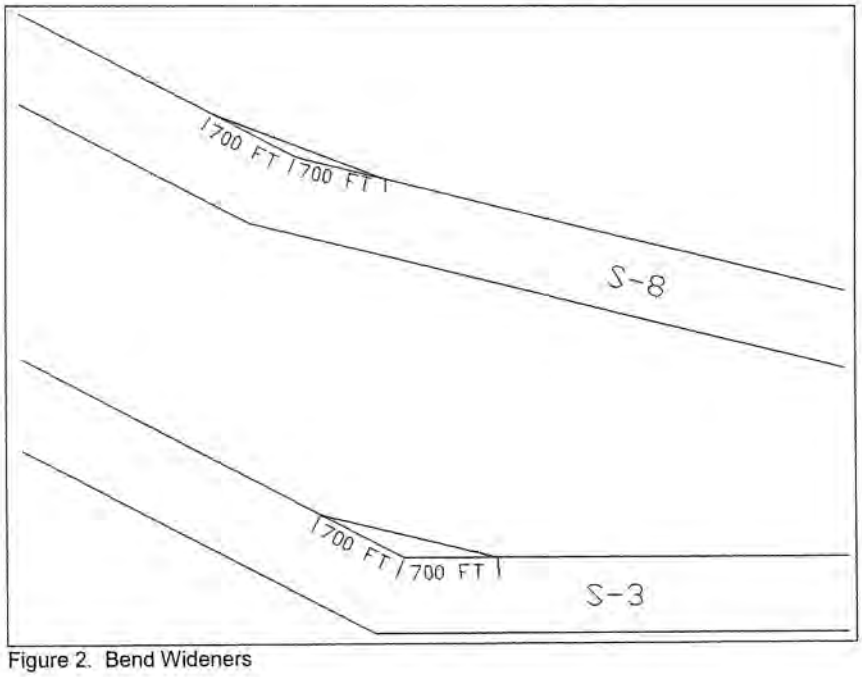


Figure 2. Bend Wideners

09 MAR 2010

CEERD-HN-ND
SUBJECT: Savannah Harbor Entrance Channel Simulations 2010 Report

4. Testing. Simulation testing was conducted over a 2 week period at the ERDC Ship/Tow Simulator in Vicksburg, MS. Exercises were run over a 3 day period for each of the 2 weeks. Four pilots participated in the study. They were Captains William T. Browne III, George W. Henry, Jr., Rick Wesley and Trey Thompson. All four are members of the Savannah Harbor Pilots Association.

5. The simulation design vessels were the *Susan Maersk*, a 1140- x 140- x 47.5-ft post-Panamax containership and the *SL Performance* a 950- x 106- x 33 ft Panamax containership. Exercises were run inbound and outbound for both maximum flood and ebb currents.

6. Results. Results are shown in the form of composite track plots and final pilot questionnaires. The questionnaires are enclosed. The track plots do not show the entire simulation run. The plots are zoomed in to better show the turn and the approach to the turn.

7. A composite track plot of all inbound runs conducted in the S-8 channel without ranges is shown in Plate 1. One ship left the channel by approximately 25 ft. The composite plot of the same condition for the S-3 channel is shown in Plate 2. Ships left both the north and south side of the channel as they approached the turn. Ships also left the south side of the channel after the turn.

8. A composite track plot of all inbound runs conducted in the S-8 channel with ranges is shown in Plate 3. None of the ships had difficulty making the turn. The composite plot of the S-3 inbound runs with ranges is shown in Plate 4. All ships were able to stay in the channel and make the turn.

9. A composite track plot of all outbound runs conducted in the S-8 channel without ranges is shown in Plate 5. All ships made the turn. The pilots deemed that this run was easy enough without the ranges that there was no need to test the S-8 outbound with ranges. The composite plot of the same condition for the S-3 channel is shown in Plate 6. Seven of the runs left the channel after making the turn. Most left the channel by a large distance. The most any ship left the channel was 250 ft. Runs conducted in the S-3 channel with ranges are shown in Plate 7. They show a significant improvement over the S-3 without ranges, but still some of the ships left the channel.

10. A composite track plot of all inbound runs conducted in the S-8 channel with bend widener and ranges is shown in Plate 8. All runs were successful and the ships remained close to the center of the channel. A composite track plot of all inbound runs conducted in the S-3 channel with bend widener and ranges is shown in Plate 9. One run left the channel by approximately 30 ft.

CEERD-HN-ND 09 MAR 2010
SUBJECT: Savannah Harbor Entrance Channel Simulations 2010 Report

11. A composite track plot of all outbound runs conducted in the S-8 channel with bend widener and ranges is shown in Plate 10. All runs were successful and the ships remained close to the center of the channel. A composite track plot of all outbound runs conducted in the S-3 channel with bend widener and ranges is shown in Plate 11. Two runs left the channel by approximately 30 ft.

12. A composite track plot of all two-way runs conducted in the S-8 channel with ranges is shown in Plate 12. The ships meet near the bend due to their starting locations. One ship left the channel by about 70 ft. The composite plot of the same condition for the S-3 channel is shown in Plate 13. Several runs left the channel limits, with one ship going completely out of the channel.

13. A composite track plot of all two-way runs conducted in the S-8 with widener channel with ranges is shown in Plate 14. One outbound ship left the channel by approximately 40 ft. A composite track plot of all two-way runs conducted in the S-3 with widener channel with ranges is shown in Plate 15.

14. Conclusions. Based upon the simulation results, both trackplots and pilot questionnaires, the following conclusions are drawn.

a. Without ranges, alignment S-3 was not adequate for these ships. This is true for the alignment with and without the bend widener. One pilot commented that if no ranges were built he would rather be without ranges for the shortest amount of time. However, he did state that ranges were a necessity.

b. The addition of inbound ranges improved both alignments.

c. Alignment S-8 appeared to be adequate for one-way traffic, even without ranges. The addition of ranges and the bend widener allowed for meeting of a Panamax ship with a post-Panamax ship.

d. Crabbing occurs in adverse wind conditions. Under the conditions tested crabbing was not a serious issue. Neither alignment made crabbing more severe.

15. Recommendations. Alignment S-8, with ranges and the bend widener, is recommended.

16. If you have any questions contact Mr. Dennis W. Webb at 601-634-2455.

Encl

WILLIAM D. MARTIN, PhD, PE
Director

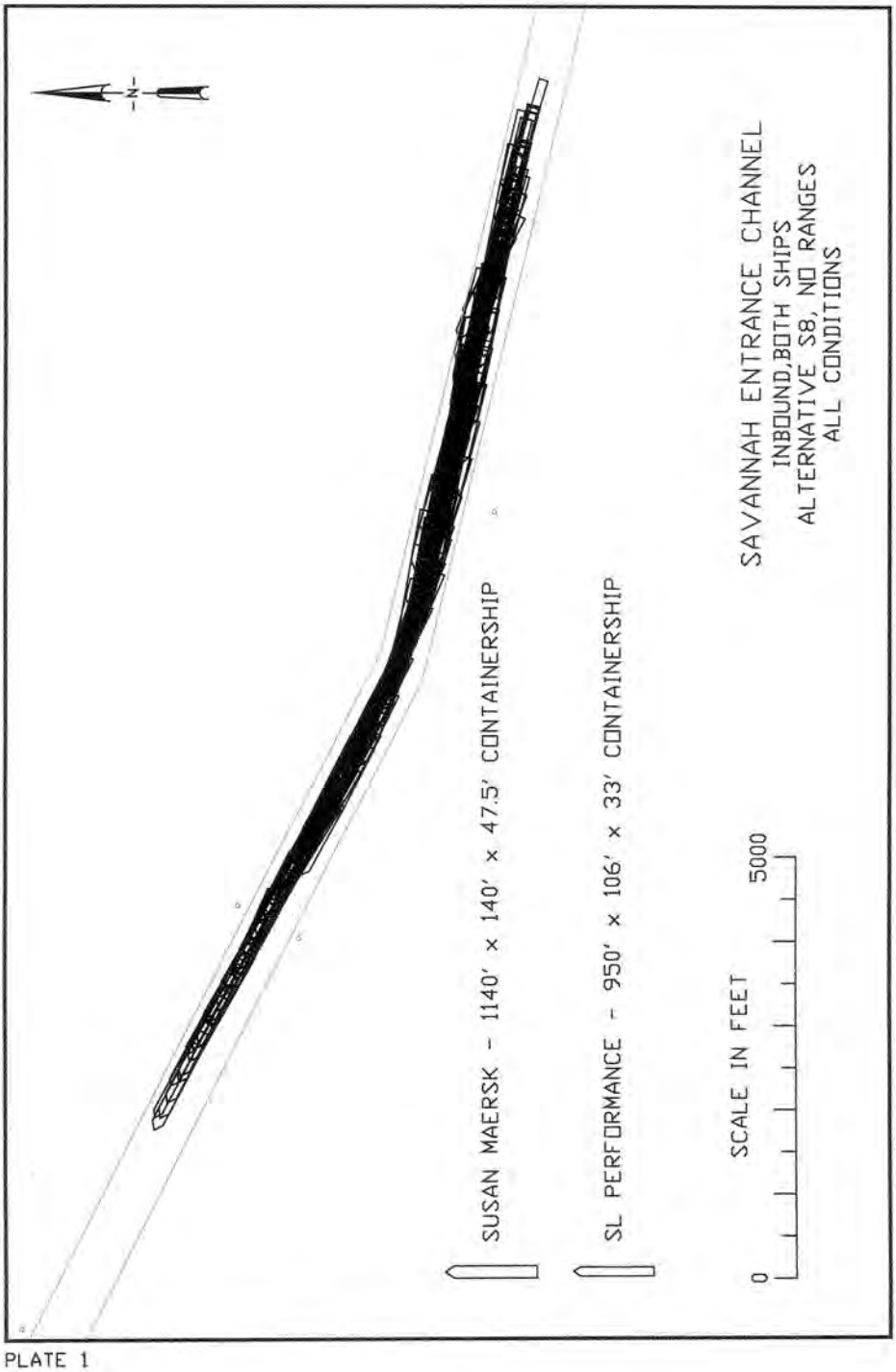

N
SUSAN MAERSK - 1140' x 140' x 47.5' CONTAINERSHIP
SL PERFORMANCE - 950' x 106' x 33' CONTAINERSHIP
SCALE IN FEET
0
5000
SAVANNAH ENTRANCE CHANNEL
INBOUND,BOTH SHIPS
ALTERNATIVE S8, NO RANGES
ALL CONDITIONS

PLATE 1

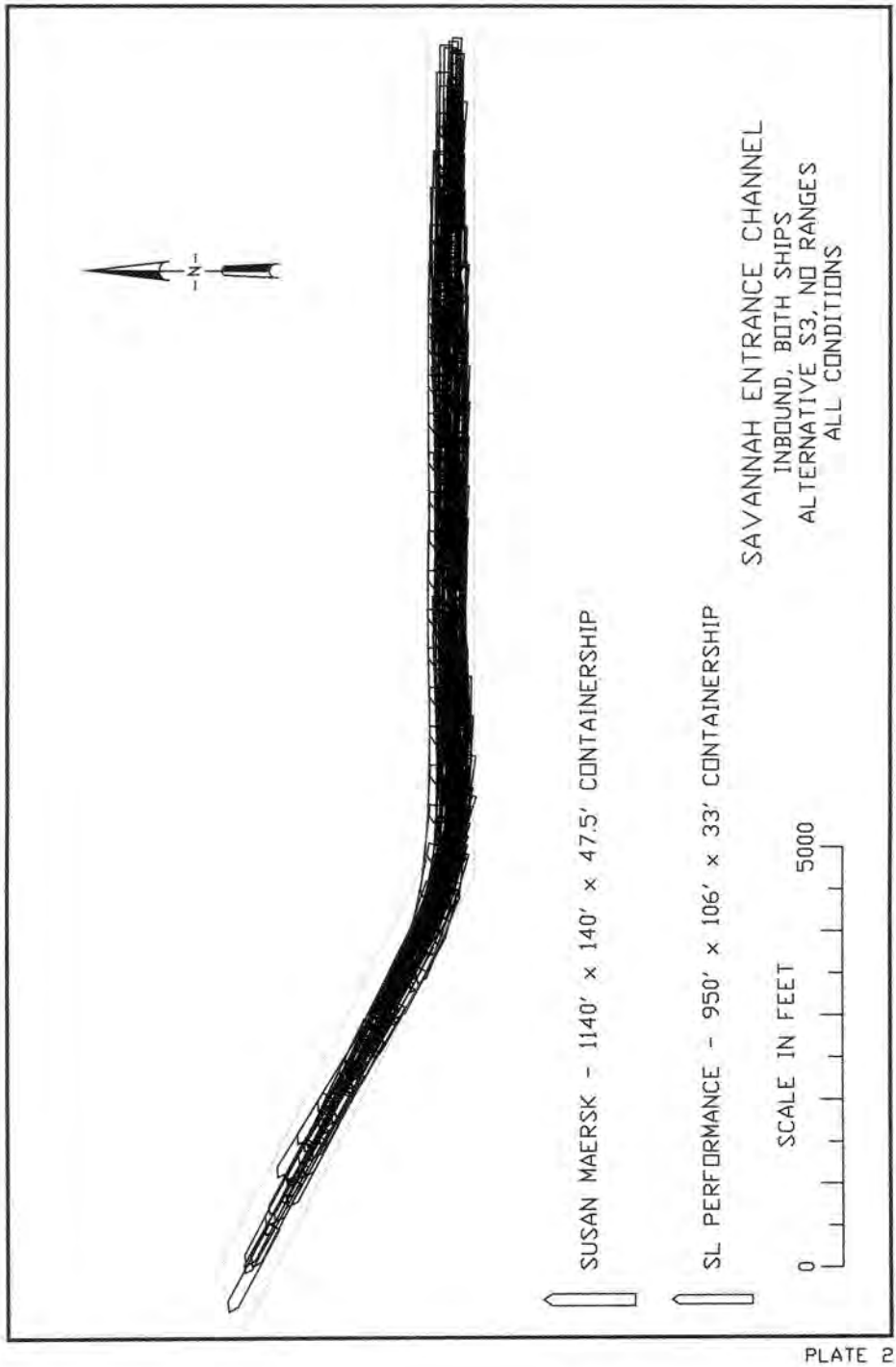

N
SAVANNAH ENTRANCE CHANNEL
INBOUND, BOTH SHIPS
ALTERNATIVE S3, NO RANGES
ALL CONDITIONS
SUSAN MAERSK - 1140' x 140' x 47.5' CONTAINERSHIP
SL PERFORMANCE - 950' x 106' x 33' CONTAINERSHIP
SCALE IN FEET
0
5000

PLATE 2

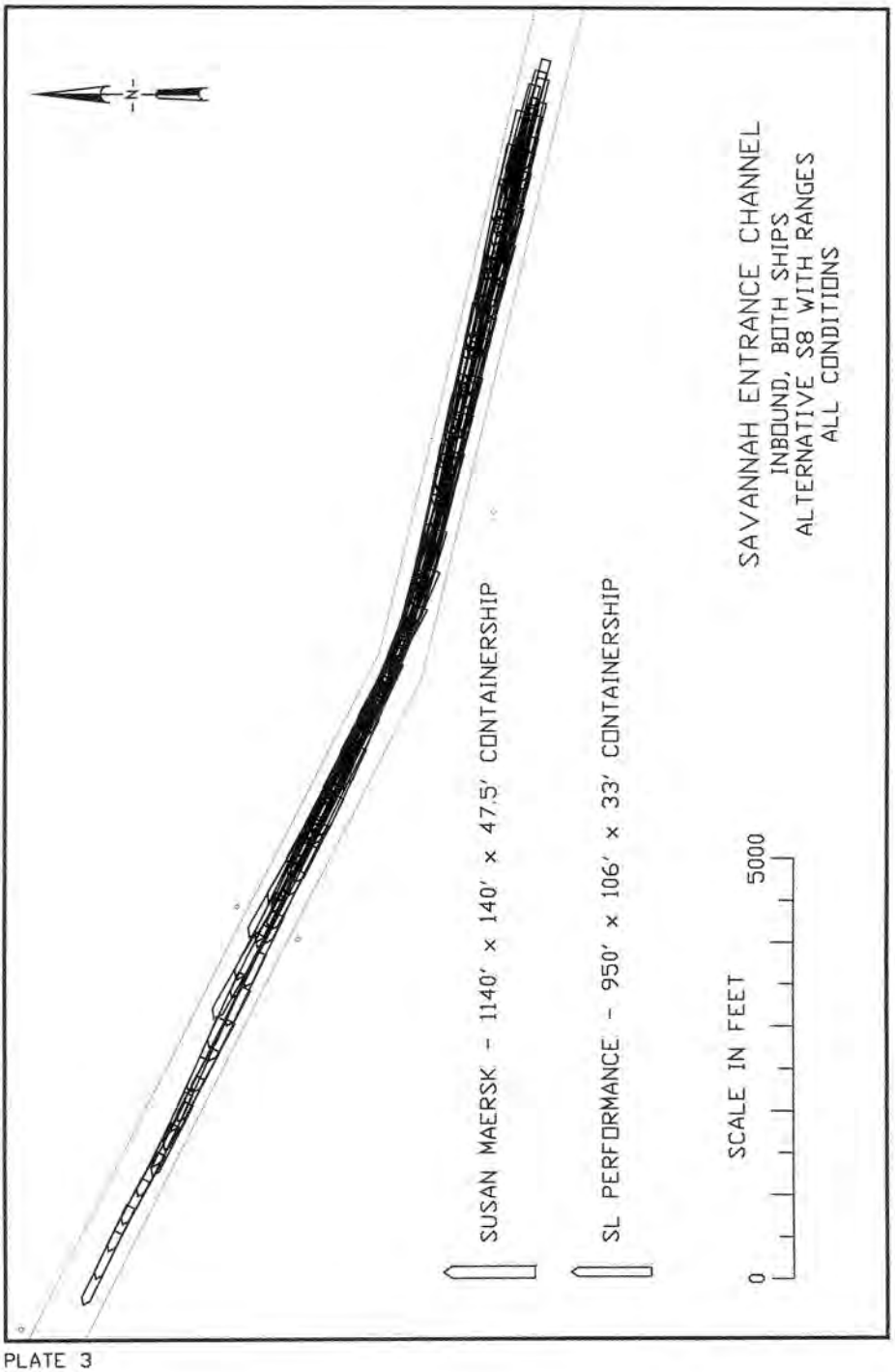

N
SUSAN MAERSK - 1140' x 140' x 47.5' CONTAINERSHIP
SL PERFORMANCE - 950' x 106' x 33' CONTAINERSHIP
SCALE IN FEET
0
5000
SAVANNAH ENTRANCE CHANNEL
INBOUND, BOTH SHIPS
ALTERNATIVE S8 WITH RANGES
ALL CONDITIONS

PLATE 3

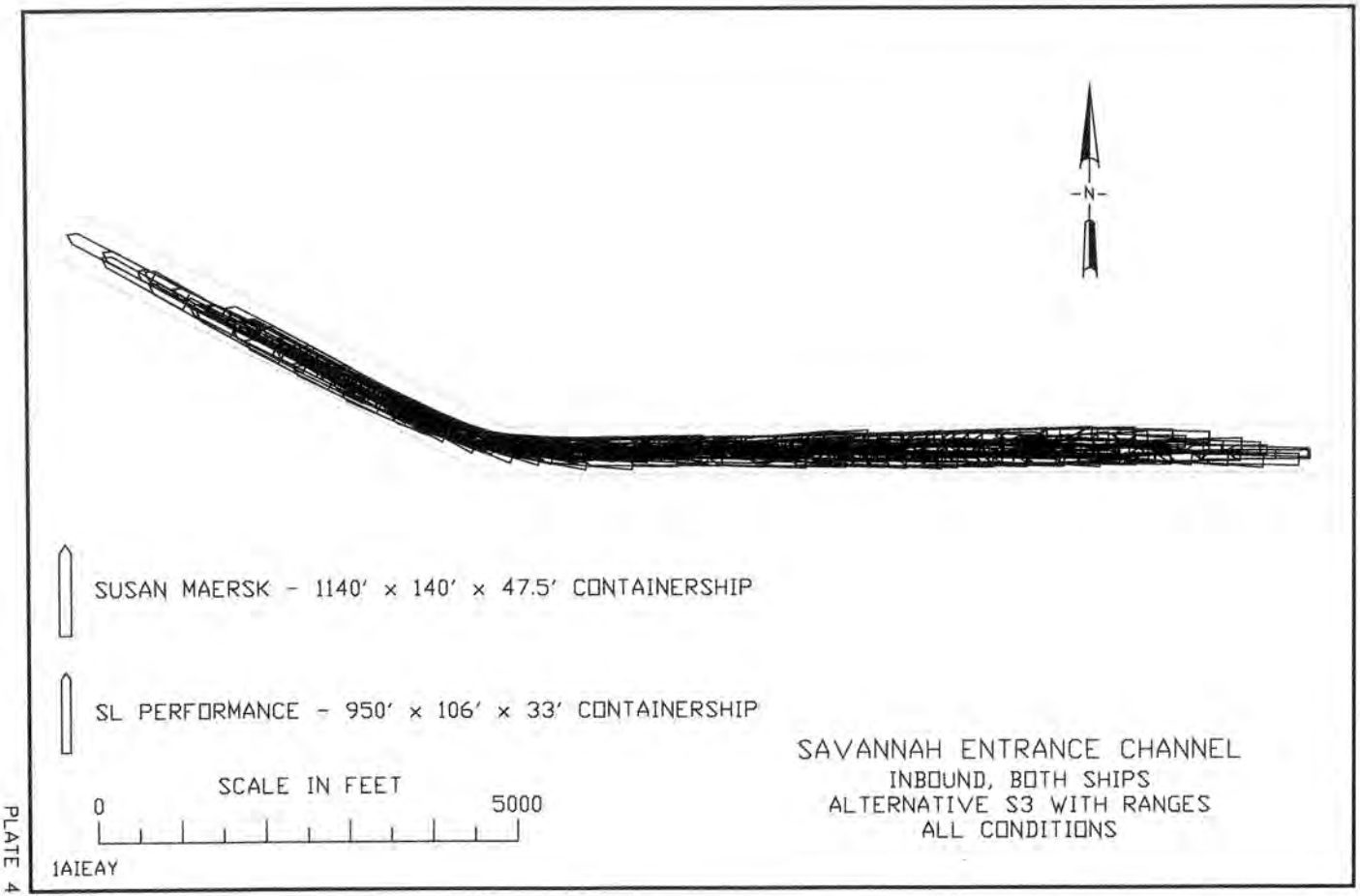

-N-
SUSAN MAERSK - 1140' x 140' x 47.5' CONTAINERSHIP
SL PERFORMANCE - 950' x 106' x 33' CONTAINERSHIP
SCALE IN FEET
0
5000
SAVANNAH ENTRANCE CHANNEL
INBOUND, BOTH SHIPS
ALTERNATIVE S3 WITH RANGES
ALL CONDITIONS
1AIEAY

PLATE 4

1030

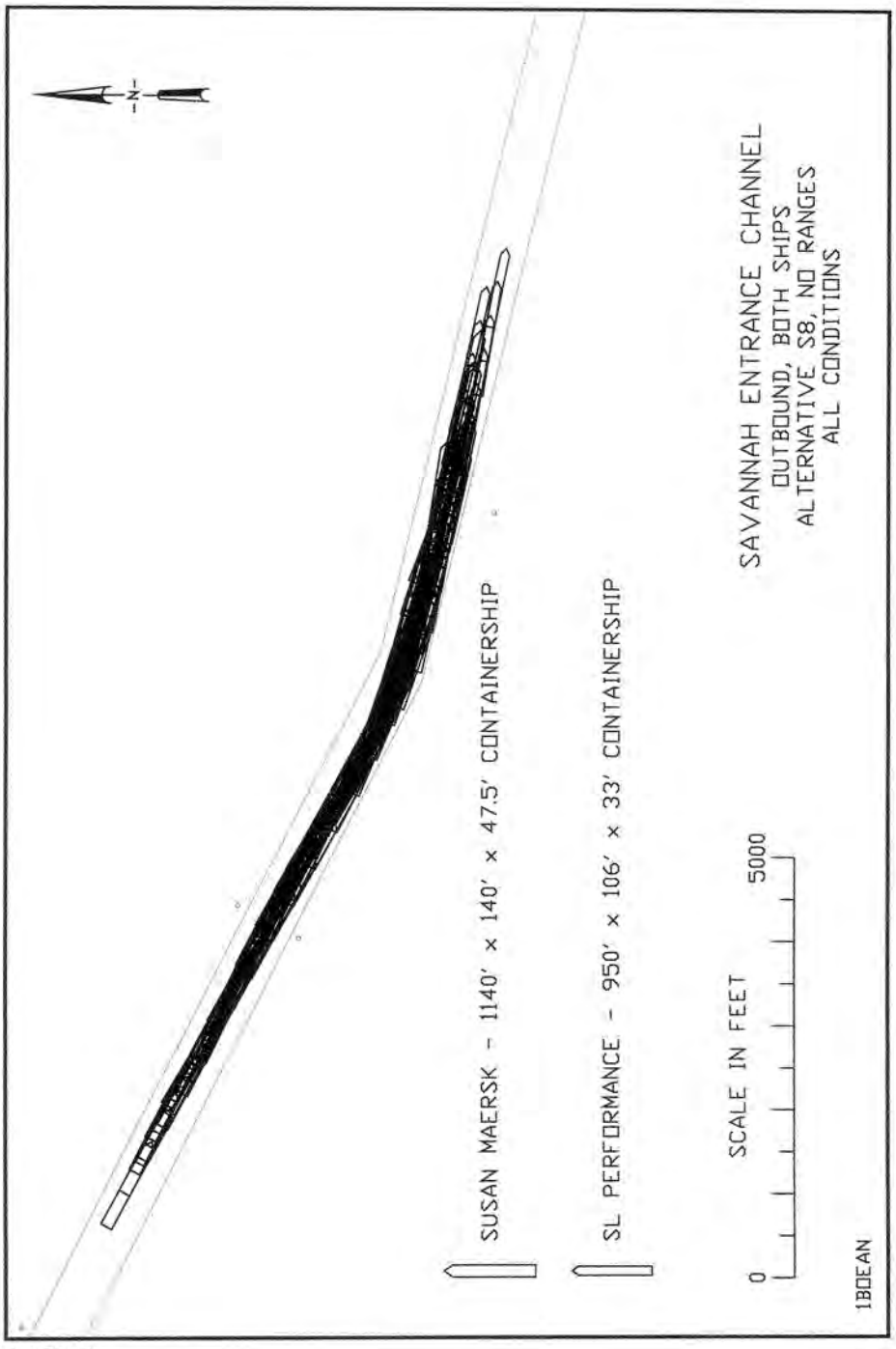

N
SUSAN MAERSK - 1140' x 140' x 47.5' CONTAINERSHIP
SL PERFORMANCE - 950' x 106' x 33' CONTAINERSHIP
SCALE IN FEET
0
5000
SAVANNAH ENTRANCE CHANNEL
OUTBOUND, BOTH SHIPS
ALTERNATIVE S8, NO RANGES
ALL CONDITIONS
1BOEAN

PLATE 5

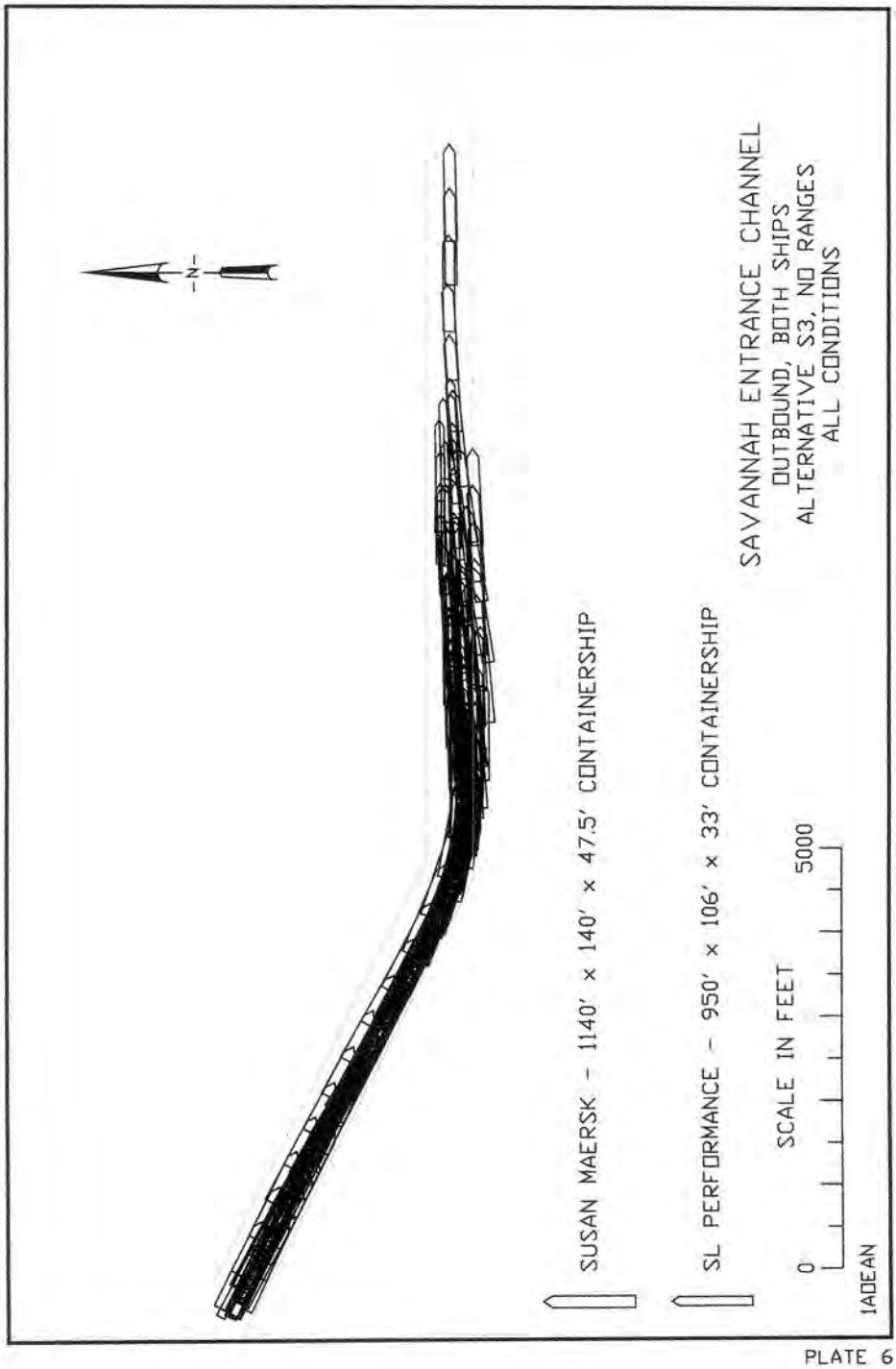

N
SAVANNAH ENTRANCE CHANNEL
OUTBOUND, BOTH SHIPS
ALTERNATIVE S3, NO RANGES
ALL CONDITIONS
SUSAN MAERSK - 1140' x 140' x 47.5' CONTAINERSHIP
SL PERFORMANCE - 950' x 106' x 33' CONTAINERSHIP
SCALE IN FEET
0
5000
IADEAN

PLATE 6

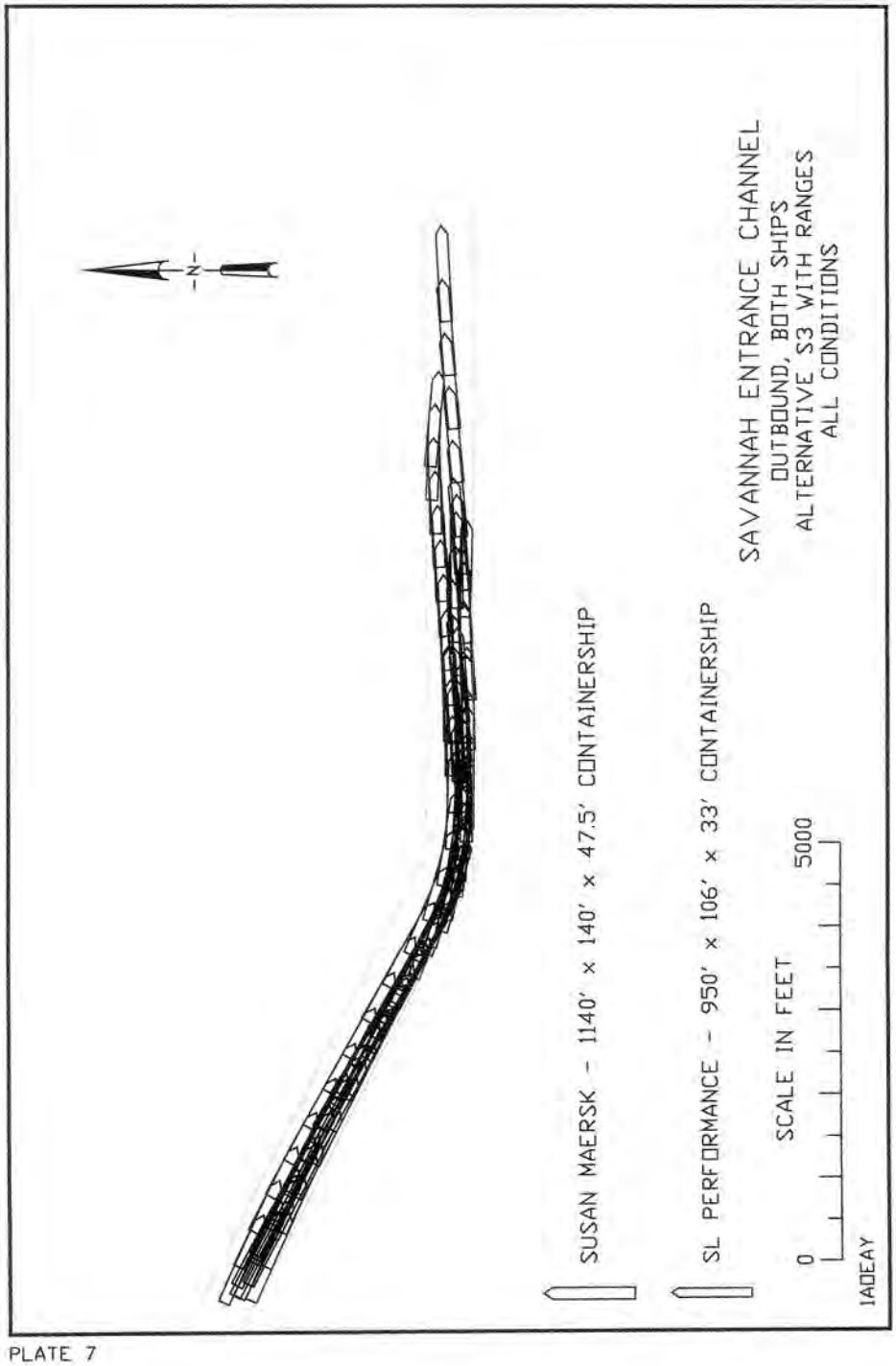

N
SAVANNAH ENTRANCE CHANNEL
OUTBOUND, BOTH SHIPS
ALTERNATIVE S3 WITH RANGES
ALL CONDITIONS
SUSAN MAERSK - 1140' x 140' x 47.5' CONTAINERSHIP
SL PERFORMANCE - 950' x 106' x 33' CONTAINERSHIP
SCALE IN FEET
0
5000
IADEAY

PLATE 7

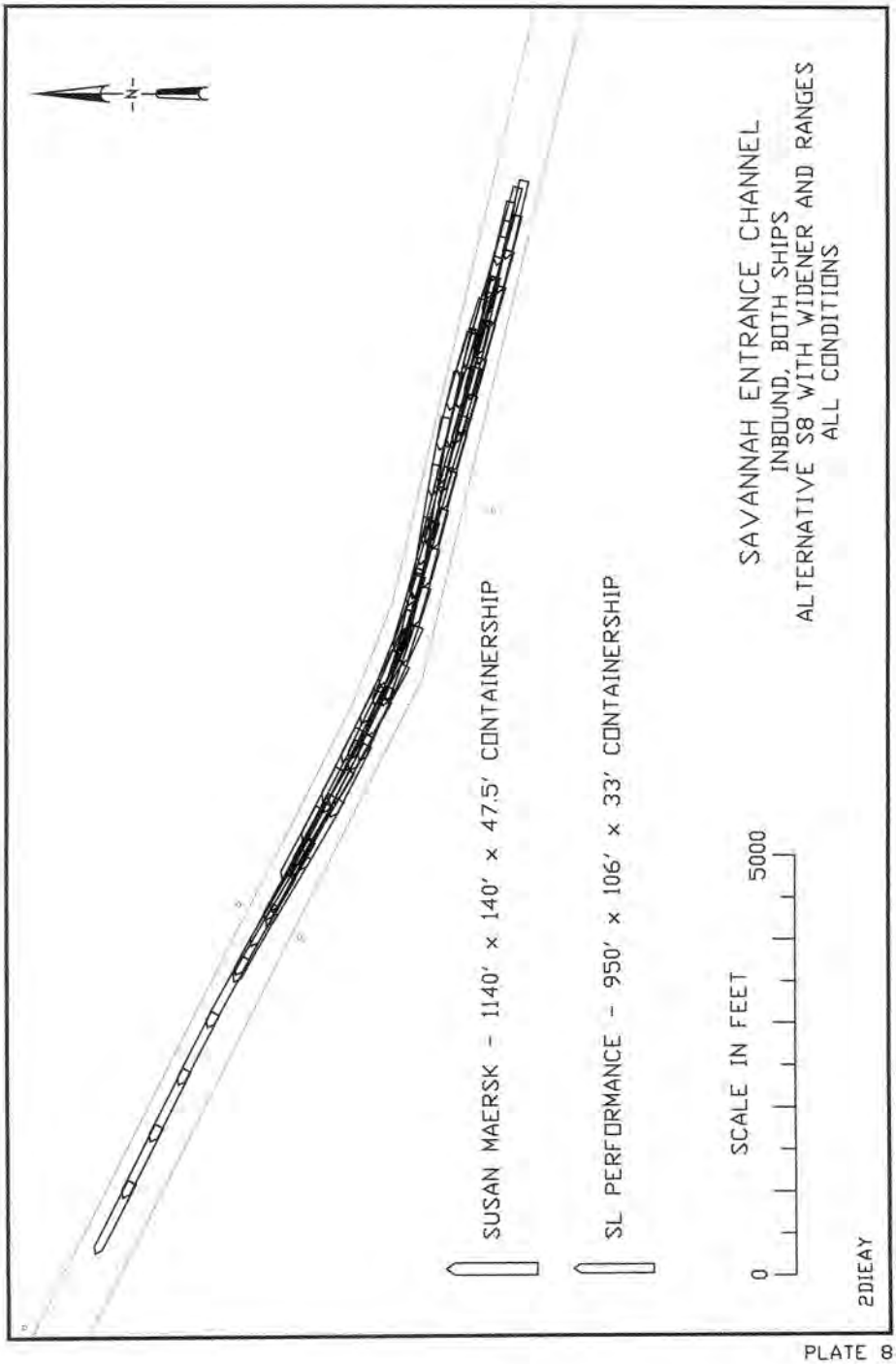

SAVANNAH ENTRANCE CHANNEL
INBOUND, BOTH SHIPS
ALTERNATIVE S8 WITH WIDENER AND RANGES
ALL CONDITIONS
SCALE IN FEET
0
5000
SUSAN MAERSK - 1140' x 140' x 47.5' CONTAINERSHIP
SL PERFORMANCE - 950' x 106' x 33' CONTAINERSHIP
2DIEAY

PLATE 8

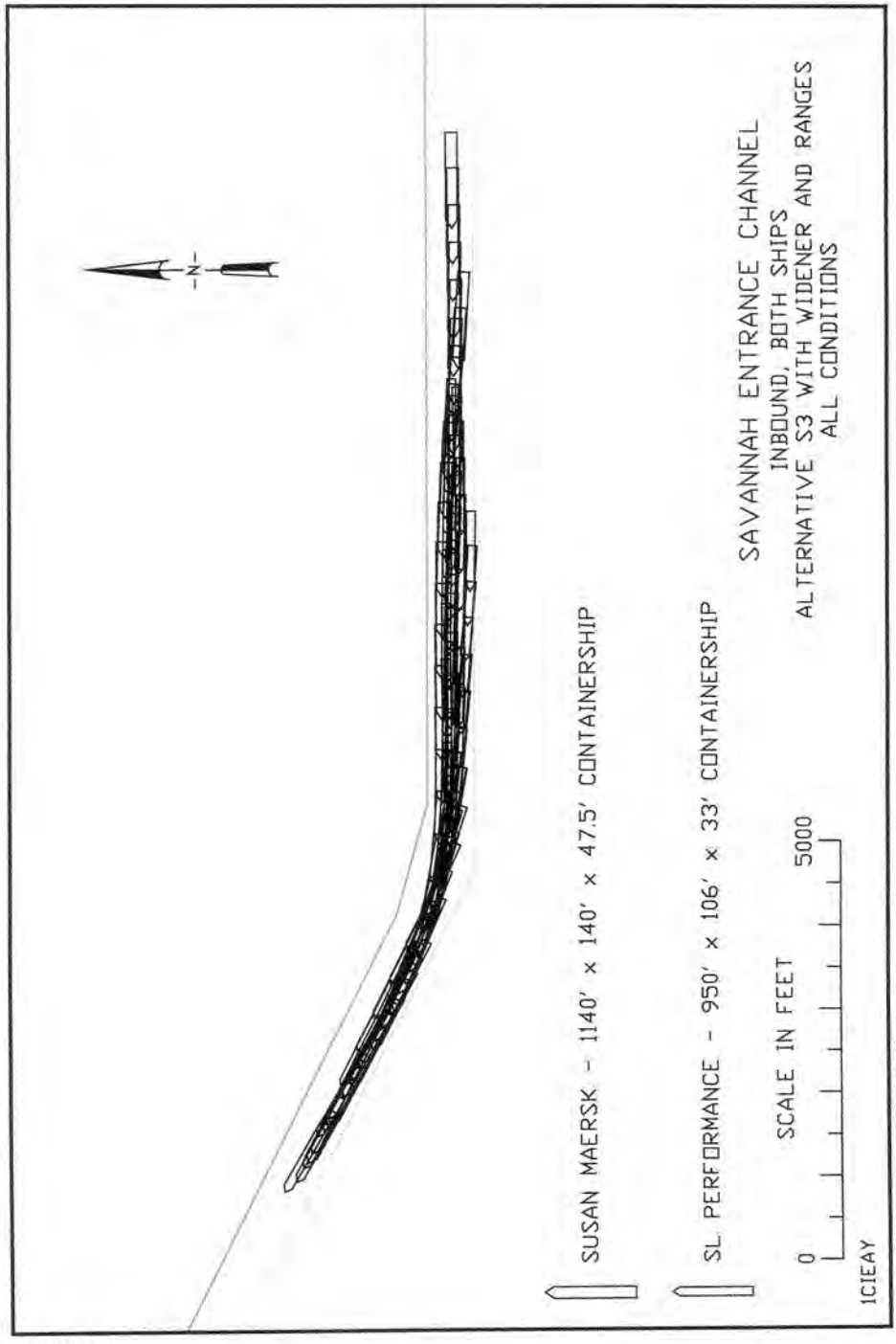

N
SUSAN MAERSK - 1140' x 140' x 47.5' CONTAINERSHIP
SL. PERFORMANCE - 950' x 106' x 33' CONTAINERSHIP
SCALE IN FEET
0
5000
SAVANNAH ENTRANCE CHANNEL
INBOUND, BOTH SHIPS
ALTERNATIVE S3 WITH WIDENER AND RANGES
ALL CONDITIONS
ICIEAY

PLATE 9

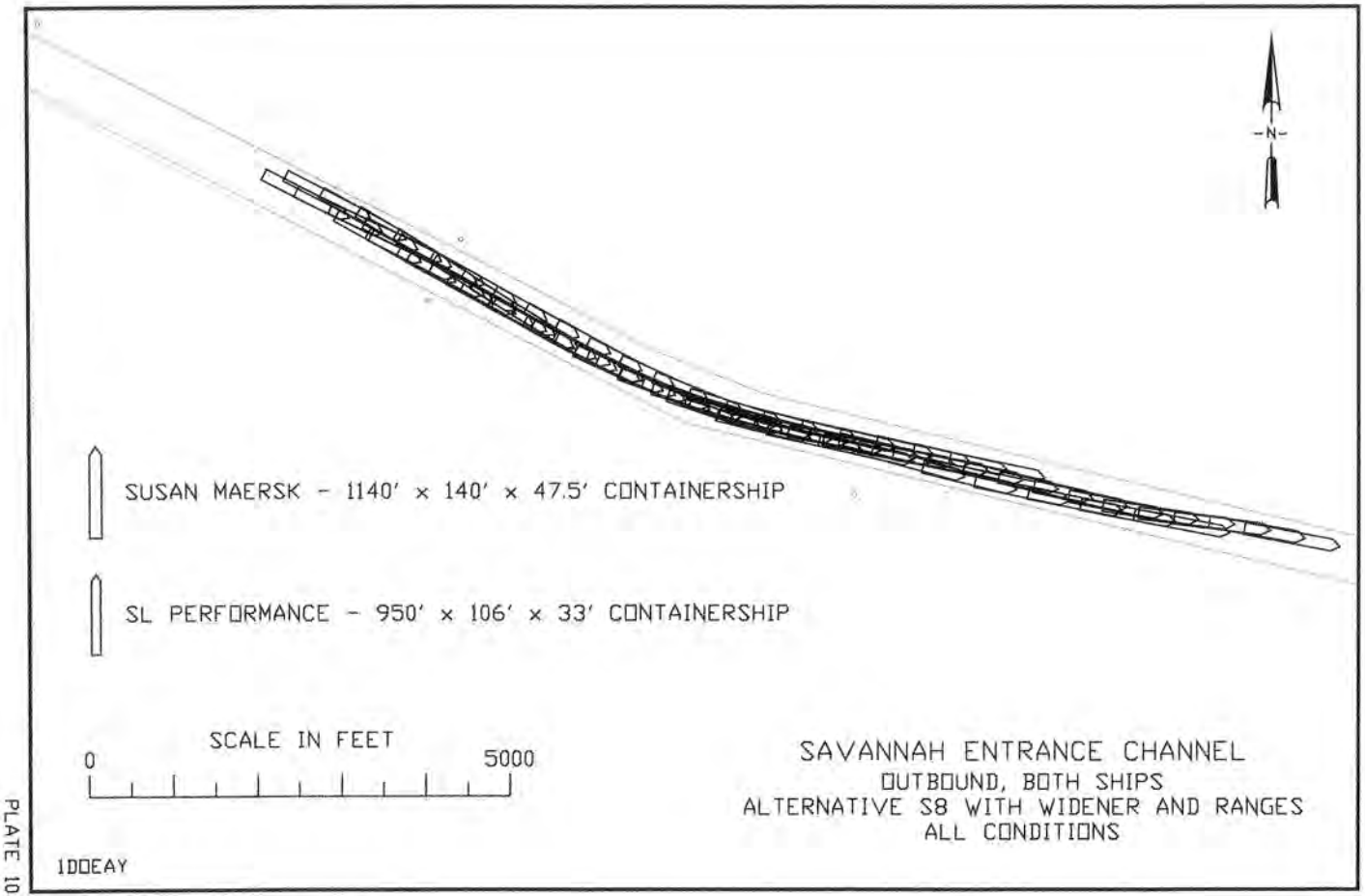

-N-
SUSAN MAERSK - 1140' x 140' x 47.5' CONTAINERSHIP
SL PERFORMANCE - 950' x 106' x 33' CONTAINERSHIP
SCALE IN FEET
0
5000
SAVANNAH ENTRANCE CHANNEL
OUTBOUND, BOTH SHIPS
ALTERNATIVE S8 WITH WIDENER AND RANGES
ALL CONDITIONS
1DDEAY

PLATE 10

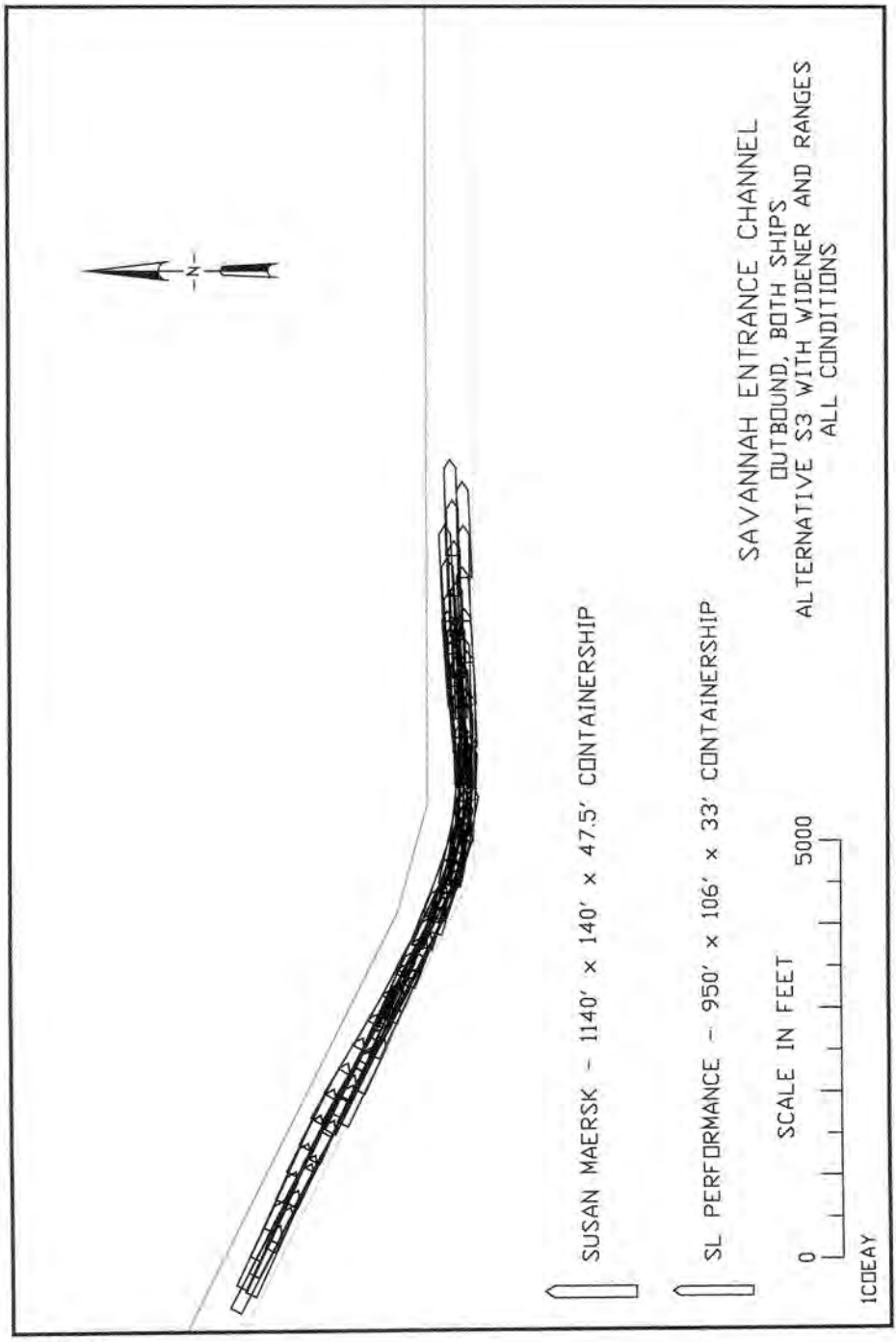

N
SAVANNAH ENTRANCE CHANNEL
OUTBOUND, BOTH SHIPS
ALTERNATIVE S3 WITH WIDENER AND RANGES
ALL CONDITIONS
SUSAN MAERSK - 1140' x 140' x 47.5' CONTAINERSHIP
SL PERFORMANCE - 950' x 106' x 33' CONTAINERSHIP
SCALE IN FEET
0
5000
ICOEAY

PLATE 11

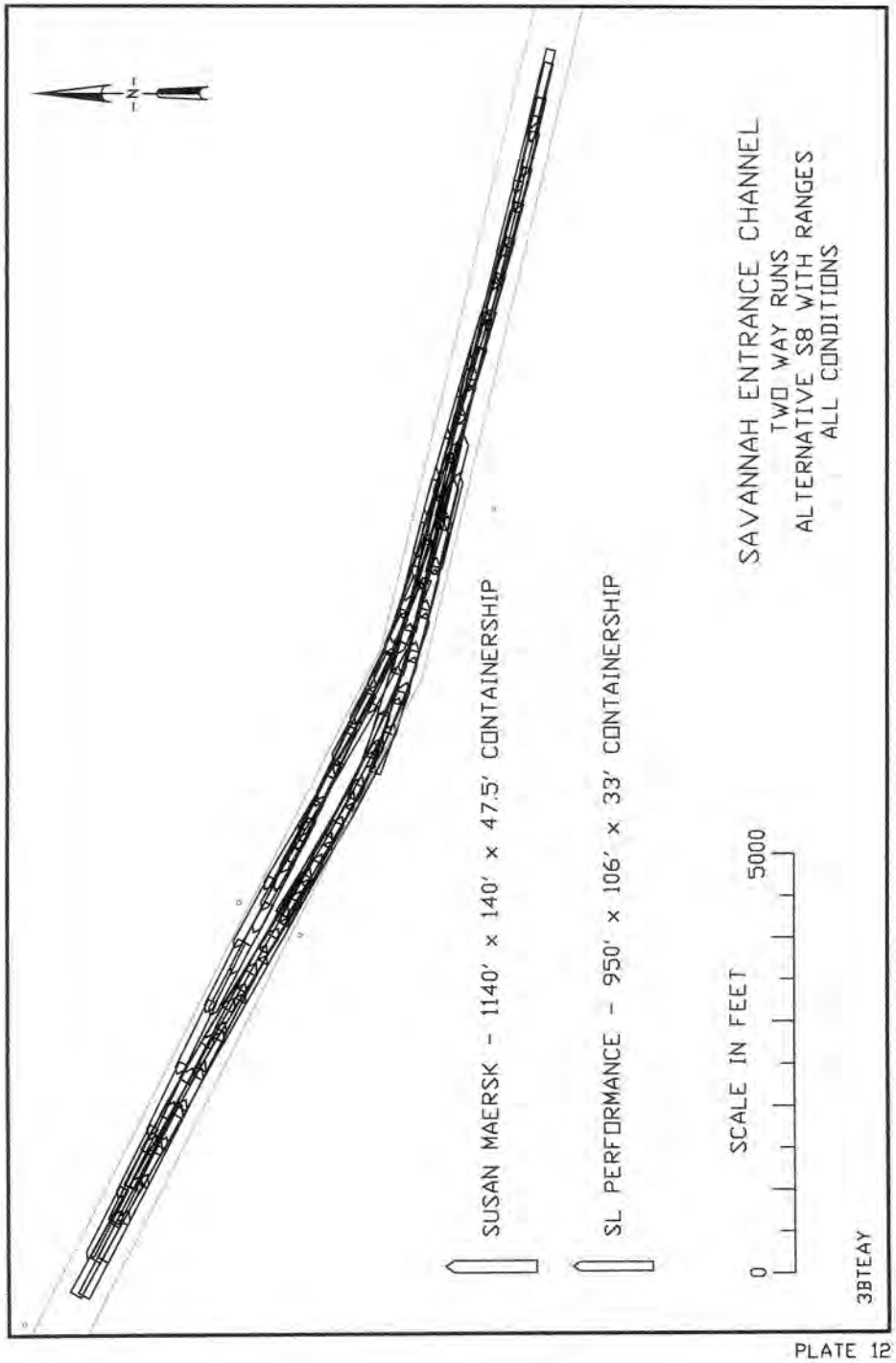

N
SUSAN MAERSK - 1140' x 140' x 47.5' CONTAINERSHIP
SL PERFORMANCE - 950' x 106' x 33' CONTAINERSHIP
SCALE IN FEET
0
5000
SAVANNAH ENTRANCE CHANNEL
TWO WAY RUNS
ALTERNATIVE S8 WITH RANGES
ALL CONDITIONS
3BTEAY

PLATE 12

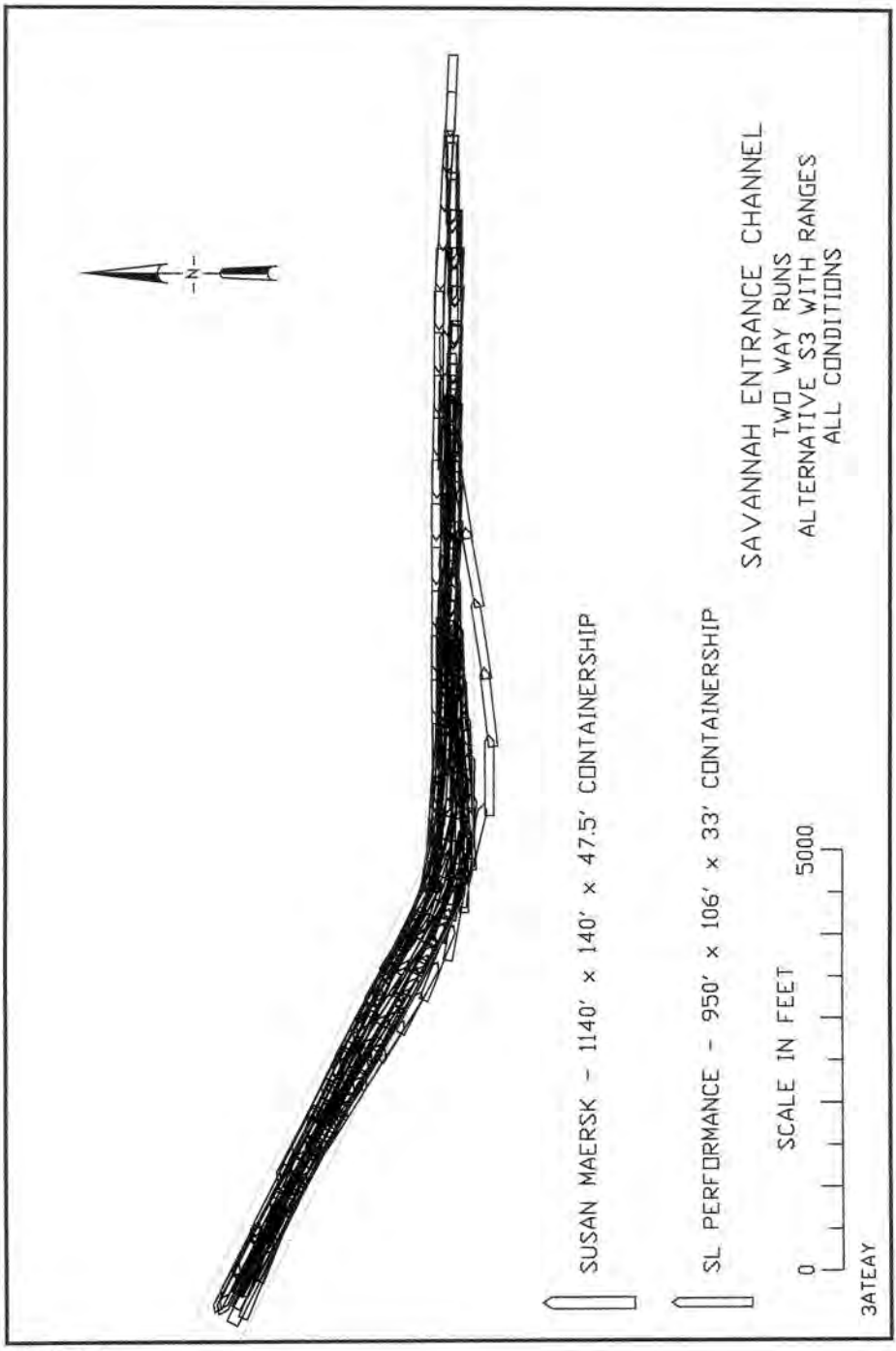

N
SUSAN MAERSK - 1140' x 140' x 47.5' CONTAINERSHIP
SL PERFORMANCE - 950' x 106' x 33' CONTAINERSHIP
SAVANNAH ENTRANCE CHANNEL
TWO WAY RUNS
ALTERNATIVE S3 WITH RANGES
ALL CONDITIONS
SCALE IN FEET
0
5000
3ATEAY

PLATE 13

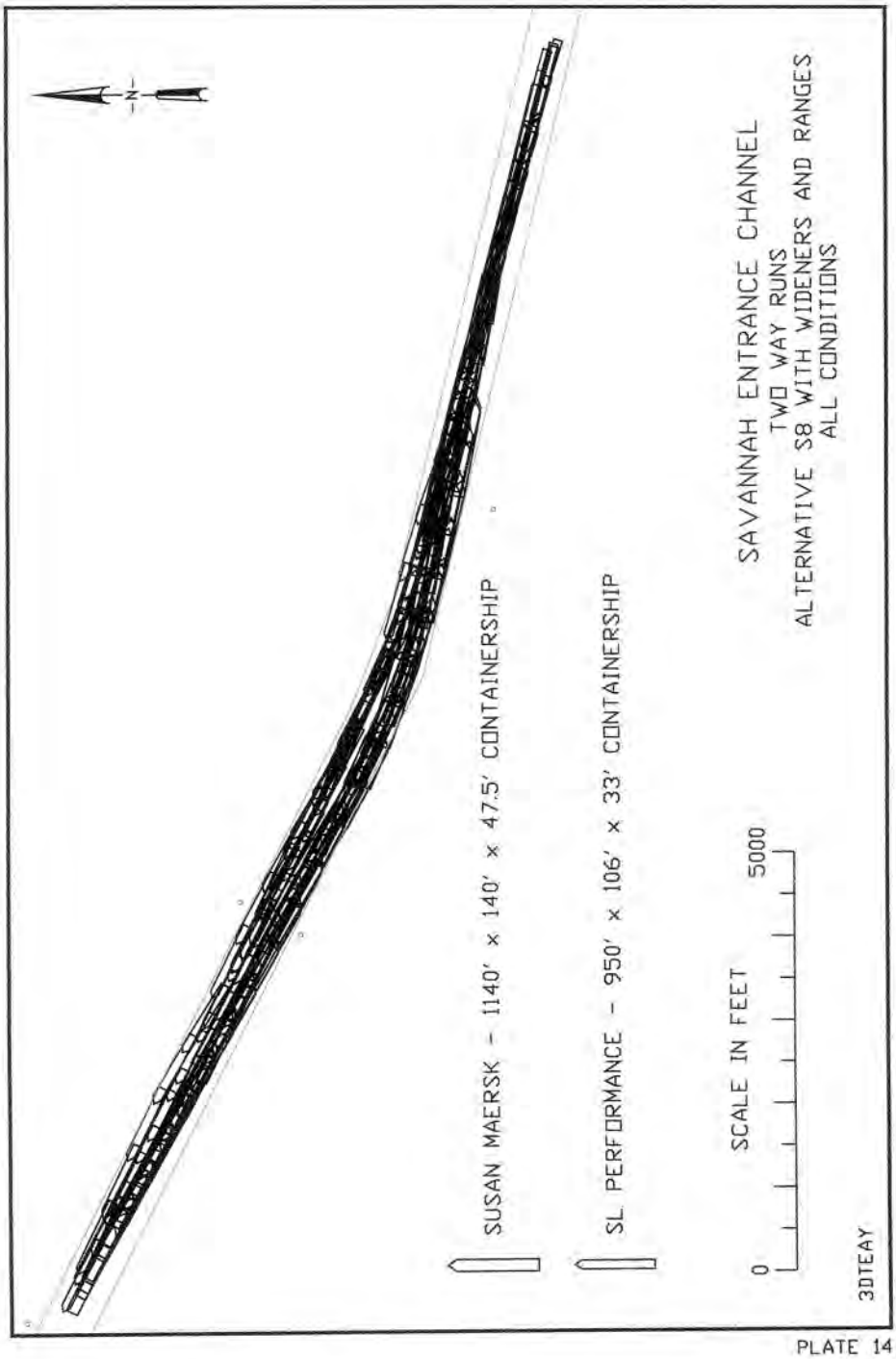

N
SUSAN MAERSK - 1140' x 140' x 47.5' CONTAINERSHIP
SL PERFORMANCE - 950' x 106' x 33' CONTAINERSHIP
SCALE IN FEET
0
5000
SAVANNAH ENTRANCE CHANNEL
TWO WAY RUNS
ALTERNATIVE S8 WITH WIDENERS AND RANGES
ALL CONDITIONS
3DTEAY

PLATE 14

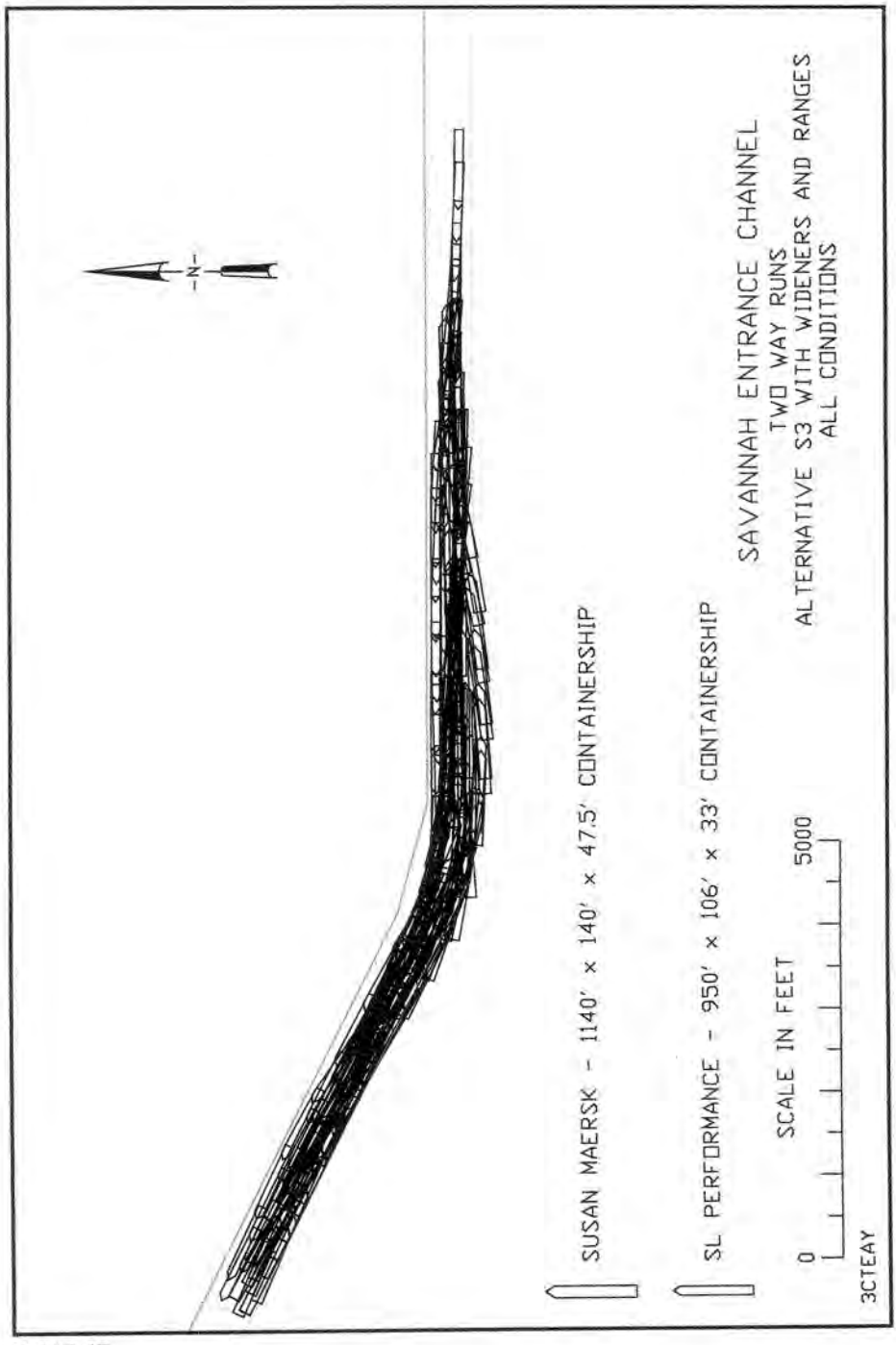

N
SUSAN MAERSK - 1140' x 140' x 47.5' CONTAINERSHIP
SL PERFORMANCE - 950' x 106' x 33' CONTAINERSHIP
SAVANNAH ENTRANCE CHANNEL
TWO WAY RUNS
ALTERNATIVE S3 WITH WIDENERS AND RANGES
ALL CONDITIONS
SCALE IN FEET
0
5000
3CTEAY

PLATE 15

Savannah Entrance Channel Pilot Questionnaire

January 29, 2010

Pilot: Rick Wesley

1. Based upon your simulation runs, did you have a preference for either alignment S-3, or S-8?

S-8 seems to be a gentler turn making it easier. I would except either turn with widners & Ranges.

1000 ft widners minimum

2. Was the addition of inbound ranges helpful?

Without a doubt!! To continue this project using only moving AIDS which aren't 100% Reliable is not safe. Ranges are a valuable part of this transit

3. Was the addition of the bend widener helpful?

Yes weather conditions vary to much off shore. the need for this safety feature is necessary.

ENCL

4. Did you experience a problem with crab angle for either alignment?

Yes I did, But adjusting for Leeway is a factor for most transits with current or adverse weather.

5. How could either alignment be improved?

wider channel

6. Did you experience any problems in the meeting scenarios for either alignment?

Only in the turns with no widner.

7. Any other comments?

to continues transiting the Sac River Safely with these larger and Deeper Ships, the widnes & Ranges are needed. A wider last Reach also would add to the future safety of the SAC River Traffic.

Savannah Entrance Channel Pilot Questionnaire

January 29, 2010

Pilot: TREY THOMPSON

1. Based upon your simulation runs, did you have a preference for either alignment S-3, or S-8?

IT DEPENDS ON WHAT IMPROVEMENTS ARE ADDED. I.E RANGES OR WIDENERS. WITHOUT RANGES, I PREFER S3 BECAUSE IT WOULD BE A SHORTER RUN WITHOUT THEM. WITHOUT WIDENERS, S-8 IS BETER BECAUSE OF THE GENTLER TURN. WITH BOTH S-8 IS BETTER BECAUSE OF THE OVERALL SHORTER DISTANCE TO EXTEND COMBINED WITH AN EASIER TURN.

2. Was the addition of inbound ranges helpful?

RANGES ARE A NECESSITY IN MY OPINION. WITHOUT THEM S-3 IS THE BETTER OPTION BECAUSE ITS A SHORTER DISTANCE. IN MORE CASES THAN NOT, I WOULD NOT PASS ON EITHER S-3 OR S-8 WITHOUT RANGES. I WOULD WAIT TO START IN UNTIL THE OUTBOUND CLEARED OR I WOULD MAKE SURE I COULD GET OVER TYBEE RANGE TO MEET.

3. Was the addition of the bend widener helpful?

WIDENERS ARE ALWAYS HELPFUL, ESPECIALLY WHEN PASSING NEAR A TURN WITH THEM TRAFFIC COULD FLOW ALOT EASIER. WITHOUT WIDENERS, ONCE AGAIN I WOULD HOLD UP MY TRANSIT TO MAKE SURE I DON'T MEET NEAR THE TURN

4. Did you experience a problem with crab angle for either alignment?

NO CRABBING WAS NEVER AN ISSUE.

5. How could either alignment be improved?

IF RANGES AND WIDENERS ARE ADDED TO BOTH SCENARIOS, THE ONLY OTHER IMPROVEMENT WOULD BE TO WIDEN THE WHOLE EXTENSION.

6. Did you experience any problems in the meeting scenarios for either alignment?

YES WITHOUT THE RANGES AND WIDENERS, I WENT OUT OF THE CHANNEL A FEW TIMES.

7. Any other comments?

TO SUMMARIZE MY OPINION I PREFER

S-3 IF NO RANGES WILL BE BUILT

S-8 IF RANGES WILL BE,

WIDENERS ARE NECESSARY ON ANY OFFSHORE TURNS BECAUSE OF THE GREATER EFFECTS OF WIND AND SPEED.

Savannah Entrance Channel Pilot Questionnaire

January 29, 2010

Pilot:

1. Based upon your simulation runs, did you have a preference for either alignment S-3, or S-8?

S-3 is not as safe as S-8.

2. Was the addition of inbound ranges helpful?

Yes

3. Was the addition of the bend widener helpful?

Yes

4. Did you experience a problem with crab angle for either alignment?

NO

5. How could either alignment be improved?

~~A~~ NO

6. Did you experience any problems in the meeting scenarios for either alignment?

Yes 5-3 was a sharp angle and we had a very close pass.

7. Any other comments?

5-3 is a difficult turn.

Savannah Entrance Channel Pilot Questionnaire

January 29, 2010

Pilot:

1. Based upon your simulation runs, did you have a preference for either alignment S-3, or S-8?

I believe S-3 would be a better set up.

2. Was the addition of inbound ranges helpful?

yes

3. Was the addition of the bend widener helpful?

yes

4. Did you experience a problem with crab angle for either alignment?

No

5. How could either alignment be improved?

As far as S-3 I don't believe it could be improved enough to make a difference. S-8 on the other hand is fine the way it is, A nice gentle bend to the Right

6. Did you experience any problems in the meeting scenarios for either alignment?

No problems, but S-3 just seems to sharp of A turn.

7. Any other comments?

I believe S-8 is the better Alignment.

DEPARTMENT OF THE ARMY
ENGINEER RESEARCH AND DEVELOPMENT CENTER, CORPS OF ENGINEERS
COASTAL AND HYDRAULICS LABORATORY
WATERWAYS EXPERIMENT STATION, 3909 HALLS FERRY ROAD
VICKSBURG, MISSISSIPPI 39180-6199

CEERD-HN-N

31 MAR 2009

MEMORANDUM FOR Commander, US Army Engineer District, Savannah (CESAW-TS-EC/Mr. Wilbur Wiggins), P.O. Box 889, Savannah, GA 31401-3640

SUBJECT: Savannah Harbor Simulations Study 2009

1. During 2002 and 2003, the US Army Engineer Research and Development Center (ERDC) conducted a ship simulator based navigation study for the Savannah District (SAS). In 2008, SAS contacted ERDC to revisit that study and conduct additional simulations for three different reaches (Figure 1) to evaluate proposed changes to the channel recommended in the earlier study. The following are the three reaches:

a. Reach 1: Long Island Range. The earlier study recommended that the Long Island Range be widened to allow for two-way traffic of the design vessel. The SAS wishes to determine if the reach needs to be widened for its entire length or if a shorter portion of the reach can safely provide a meeting area.

b. Reach 2: Oglethorpe Range. The study recommended widening the transition from Ft. Jackson Range to Oglethorpe Range a distance of 100 ft. This area appears too short to safely accommodate a meeting lane. Oglethorpe Range (Figure 2) is longer and centrally located to the project and is thought to have good potential as a meeting area but the required length needs to be determined from simulation

c. Reach 3: Marsh Island Channel to Kings Island Turning Basin. This reach (Figure 3) needs to be narrowed to accommodate additional berth width required by the design vessel for the Savannah Harbor Expansion Project. In addition, the SAS's original improvement plan widened the Kings Island Turning Basin by 100 ft. The SAS wishes to determine if the 50-ft narrowing (32 ft additional for berth width + 18 ft for deepening) adversely impacts navigation traffic and affects the approach into Kings Island Turning Basin.

2. Two simulation sessions were conducted. The first was January 14 – 16, 2009. The pilots for that session were Capt. John Ebberwein and Capt. Robert A. King. The second session was January 21 – 23, 2009 and the pilots were Capt. Rick Wesley and Capt. Robert (Trey) Thompson, III. Each pilot was given a final questionnaire at the end of the week. Those questionnaires are included as Appendix A.

3. Week 1 Simulations. The first week of simulations concentrated on evaluating the length of the passing zone required for Long Island Range. This was accomplished by starting inbound and outbound ships at various locations and telling the pilots to meet in the middle of Long Island Range. This way the necessary length could be bracketed. Based upon the results of the first week, passing zone lengths of 5,000, 6,000, and 7,000 ft were selected for the second week of testing. Meeting scenarios in the Oglethorpe Range were attempted. However, the ship-to-

CEERD-HN-N 31 MAR 2009
SUBJECT: Savannah Harbor Simulations Study 2009

ship interaction was too severe. Therefore, it was agreed to wait until the interaction could be fixed before simulating two-way traffic in Oglethorpe Range. The interaction problems were corrected prior to the second week of testing. A number of transits were conducted through the City Front Area (Marsh Island Channel and Kings Island Turning Basin. Results from those exercises will be presented in composite plots with those runs completed in the second week of testing.

4. Week 2 Simulations. Results from the second week of simulations are presented in the form of track plots in Plates 1 – 25.

a. Individual track plots for two-way traffic on Long Island Channel are shown in Plate 1 – 17. Plots for the 5,000-ft long zone are shown in Plates 1 – 3. One pilot had difficulty getting his ship back in the channel before the end of the 5,000-ft section (Plate 1). Two pilots cut the corner of the channel at the southern end of the zone to get out of the way of the outbound ship (Plates 2 and 3). Plots for the 6,000-ft zone are shown in Plates 4 – 9. With the exception of Plate 9, the pilots had difficulty timing their meeting for the 6,000-ft long section. Results from the 7,000-ft long zone are shown in Plates 10 – 17. The pilots had an easier time meeting in the 7,000-ft zone than in either the 5,000 or 6,000-ft zones. However, several of the runs meet at the extreme northern end of the zone (Plates 10, 14, 15, and 16).

b. Individual track plots for two-way traffic in Oglethorpe Range are shown in Plates 18 – 21. These plots are for two Susan Maersk ships meeting each other. These runs were successful and required the entire length of Oglethorpe Range.

c. Composite plots of the city front area (Marsh Island Channel and Kings Island Turning Basin) are shown in Plate 22 – 25. All runs were successful and the ships did not have a problem with the 50 ft narrowing.

5. Recommendations. The 7,000-ft long meeting zone on Long Island Channel was more successful than either the 5,000 or 6,000-ft long zones. However, the pilots still had some difficulties meeting in the 7,000 ft length. Therefore, a length of 8,000 ft is recommended for the zone. The 100-ft widening of Oglethorpe Range was adequate for two-way traffic of the Susan Maersk. The 50-ft narrowing of Marsh Island Range did not adversely affect traffic.

William D. Martin

Encls

WILLIAM D. MARTIN, PhD, PE
Director

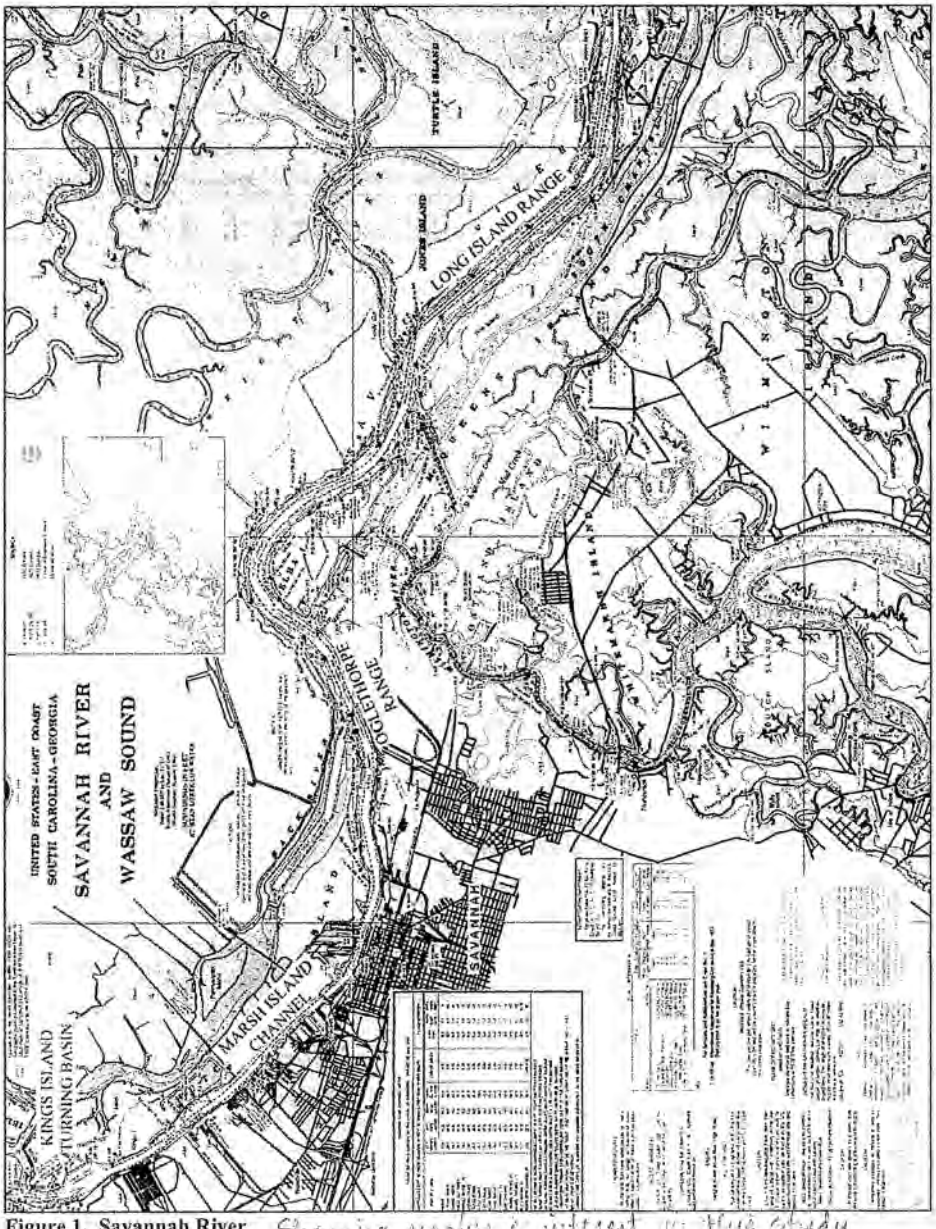


Figure 1. Savannah River Showing reaches of interest in this study

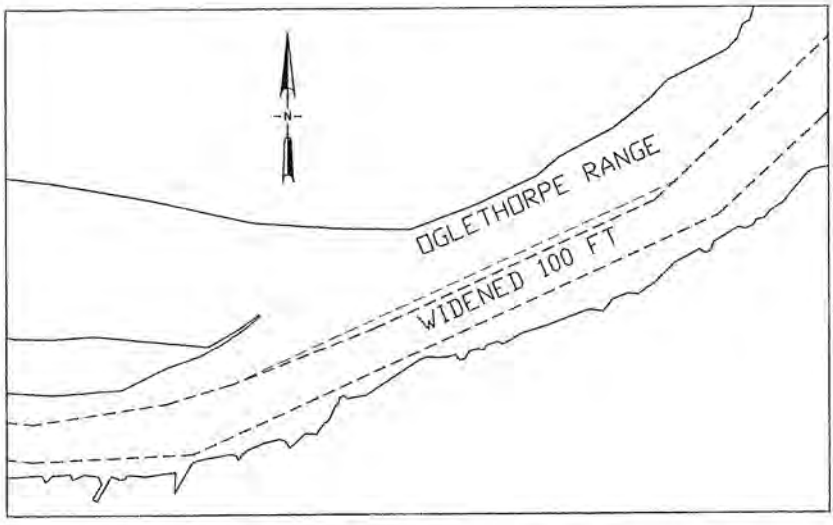


Figure 2. Oglethorpe Range

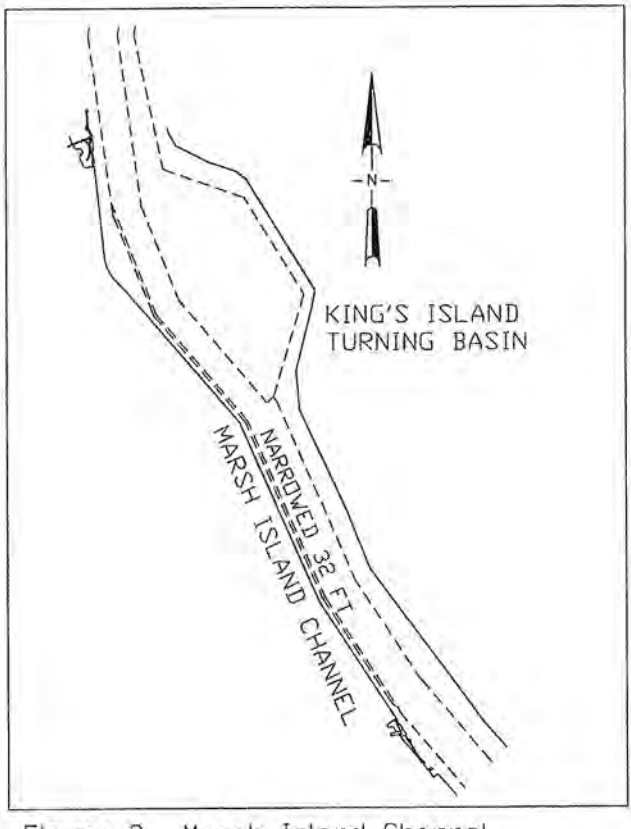


Figure 3. Marsh Island Channel

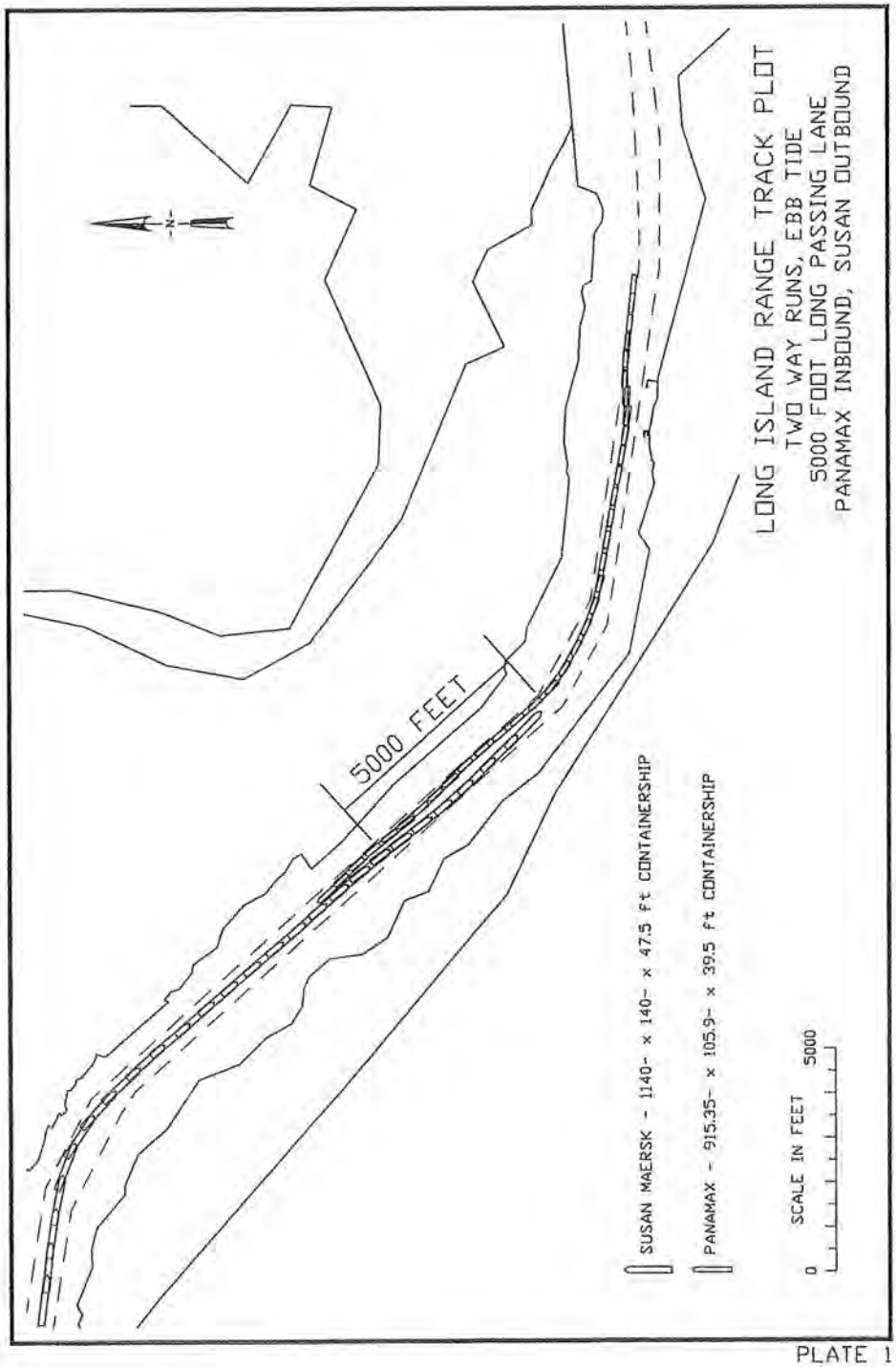

LONG ISLAND RANGE TRACK PLOT
TWO WAY RUNS, EBB TIDE
5000 FOOT LONG PASSING LANE
PANAMAX INBOUND, SUSAN OUTBOUND
5000 FEET
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
PANAMAX - 915.35- x 105.9- x 39.5 ft CONTAINERSHIP
0 SCALE IN FEET 5000

PLATE 1

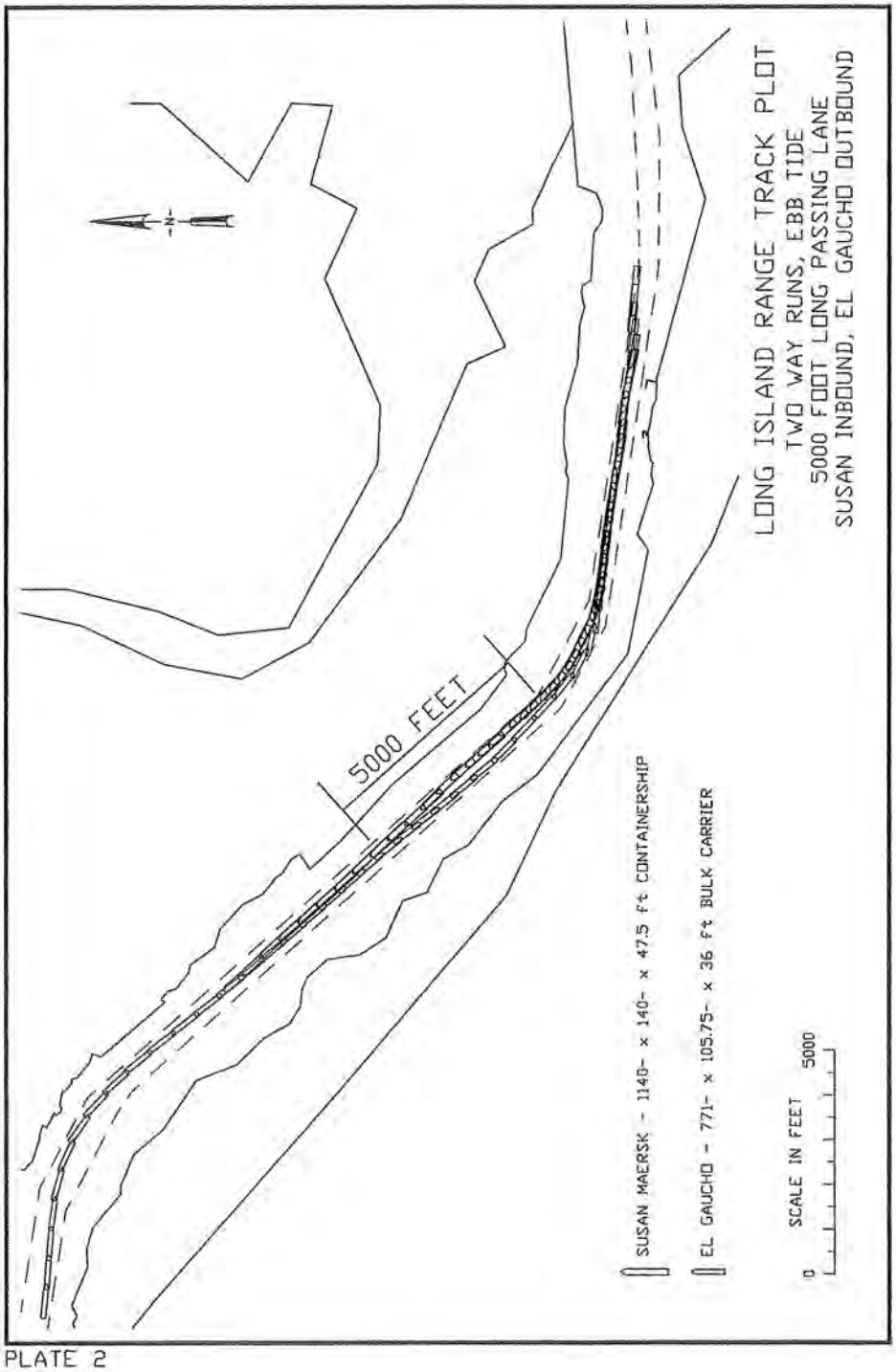

LONG ISLAND RANGE TRACK PLOT
TWO WAY RUNS, EBB TIDE
5000 FOOT LONG PASSING LANE
SUSAN INBOUND, EL GAUCHO OUTBOUND
5000 FEET
SUSAN MAERSK - 1140- x 140- x 47.5 Ft CONTAINERSHIP
EL GAUCHO - 771- x 105.75- x 36 Ft BULK CARRIER
SCALE IN FEET
0
5000

PLATE 2

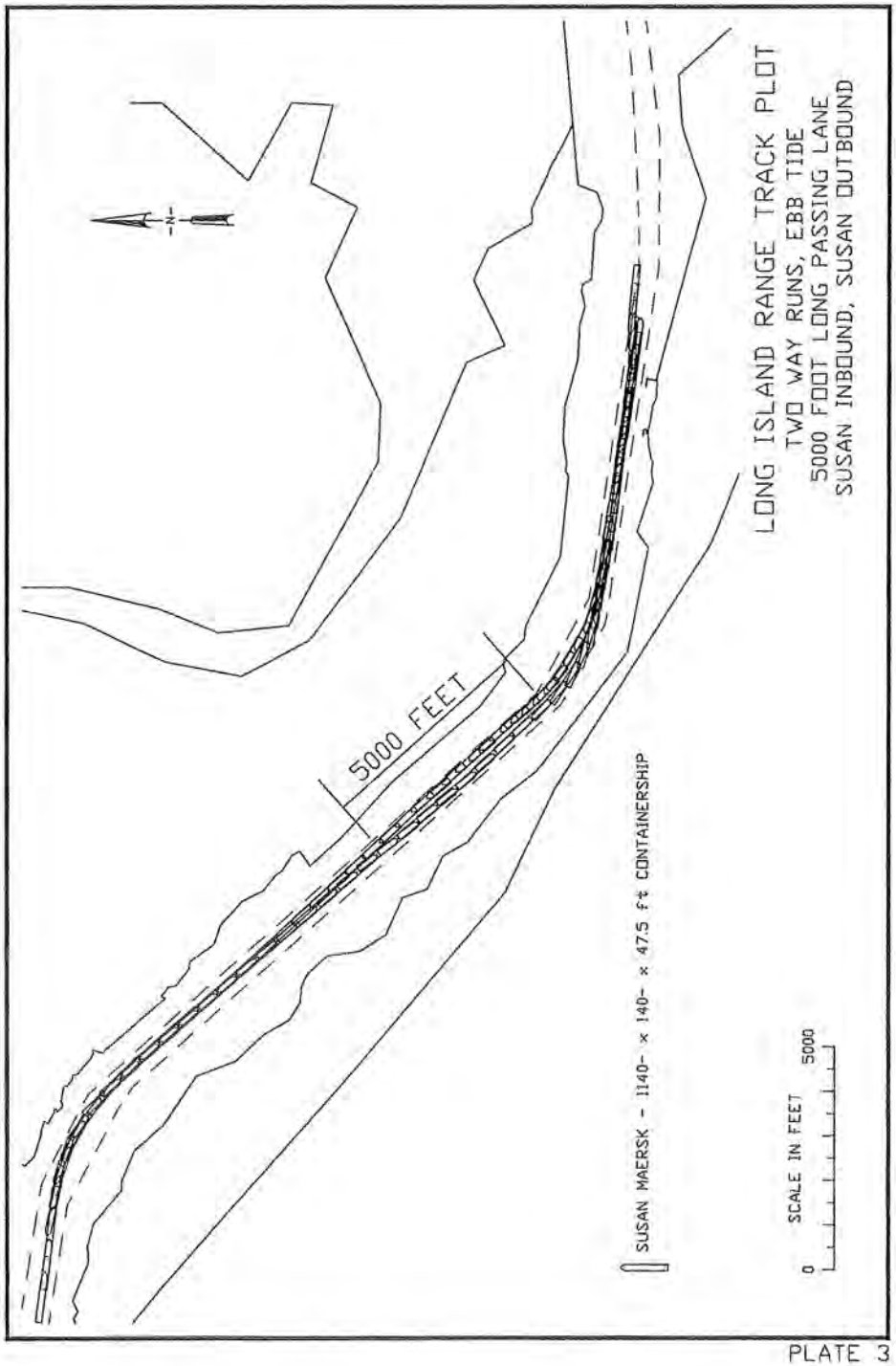

LONG ISLAND RANGE TRACK PLOT
TWO WAY RUNS, EBB TIDE
5000 FOOT LONG PASSING LANE
SUSAN INBOUND, SUSAN OUTBOUND
5000 FEET
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
SCALE IN FEET
0
5000

PLATE 3

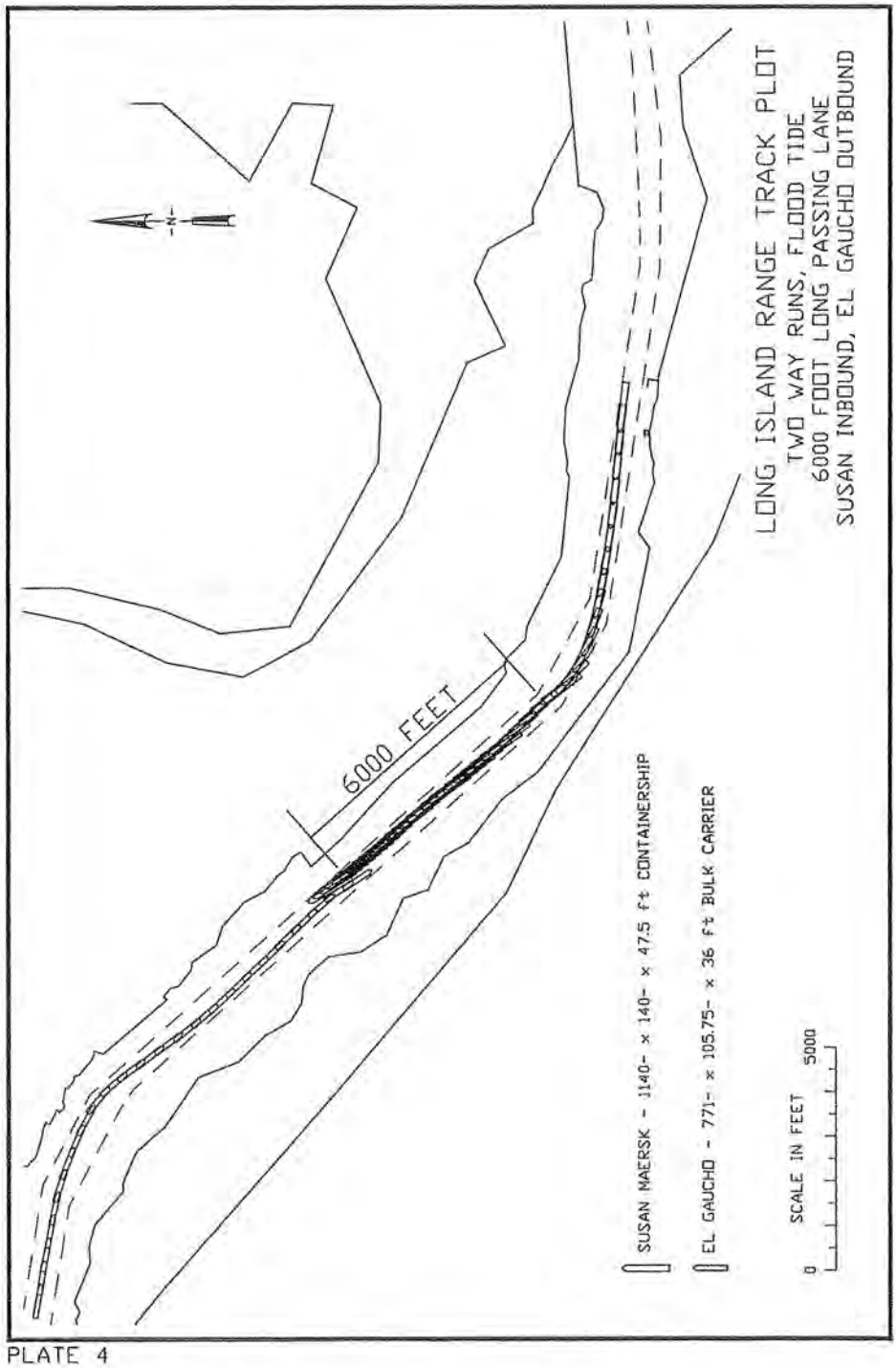

LONG ISLAND RANGE TRACK PLOT
TWO WAY RUNS, FLOOD TIDE
6000 FOOT LONG PASSING LANE
SUSAN INBOUND, EL GAUCHO OUTBOUND
6000 FEET
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
EL GAUCHO - 771- x 105.75- x 36 ft BULK CARRIER
SCALE IN FEET
0
5000

PLATE 4

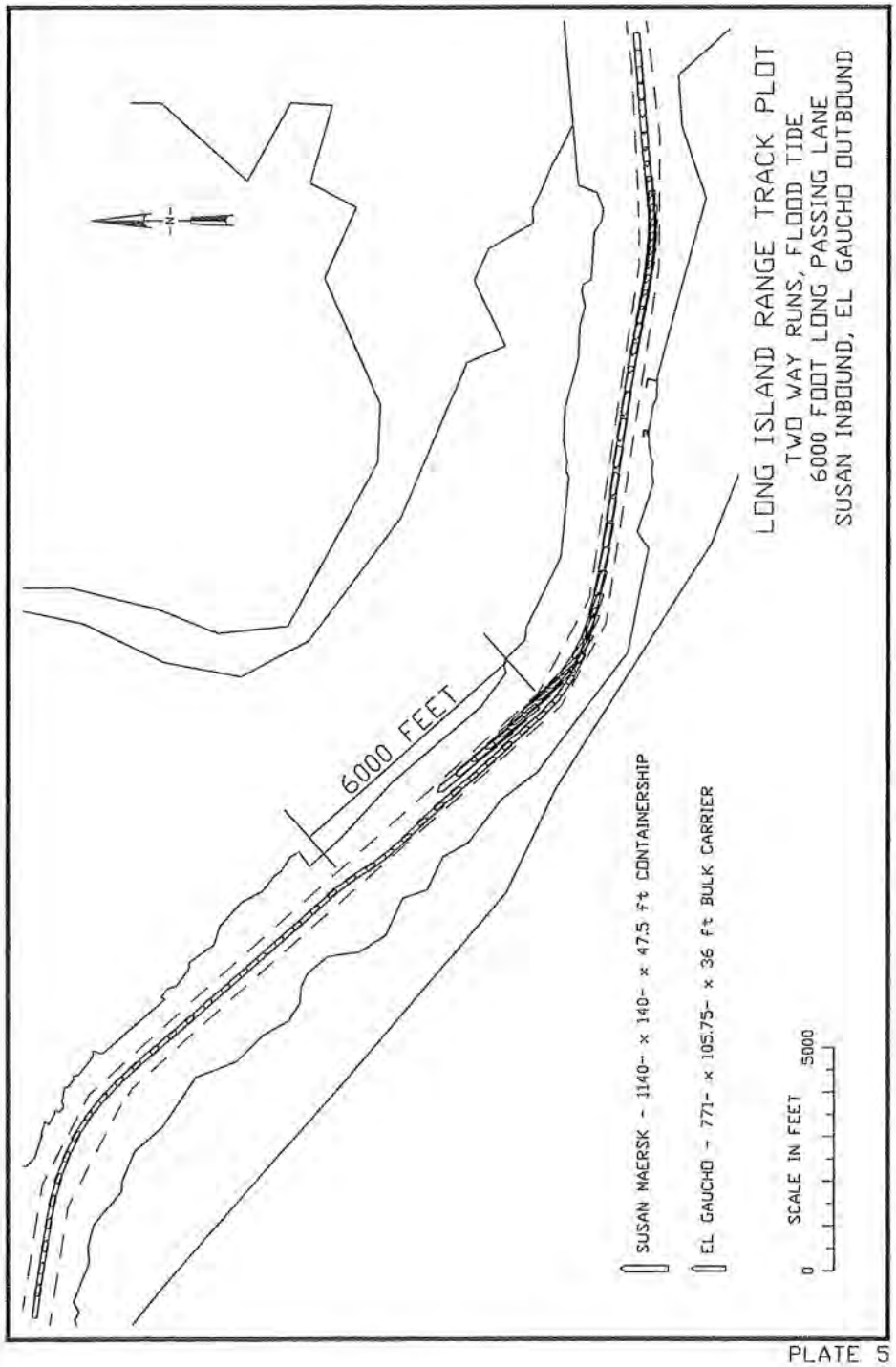

LONG ISLAND RANGE TRACK PLOT
TWO WAY RUNS, FLOOD TIDE
6000 FOOT LONG PASSING LANE
SUSAN INBOUND, EL GAUCHO OUTBOUND
6000 FEET
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
EL GAUCHO - 771- x 105.75- x 36 ft BULK CARRIER
SCALE IN FEET
0
5000

PLATE 5

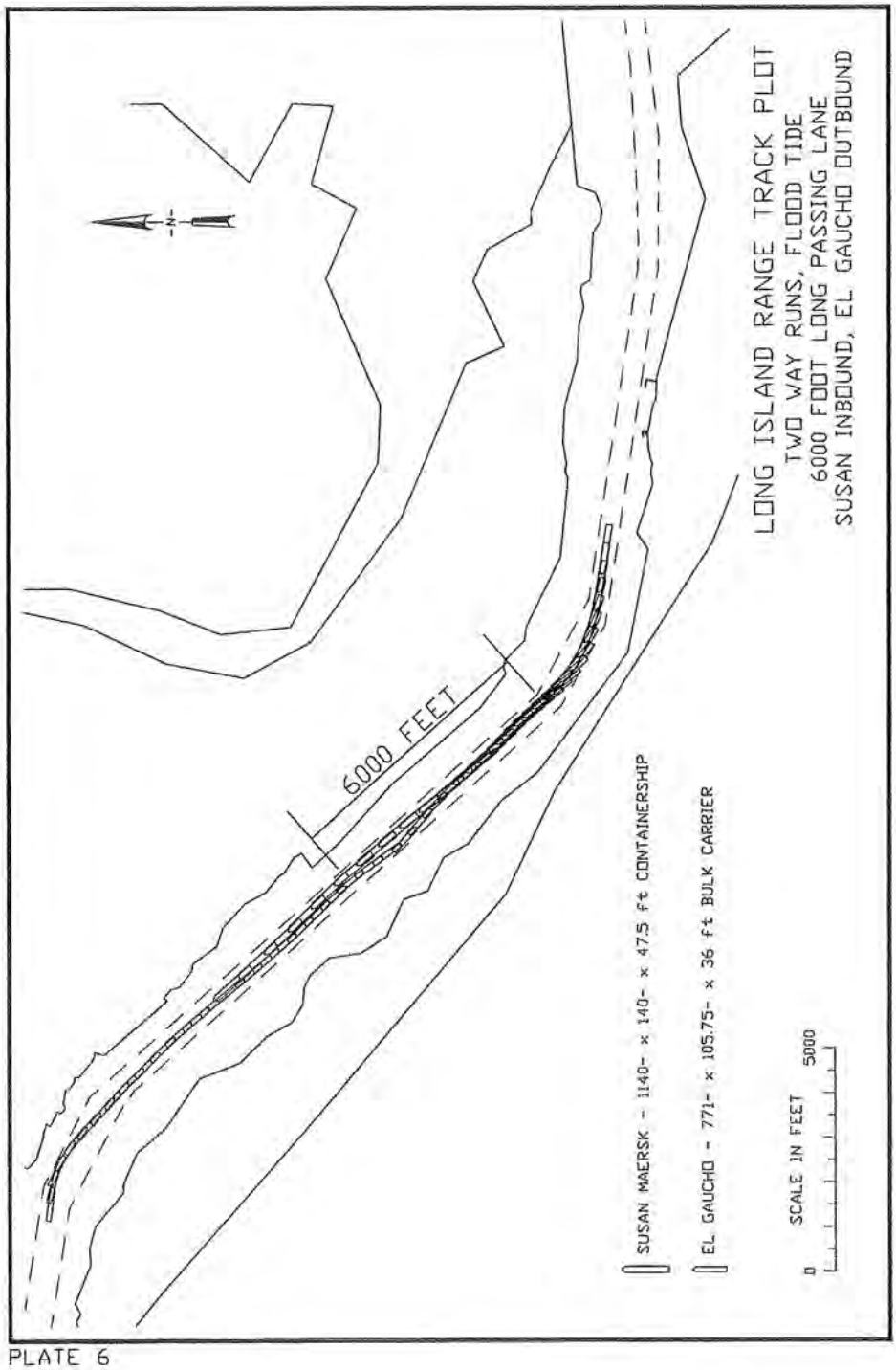

LONG ISLAND RANGE TRACK PLOT
TWO WAY RUNS, FLOOD TIDE
6000 FOOT LONG PASSING LANE
SUSAN INBOUND, EL GAUCHO OUTBOUND
6000 FEET
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
EL GAUCHO - 771- x 105.75- x 36 ft BULK CARRIER
SCALE IN FEET
0
5000

PLATE 6

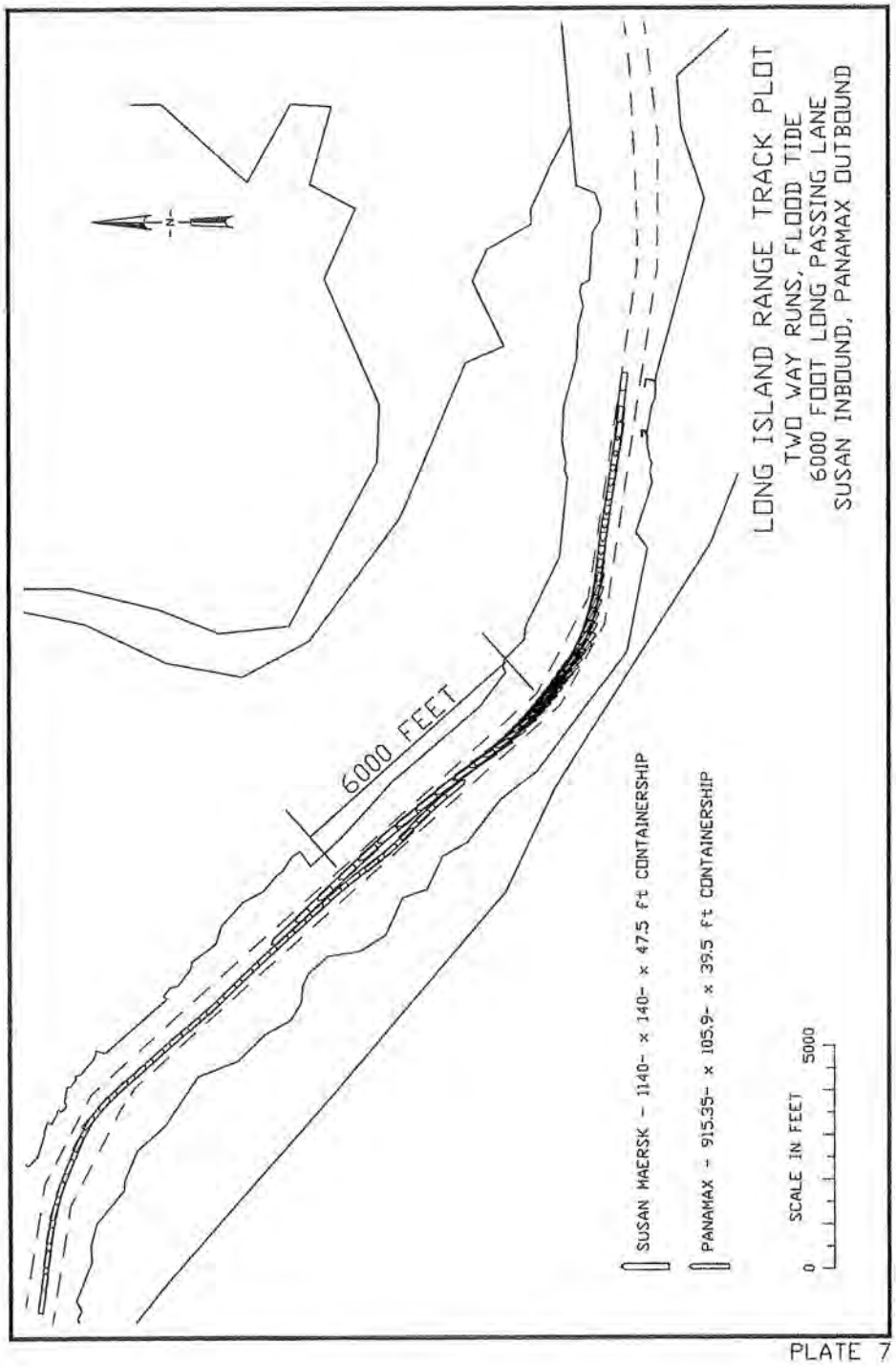

LONG ISLAND RANGE TRACK PLOT
TWO WAY RUNS, FLOOD TIDE
6000 FOOT LONG PASSING LANE
SUSAN INBOUND, PANAMAX OUTBOUND
6000 FEET
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
PANAMAX - 915.35- x 105.9- x 39.5 ft CONTAINERSHIP
SCALE IN FEET
0
5000

PLATE 7

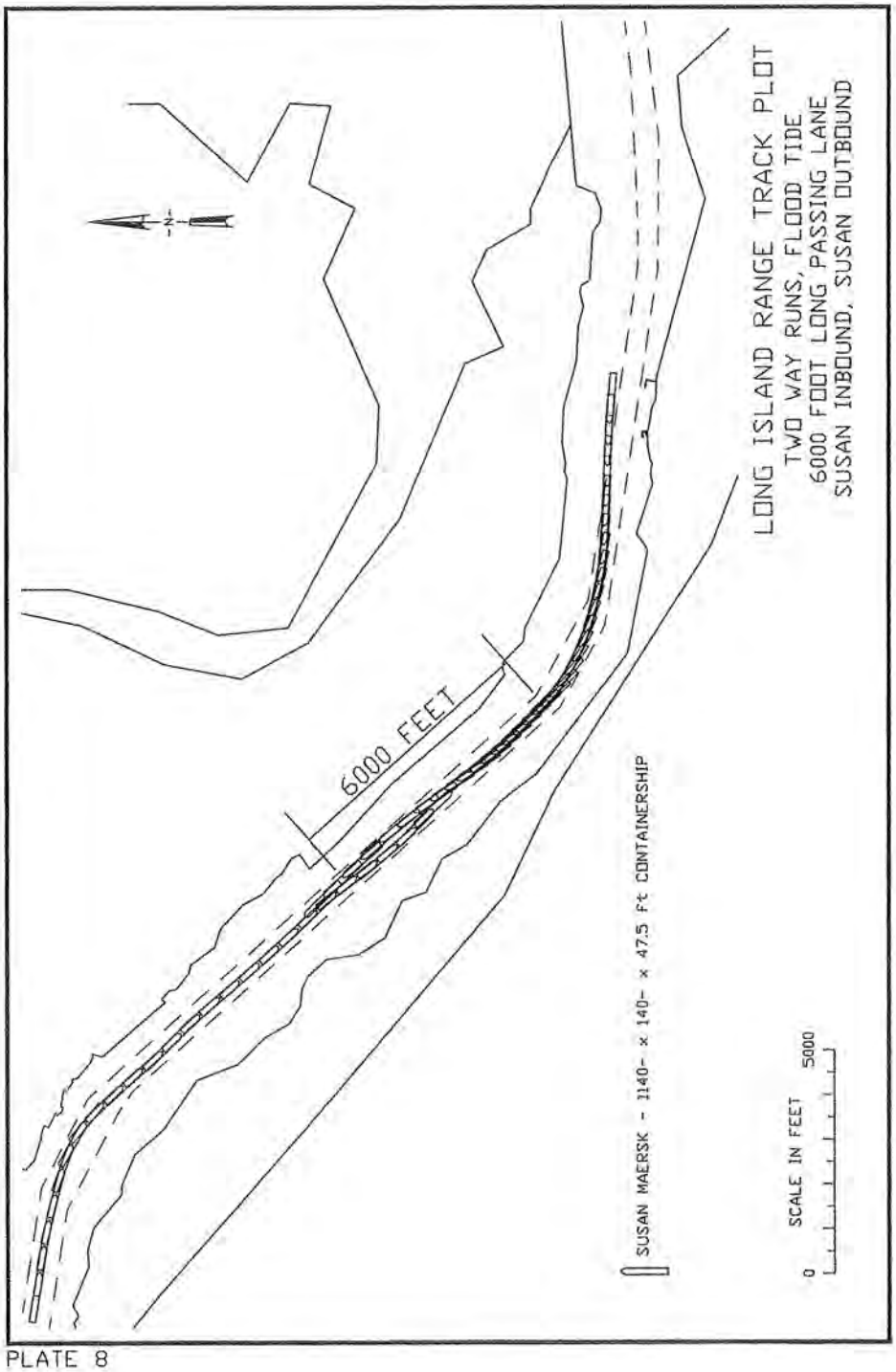

LONG ISLAND RANGE TRACK PLOT
TWO WAY RUNS, FLOOD TIDE
6000 FOOT LONG PASSING LANE
SUSAN INBOUND, SUSAN OUTBOUND
6000 FEET
SUSAN MAERSK - 1140- x 140- x 47.5 Ft CONTAINERSHIP
SCALE IN FEET
0
5000

PLATE 8

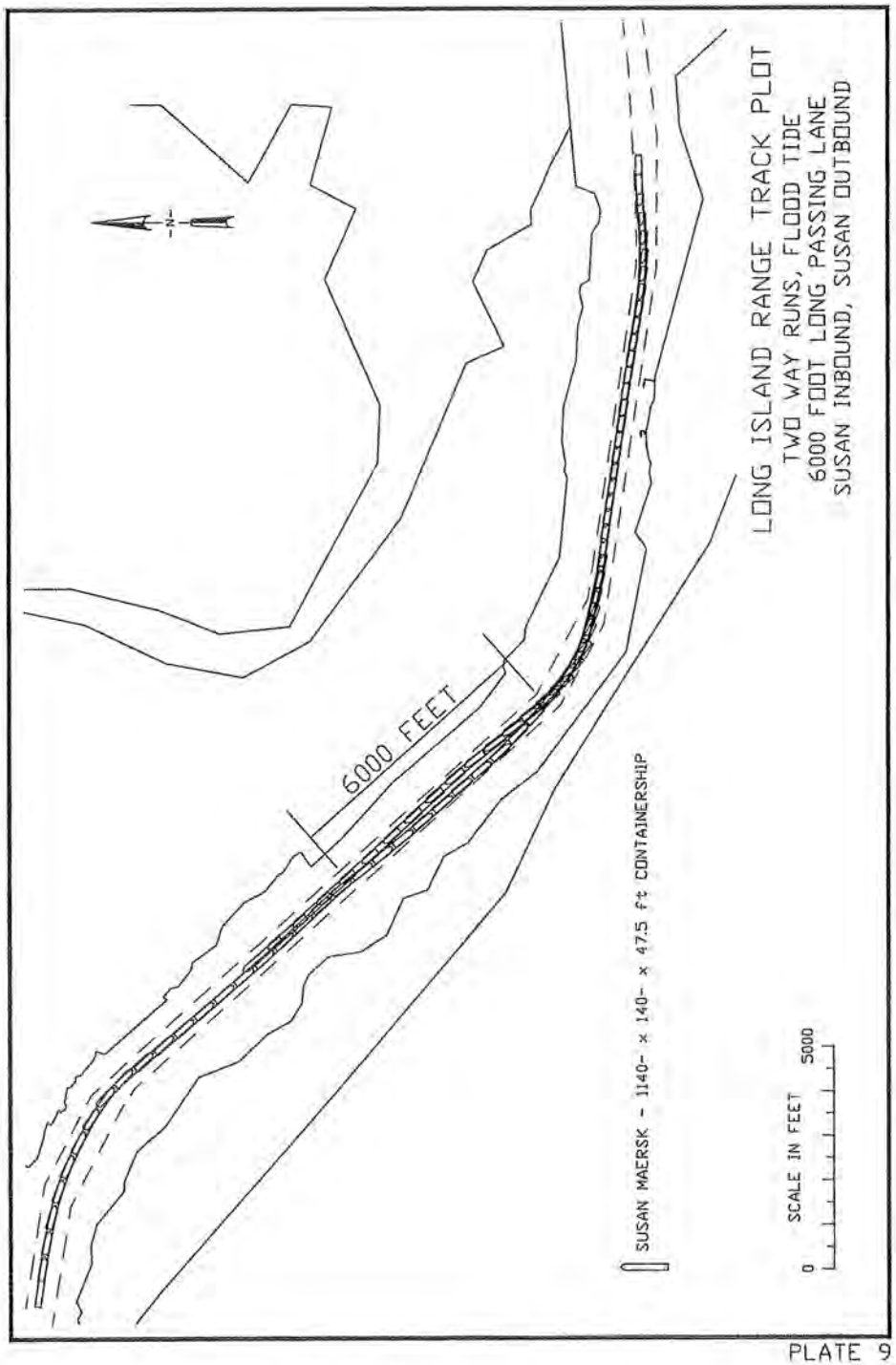

LONG ISLAND RANGE TRACK PLOT
TWO WAY RUNS, FLOOD TIDE
6000 FOOT LONG PASSING LANE
SUSAN INBOUND, SUSAN OUTBOUND
6000 FEET
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
SCALE IN FEET
0
5000

PLATE 9

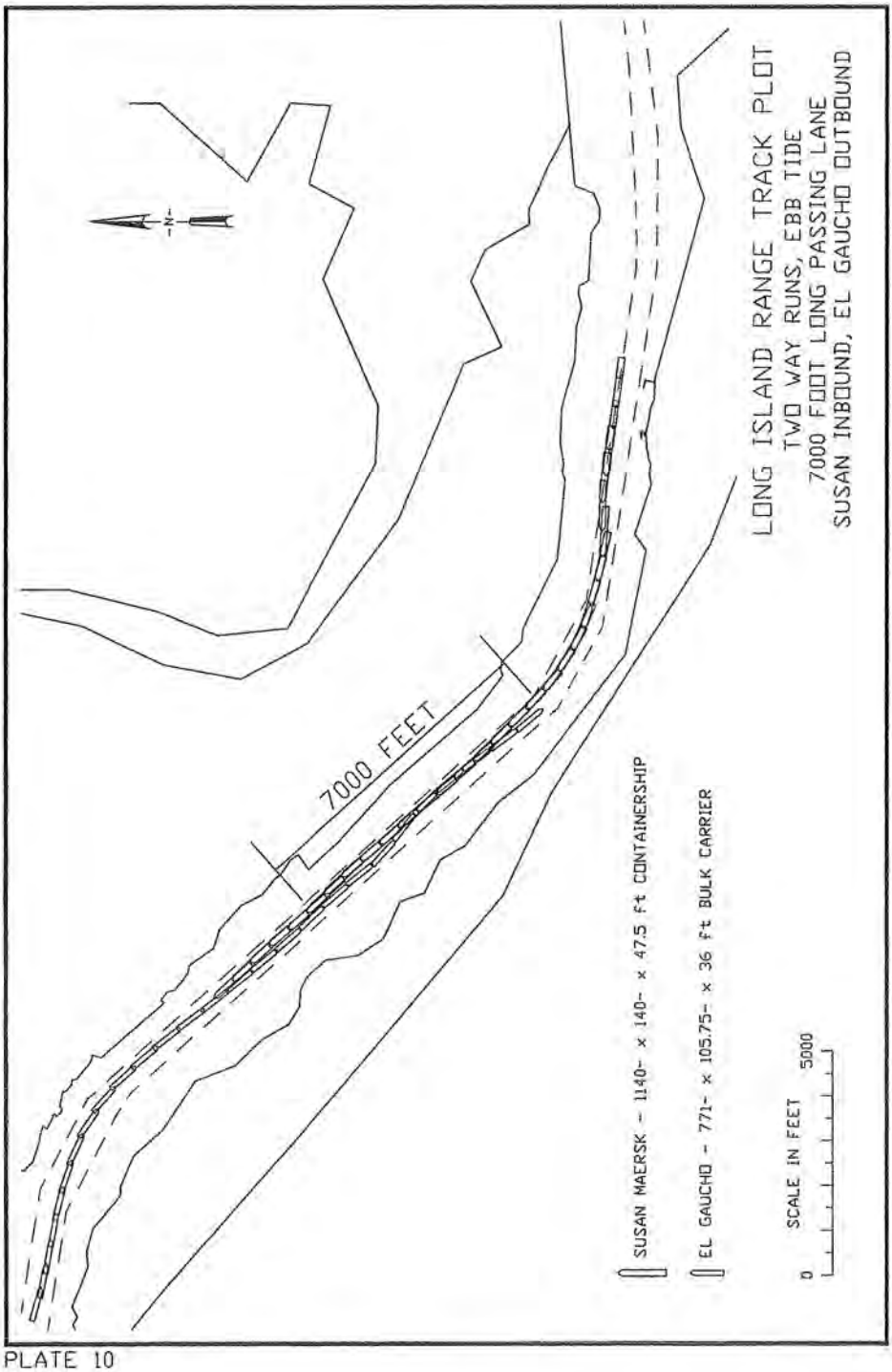

LONG ISLAND RANGE TRACK PLOT
TWO WAY RUNS, EBB TIDE
7000 FOOT LONG PASSING LANE
SUSAN INBOUND, EL GAUCHO OUTBOUND
7000 FEET
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
EL GAUCHO - 771- x 105.75- x 36 ft BULK CARRIER
0
SCALE IN FEET
5000

PLATE 10

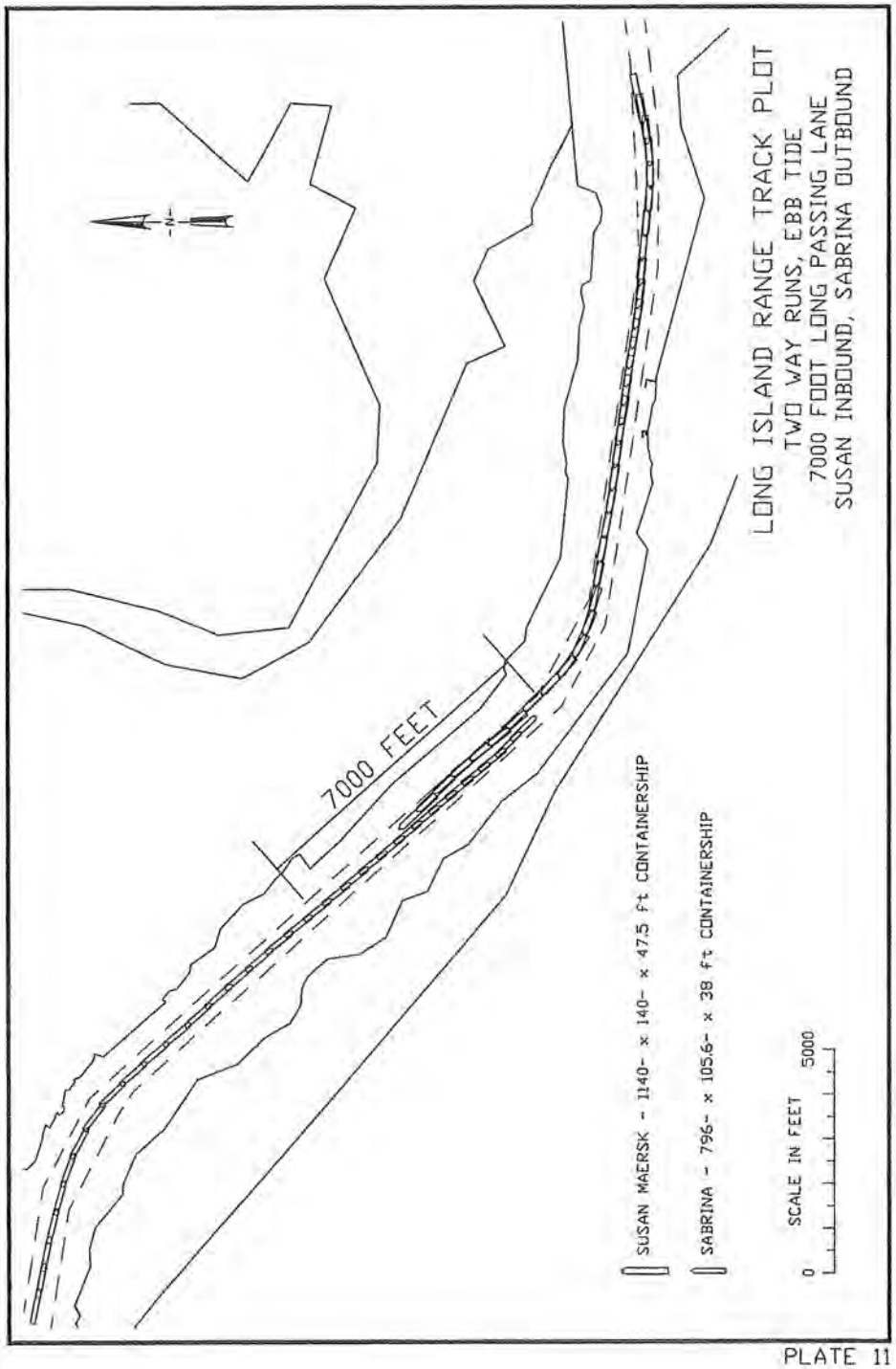

LONG ISLAND RANGE TRACK PLOT
TWO WAY RUNS, EBB TIDE
7000 FOOT LONG PASSING LANE
SUSAN INBOUND, SABRINA OUTBOUND
7000 FEET
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
SABRINA - 796- x 105.6- x 38 ft CONTAINERSHIP
SCALE IN FEET
0
5000

PLATE 11

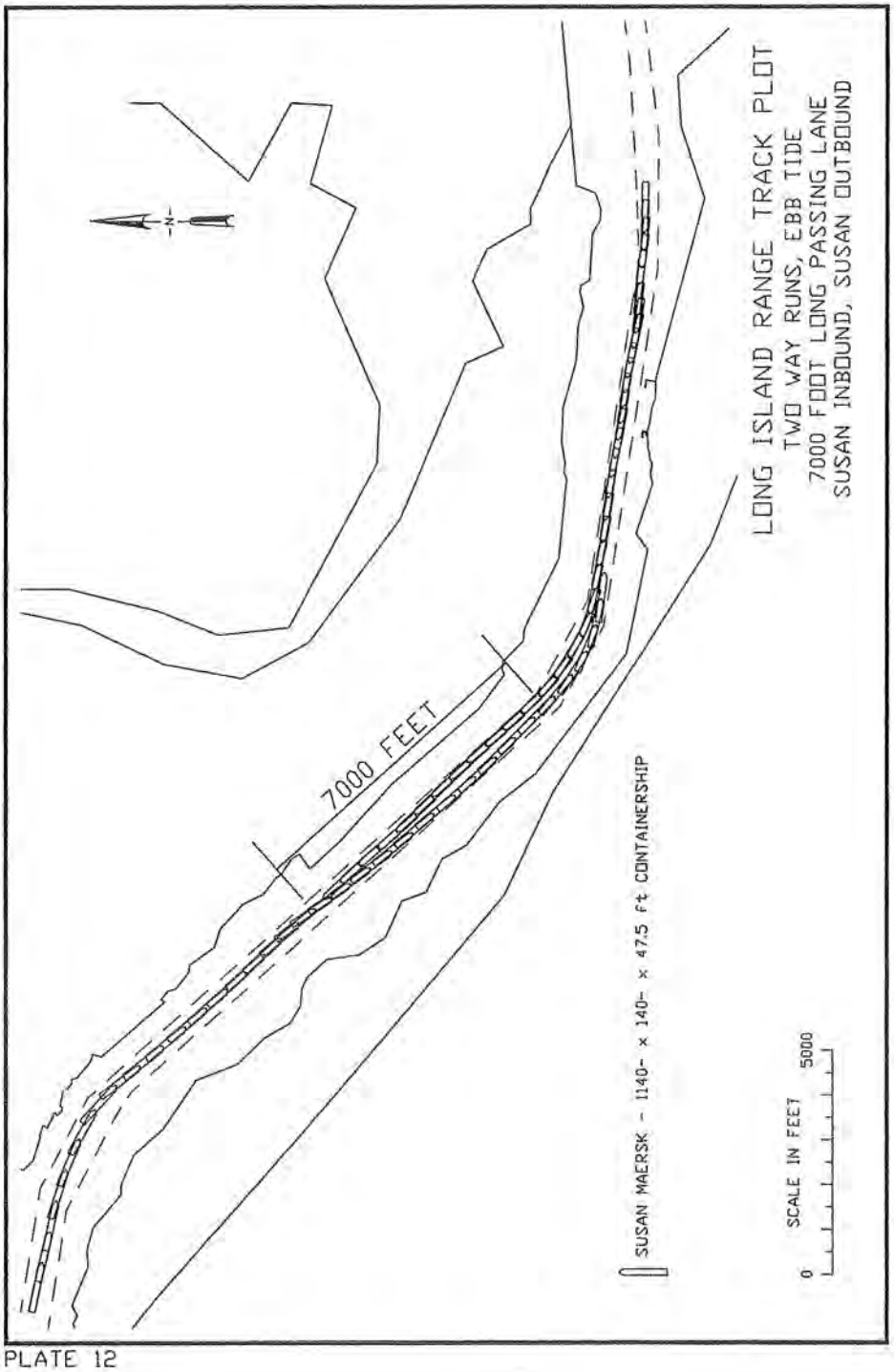

LONG ISLAND RANGE TRACK PLOT
TWO WAY RUNS, EBB TIDE
7000 FOOT LONG PASSING LANE
SUSAN INBOUND, SUSAN OUTBOUND
7000 FEET
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
SCALE IN FEET
0
5000

PLATE 12

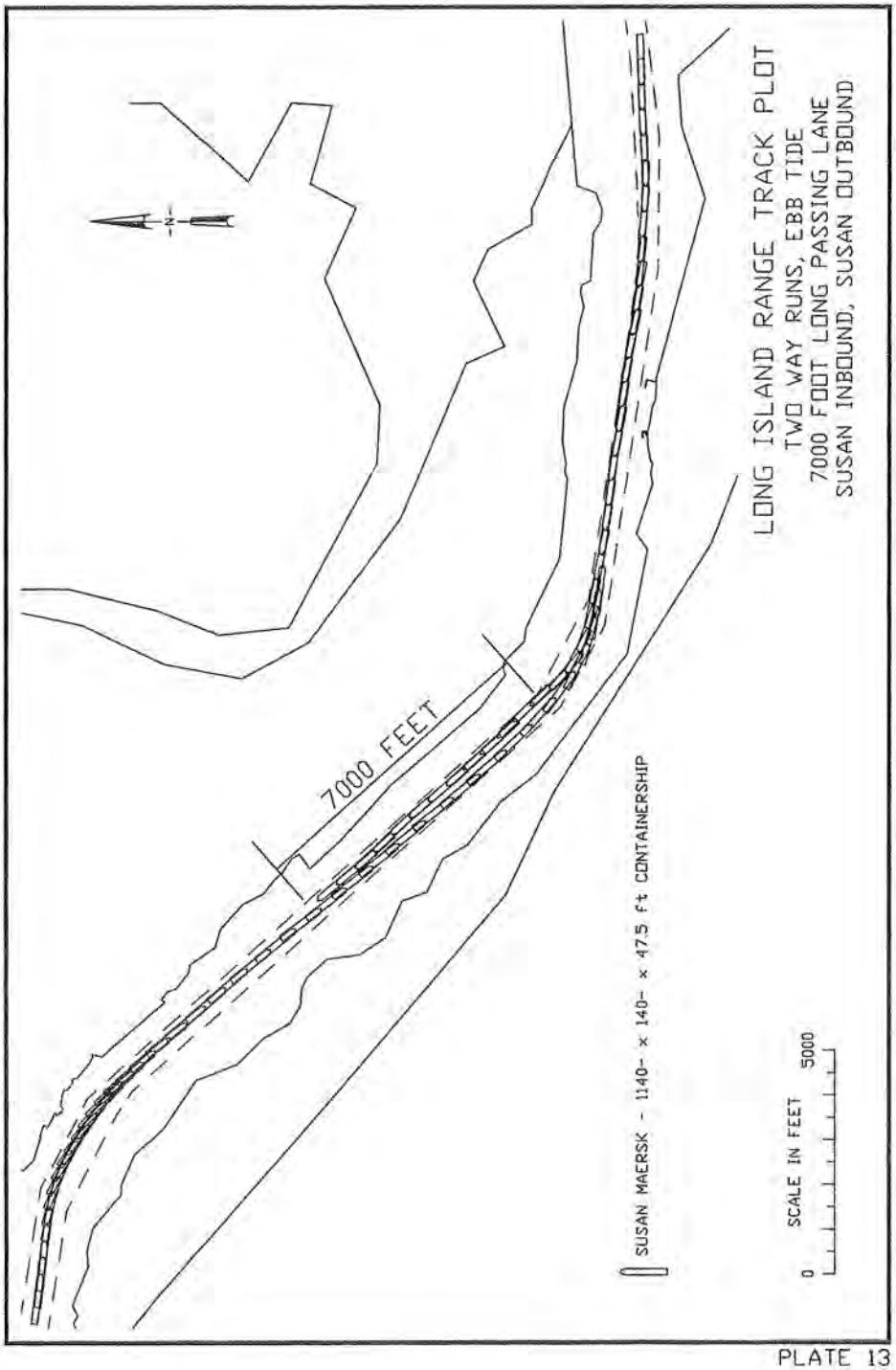

LONG ISLAND RANGE TRACK PLOT
TWO WAY RUNS, EBB TIDE
7000 FOOT LONG PASSING LANE
SUSAN INBOUND, SUSAN OUTBOUND
7000 FEET
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
0 SCALE IN FEET 5000

PLATE 13

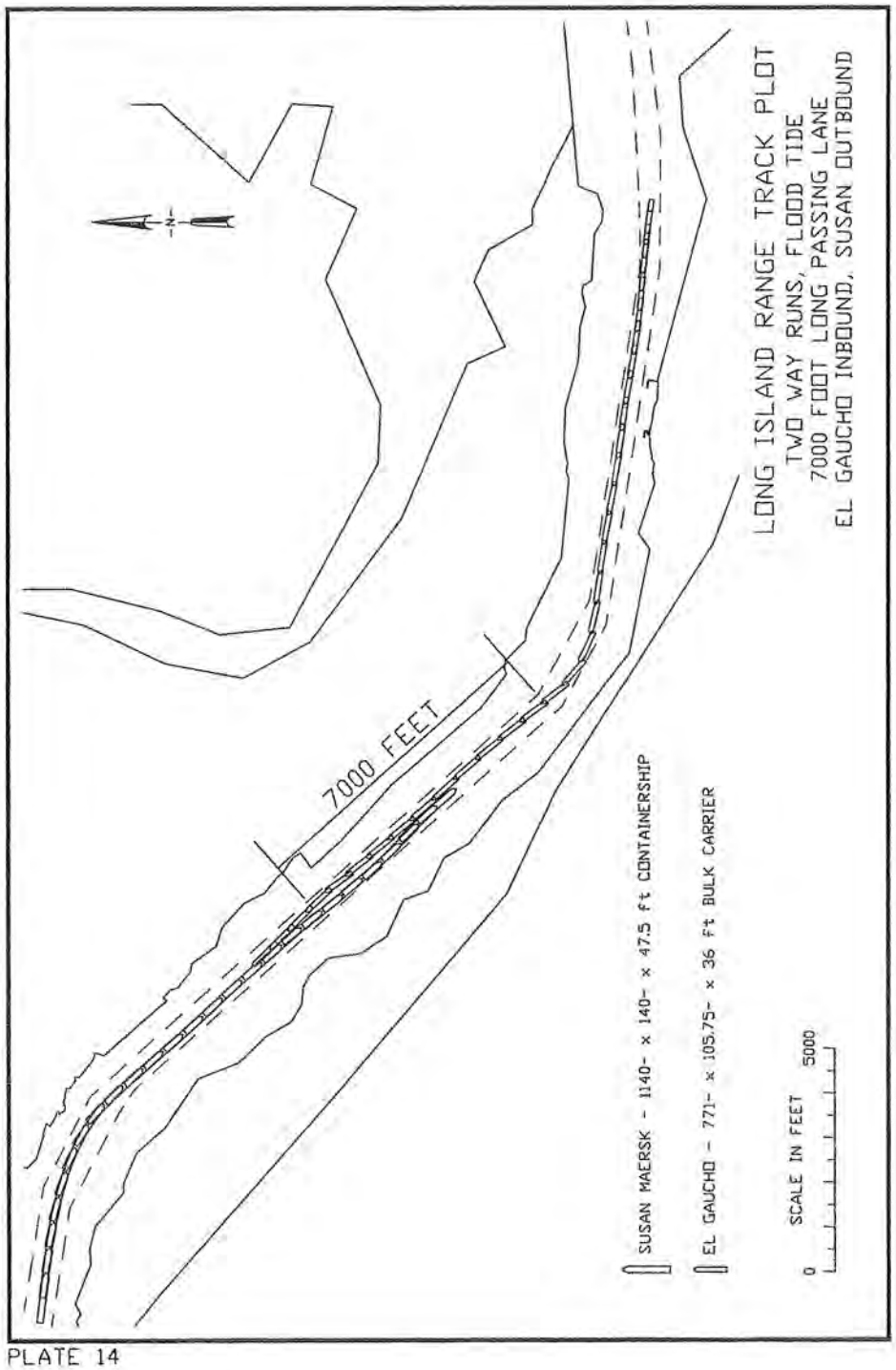

LONG ISLAND RANGE TRACK PLOT
TWO WAY RUNS, FLOOD TIDE
7000 FOOT LONG PASSING LANE
EL GAUCHO INBOUND, SUSAN OUTBOUND
7000 FEET
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
EL GAUCHO - 771- x 105.75- x 36 ft BULK CARRIER
SCALE IN FEET
0
5000

PLATE 14

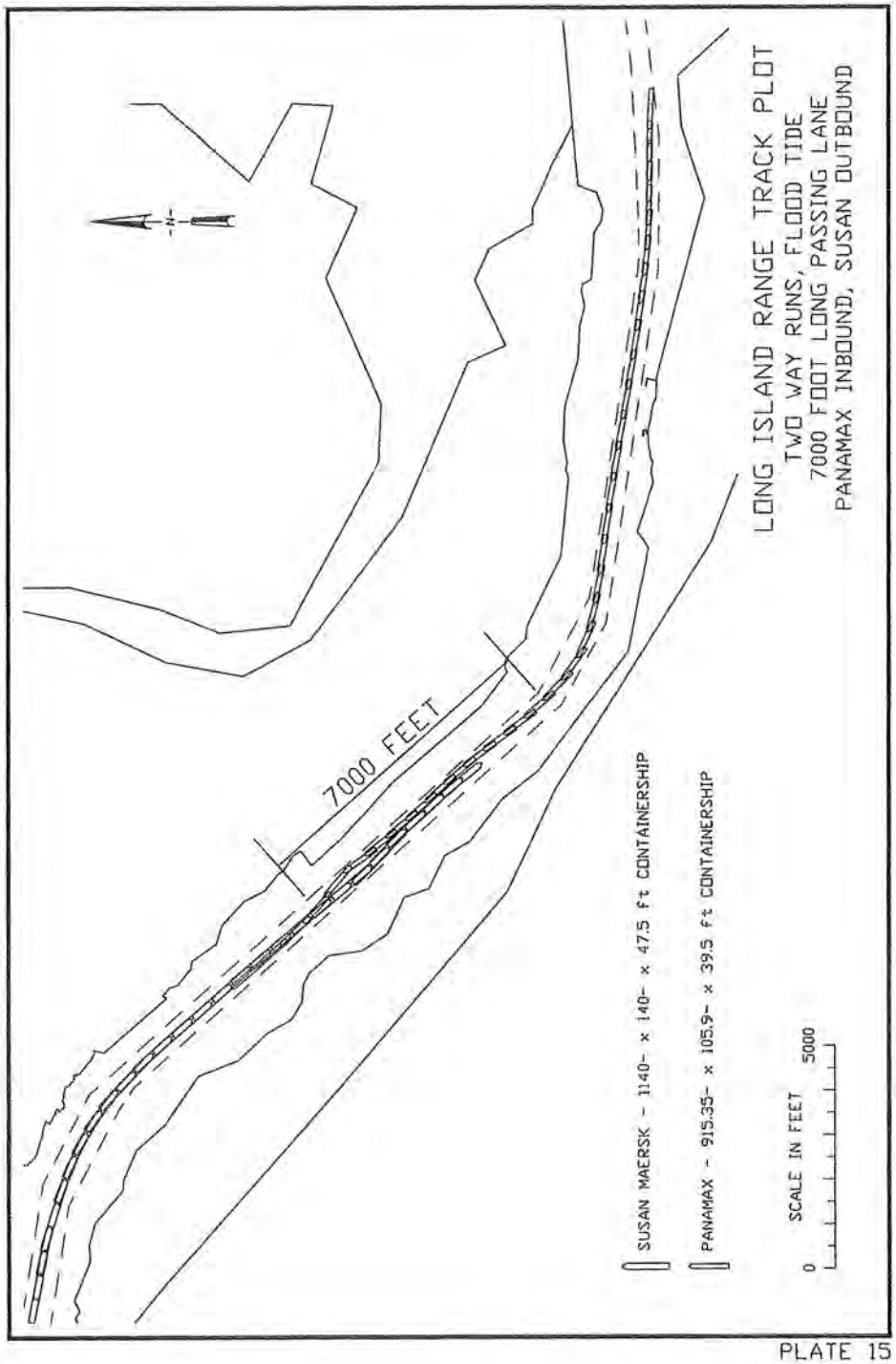

LONG ISLAND RANGE TRACK PLOT
TWO WAY RUNS, FLOOD TIDE
7000 FOOT LONG PASSING LANE
PANAMAX INBOUND, SUSAN OUTBOUND
7000 FEET
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
PANAMAX - 915.35- x 105.9- x 39.5 ft CONTAINERSHIP
0 SCALE IN FEET 5000

PLATE 15

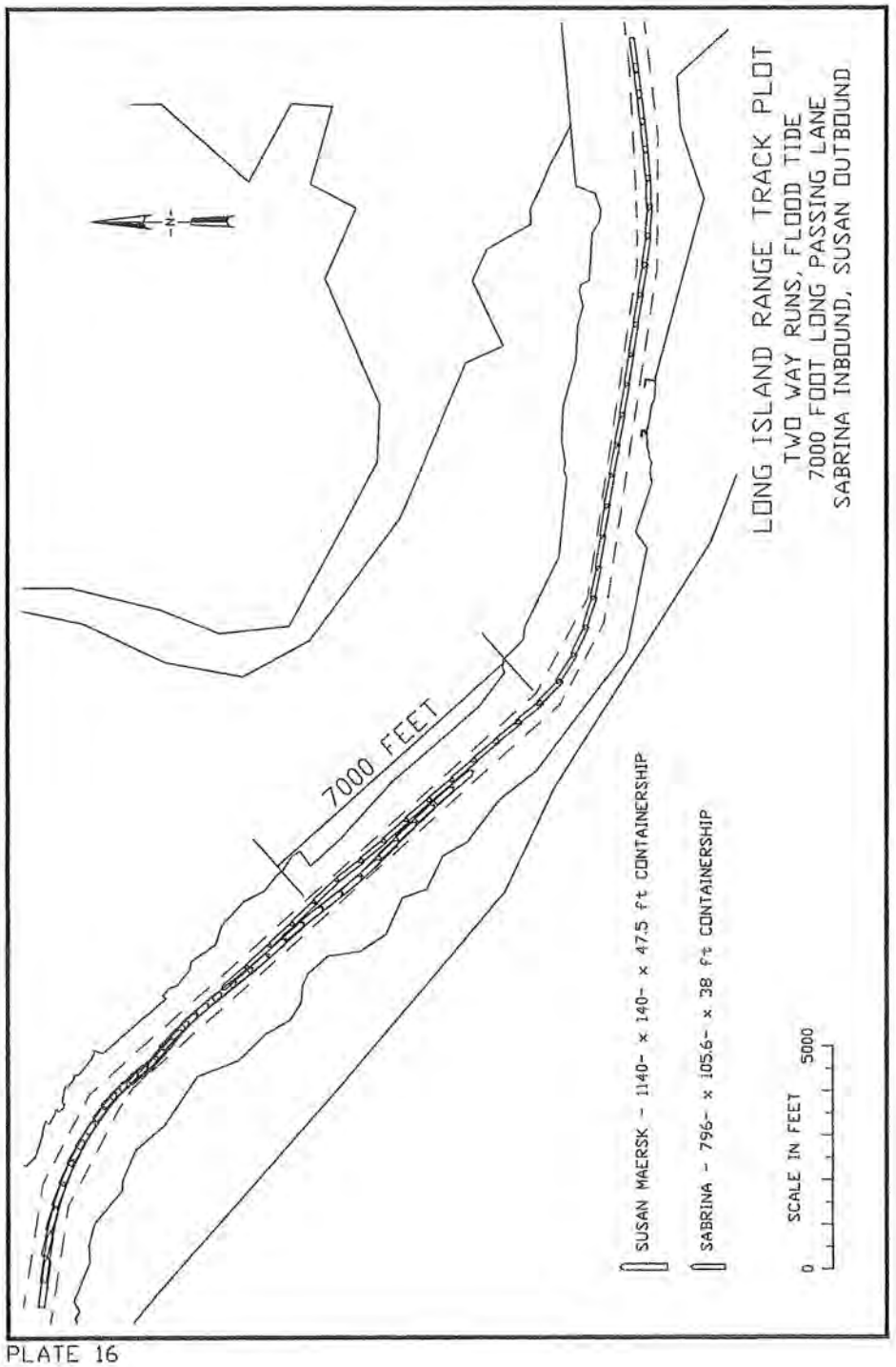

LONG ISLAND RANGE TRACK PLOT
TWO WAY RUNS, FLOOD TIDE
7000 FOOT LONG PASSING LANE
SABRINA INBOUND, SUSAN OUTBOUND
7000 FEET
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
SABRINA - 796- x 105.6- x 38 ft CONTAINERSHIP
SCALE IN FEET
0
5000

PLATE 16

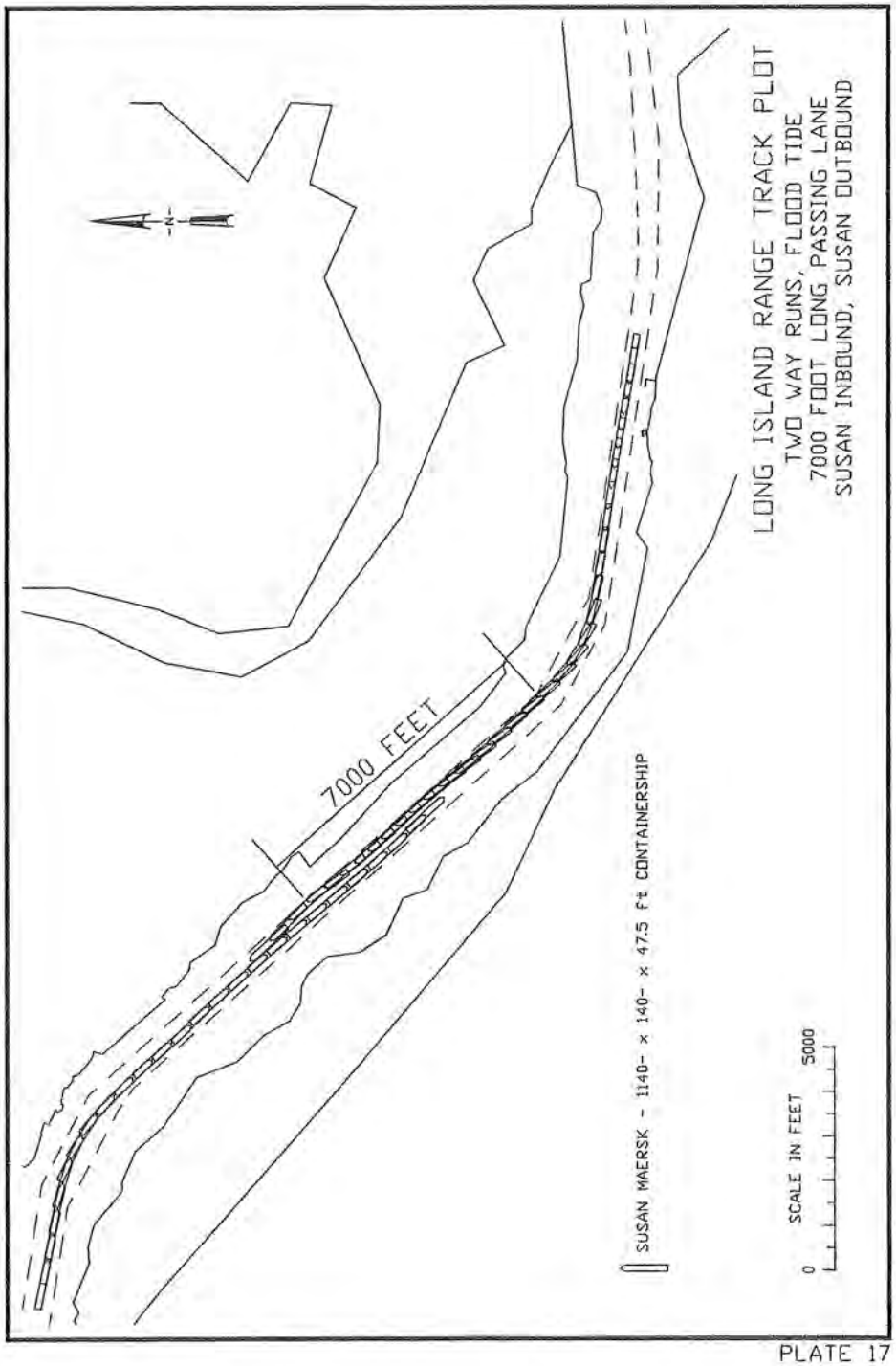

LONG ISLAND RANGE TRACK PLOT
TWO WAY RUNS, FLOOD TIDE
7000 FOOT LONG PASSING LANE
SUSAN INBOUND, SUSAN OUTBOUND
7000 FEET
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
0 SCALE IN FEET 5000

PLATE 17

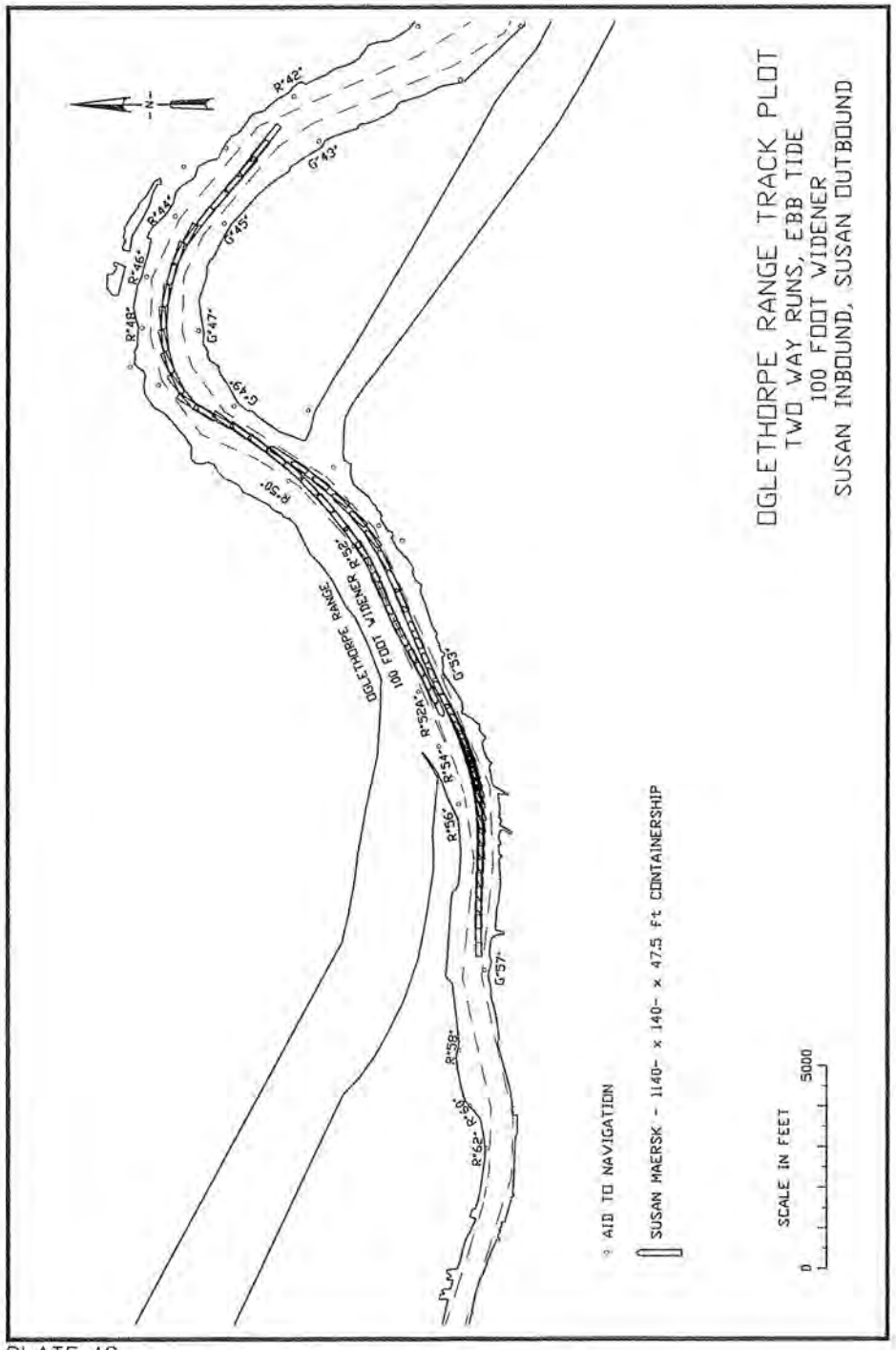
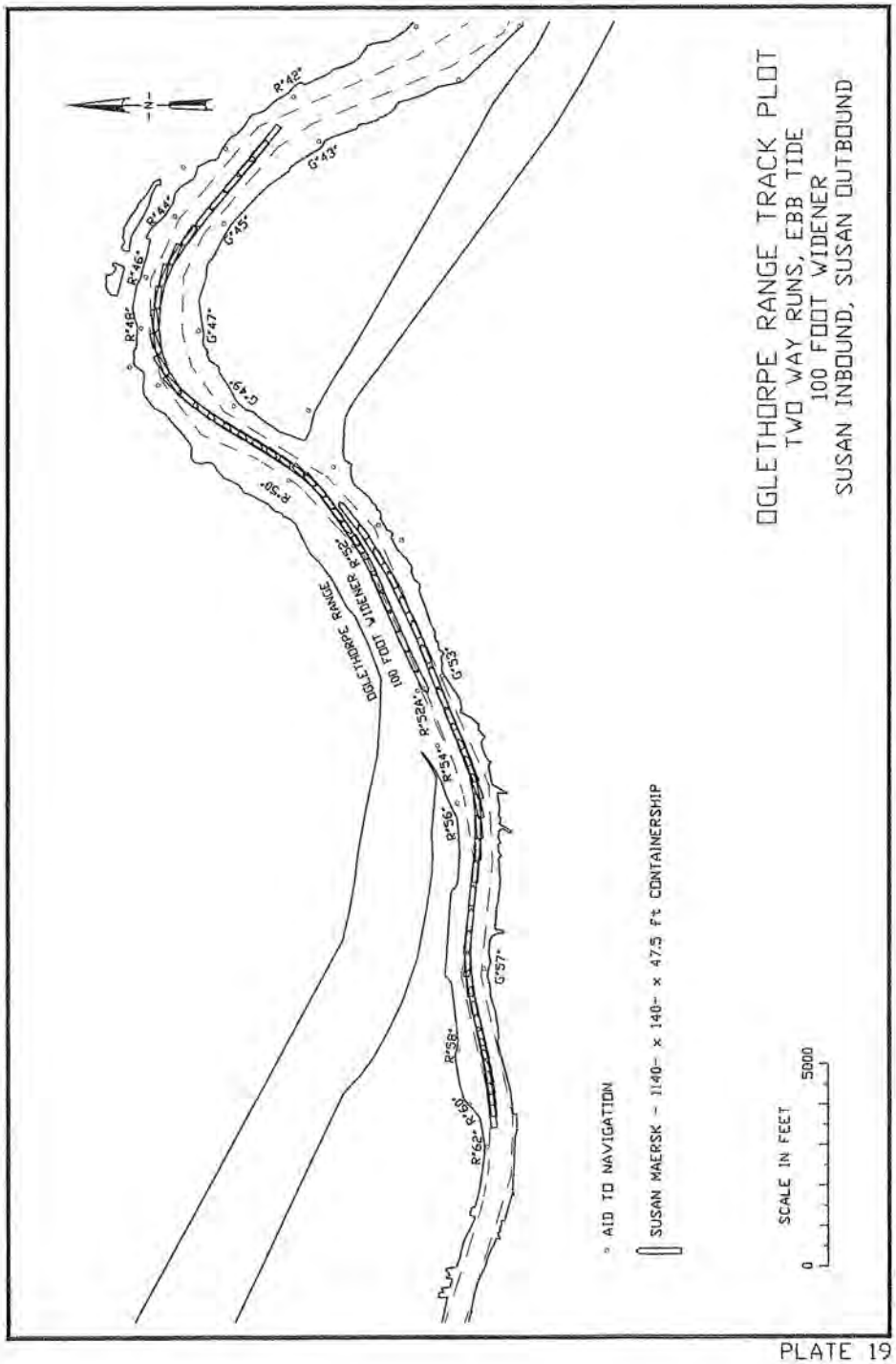

OGLETHORPE RANGE TRACK PLOT
TWO WAY RUNS, EBB TIDE
100 FOOT WIDENER
SUSAN INBOUND, SUSAN OUTBOUND
OGLETHORPE RANGE
100 FOOT WIDENER
R"42"
G"43"
R"44"
R"46"
G"45"
R"48"
G"47"
G"49"
R"50"
R"52"
G"53"
R"54"
R"56"
G"57"
R"58"
R"60"
R"62"
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 Ft CONTAINERSHIP
SCALE IN FEET
0
5000

PLATE 18


OGLETHORPE RANGE TRACK PLOT
TWO WAY RUNS, EBB TIDE
100 FOOT WIDENER
SUSAN INBOUND, SUSAN OUTBOUND
OGLETHORPE RANGE
100 FOOT WIDENER
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 Ft CONTAINERSHIP
SCALE IN FEET
0
5000
PLATE 19

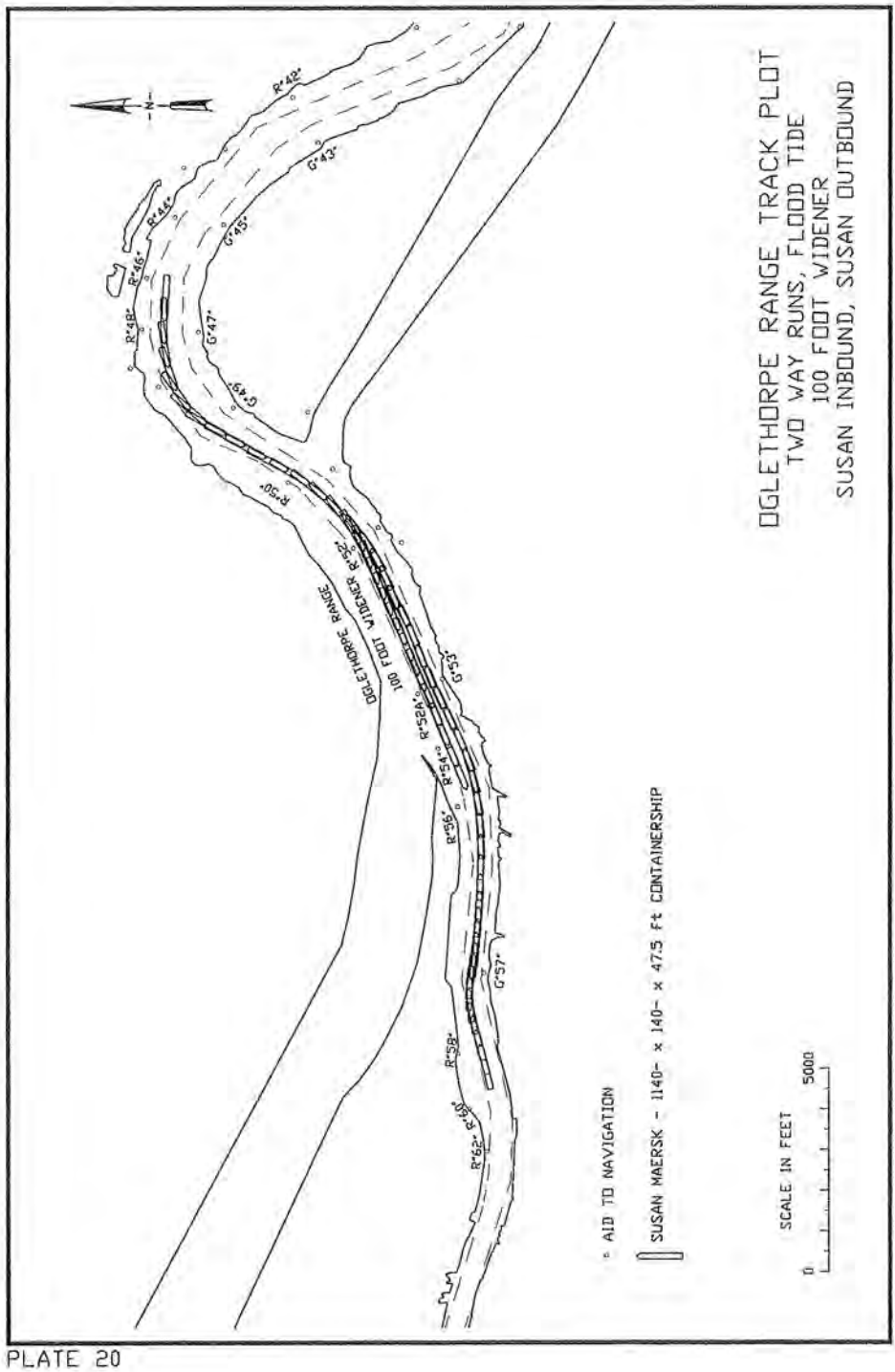

OGLETHORPE RANGE TRACK PLOT
TWO WAY RUNS, FLOOD TIDE
100 FOOT WIDENER
SUSAN INBOUND, SUSAN OUTBOUND
OGLETHORPE RANGE
100 FOOT WIDENER
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
SCALE IN FEET
0
5000

PLATE 20

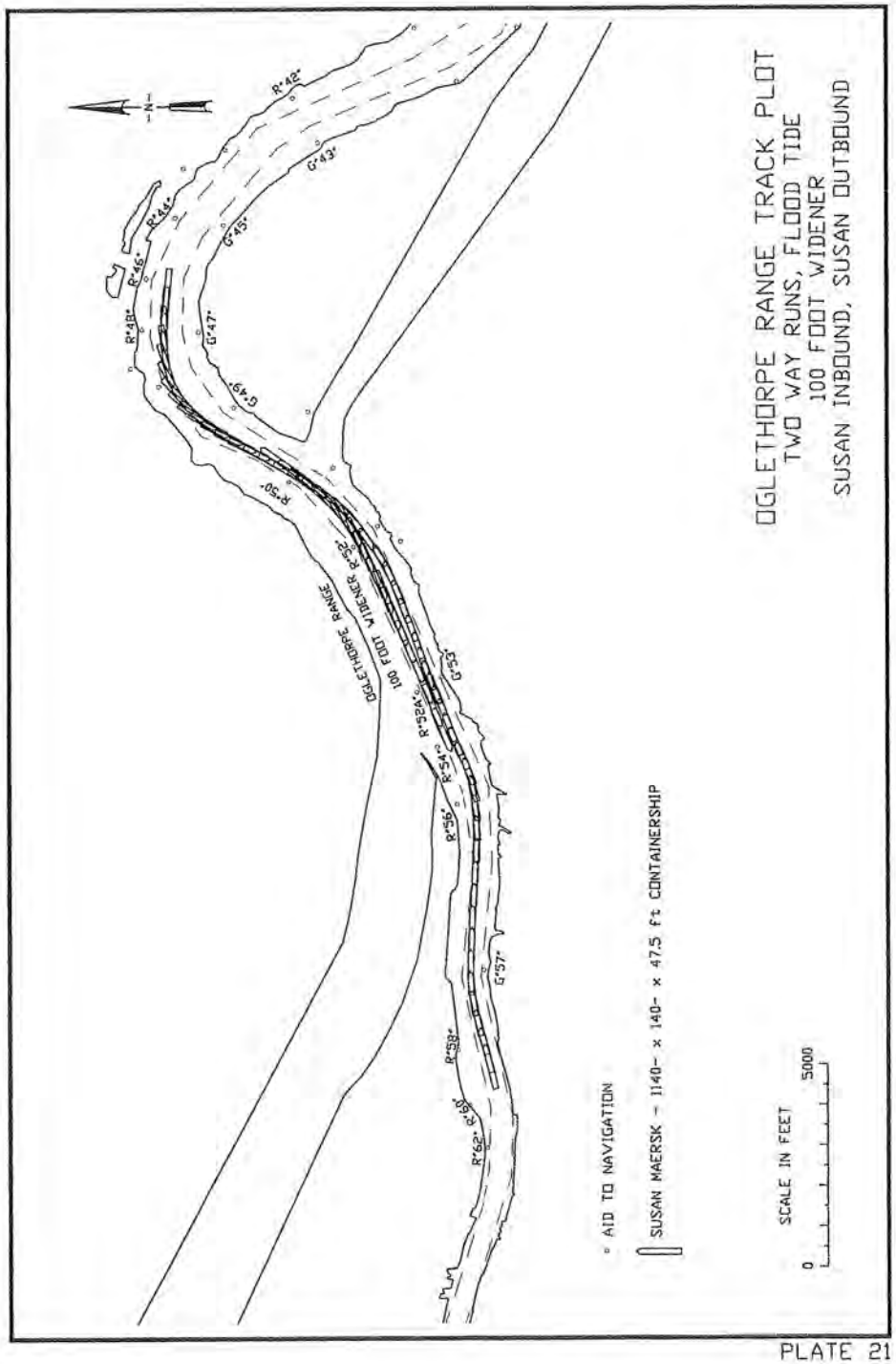

OGLETHORPE RANGE TRACK PLOT
TWO WAY RUNS, FLOOD TIDE
100 FOOT WIDENER
SUSAN INBOUND, SUSAN OUTBOUND
N
R°48'
R°46'
R°44'
R°42'
G°43'
G°45'
G°47'
G°49'
R°50'
R°52'
R°54'
R°56'
R°58'
R°60'
R°62'
G°53'
G°55'
G°57'
OGLETHORPE RANGE
100 FOOT WIDENER
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
SCALE IN FEET
0
5000

PLATE 21

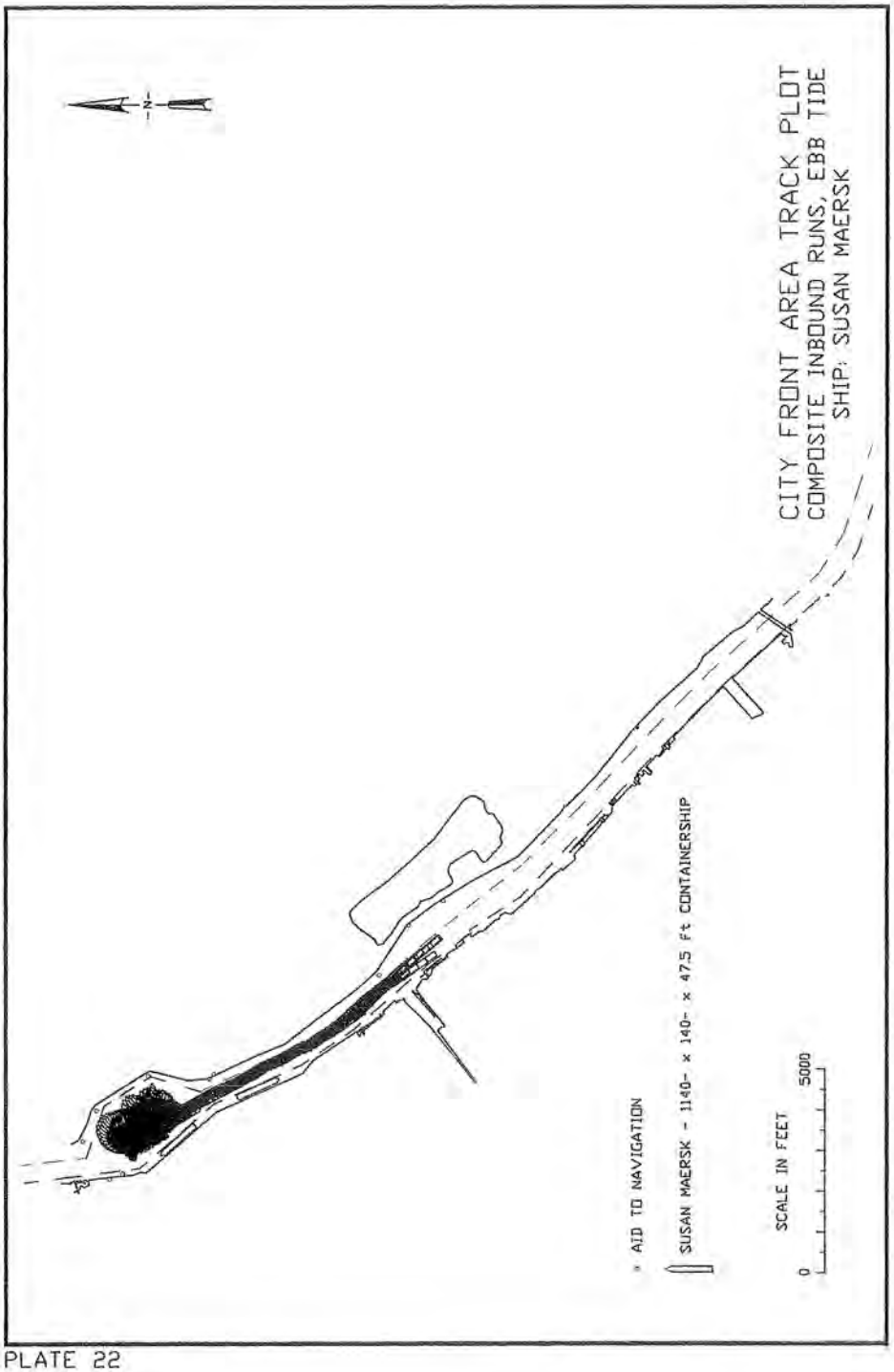

CITY FRONT AREA TRACK PLOT
COMPOSITE INBOUND RUNS, EBB TIDE
SHIP: SUSAN MAERSK
N
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
AID TO NAVIGATION
SCALE IN FEET
0
5000

PLATE 22

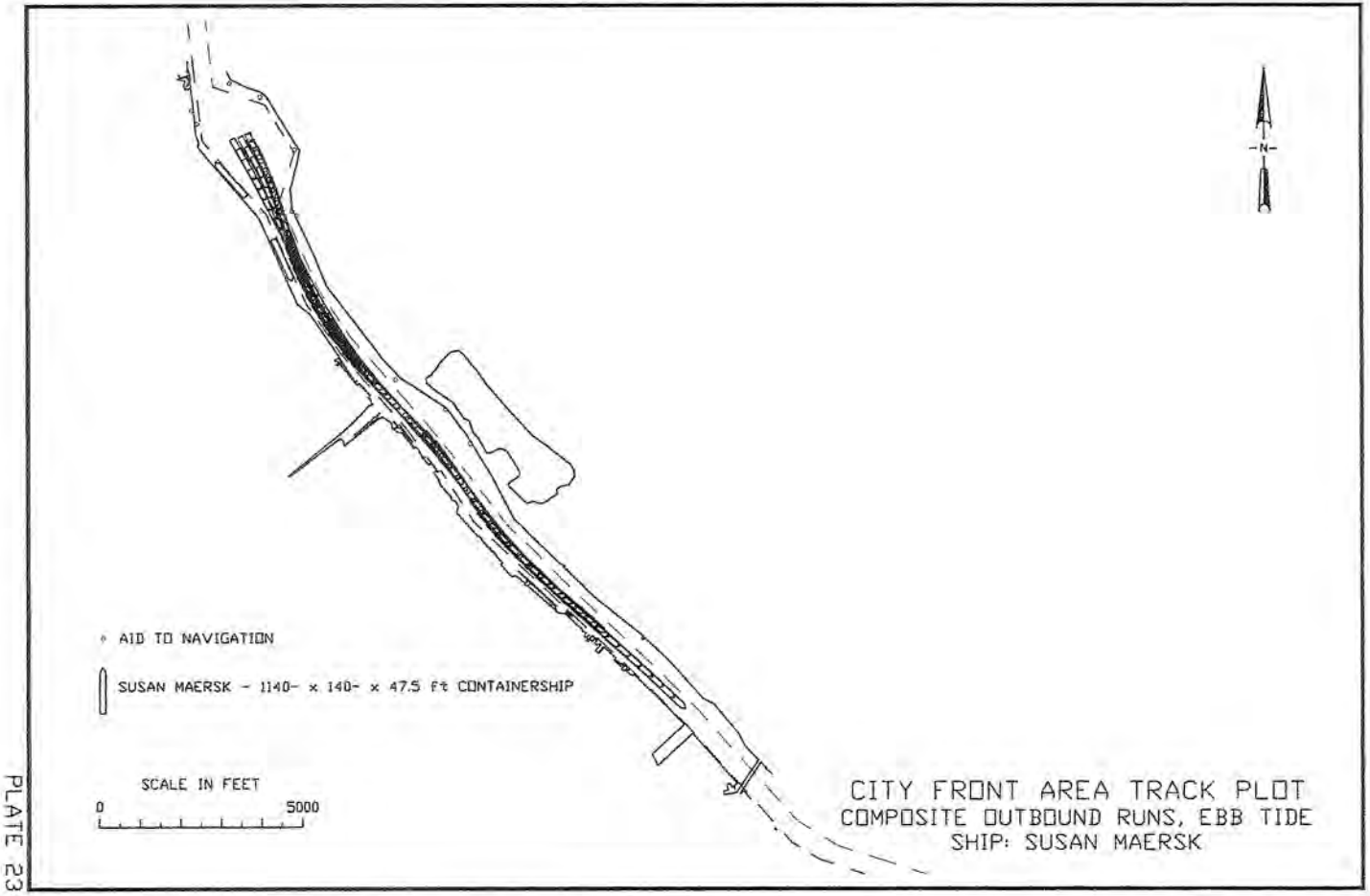

N
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
SCALE IN FEET
0
5000
CITY FRONT AREA TRACK PLOT
COMPOSITE OUTBOUND RUNS, EBB TIDE
SHIP: SUSAN MAERSK

PLATE 23

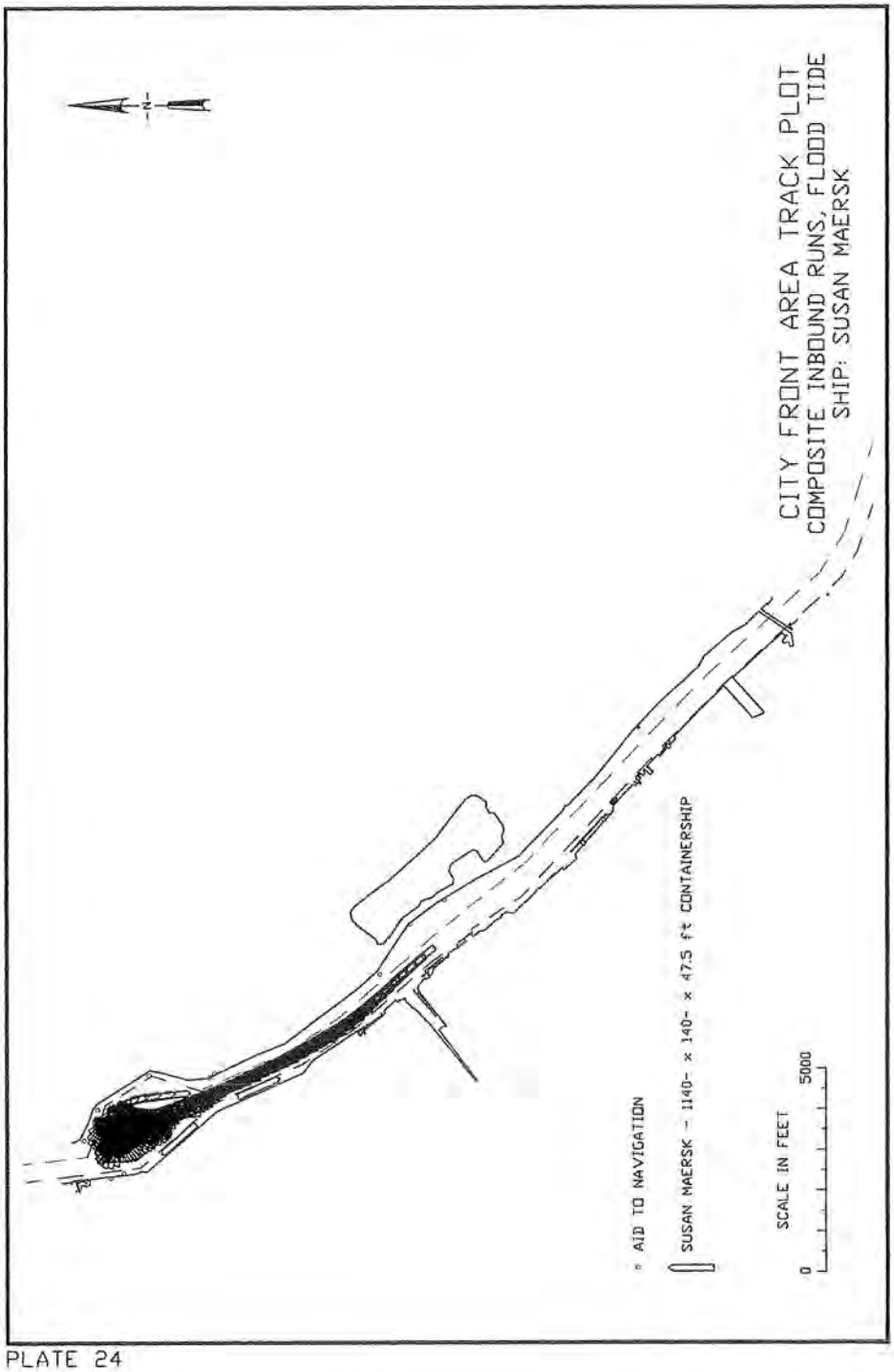

CITY FRONT AREA TRACK PLOT
COMPOSITE INBOUND RUNS, FLOOD TIDE
SHIP: SUSAN MAERSK
N
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
SCALE IN FEET
0
5000

PLATE 24

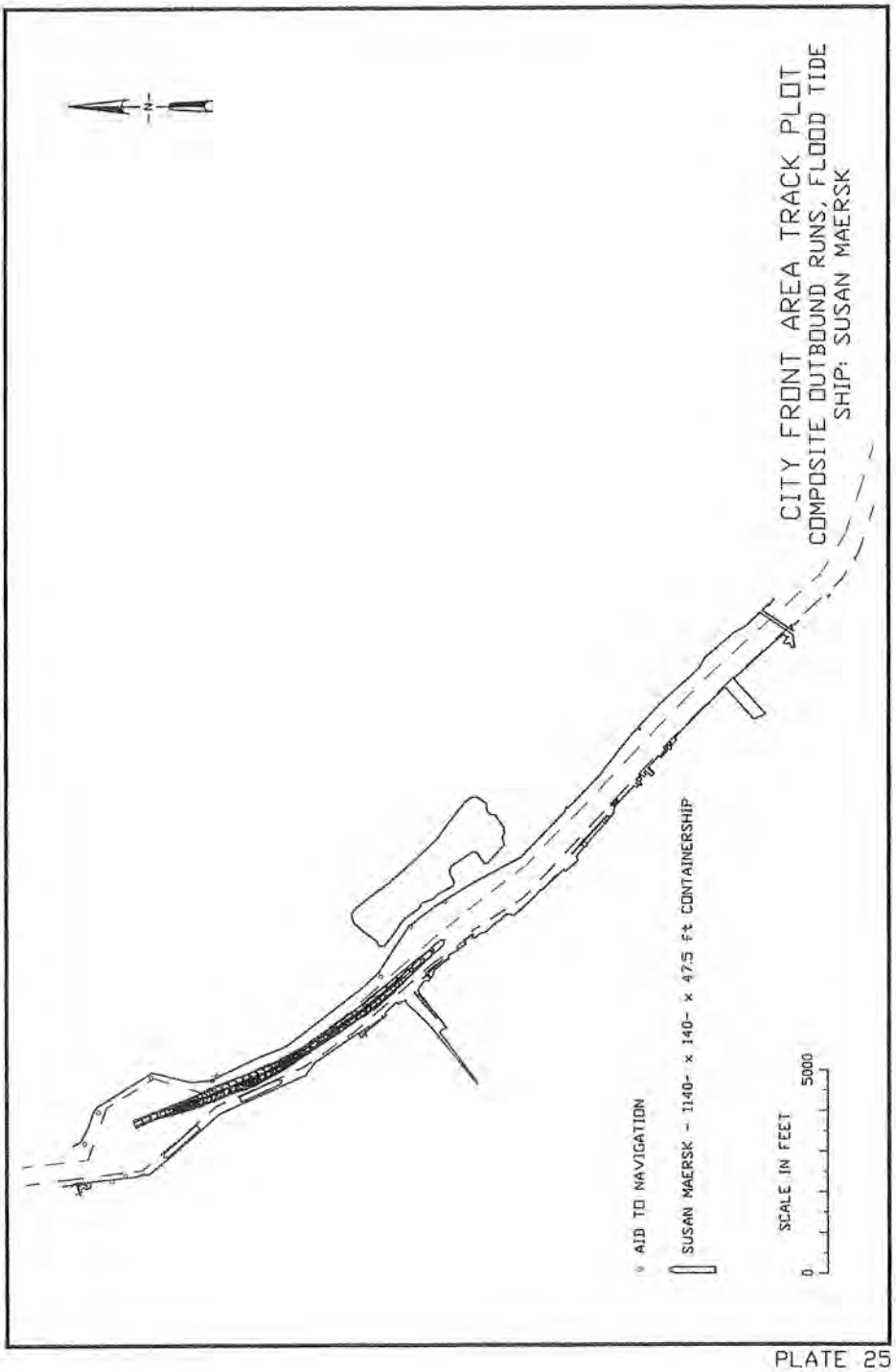

CITY FRONT AREA TRACK PLOT
COMPOSITE OUTBOUND RUNS, FLOOD TIDE
SHIP: SUSAN MAERSK
N
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
SCALE IN FEET
0
5000

PLATE 25

Date 1-22-09 Pilot: Rick Wesley

1. How long a distance does the physics of two ships meeting require? This is the minimum distance required for two ships to meet.

There are many factors that contribute to this, none of which a minimum. Speed, draft, current, weather etc. However in this study with the Susan Maersk the minimum should be 3 x the length of each vessel. 1100 x 3 3300 + 3300 = 6600 ft, in a perfect scenario.

2. What circumstances require the passing lane be longer than the distance given as the answer to question 1.

Speed, weather, draft, width of channel, handling characteristics of vessel, Beam,

Questions 3 – 5 pertain to Long Island Range.

3. Was the 500ft passing range adequate, or is 600ft necessary?

No. Minimum 6600 ft.!

Date JAN 16, 2009 Pilot: ROB KING

1. How long a distance does the physics of two ships meeting require? This is the minimum distance required for two ships to meet. BASED ON SIMULATOR WORK, THE REQUIRED DISTANCE FOR TWO SHIPS TO SAFELY MEET IS AT A MINIMUM 3,0000 FT. THIS, HOWEVER, DOES NOT TAKE INTO ACCOUNT THE SAFE PRACTICE OF SETTING UP TO MEET MORE THAN 1 SHIP LENGTH AWAY. MY PERSONAL VIEW ON THIS, BASED UPON PROFESSIONAL EXPERIENCE, IS ABOUT 6,0000 FT.

2. What circumstances require the passing lane be longer than the distance given as the answer to question 1. THE MAIN CONSIDERATION IS TIME. A ONE-MINUTE CHANGE IN THE TIMING OF TWO MEETING SHIPS, CHANGES THE MEETING ZONE BY 1,0000 FT. THERE ARE ALMOST ALWAYS CIRCUMSTANCES BEYOND A PILOT'S CONTROL THAT CAN CHANGE TIMING BY UP TO 45 MINUTES.

Questions 3 – 5 pertain to Long Island Range.

3. For Long Island Range, how long of a passing lane is required for safe two-way traffic of a post-panamax and a panamax ship? MY RECOMMENDATION IS FOR A MINIMUM OF 9,0000 FT.

4. Are there any improvements, such as ATONS, that could reduce that distance?

No.

5. Should the passing range be on the south end of the range, the middle, or the north end?

IDEALLY, THE ENTIRE RANGE SHOULD BE USED. IF THAT IS NOT POSSIBLE, LOCATING THE PASSING LANE ON THE SOUTHERN END WOULD PROBABLY PROVIDE FOR THE SAFEST, MOST CONVENIENT TRANSIT.

Questions 6 - 8 pertain to Oglethorpe Range

6. For Oglethorpe Range, how long of a passing lane is required for safe two-way traffic of a post-panamax and a panamax ship? FROM BUOY 50 TO 54.

7. Are there any improvements, such as ATONS, that could reduce that distance?

No.

8. Should the passing range be on the west end of the range, the middle, or the east end?

ONCE AGAIN, I PENCIL THE ENTIRETY OF THE RANGE, BUT ON THE EAST END IF THE AFOREMENTIONED IS NOT POSSIBLE.

Questions 9 - 11 pertain to the Marsh Island Channel

9. Did narrowing the west side channel to increase the berthing area make the transit more difficult?

NO.

10. If the answer in 9 was "yes," do you still consider the transit safe to make?

11. Are there any improvements, such as ATONS, that could make this transit safer?

NO, BUT ALLOWING THE SAME AMOUNT OF CHANNEL BEING TAKEN AWAY TO BE GIVEN BACK ON THE OPPOSITE SIDE OF THE RIVER WOULD MAKE THIS A MOOT POINT WITH SAFETY BEING MAINTAINED BOTH FOR MOORED & TRANSITTING VESSELS.

12. Other comments on this simulation study?

WHILE THERE IS A LARGE DIFFERENCE IN THE RECOMMENDED LENGTH OF PASSING LANES BETWEEN LONG ISLAND RANGE & OGLETHORPE RANGE, IT SHOULD BE NOTED THAT GREATER TRANSIT SPEEDS ON LONG ISLAND NECESSITATE A LONGER ZONE. THE MOST IMPORTANT FACTOR IN BOTH CASES IS TIMING. SINCE THERE IS NO WAY TO ADDRESS ALL OF THE EVENTS THAT AFFECT A PILOT'S TIMING, GIVING MORE ROOM FOR PILOTS TO MANUVER IS THE SAFEST ROUTE.

AS FAR AS THE MARSH ISLAND PROJECT IS CONCERNED, REDRAWING LINES DOESN'T MAKE A DIFFERENCE IN THE ACTUAL PILOTING. IT DOES, HOWEVER, TAKE US INTO LEGAL REALMS THAT WE MAY NOT WISH TO VISIT.

(THADENCE@GMAIL.COM)

Date 1-16-09 Pilot: John P. Ebbenwein

1. How long a distance does the physics of two ships meeting require? This is the minimum distance required for two ships to meet.

In determining this minimum requirement you must consider factors such as size of the ship and outside factors such as wind, current and location in the channel. The minimum required based on the simulations run this week would be approximately 3 ship lengths.

2. What circumstances require the passing lane be longer than the distance given as the answer to question 1.

Typically in a transit upon the river a ship will be arranging more than one passing during it's transit. Timing plays an important role in making sure the two vessels meet where they need to.

Questions 3 – 5 pertain to Long Island Range.

3. For Long Island Range, how long of a passing lane is required for safe two-way traffic of a post-panamax and a panamax ship?

In reality it would be ideal to ~~length~~ widen the full length of Long Island to eliminate a bottleneck effect within the length that exists. In manipulating vessels with simulation we were able to pass vessels safely within approximately 9000 ft of passing lane.

4. Are there any improvements, such as ATONS, that could reduce that distance?

ATONS assist us in providing info to boundaries but would not be a factor in reducing the distance needed for passing

5. Should the passing range be on the south end of the range, the middle, or the north end?

In my opinion, South end.

Questions 6 - 8 pertain to Oglethorpe Range

6. For Oglethorpe Range, how long of a passing lane is required for safe two-way traffic of a post-panamax and a panamax ship?

In simulation we were unable to run this scenario. The suggestion would be from Buoy 50 to buoy 54 but timing here is critical.

7. Are there any improvements, such as ATONS, that could reduce that distance?

NO

8. Should the passing range be on the west end of the range, the middle, or the east end?

East end

Questions 9 - 11 pertain to the Marsh Island Channel

9. Did narrowing the west side channel to increase the berthing area make the transit more difficult?

NO it does not seem to be more difficult in simulation but will place ships ~~with have on ships proceeding~~ very near the edge of the channel. The ideal situation would be to move the proposed line 50ft. on the berth side and on the opposite side dredge 50ft. to allow for less effect on moored vessels.

10. If the answer in 9 was "yes," do you still consider the transit safe to make?

The answer is yes but we were unable to realize the effects of moored vessels in simulation with a ship that is post-panamax size.

11. Are there any improvements, such as ATONS, that could make this transit safer?

NO

12. Other comments on this simulation study?

The simulator in many ways allowed us to practice passing ships within the proposed channel modifications safely. There are factors that exist in reality that obviously can not be simulated. On Long Island I believe a dredging of the full length would provide ships with the safest scenario for passing post-panamax vessels. If that is not feasible then we will pass within the proposed passing lane but I would anticipate more manipulation of transit times and possible delays to larger vessels.

The simulation on Bayethorpe is hard to comment on due to problems with the simulator and the fact that we were unsuccessful in completing a passing in this area.

Kings Island proposal is to prevent ships alongside from resting in the navigable channel. This may also mean at times ships transiting that area may move outside the navigable channel.

Thank you for the opportunity to work on this study and to the staff in Vicksburg for their hospitality! Please feel free to contact me:
ebberwein@aol.com

Date 1/23/09 Pilot: TREY THOMPSON

1. How long a distance does the physics of two ships meeting require? This is the minimum distance required for two ships to meet.

I BELIEVE SHIPS BEGIN AFFECTING EACH OTHER TWO TO THREE SHIP LENGTHS APART AND CONTINUE UNTIL ONE TO TWO SHIP LENGTHS AFTER CLEARING EACH OTHER. SO FOR A SHIP ~~OF~~ WITH A LOA OF 1000', THE VERY MINIMUM WOULD BE AROUND 6000'.

2. What circumstances require the passing lane be longer than the distance given as the answer to question 1.

MY ANSWER ABOVE SPEAKS TO THE MINIMUM, SHIP'S SPEEDS CANNOT BE CONTROLLED TO EXACTNESS THEREFORE SOME DEGREE OF ERROR HAS TO BE BUILT IN. IN ORDER FOR TWO SHIPS TO MEET IN A SPECIFIC AREA.

Questions 3 – 5 pertain to Long Island Range.

3. Was the 5000 ft passing range adequate, or is 6000 ft or 7000 ft necessary?

AS STATED ABOVE IF THE TWO SHIPS COULD BE "PINPOINT PRECISE" 100% OF THE TIME, 5000' COULD WORK. BUT THIS ISN'T VERY REALISTIC. THEREFORE, 6000' OR MORE IS NECESSARY IN MY OPINION TO GIVE SOME ROOM FOR MISCALCULATION. IF NOT IT'S 7000' OR EVEN MORE. IT COULD BE POSSIBLE FOR UNDER IDEAL CONDITIONS TO MEET TWO SHIPS INSTEAD OF ONE IT ALSO ALLOWS FOR MORE RECOVERY TIME IF THE BANK EFFECT OR SUCTION GETS YOU IN TROUBLE.

4. Are there any improvements, such as ATONS, that could reduce that distance?

ATONS WILL BE NECESSARY TO MARK TO PASSING LANE. BUT THEY WILL NOT HELP IN REDUCING THE LENGTH OF ALL.

5. Do you agree with locating the passing range on the south end of the range?

NO. I WOULD RATHER SEE IT IN THE MIDDLE OF THE RANGE FOR TWO REASONS. MAINLY BECAUSE ON EBB TIDE THE OUTBOUND IS LESS LIKELY TO BE ABLE TO SLOW DOWN AND THE INBOUND IS AT THE COAST GUARD STATION SO HE IS UNABLE TO "HURRY UP" BECAUSE OF HIS DRAFT ISSUE. I BELIEVE IF AN ERROR IN PRECISENESS OCCURRED THE SHIPS WOULD THEN HAVE TO MEET IN THE TURN BETWEEN BUOYS 26 AND 28.

Questions 6 - 8 pertain to Oglethorpe Range

6. For Oglethorpe Range, how long of a passing lane is required for safe two-way traffic of a post-panamax and a panamax ship?

BECAUSE OF THE DIFFERENCE IN THE SIZES OF THESE SHIPS AND THE SLOWER SPEEDS IN THIS AREA, THE PASSING LANE COULD BE REDUCED SOMEWHAT. BUT IN MY OPINION SINCE THESE SHIPS ARE DIFFERENT THE EFFECTS WOULD BE REDUCED ON EACH OTHER SO THE WIDTH OF THE WIDNESS COULD BE SMALLER INSTEAD OF THE LENGTH.

7. Are there any improvements, such as ATONS, that could reduce that distance?

I DON'T BELIEVE THERE ARE ANY IMPROVEMENTS THAT COULD REDUCE THE DISTANCE. IT'S ALL ABOUT THE SIZE OF THE SHIPS AND THE TIME REQUIRED TO MANEUVER IT INTO PLACE.

8. Should the passing range be on the west end of the range, the middle, or the east end?

AGAIN I LIKE THE MIDDLE BECAUSE IF ON ONE END OF THE OTHER YOUR CHANCES OF MEETING IN THE TURN ARE INCREASED IF THERE IS A MISCALCULATION.

Questions 9 - 11 pertain to the Marsh Island Channel

9. Did narrowing the west side channel to increase the berthing area make the transit more difficult?

NO IT IS JUST NOT POSSIBLE TO MEET IN THIS AREA ANYMORE.

10. If the answer in 9 was "yes," do you still consider the transit safe to make?

11. Are there any improvements, such as ATONS, that could make this transit safer?

NO.

12. Other comments on this simulation study?

AS REALISTIC AS THIS SIMULATOR IS, IT IS NOT EXACTLY THE SAME AS HANDLING A SHIP. WITH THAT BEING SAID, I DON'T THINK THAT LOOKING AT BARE MINIMUM DISTANCE FOR A PASSING LANE IS A GREAT IDEA. WE ARE ALSO ONLY LOOKING AT ONE SINGLE PASSING. I PERSONALLY HAVE PASSED AS MANY AS THREE OTHER SHIPS ON LONG ISLAND.

4. Are there any improvements, such as ATONS, that could reduce that distance?

No.

5. Do you agree with locating the passing range on the south end of the range?

If the entire length can not be widened, either end would work for me.

Questions 6 - 8 pertain to Oglethorpe Range

6. For Oglethorpe Range, how long of a passing lane is required for safe two-way traffic of a post-panamax and a panamax ship?

Because the speed is reduced in this area, the distance could be less than 3x length the length of the vessels in Savannah usually are 900 - 965 (post-panamax & panamax) So 900 x 3 = 2700 x 2 = 5400 ft around 1 mile.

7. Are there any improvements, such as ATONS, that could reduce that distance?

No.

8. Should the passing range be on the west end of the range, the middle, or the east end?

All of the Above !!

Questions 9 - 11 pertain to the Marsh Island Channel

9. Did narrowing the west side channel to increase the berthing area make the transit more difficult?

No - the restrictions caused by the new post-Panamax cranes are already doing this.

10. If the answer in 9 was "yes," do you still consider the transit safe to make?

11. Are there any improvements, such as ATONS, that could make this transit safer?

No.

12. Other comments on this simulation study?

I Am always Amazed & impressed with the Vicksburg Simulator & the work of the people here. There attention to detail work ethic and professionalism is unchallenged. thank you for your help on the Savannah River.

There are too many added factors that cannot be simulated making even 1000 ft. too little. The entire Reach of Long Island needs to be widened.

ERDC/CHL TR-04-13

US Army Corps
of Engineers®
Engineer Research and
Development Center

Navigation Study for Savannah Harbor Channel Improvements

Dennis Webb

September 2004

Coastal and Hydraulics Laboratory

Approved for public release; distribution is unlimited.

ERDC/CHL TR-04-13
September 2004

Navigation Study for Savannah Harbor Channel Improvements

Dennis Webb

Coastal and Hydraulics Laboratory
U.S. Army Engineer Research and Development Center
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

Final report

Approved for public release; distribution is unlimited.

Prepared for U.S. Army Engineer District, Savannah
PO Box 889
Savannah, GA 31402-0889

ABSTRACT: Savannah Harbor is located on the eastern shore of the state of Georgia. The harbor is being evaluated for deepening and widening. The purpose of the proposed improvements is to accommodate larger, deep-draft containerships to use the port. The widening is being considered to provide additional room for two-way traffic. To evaluate these improvements a real-time ship simulation study was undertaken. Simulation models were developed for both Savannah's present and future conditions. Pilots from Savannah Harbor operated the simulator as they would in real-life. Based upon these simulations, a final improved channel was developed.

DISCLAIMER: The contents of this report are not to be used for advertising, publication, or promotional purposes. Citation of trade names does not constitute an official endorsement or approval of the use of such commercial products. All product names and trademarks cited are the property of their respective owners. The findings of this report are not to be construed as an official Department of the Army position unless so designated by other authorized documents.

DESTROY THIS REPORT WHEN NO LONGER NEEDED. DO NOT RETURN IT TO THE ORIGINATOR.

Contents

Preface vii

1—Introduction 1

Location and Description 1
Proposed Improvements 3

2—Reconnaissance Trip 8

3—Database Development 10

Tidal Current Modeling 10
ERDC Ship/Tow Simulator 11

4—Results 15

Tybee Roads 15
Existing conditions, ebb tide 15
Existing conditions, flood tide 16
Plan 1 conditions, ebb tide 16
Plan 1 conditions, flood tide 17
Widener at turn between Tybee Range and Bloody Point Range 17
Long Island Range 19
Existing conditions, ebb tide 19
Existing conditions, flood tide 21
Plan 1 conditions, ebb tide 21
Plan 1 conditions, flood tide 22
Plan 2 conditions, ebb tide 23
Plan 2 conditions, flood tide 23
Wideners for Long Island Range tests 24
The Bight and Fort Jackson Area 24
Existing conditions, ebb tide 24
Existing conditions, flood tide 26
Plan 2 conditions, ebb tide 26
Plan 2 conditions, flood tide 27
Plan 3 conditions, ebb tide 28
Plan 3 conditions, flood tide 28
City Front 29
Kings Island 30
Additional Runs with 43-ft Draft *Susan Maersk* 30
Vertical Motion Study 32

5—Conclusions and Recommendations 36

Plates 1-171

SF 298

List of Figures

Figure 1. Project location 1

Figure 2. Channel deepened on existing side slopes 2

Figure 3. Existing and proposed channels, New Channel Range to Upper Flats Range 2

Figure 4. Existing and proposed channels, The Bight to City Front Channel 3

Figure 5. Existing and proposed channels, Tybee Range – Tybee Knoll Cut Range 5

Figure 6. Pipeline requires shifting channel to east 5

Figure 7. Fort Jackson Range, Plan 1 6

Figure 8. Fort Jackson Range, Plan 2 6

Figure 9. Existing and proposed channels, City Front to Kings Island Turning Basin 7

Figure 10. Camera setup on starboard wing, *Ludwigshafen Express* 9

Figure 11. Ebb-tidal currents 10

Figure 12. Flood-tidal currents 11

Figure 13. ERDC Ship/Tow Simulator, Savannah Harbor 12

Figure 14. ERDC simulator layout 13

Figure 15. Arrangement of ERDC Ship/Tow bridge module 14

Figure 16. Composite S-class runs on turn between Tybee Range and Bloody Point Range 18

Figure 17. Jones Island Range – all S-class runs 18

Figure 18. Ownship view of inbound *Susan Maersk* 20

Figure 19. Composite plot of all S-class runs through New Channel Range widener 25

Figure 20. Composite plot of all S-class runs through Flats Range Area wideners 25

Figure 21. 43-ft draft *Susan Maersk* at turn between Tybee and Bloody Point Ranges 31

Figure 22. 43-ft draft *Susan Maersk* at Jones Island Range Turn 31

Figure 23. 43-ft *Susan Maersk* through Upper and Lower Flats Ranges 32

Figure 24. Recommended turn with tracks of all S-class containership simulations 36

Figure 25. Jones Island Range, all S-class containership tracks 37

Figure 26. Recommended widener for Jones Island Range 37

Figure 27. Channel recommendations Lower Flats Range through The Bight Channel 38

List of Tables

Table 1. Clearance for *Susan Maersk* Drafting 47.5 ft 34

Table 2. Clearance for *Susan Maersk* Drafting 46.0 ft 35

Conversion Factors, Non-SI to SI Units of Measurement

Non-SI units of measurement used in this report can be converted to SI units as follows:

Multiply	By	To Obtain
cubic feet	0.02831685	cubic meters
degrees (angle)	0.01745329	radians
feet	0.3048	meters
miles (U.S. statute)	1.609347	kilometers
square miles	2,589,998	square meters

Preface

The model investigation described herein was conducted for the U.S. Army Corps of Engineer District, Savannah, by the U.S. Army Engineer Research and Development Center (ERDC), Vicksburg, MS. The simulator experiments were performed during the period of Sept 2003 to October 2003 by personnel of the Coastal and Hydraulics Laboratory (CHL), under the general supervision of Mr. Thomas W. Richardson, Director, CHL; Dr. William D. Martin, Deputy Director, CHL; Mr. Donald. C. Wilson, Chief of Navigation Branch, CHL; and Dr. Sandra Knight, and Ms. Joan Pope, Technical Directors, CHL.

During the course of the model study, representatives of the Savannah District and other navigation interest visited ERDC at various times to observe the simulator and discuss tests results. The Savannah District was informed of the progress of the simulator study through monthly progress reports. The simulation models for the *Susan Maersk* and *SL Performance* were developed by Designers and Planners Inc.

The principal investigator in immediate charge of the navigation portion of the simulator study was Mr. Dennis Webb, assisted by Ms. Peggy Van Norman, and Ms Donna D. Derrick, all of the Navigation Branch, and Ms. Sally Harrison, contractor for Analytical Services, Inc. Mr. Webb prepared this report.

The Director of ERDC during publication of this report was Dr. James Houston. Colonel James Rowan, EN, was Commander and Executive Director.

1 Introduction

Location and Description

Savannah Harbor is located on the eastern shore of the state of Georgia (Figure 1) and is presently 42 ft deep. To accommodate larger, deeper drafted containerships, the U.S. Army Engineer District, Savannah, is evaluating channel designs to deepen much of the harbor to a depth not to exceed 48 ft. Nearly 30 miles of the existing 42-ft project will be deepened as well as an extension in the Atlantic Ocean. The tidal range for Savannah Harbor is typically 8 ft.

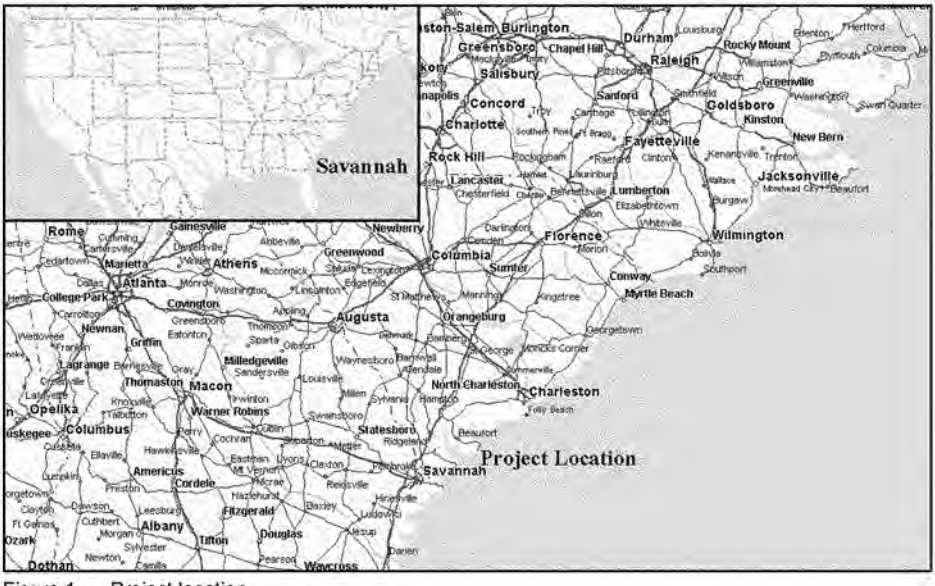


Figure 1. Project location

Most of the deepening of Savannah Harbor is anticipated to be done on the existing side slopes (Figure 2). This will effectively reduce the bottom width of the navigation channel in most areas. However, the Savannah District proposes bend wideners in most channel turns. Also, a plan to widen the Long Island Crossing Range by 100 ft on the south is being considered to provide additional room for two-way traffic (Figure 3). In addition, the Fort Jackson Reach (Figure 4) was realigned to avoid relocating pipelines.

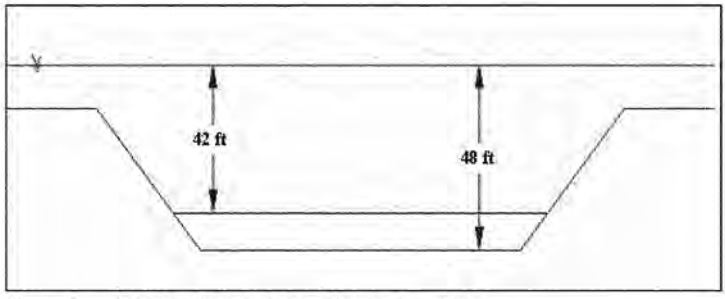


Figure 2. Channel deepened on existing side slopes

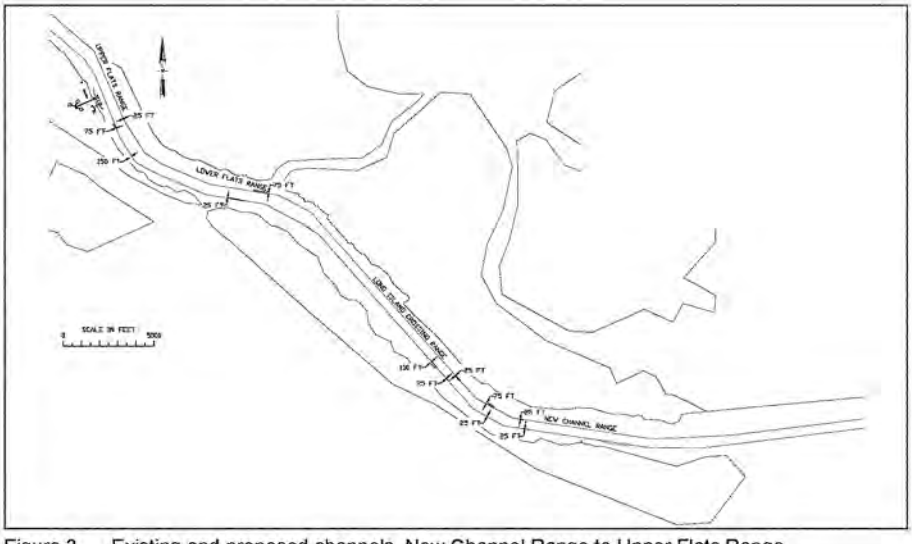


Figure 3. Existing and proposed channels, New Channel Range to Upper Flats Range

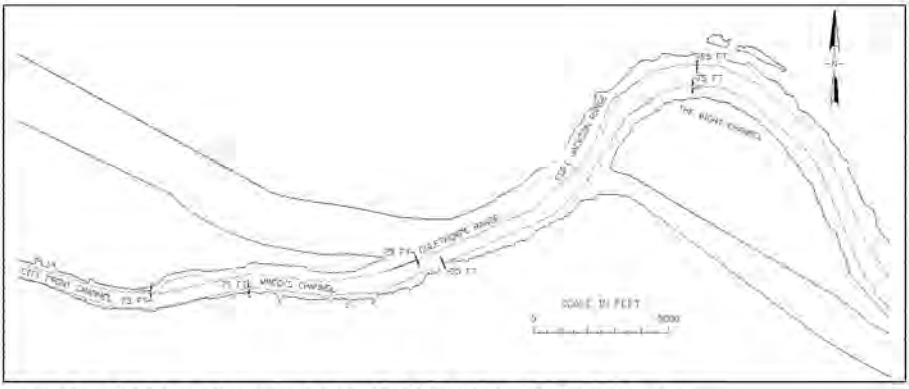


Figure 4. Existing and proposed channels, The Bight to City Front Channel

The U.S. Army Engineer Research and Development Center (ERDC) conducted a navigation study utilizing real-time ship simulation modeling to evaluate the proposed improvements to Savannah Harbor. Model development and on-line testing occurred at the ERDC Waterways Experiment Station (WES) in Vicksburg, MS, during the period from December 2001 to January 2003.

Two design ships were used for the study: one to represent existing vessel traffic and the other to represent future traffic. The design ship for the existing channel was the *SL Performance*, a panamax containership loaded to 33 ft. The *SL Performance* is 950 ft long with a beam of 106 ft. The design ship for the proposed channel was the *Susan Maersk*. The *Susan Maersk* is a post-panamax S-class containership with a length of 1,140 ft and a beam of 144 ft. The *Susan Maersk* loaded to 47.5 ft.

Proposed Improvements

Most of the deepening of Savannah Harbor will be done on the existing side slopes (Figure 2), which will effectively reduce the bottom width of the navigation channel in most areas. However, the Savannah District proposes bend wideners in most channel turns.

The changes to the horizontal channel limits will be presented, beginning with the entrance channel and proceeding inland. Unless otherwise indicated, these changes are part of Plan 1.

The existing Tybee Range is 600 ft wide. Deepening to 48 ft on the existing side slopes will narrow the proposed channel to approximately 550 ft (Figure 3). The west side of the turn onto Bloody Point Range is deepened on the existing side slope and thus the channel width is reduced by about 25 ft on the west side. However, the Savannah District has proposed a 75 ft widener on the east side of the turn. The Bloody Point Range is presently 600 ft wide. The 25-ft reduction

on each side caused by deepening on the existing side slopes will narrow the channel to approximately 550 ft. The Jones Island Range, which is the turn from Bloody Point Range to Tybee Knoll Cut Range, was reduced by 25 ft on the north side, but t the Savannah District proposal widened the channel by 75 ft on the south. Therefore, the width of Jones Island Range was increased from 700 ft to 750 ft. Tybee Knoll Cut Range is presently 500 ft wide. Deepening to 48 ft on the existing side slopes reduced that width to 450 ft.

The New Channel Range (Figure 4) is 500 ft wide. The proposed 48-ft channel will narrow New Channel Range to 450 ft. The west side of the turn onto Long Island Crossing Range is deepened on the existing side slope and thus the channel width is reduced by about 25 ft on the west side. However, SAS has proposed a 75 ft widener on the east side of the turn. The Long Island Crossing Range is presently 500 ft wide. There are two proposed widths for Long Island Crossing Range. Plan 1, deepened upon the existing side slopes, reduces the channel width to 450 ft. Plan 2, widens the western side of the Long Island Crossing Range deepened channel by 100 ft, thus increasing the channel width to 550 ft. Plans 1 and 2 were identical for the reaches immediately east and west of Long Island Crossing Range. The existing Lower Flats Range is 600 ft wide. The proposed Plan 1 widened the north side of Lower Flats Range by 75 ft. The south side of Lower Flats Range was narrowed by 25 ft due to deepening on the existing side slope. Therefore, the Plan 1 Lower Flats Range is 650 ft wide. SAS has provided an additional 150 ft on the west side of the turn between Lower Flats Range and Upper Flats Range. The east side of the turn was narrowed by 25 ft due to deepening on the existing side slope. The Upper Flats Range is 550 ft wide. The proposed Plan 1 Upper Flats Range was widened by 75 ft on the west side. The east side of the proposed Plan 1 Upper Flats Range was narrowed by 25 ft due to deepening on the existing side slope. Therefore, the Plan 1 Upper Flats Range was 600 ft wide.

The Bight Channel is currently a series of 800 ft wide segments as shown in Figure 5. The north side of Plan 1 Bight Channel was narrowed by 25 ft due to deepening on the existing side slope. The south side of the Plan 1 Bight Channel was widened 75 ft. Thus, the Plan 1 Bight Channel is 850 ft wide. The channel immediately west of The Bight Channel, the Fort Jackson Reach was realigned to avoid relocating pipelines (Figure 6). The first proposed alignment, Plan 1, shifted the channel to the east and provided a large triangular area for the ship's stern to swing when heading outbound (Figure 7). However, concern over inbound ships using the triangular area and then running aground because they were too far west lead to Plan 1 being abandoned and Plan 2 being developed. Plan 2 is shown in Figure 8 and removed the large triangular area. A third plan, Plan 3, was also developed. Plan 3 is not shown since it is the existing channel deepened to 48 ft. Plan 3 did not deepen on the existing side slopes, so its footprint is the same as the existing Fort Jackson Range.

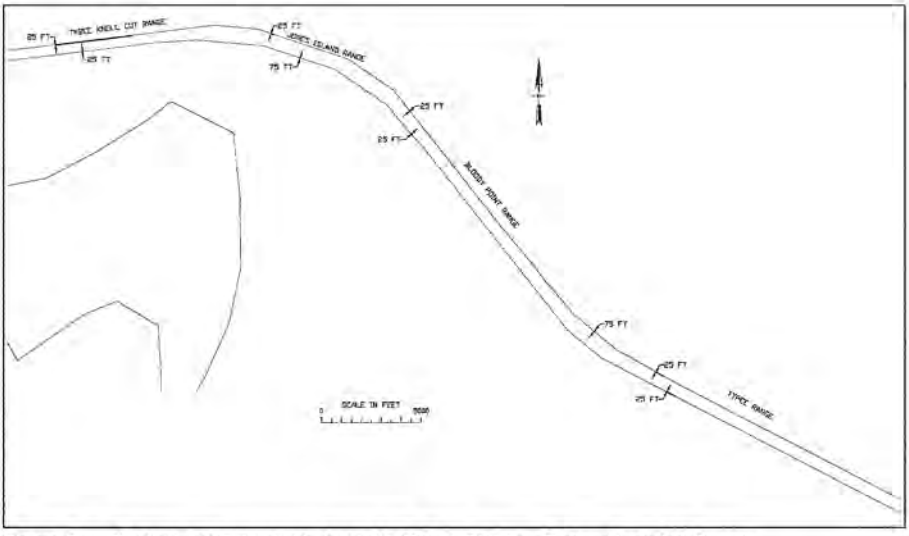


Figure 5. Existing and proposed channels, Tybee Range – Tybee Knoll Cut Range

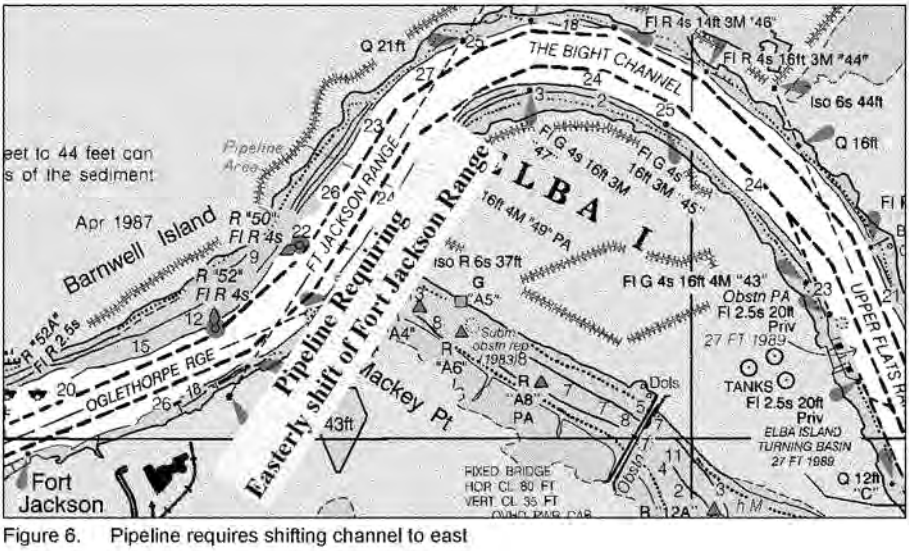


Figure 6. Pipeline requires shifting channel to east

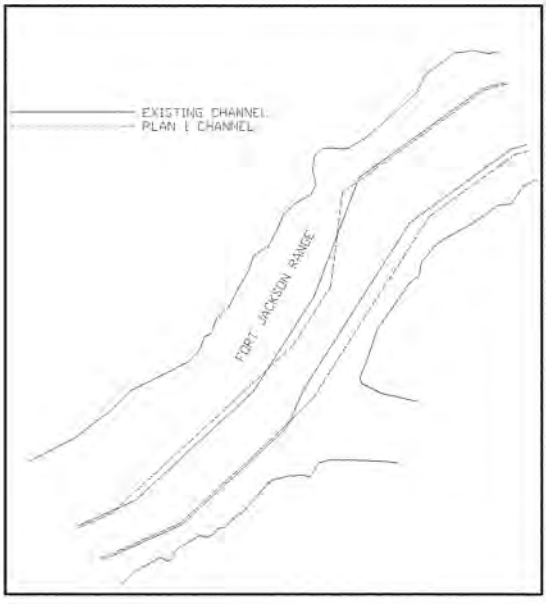


Figure 7. Fort Jackson Range, Plan 1

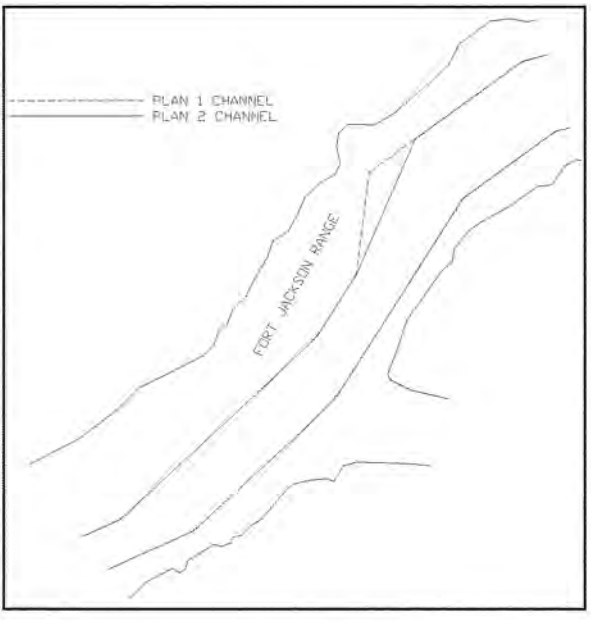


Figure 8. Fort Jackson Range, Plan 2

There was only one proposed deepening plan for Oglethorpe Range and the Wrecks Channel. Both plans deepened on the existing side slopes. This reduced the width of both deepened channels from 500 to 450 ft. A 75-ft widener was proposed for the turn at the western end of the Wrecks Channel. A second plan, Plan 2, was developed without the widener. The existing turn was deepened along its side slopes, thus reducing the south side of the turn by 25 ft. Plan 1 also widened the turn east of City Front Channel by 75 ft on the north side.

The turn between City Front Channel and Marsh Island Channel was widened by 75 ft as part of Plan 1 (Figure 9). The remainder of March Island Channel was deepened on the existing side slopes, thus reducing the channel width from 500 to 450 ft. Plan 1 widens the turn between Marsh Island Channel and Kings Island Channel by 75 ft on the north side. The remainder of Kings Island Channel was deepened on the existing side slopes, thus reducing the channel width from 500 to 450 ft. The north side of Kings Island Turning Basin was widened by 75 ft. The rest of the basin was reduced by 25 ft by deepening along the existing side slopes.

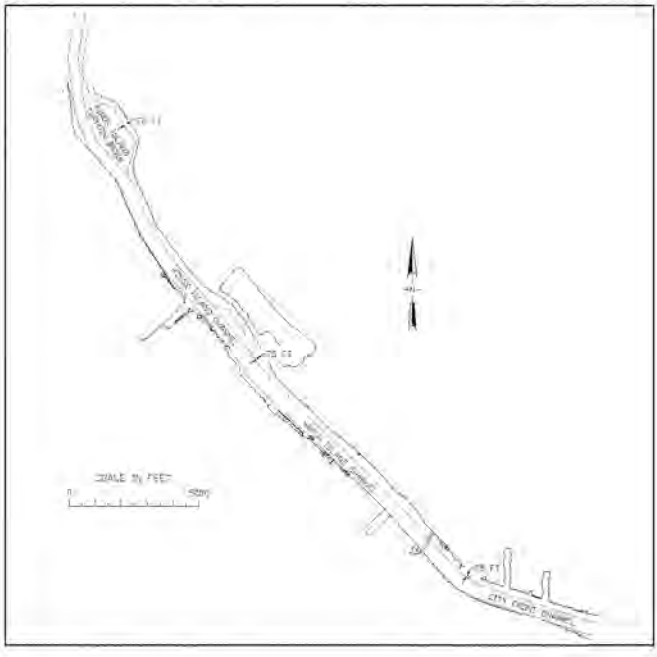


Figure 9. Existing and proposed channels, City Front to Kings Island Turning Basin

2 Reconnaissance Trip

The reconnaissance trip for Savannah Harbor was undertaken December 3-5, 2001. The purpose of the reconnaissance trip was to observe navigation conditions in the Savannah River. The project site was photographed to update the simulation visual scene.

On December 3, representatives of the Savannah District and ERDC boarded the *Ludwigshafen Express* at approximately 0800, and were by accompanied Capt. Spencer Edleman of the Savannah pilots Association. The *Ludwigshafen Express* (Capt. Martin Huls) is a Panamax containership, 965 ft length overall with a beam of 105 ft. The ship's draft was 35 ft. The transit was conducted at high water, estimated to be +9 ft by Capt. Edleman. Typically, high water is +8 ft. Two digital video cameras were mounted on the starboard wing. One looked over the bow and the other perpendicular to the ship (Figure 10). One digital video camera was mounted on the port wing, looking perpendicular to the ship. Additional still digital photos were taken throughout the transit. A hand-held Global Positioning System (GPS) unit was placed on the starboard wing to track the ship's progress though the channel.

During the transit, Capt. Edleman provided insight to navigation conditions on the Savannah River as follows:

a. Wind-driven currents occur in the Atlantic, typically with a wind from the south/southwest and combined with flood tide. The crosscurrents occur in the two easternmost channel segments.

b. The currents are usually aligned with the channel in the protected portions of the river.

c. It would be helpful to widen the Long Island Crossing Range by 100 ft on the south to provide additional room for meeting.

d. Ships are restricted to 4-ft underkeel clearance in the entrance and 2-ft underkeel clearance inside.

e. A new liquified natural gas (LNG) facility and turning basin are under construction along the south side of Upper Flats Range. The turning basin is not part of the channel improvements being evaluated by this study. Ships will not meet near the facility when an LNG tanker is docked.

f. Two-way traffic occurs over most of the project. Pilots try to time their meetings for the straight reaches.

Figure 10. Camera setup on starboard wing, *Ludwigshafen Express*

Transit continued to the King's Island Turning Basin. The ship was turned and docked at container terminal No. 3. The representatives departed the ship about 1245.

On December 5, the representatives boarded thePanamex containership *Hanjin Tokyo* at 0700. The draft of the *Hanjin Tokyo* was 34 ft. The pilot was Capt. Sam Meyer. Low water occurred at 0500, 2 hr into the flood-tidal cycle. Capt. Meyer noted two areas (inside the jetties and near Fort Jackson) where the ships were affected by currents. Currents ebbing from the Back River can affect ships near Fort Jackson. Capt. Meyer also noted that ebb-tidal currents work against inbound ships when making the turn from the Bight Channel to Fort Jackson Channel. The ship docked at a container berth near the southern end of the King's Island Turning Basin. The ship was not turned. It was docked port side to the dock.

3 Database Development

Tidal Current Modeling

Currents for the proposed 48 ft channel were calculated at ERDC with TABS-MD study. Simulations were conducted for maximum ebb- and flood-tidal currents. The currents used to develop the simulation models of existing conditions are shown in Figures 11 and 12.

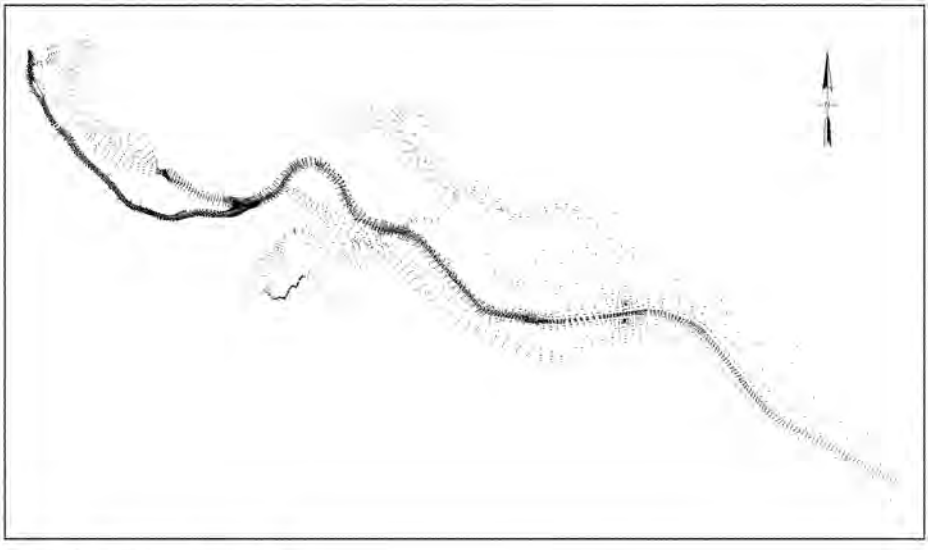


Figure 11. Ebb-tidal currents

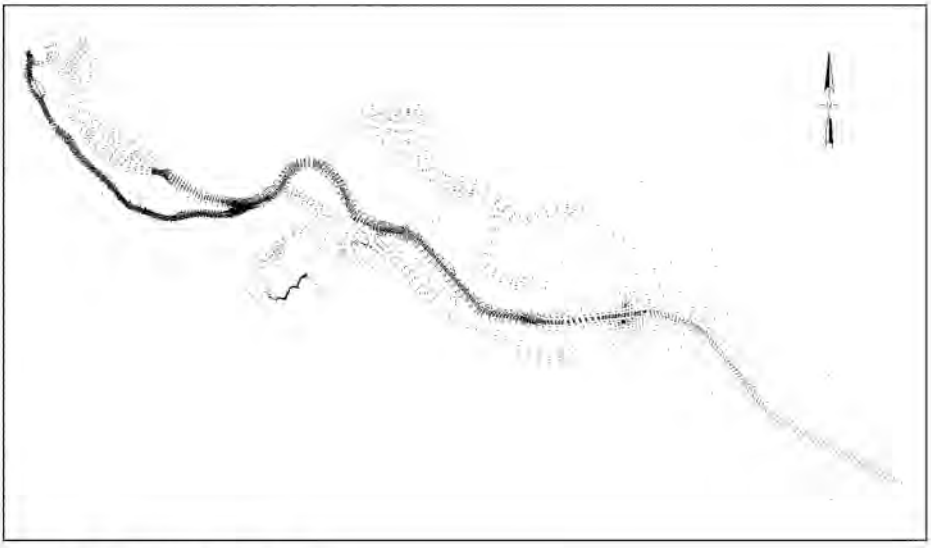


Figure 12. Flood-tidal currents

Currents were also modeled for two deepened conditions.

Wave conditions for the approach to Savannah Harbor were modeled in a separate study at ERDC (Thompson, in preparation).[1]

ERDC Ship/Tow Simulator

The new ERDC Ship/Tow Simulators have been operational since February 2002. The simulators are Computer Sciences Corp. (CSC) Virtual Ship 2000 models. The simulators are real-time, i.e. ship movements on the simulator require the same amount of time as in real life. Environmental forces such as currents, wind, banks, ship-ship interactions all act upon the vessel during a transit. The pilot cons the simulated vessel's engine speed and rudder. The pilot also has radio contact with assist tugs. The *Susan Maersk* has bow and stern thrusters that are pilot controlled. The two simulators were coupled together for two-way traffic. Figure 13 shows the ERDC simulator being operated during the Savannah study.

[1] Thompson, E. (in preparation). "Wave modeling navigation study for Savannah Harbor, Georgia," U.S. Army Engineer Research and Development Center, Vicksburg, MS.

Figure 13. ERDC Ship/Tow Simulator, Savannah Harbor

A plan of the ERDC simulator facility is shown in Figure 14. The facility consists of two bridge modules, a viewing area, a pilot debriefing room and an operator station. A description of a bridge module is shown in Figure 15.

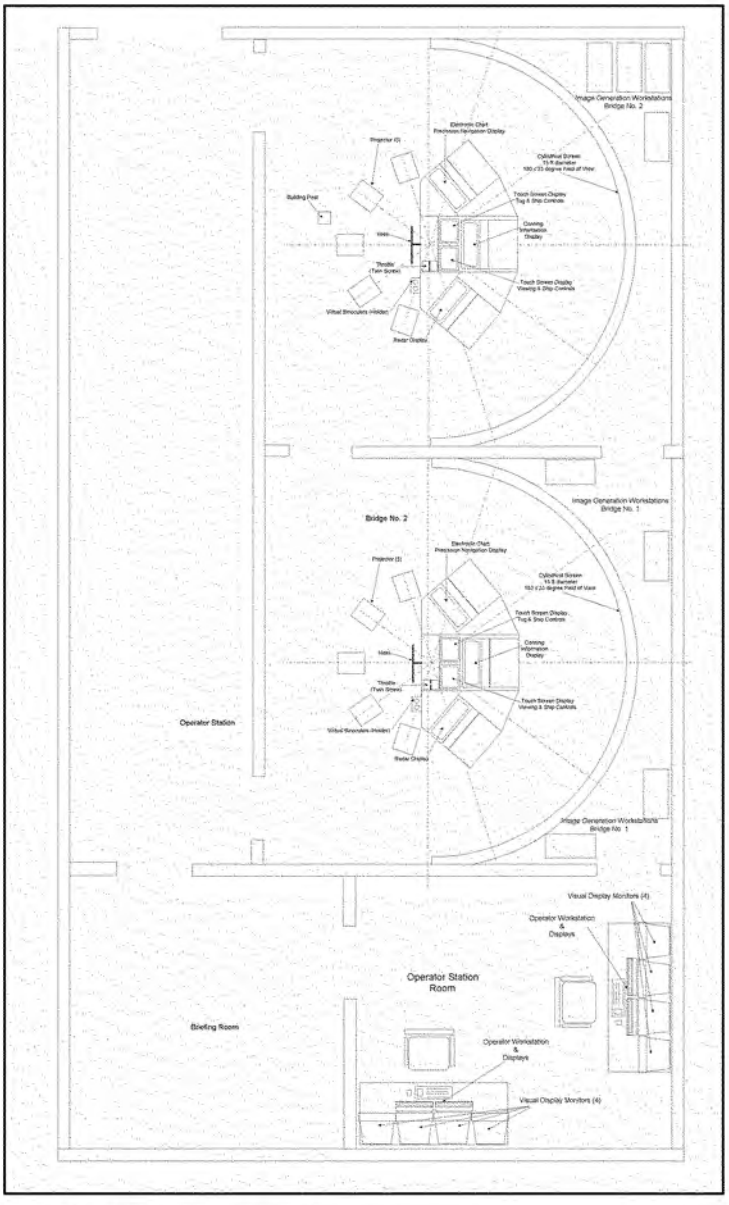


Figure 14. ERDC simulator layout

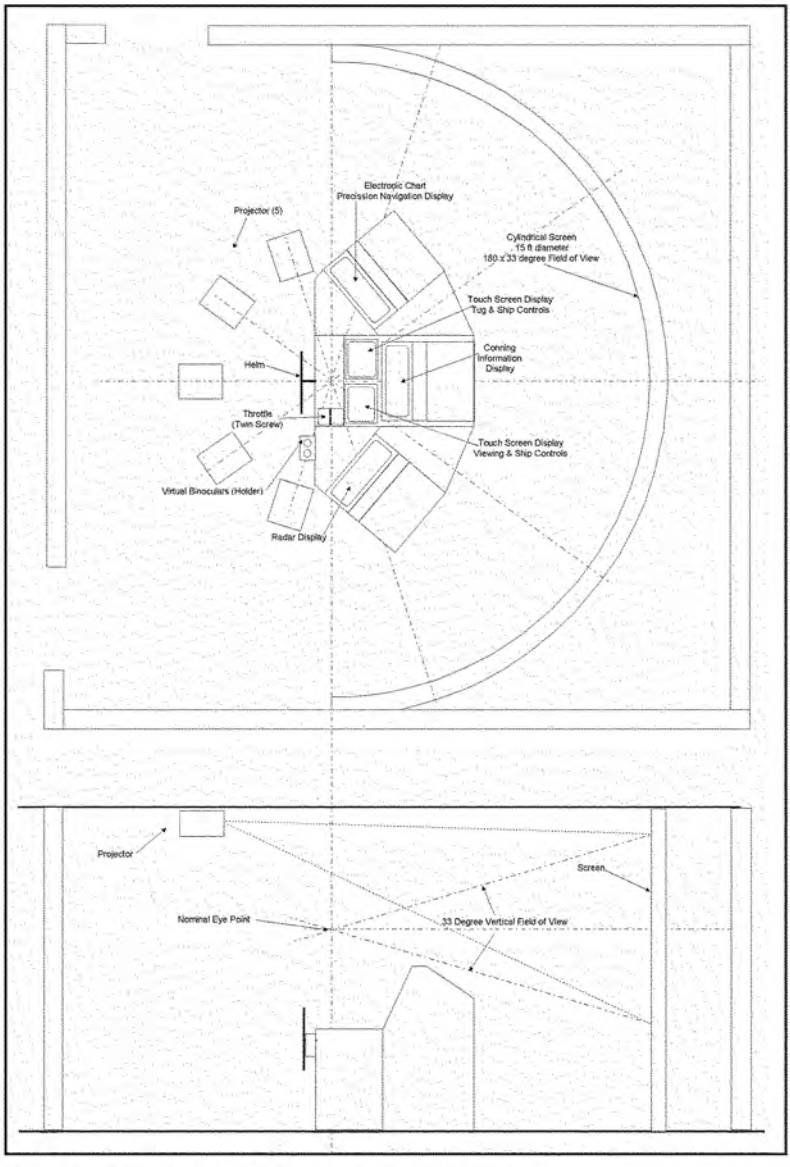


Figure 15. Arrangement of ERDC Ship/Tow bridge module

4 Results

Tybee Roads

The results for the Tybee Roads simulations are presented in Plates 1-28. Two channel layouts were simulated, existing and Plan 1. There was only one proposed channel configuration tested in this area. Both the existing and Plan 1 channels were simulated for two-way traffic operating in both ebb- and flood-tidal currents. The simulations' starting positions were adjusted so that the meeting occurred on Bloody Point Range. The design ship for the existing channel was the SL Performance loaded to 33 ft. The design ship for the Plan 1 channel was the *Susan Maersk*, loaded to 47.5 ft.

The track plots for each simulation are presented on two plates to allow plotting at a readable scale. The western area is presented first, followed by the eastern area. Both the western and eastern plates are plotted to the same scale.

Existing conditions, ebb tide

The track plots for existing conditions, ebb tide, with pilot 1 inbound and pilot 2 outbound are shown in Plates 1 and 2. The two ships met on Bloody Point Range, between buoys 10 and 12. The ships were about 250 ft apart when they met. The inbound ship crossed the channel line by about 10 ft during meeting. Both the inbound and outbound ships left the Jones Island Range. The inbound ship went completely out of the channel while making the turn near buoy 14. The outbound ship waited a little too late to begin turning to starboard near buoy 15 and left the channel by approximately 90 ft.

The track plots for existing conditions, ebb tide, with pilot 3 inbound and pilot 4 outbound are shown in Plates 3 and 4. The two ships met on Bloody Point Range, between buoys 10 and 12, but closer to buoy 12. The ships were about 230 ft apart while meeting and the inbound ship was about 5 ft out of the channel. Both ships went entirely out of the channel near buoy 14, while turning between Jones Island Range and Bloody Point Range.

The track plots for existing conditions, ebb tide, with pilot 4 inbound and pilot 3 outbound are shown in Plates 5 and 6. The two ships met on Bloody Point Range, between buoys 10 and 12. The ships were about 290 ft apart when

they met, with neither ship leaving the channel. The outbound ship left the channel by approximately 50 ft near buoy 18 and by about 5 ft near buoy 14.

Existing conditions, flood tide

The track plots for existing conditions, flood tide, with pilot 1 inbound and pilot 2 outbound are shown in Plates 7 and 8. The two ships met on Bloody Point Range, midway between buoys 10 and 12. Neither ship left the channel. The inbound ship left the channel on the north side near buoy 14. The ships were approximately 180 ft apart when they met.

The track plots for existing conditions, flood tide, with pilot 3 inbound and pilot 4 outbound are shown in Plates 9 and 10. The two ships met on Bloody Point Range, midway between buoys 10 and 12. The ships were extremely far apart at the meeting point, nearly 290 ft. Both ships crossed out of the channel limits by about 10 ft. Both ships left the channel near buoy 14. The inbound ship left by about 25 ft and the outbound by nearly 55 ft. The inbound ship just crossed over the north side of the channel, west of buoy 18, when the exercise was ended.

The track plots for existing conditions, flood tide, with pilot 4 inbound and pilot 3 outbound are shown in Plates 11 and 12. The two ships met on Bloody Point Range, midway between buoys 10 and 12. The ships were nearly 410 ft apart, but the inbound ship went entirely out of the channel. The inbound ship also went entirely out of the channel between buoys 14 and 18 and nearly 80 ft out of the channel west of buoy 18.

Plan 1 conditions, ebb tide

The track plots for proposed conditions, ebb tide, with pilot 1 inbound and pilot 2 outbound are shown in Plates 13 and 14. The two ships met on Bloody Point Range, between buoys 10 and 12. The ships were about 150 ft apart when they met, with the inbound ship crossing the channel line by less than 25 ft. The inbound ship touched the northern channel edge near buoy 14. That was the only incident of a ship leaving the channel in the Jones Island Range area.

The track plots for proposed conditions, ebb tide, with pilot 2 inbound and pilot 1 outbound are shown in Plates 15 and 16. The two ships met between gated buoys 11 and 12. The ships were about 70 ft apart when they met and neither ship left the channel. Both the inbound and outbound ship came to the channel's edge near buoy 14, but neither left the channel. The outbound ship left the channel by about 25 ft while entering the Jones Island Range near buoy 18.

The track plots for proposed conditions, ebb tide, with pilot 3 inbound and pilot 4 outbound are shown in Plates 17 and 18. The two ships met on Bloody Point Range, between buoys 10 and 12. The ships were approximately 150 ft apart and neither left the channel. The inbound ship left the channel by nearly 70 ft near buoy 14. The outbound ship crossed the channel line by about 10 ft at the same point as the inbound ship. The inbound ship crossed the channel limits by 10 ft at buoy 18.

The track plots for proposed conditions, ebb tide, with pilot 4 inbound and pilot 3 outbound are shown in Plates 19 and 20. The two ships met on Bloody Point Range, between buoys 10 and 12. Both ships were further east than usual when they met. The two ships were about 100 ft apart and this forced the inbound ship nearly 50 ft out of the channel. The inbound ship left the channel near buoy 14 by approximately 90 ft. The outbound ship did not leave the channel at this point. However, the outbound ship did leave the channel by nearly 50 ftat buoy 18.

Plan 1 conditions, flood tide

The track plots for proposed conditions, flood tide, with pilot 1 inbound and pilot 2 outbound are shown in Plates 21 and 22. The two ships met on Bloody Point Range, between buoys 10 and 12. The two ships were about 120 ft apart at meeting. Although the inbound ship was close to the eastern channel edge, neither ship left the channel while meeting. The outbound ship did not leave the channel at any time during the run, and the inbound ship left the channel by about 60 ft at buoy 14.

The track plots for proposed conditions, flood tide, with pilot 2 inbound and pilot 1 outbound are shown in Plates 23 and 24. The two ships met on Bloody Point Range, between buoys 10 and 12, closer to gated buoys 11 and 12. The ships were about 110 ft apart at the meeting. The inbound ship barely crossed the channel line by approximately 2 ft. The outbound ship left the channel by nearly 80 ft at buoy 14. The inbound ship stayed well within the channel at that point. Neither ship left the channel near buoy 18. The outbound ship came within 15 ft of the channel's edge at buoy 18.

The track plots for proposed conditions, flood tide, with pilot 3 inbound and pilot 4 outbound are shown in Plates 25 and 26. The two ships met between gated buoys 11 and 12. The two ships were about 110 ft apart, and neither ship left the channel. The inbound ship entirely left the channel on Jones Island Range, between buoys 14 and 18. The inbound ship came near the northern channel edge on the eastern end of Tybee Knoll Cut Range, but did not leave the channel.

The track plots for proposed conditions, flood tide, with pilot 4 inbound and pilot 3 outbound are shown in Plates 27 and 28. The two ships met on Bloody Point Range, between buoys 10 and 12. The two ships were about 110 ft apart, and neither ship left the channel. Both ships came close to the channel edge near buoy 14, but neither crossed the authorized channel limits. The inbound ship left the channel by 40 ft on the eastern end of Tybee Knoll Cut Range.

Widener at turn between Tybee Range and Bloody Point Range

Composite runs of all S-class containerships passing through the Tybee Roads wideners are shown in Figures 16 and 17.

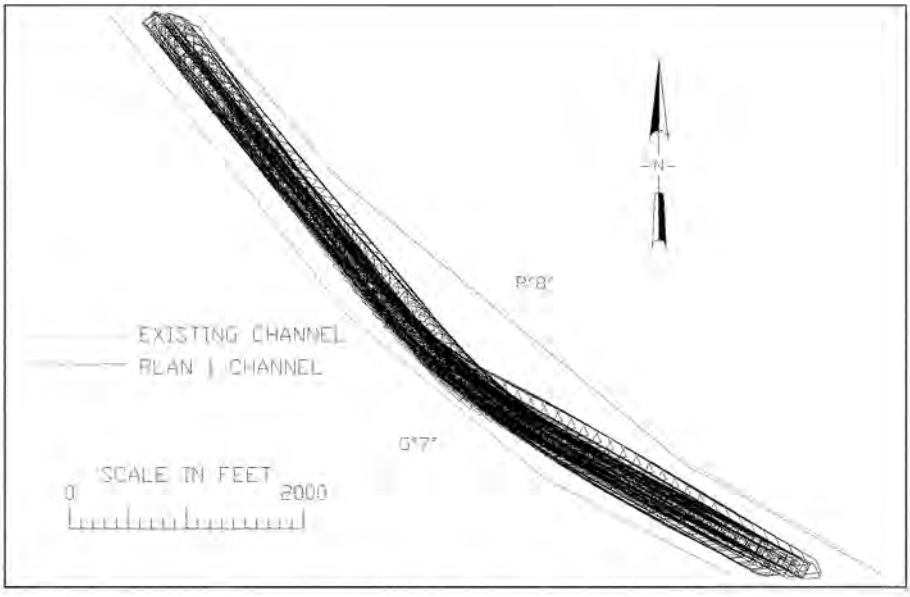


Figure 16. Composite S-class runs on turn between Tybee Range and Bloody Point Range

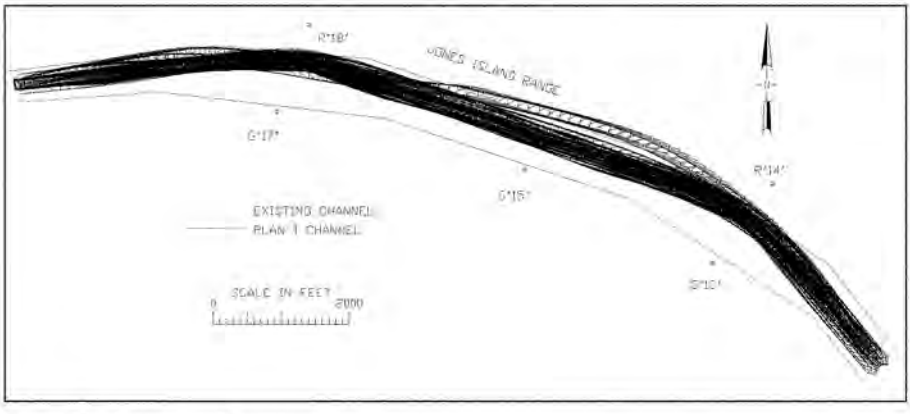


Figure 17. Jones Island Range – all S-class runs

Long Island Range

The results for the Long Island Range simulations are presented in Plates 20-72. Three channel layouts were simulated, existing, Plan 1, and Plan 2. The difference between Plans 1 and 2 was that Plan 2 widened the south side of Long Island Range deepened channel by an additional 100 ft. Simulation runs were undertaken for two-way traffic operating in both ebb- and flood-tidal currents. The simulations' starting positions were adjusted so that the meeting occurred midway along Long Island Reach. The design ship for the existing channel was the *SL Performance* loaded to 33 ft. The design ship for the proposed channel was the *Susan Maersk* loaded to 47.5 ft.

Two-way traffic of two S-class containerships was simulated with both S-class containerships being conned by the pilot. The Savannah District desired to evaluate the meeting of the *Susan Maersk* and the *SL Performance* in both the Plan 1 and Plan 2 channels. This was accomplished without additional simulation runs by adding two computer-controlled ships to simulations of the proposed channels. Versions of the *SL Performance* ran both inbound and outbound. The starting time and position of the computer-controlled *SL Performance* was set to ensure that the piloted *Susan Maersk* met the computer-controlled *SL Performance* prior to meeting the other pilot-controlled ship. Figure 18 shows all four ships in the visual scene. The simulator's *Susan Maersk* (ownship)[1] is shown as the bow image. The ownship is inbound for this picture. The ownship is meeting an outbound computer-controlled version of the *SL Performance*. Ownship's pilot can see the outbound pilot-controlled *Susan Maersk* (the other simulator's ownship). The outbound *Susan Maersk* has just met the inbound computer-controlled *SL Performance*. The computer-controlled ships ran on a straight line offset from the channel's edge.

The track plots for each simulation are presented on two plates to allow plotting at a readable scale. The western area is presented first, followed by eastern area. Both the western and eastern plates are plotted to the same scale.

Existing conditions, ebb tide

The track plots for existing conditions, ebb tide, with pilot 3 inbound and pilot 4 outbound are shown in Plates 29 and 30. The inbound ship left the channel by approximately 60 ft, west of buoy 24. The two ships met near buoy 30. The inbound ship left the channel by nearly 50 ft at the meeting, and the outbound ship ran along the channel edge. The outbound ship began the simulation too far to the east and was actually out of the Long Island Crossing Range. The outbound ship left the channel by approximately 50 ft while turning into the New Channel Range. The ships were nearly 260 ft apart when meeting.

[1] Ownship is the simulated vessel being controlled by the pilot at the helm. The other vessel in the simulator is referred to as the traffic ship.

Figure 18. Ownship view of inbound *Susan Maersk*

The track plots for existing conditions, ebb tide, with pilot 4 inbound and pilot 3 outbound are shown in Plates 31 and 32. Neither ship left the channel until the meeting near buoy 30. The inbound ship left the channel by nearly 45 ft when meeting the outbound ship. The ships were nearly 310 ft apart when meeting.

The track plots for existing conditions, ebb tide, with pilot 5 inbound and pilot 6 outbound are shown in Plates 33 and 34. Neither ship left the channel until the meeting near buoy 30. The inbound ship left the channel by nearly 60 ft when meeting the outbound ship, which left the channel by approximately 20 ft. The ships were nearly 335 ft apart when meeting.

The track plots for existing conditions, ebb tide, with pilot 6 inbound and pilot 5 outbound are shown in Plates 35 and 36. The inbound ship went entirely out of the channel west of buoy 24. This incident occurred because the ship's wheel was turned hard to starboard when the simulation began. The pilot recovered and the run continued. Other than the inbound pilot's initial problem, neither ship left the channel until the meeting south of buoy 30. Both ships left the channel at that point. The inbound ship went completely out of the channel and the

outbound ship left the channel by almost 50 ft. The ships were separated by approximately 450 ft.

Existing conditions, flood tide

The track plots for existing conditions, flood tide, with pilot 3 inbound and pilot 4 outbound are shown in Plates 37 and 38. The meeting occurred just south of buoy 32. Both ships left the channel while meeting. The inbound ship just crossed the channel line, while the outbound ship went entirely out of the channel. The ships were nearly 500 ft apart.

The track plots for existing conditions, flood tide, with pilot 4 inbound and pilot 3 outbound are shown in Plates 39 and 40. The ships met near buoy 30, with the outbound ship leaving the channel by about 80 ft. The separation distance between the two ships was nearly 240 ft. Neither ship left the channel at any other time during the run.

The track plots for existing conditions, flood tide, with pilot 6 inbound and pilot 5 outbound are shown in Plates 41 and 42. The ships met between buoys 30 and 32. The outbound ship ran along the channel edge while the inbound ship remained within the authorized channel. The ships were approximately 210 ft apart at meeting.

Plan 1 conditions, ebb tide

The track plots for the Plan 1 conditions, ebb tide, with pilot 3 inbound and pilot 4 outbound are shown in Plates 43 and 44. The inbound ship left the channel by approximately 60 ft, west of buoy 24. The inbound *Susan Maersk* also clipped the channel edge while making the turn near buoy 28. This was probably caused by trying to remain on the east side of the channel in anticipation of meeting the outbound, computer-controlled, *SL Performance*. That meeting occurred between buoys 28 and 30 without any problems. The two *Susan Maersk*s met between buoys 30 and 32. The outbound ship left the channel by nearly 100 ft and the ships were separated by approximately 160 ft. After the ships met, the inbound ship left the channel by about 10 ft. The inbound ship also crossed the channel edge while making the turn into Lower Flats Range, across from buoy 33.

The track plots for the Plan 1 conditions, ebb tide, with pilot 4 inbound and pilot 3 outbound are shown in Plates 45 and 46. The inbound *Susan Maersk* clipped the channel edge while making the turn near buoy 28 while setting up to meet the outbound, computer-controlled, *SL Performance*. Neither piloted vessel had any difficulty meeting the computer-controlled ship. The piloted ships met between 30 and 32, with the inbound ship leaving the channel by 40 ft. There was 90 ft between the ships. Neither ship had any difficulties in the Lower and Upper Flat Range reaches. The outbound ship left the channel by nearly 60 ft while making the turn into the New Channel Range.

The track plots for the Plan 1 conditions, ebb tide, with pilot 5 inbound and pilot 6 outbound are shown in Plates 47 and 48. The inbound *Susan Maersk*

clipped the channel edge while making the turn near buoy 28 while setting up to meet the outbound, computer-controlled, *SL Performance*. Neither piloted vessel had any difficulty meeting the computer controlled ship. The piloted ships met between buoys 30 and 32, with the inbound ship leaving the channel by nearly 85 ft on the east side of the channel. After meeting, the ship-ship interaction forces caused the inbound ship to leave the west side of the channel by nearly 15 ft. The outbound ship left the Upper Flat Range area twice. The first occurred just south of the LNG terminal. This appeared to be caused by the ship's initial heading. The second was by about 30 ft as the ship approached the turn near buoy 39. The ships were approximately 60 ft apart when they met.

The track plots for the Plan 1 conditions, ebb tide, with pilot 6 inbound and pilot 5 outbound are shown in Plates 49 and 50. The inbound ship left the channel by approximately 60 ft while making the turn onto the New Channel Range, west of buoy 24. The inbound *Susan Maersk* clipped the channel edge while making the turn near buoy 28 while setting up to meet the outbound, computer-controlled, *SL Performance*. The inbound *Susan Maersk* crossed the channel limits while meeting the outbound, computer-controlled, *SL Performance*. The two *Susan Maersk*s met just north of buoy 30. The inbound ship left the channel by nearly 30 ft. The two ships were separated by about 65 ft. The outbound ship left the channel just south of the LNG terminal, due to the ship's initial heading.

Plan 1 conditions, flood tide

The track plots for the Plan 1 conditions, flood tide, with pilot 3 inbound and pilot 4 outbound are shown in Plates 51 and 52. The two *Susan Maersk*s meet just south of buoy 32. The outbound ship left the channel by about 30 ft and the two ships were about 65 ft apart. There were no other incidents by either ship during the exercise.

The track plots for the Plan 1 conditions, flood tide, with pilot 4 inbound and pilot 3 outbound are shown in Plates 53 and 54. The inbound *Susan Maersk* left the channel by about 30 ft on the south side of the channel between buoys 26 and 28. The two piloted ships met just north of buoy 30. The outbound ship left the channel by about 75 ft and the two ships were nearly 65 ft apart. The inbound *Susan Maersk* left the channel by about 15 ft on the north side of Lower Flats Range.

The track plots for the Plan 1 conditions, flood tide, with pilot 5 inbound and pilot 6 outbound are shown in Plates 55 and 56. The two piloted ships met between buoys 30 and 32. The outbound ship went entirely out of the channel during the meeting. The inbound ship left the north side of the channel by about 40 ft, across from buoy 35.

The track plots for the Plan 1 conditions, flood tide, with pilot 6 inbound and pilot 5 outbound are shown in Plates 57 and 58. The two *Susan Maersk*s met between of buoys 30 and 32. Both ships went about 50 ft out of the channel and were about 90 ft apart. The outbound ship left the north side of the channel by about 15 ft, across from buoy 35.

Plan 2 conditions, ebb tide

The track plots for the Plan 2 conditions, ebb tide, with pilot 3 inbound and pilot 4 outbound are shown in Plates 59 and 60. The inbound *Susan Maersk* clipped the channel edge while turning onto the New Channel Range. The inbound ship also clipped the channel edge while making the turn near buoy 28 while setting up to meet the outbound, computer-controlled, *SL Performance*. The two *Susan Maersk*s met between of buoys 30 and 32. The outbound ship ran along the channel's edge and the two ships were about 170 ft apart when they met. The outbound *Susan Maersk* went far into the turning basin across from the LNG terminal due the ship's initial heading.

The track plots for the Plan 2 conditions, ebb tide, with pilot 4 inbound and pilot 3 outbound are shown in Plates 61 and 62. The inbound *Susan Maersk* clipped the channel edge while turning onto the New Channel Range. The two-piloted ships met just north of buoy 30. Neither ship left the channel, although the outbound ship did go to the channel's edge. The ships were 125 ft apart when they met. The outbound ship left the channel by nearly 40 ft when making the turn onto the New Channel Range.

The track plots for the Plan 2 conditions, ebb tide, with pilot 5 inbound and pilot 6 outbound are shown in Plates 63 and 64. The two *Susan Maersk*s met near buoy 32. Both ships stayed within the channel limits and were 110 ft apart when they met. The outbound ship left the channel by nearly 50 ft when making the turn onto the New Channel Range.

Plan 2 conditions, flood tide

The track plots for the Plan 2 conditions, flood tide, with pilot 3 inbound and pilot 4 outbound are shown in Plates 65 and 66. The two *Susan Maersk*s met near buoy 32. Although the outbound ship ran along the channel edge during the meeting, both ships stayed within the channel limits. The ships were approximately 125 ft apart when they met.

The track plots for the Plan 2 conditions, flood tide, with pilot 4 inbound and pilot 3 outbound are shown in Plates 67 and 68. The two *Susan Maersk*s met just north of buoy 30. Although the outbound ship ran along the channel edge during the meeting, both ships stayed within the channel limits. The ships were nearly 100 ft apart when they met.

The track plots for the Plan 2 conditions, flood tide, with pilot 5 inbound and pilot 6 outbound are shown in Plates 69 and 70. The two *Susan Maersk*s met between buoys 30 and 32. Although the outbound ship ran along the channel edge during the meeting, both ships stayed within the channel limits. The ships were about 110 ft apart when they met.

The track plots for the Plan 2 conditions, flood tide, with pilot 6 inbound and pilot 5 outbound are shown in Plates 71 and 72. The inbound *Susan Maersk* clipped the channel edge while making the turn near buoy 28 while setting up to meet the outbound, computer-controlled, *SL Performance*. The two *Susan*

*Maersk*s met just north of buoy 30. Both ships went about 30 ft out of the channel while meeting. The ships were 130 ft apart when they met.

Wideners for Long Island Range tests

Composite runs of all S-class containerships passing through the Long Island Range wideners are shown in Figures 19 and 20.

The Bight and Fort Jackson Area

The results for the Bight and Fort Jackson Area simulations are presented in Plates 73-97. Three channel layouts were tested in this area. Two proposed channel configurations were tested. These two plans are referred to as Plan 2 and Plan 3. Plan 1 was eliminated during preliminary testing. The existing, Plan 2, and Plan 3 channels were simulated for two-way traffic operating in both ebb- and flood-tidal currents. The design ship for the existing channel was the *SL Performance*, loaded to 33 ft. The design ship for the Plan 2 and Plan 3 channels was the *Susan Maersk*, loaded to 47.5 ft.

Existing conditions, ebb tide

The track plot for existing conditions, ebb tide, with pilot 1 inbound and pilot 2 outbound is shown in Plate 73. Both the inbound and outbound ship stayed to the north side of the channel while making the turn through the Bight. The outbound ship left the channel by nearly 85 ft near buoy 44. The ships met in Fort Jackson Range near buoy 50. The ships kept far apart and the outbound ship left the channel by nearly 65 ft. The ships were about 265 ft apart when they met. The inbound ship went more than 60 ft out of the channel west of buoy 52 and by 40 ft on the north side of the Wrecks Channel.

The track plot for existing conditions, ebb tide, with pilot 4 inbound and pilot 3 outbound is shown in Plate 74. Both the inbound and outbound ship stayed to the north side of the channel while making the turn through the Bight. The outbound ship went nearly 120 ft out of the channel west of buoy 48. The inbound ship went completely out of the channel at the same point. The ships met on Oglethorpe Range, west of buoy 52. The inbound ship went completely out of the channel during the meeting. The ships were nearly 300 ft apart at this point. The inbound ship also left the north side of the Wrecks Channel by nearly 80 ft.

The track plot for existing conditions, ebb tide, with pilot 5 inbound and pilot 6 outbound is shown in Plate 75. The inbound ship left the north side of the channel twice, once west of buoy 42 and again west of buoy 48. The outbound ship left the channel by 90 ft while making the turn through the Bight. The ships met on Oglethorpe Range. The inbound ship went completely out of the channel west of buoy 52. The ships were nearly 280 ft apart when they met.

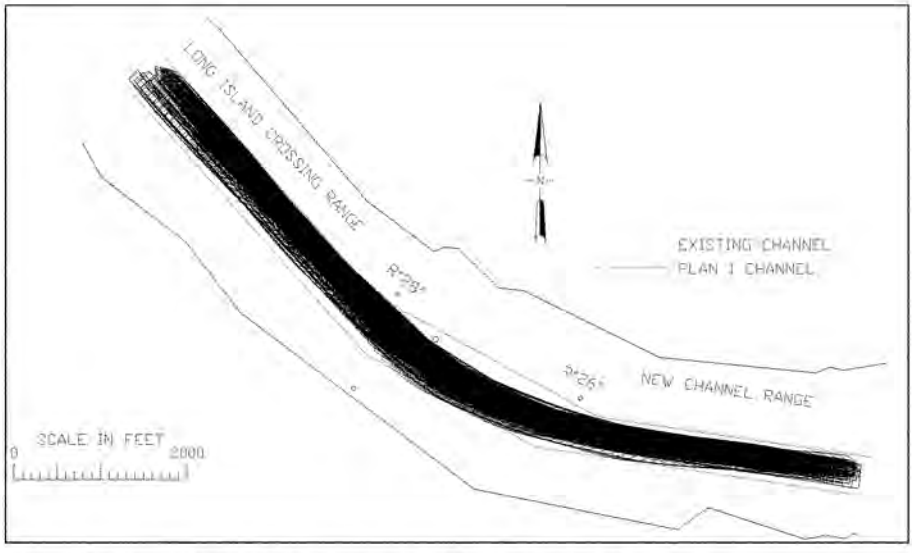


Figure 19. Composite plot of all S-class runs through New Channel Range widener

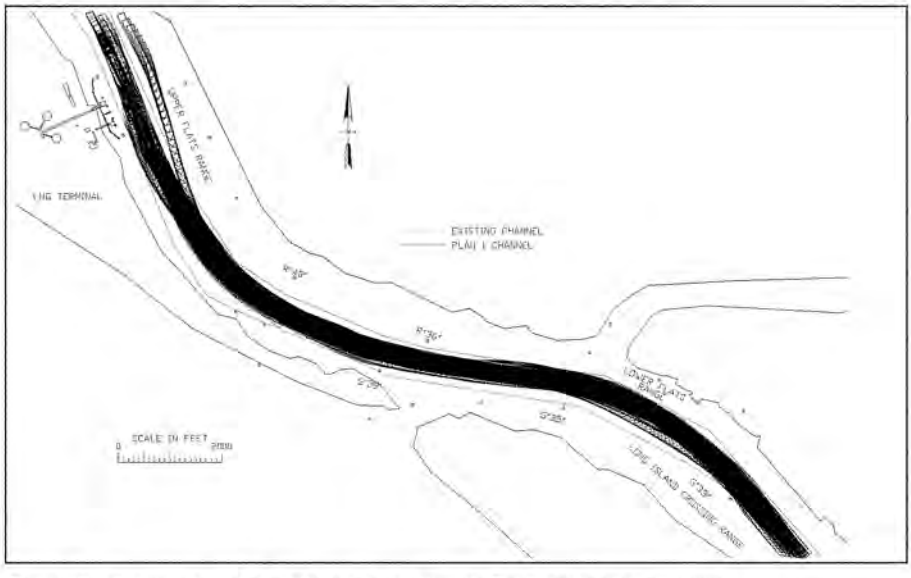


Figure 20. Composite plot of all S-class runs through Flats Range area wideners

The track plot for existing conditions, ebb tide, with pilot 6 inbound is shown in Plate 76. Pilot 5 was outbound for this run, but due to a simulator error, the data for the outbound ship was destroyed. The inbound ship left the channel by nearly 30 ft west of buoy 44. The inbound ship left the Oglethorpe Range by nearly 140 ft while meeting the outbound ship. The inbound ship left the channel by nearly 50 ft near buoy 58.

Existing conditions, flood tide

The track plot for existing conditions, flood tide, with pilot 3 inbound and pilot 4 outbound is shown in Plate 77. The inbound ship made the turn through the Bight by staying about 100 ft out of the channel. The outbound ship stayed in the center of the channel while making the same turn. The inbound ship left the Fort Jackson Range by 100 ft near buoy 50. The ships met on Oglethorpe Range with both ships staying about 110 ft from the channel edge and nearly 125 ft apart. The outbound ship cut across the Fig Island Turning Basin.

The track plot for existing conditions, flood tide, with pilot 4 inbound and pilot 3 outbound is shown in Plate 78. The inbound ship made the turn through the Bight by staying about 100 ft out of the channel. The inbound ship went to the west channel edge near buoy 50, but did not go out of the channel. The ships met on Oglethorpe Range, between buoys 52A and 53. The inbound ship went nearly 90 ft out of the channel during the meeting and the ships were about 210 ft apart. The outbound ship left the north side of the channel just east of the Fig Island Turning Basin.

The track plot for existing conditions, flood tide, with pilot 5 inbound and pilot 6 outbound is shown in Plate 79. The inbound ship made the turn through the Bight by staying about 100 ft out of the channel. The outbound ship remained in the center of the channel while making the turn. The two ships met on the western end of Oglethorpe Reach. The inbound ship went entirely out of the channel and the ships were about 250 ft apart while meeting.

The track plot for existing conditions, flood tide, with pilot 6 inbound and pilot 5 outbound is shown in Plate 80. The outbound pilot asked to be started in the Bight, to the far north of the channel. The outbound ship made the turn through the Bight by staying the center of the channel. The two ships met on Oglethorpe Range and the inbound ship went entirely out of the channel. The ships were over 300 ft apart when they met. The inbound ship left the channel by about 50 ft at the eastern end of the Fig Island Turning Basin.

Plan 2 conditions, ebb tide

The track plot for Plan 2 conditions, ebb tide, with pilot 2 inbound and pilot 1 outbound is shown in Plate 81. Neither ship left the channel while turning through the Bight. The inbound ship left the channel when the two ships met near buoy 50. The inbound ship went about 80 ft out of the north side of the Wrecks Channel.

The track plot for Plan 2 conditions, ebb tide, with pilot 3 inbound and pilot 4 outbound is shown in Plate 82. Neither ship left the channel while turning through the Bight. Both ships went out of the channel while meeting near buoy 52.

The track plot for Plan 2 conditions, ebb tide, with pilot 4 inbound and pilot 3 outbound is shown in Plate 83. The inbound ship left the north side of the channel by about 20 ft while turning through the Bight. The outbound ship turned through the Bight without leaving the channel. Both ships went out of the channel while meeting near buoy 52.

The track plot for Plan 2 conditions, ebb tide, with pilot 5 inbound and pilot 6 outbound is shown in Plate 84. Both ships completed the exercise without leaving the channel. The ships were about 50 ft apart when they met.

The track plot for Plan 2 conditions, ebb tide, with pilot 6 inbound and pilot 5 outbound is shown in Plate 85. The inbound *Susan Maersk* left the north side of the channel between buoys 42 and 44. Both ships left the channel by less than 30 ft while meeting just north of buoy 50.

Plan 2 conditions, flood tide

The track plot for Plan 2 conditions, flood tide, with pilot 3 inbound and pilot 4 outbound is shown in Plate 86. The inbound ship went about 100 ft out of the channel while making the turn out of the Bight. The ships met just east of buoys 52A and 53. The inbound ship left the channel during the meeting. Immediately after the meeting, the simulator output file was corrupted and nearly 2000 ft of data for the inbound ship was lost for this run. The inbound ship also left the Wrecks Channel by about 20 ft. The outbound ship remained within the authorized channel for the entire duration of the exercise.

The track plot for Plan 2 conditions, flood tide, with pilot 4 inbound and pilot 3 outbound is shown in Plate 87. The inbound ship left the north side of the channel by about 25 ft while making the turn out of the Bight. The two ships met east of buoy 52A, where the inbound ship left the channel by about 75 ft. The outbound ship remained within the authorized channel for the entire duration of the exercise.

The track plot for Plan 2 conditions, flood tide, with pilot 5 inbound and pilot 6 outbound is shown in Plate 88. The two ships met between buoys 52A and 53, where the inbound ship left the channel by about 70 ft. The inbound ship also left the Wrecks Channel by about 40 ft. The outbound ship remained within the authorized channel for the entire duration of the exercise.

The track plot for Plan 2 conditions, flood tide, with pilot 6 inbound and pilot 5 outbound is shown in Plate 89. The inbound ship left the channel by about 15 ft south of buoy 44. The two ships met east of buoys 52A and 53, where the inbound ship left the channel by about 35 ft. The inbound ship left the channel near buoy 58. The outbound ship remained within the authorized channel for the entire duration of the exercise.

Plan 3 conditions, ebb tide

The track plot for Plan 3 conditions, ebb tide, with pilot 3 inbound and pilot 4 outbound is shown in Plate 90. The inbound ship went too far north while approaching the Bight and went entirely out of the channel near buoy 44. The outbound ship also went out of the channel in the Bight, by about 25 ft near buoy 48. The inbound ship went completely out of the channel while meeting the outbound ship on Oglethorpe Range. The outbound ship swung its stern nearly 125 ft out while making the turn on the eastern end of Oglethorpe Range. The outbound ship also left the channel by approximately 60 ft west of buoy 53 and by about 130 ft across from buoy 57.

The track plot for Plan 3 conditions, ebb tide, with pilot 4 inbound and pilot 3 outbound is shown in Plate 91. Both the inbound and outbound ships left the north side of the channel while turning through the Bight. The outbound ship remained about 80 ft out of the channel throughout most of the turn, while the inbound ship went about 125 ft out, west of buoy 48. Both ships left the channel near buoy 50. The inbound ship left by approximately 40 ft, while the outbound left the channel by nearly 80 ft. Both ships were approximately 100 ft out of the channel while meeting on Oglethorpe Range. The outbound ship left the north side of the Wrecks Channel by nearly 90 ft.

The track plot for Plan 3 conditions, ebb tide, with pilot 6 inbound and pilot 5 outbound is shown in Plate 92. Both the inbound and outbound ship ran the Bight with their ships about halfway out of the channel. The ships met between buoys 50 and 52. Both ships left the channel while meeting. The inbound ship left the east side of the channel by about 50 ft, while the outbound ship left the west side by nearly 250 ft. The inbound ship left the Wreck Channel by over 100 ft.

Plan 3 conditions, flood tide

The track plot for Plan 3 conditions, flood tide, with pilot 2 inbound and pilot 1 outbound is shown in Plate 93. The inbound ship kept its stern outside the channel edge while turning through the Bight, and remained out of the channel until past buoy 50. The inbound ship left the east side of the channel near buoy 49, while approaching the Bight, but remained within the channel limits while turning through the Bight. The ships met on Oglethorpe Range, with the inbound and outbound ships leaving the channel by approximately 50 and 15 ft, respectively. The outbound ship went entirely out of the Wrecks Channel.

The track plot for Plan 3 conditions, flood tide, with pilot 3 inbound and pilot 4 outbound is shown in Plate 94. The inbound ship left the channel while entering and leaving the Bight, each time by about 20 ft. The two ships met on Oglethorpe Range, with the inbound ship leaving the channel by about 45 ft. The inbound ship left the north side of the channel across from buoy 57.

The track plot for Plan 3 conditions, flood tide, with pilot 4 inbound and pilot 3 outbound is shown in Plate 95. The inbound ship ran outside the channel while making the turn through the Bight, while the outbound ship remained

within the channel limits. The ships met in Oglethorpe Range where the inbound ship left the channel by approximately 30 ft. The inbound ship left the south side of the channel across from buoy 56 and both ships left the north side of Wrecks Channel.

The track plot for Plan 3 conditions, flood tide, with pilot 5 inbound and pilot 6 outbound is shown in Plate 96. The inbound ship left the channel while entering and leaving the Bight, each time by about 20 ft. The two ships met near buoy 52 and were both about 20 ft out of the channel.

The track plot for Plan 3 conditions, flood tide, with pilot 6 inbound and pilot 5 outbound is shown in Plate 97. The inbound ship stayed outside the channel while turning through the Bight. The outbound ship left the channel while entering and leaving the Bight. The ships met on Oglethorpe Range with the inbound ship leaving the channel by approximately 100 ft. Both ships left the north side of the Wrecks Channel.

City Front

A limited number of simulations were conducted for the City Front Reach. They were two-way simulations and they are shown in Plates 98-101. The *SL Performance* was used for existing conditions and the *Susan Maersk* was used for the Plan 1 channel.

Track plots for the ebb-and flood-tide runs in the existing channel are shown in Plates 98 and 99, respectively. The existing condition run for ebb tide, with pilot 6 inbound and pilot 5 outbound is shown in Plate 98. The outbound ship got caught in the ebb-tidal currents and left the western end of City Front Channel by about 150 ft. The two ships met near the bend in City Front Channel, near buoy 62. Both ships left the channel during the meeting. The inbound ship left the channel by about 50 ft and the outbound by nearly 20 ft. The inbound ship left the north side of the Wrecks Channel by about 50 ft. The existing condition run for flood tide, with pilot 6 inbound and pilot 5 outbound is shown in Plate 99. The two ships met near the western end of City Front Channel. The inbound ship left the north side of the channel by approximately 20 ft while meeting the outbound ship.

Track plots for the ebb- and flood-tide runs in the Plan 1 channel are shown in Plates 100 and 101, respectively. The Plan 1 condition run for ebb tide, with pilot 5 inbound and pilot 6 outbound is shown in Plate 100. The two ships met near the bend in City Front Channel, near buoy 62. The inbound ship cut the corner on the northern side of the channel just after meeting and left the channel by approximately 125 ft. The Plan 1 condition run for flood tide, with pilot 5 inbound and pilot 6 outbound is shown in Plate 101. The ships met near the bend in City Front Channel, near buoy 62. The outbound ship left the south side of the channel, during meeting, by nearly 25 ft. The inbound ship left the channel by approximately 125 ft while preparing to meet the outbound ship.

Kings Island

Four simulations were conducted for the Kings Island Reach. They were one-way simulations and they are shown in Plates 102-105. The *Susan Maersk* was used for all four exercises.

Two outbound runs were conducted during ebb tide. The track plots for these scenarios are shown in Plates 102 and 103. The runs were completed without incident. One outbound run with flood tide was simulated and the track plot is shown in Plate 104. The ship stayed to port side of the channel for the most part, leaving the channel twice by about 10 ft. The inbound run with flood tide was ended with the ship turning in the Kings Island Turning Basin. This exercise is shown in Plate 105. The run was completed without incident. The ship stayed close to the west side of the channel while turning, leaving a clearance of over 300 ft off its bow. The proposed Kings Island Turning Basin has a diameter of 1,650 ft. This proved to be adequate when turning the 1,140-ft-long *Susan Maersk*.

Additional Runs with 43-ft Draft *Susan Maersk*

After completion of the initial simulations, a series of runs were conducted with the *Susan Maersk's* draft set to 43 ft. This was done to determine if the 43-ft-draft vessel required less bend widening than when drafting 47.5 ft. With 4.5-ft less draft, the *Susan Maersk* should handle a little easier and possibly not require the additional room in the bends. These simulations were conducted with four Savannah Harbor pilots during October and November 2003. Results from that session are compared with the 47.5-ft *Susan Maersk*. The track plots are a composite with 47.5-ft runs shown in black and the 43-ft runs shown in grey.

A composite track plot comparing the 43-ft *Susan Maersk* and the 47.5-ft *Susan Maersk* are through the turn between Tybee and Blood Point Ranges is shown in Figure 21. These plots show little difference in runs between the two drafts.

A composite track plot comparing the 43-ft *Susan Maersk* and the 47.5-ft *Susan Maersk* through the turn between Jones Island Range turn is shown in Figure 22. These plots show little difference in runs between the two drafts.

A composite track plot comparing the 43-ft *Susan Maersk* and the 47.5-ft *Susan Maersk* through the turn between Upper and Lower Flats Ranges is shown in Figure 23. As with the preceding plots there is little difference in runs between the two drafts.

Comparisons between simulations of the *Susan Maersk* drafting 43 and 47.5 ft indicate that the same bend wideners are required for both drafts.

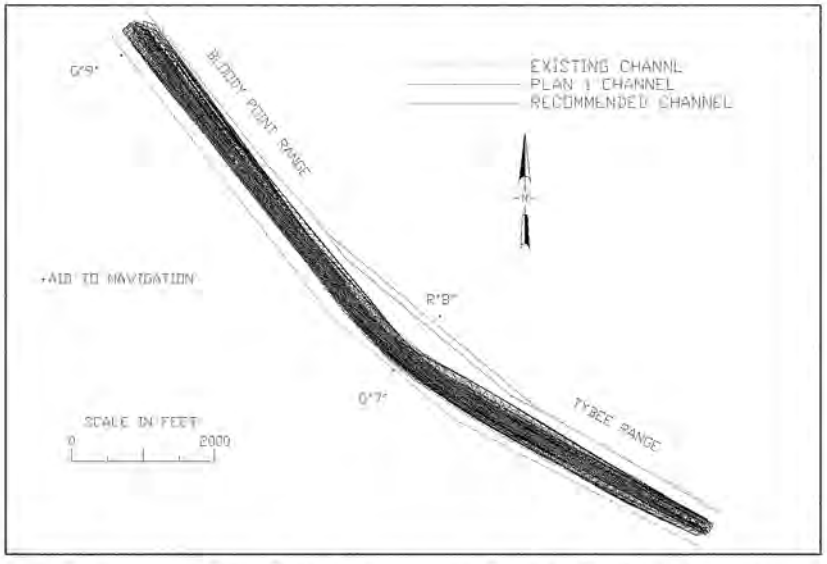


Figure 21. 43-ft draft *Susan Maersk* at turn between Tybee and Bloody Point Ranges

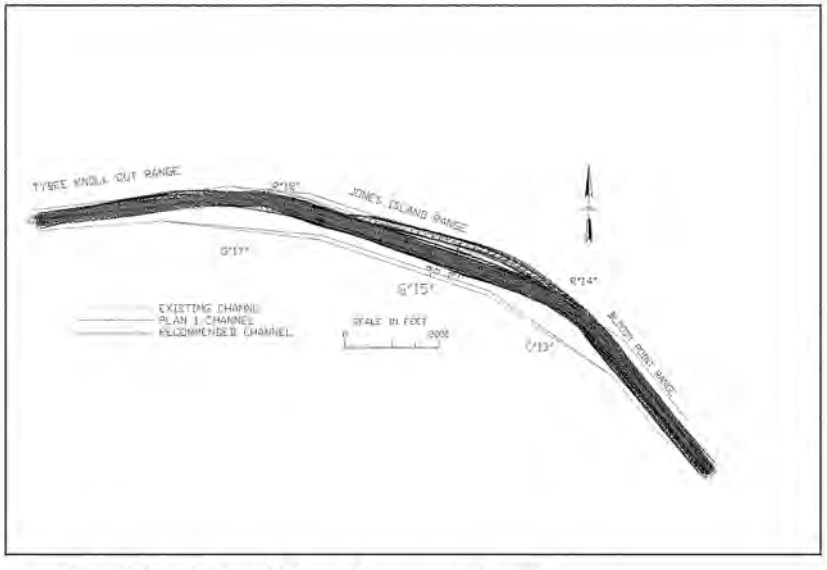


Figure 22. 43-ft draft *Susan Maersk* at Jones Island Range Turn

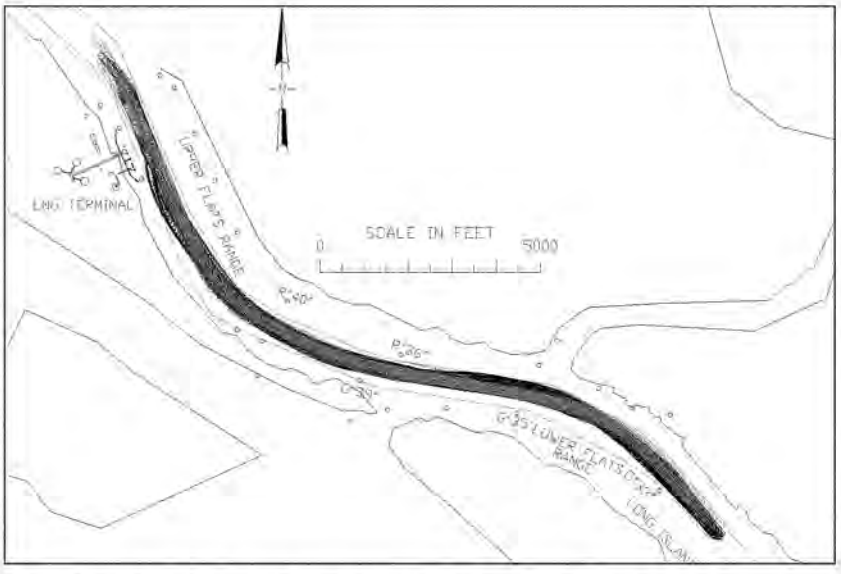


Figure 23. 43-ft *Susan Maersk* through Upper and Lower Flats Ranges

Vertical Motion Study

A vertical motion study was conducted to evaluate channel depth requirements. A series of simulations with a computer-controlled ship transiting Tybee Range were conducted. Two drafts of the *Susan Maersk* were simulated, 46ft and 47.5 ft. Wave conditions were selected based upon a concurrent wave modeled study conducted at ERDC (Thompson, in preparation).[1] Based upon analysis of the 35 percent highest waves the following conditions were chosen.

a. Waves were coming from a direction of 215 deg.

b. Wave heights of 6, 8 and 10 ft were simulated.

c. Wave periods of 8 and 10 sec were simulated.

Water depths from 48 to 56 ft were simulated, in 1-ft increments. Water depth is defined as the authorized channel depth plus tide. Therefore, a water depth of 54 ft could represent either a 54-ft channel at low water, or a 50-ft channel with 4 ft of tide.

[1] Thompson, op cit., p. 11.

The vertical motion model used was developed by Tracor Hydronautics and operated in fast-time. The simulated ship maneuvered with computer-controlled speed and heading based upon input conditions.

Results of the vertical motion study are presented in Table 1 and Plates 106-135 for the *Susan Maersk* at a 47.5-ft draft and in Table 2 and Plates 136-171 for the *Susan Maersk* at a 46.0-ft draft.

Table 1
Clearance for *Susan Maersk* Drafting 47.5 ft

Plate Number	Channel Depth, ft	Wave Height, ft	Wave Period, sec	Minimum Clearance, ft
106	52	6	8	Grounded
107	53	6	8	1
108	54	6	8	1.8
109	55	6	8	2.7
110	56	6	8	3.9
111	52	8	8	Grounded
112	53	8	8	0.6
113	54	8	8	1.6
114	55	8	8	2.6
115	56	8	8	3.8
116	52	10	8	Grounded
117	53	10	8	0.5
118	54	10	8	1.6
119	55	10	8	2.5
120	56	10	8	3.4
121	52	6	10	Grounded
122	53	6	10	0.9
123	54	6	10	1.8
124	55	6	10	2.6
125	56	6	10	3.7
126	52	8	10	Grounded
127	53	8	10	0.5
128	54	8	10	1.4
129	55	8	10	2.5
130	56	8	10	3.6
131	52	10	10	Grounded
132	53	10	10	0.3
133	54	10	10	1.2
134	55	10	10	2.4
135	56	10	10	3.5

Table 2
Clearance for *Susan Maersk* Drafting 46.0 ft

Plate Number	Channel Depth, ft	Wave Height, ft	Wave Period, sec	Minimum Clearance, ft
136	51	6	8	0.6
137	52	6	8	1.5
138	53	6	8	2.2
139	54	6	8	3.1
140	55	6	8	4.1
141	56	6	8	5.2
142	51	8	8	0.3
143	52	8	8	1.2
144	53	8	8	2.0
145	54	8	8	3.0
146	55	8	8	4.0
147	56	8	8	5.0
148	51	10	8	Grounded
149	52	10	8	1.1
150	53	10	8	1.7
151	54	10	8	2.9
152	55	10	8	3.9
153	56	10	8	4.8
154	51	6	10	0.3
155	52	6	10	1.4
156	53	6	10	2.1
157	54	6	10	3.1
158	55	6	10	4.0
159	56	6	10	5.0
160	51	8	10	0.1
161	52	8	10	1.2
162	53	8	10	2.0
163	54	8	10	3.0
164	55	8	10	3.9
165	56	8	10	5.0
166	51	10	10	Grounded
167	52	10	10	1.1
168	53	10	10	1.8
169	54	10	10	2.9
170	55	10	10	3.9
171	56	10	10	4.9

5 Conclusions and Recommendations

Recommendations are presented from the Atlantic Ocean, heading inland.

The Tybee Range Channel may be improved as per the Plan 1. Deepening to 48 ft on the existing side slopes will result in a 550-ft-wide channel. The widener on the north side of the turn between Tybee Range and Bloody Point Range was not used during any of the S-class simulations. Therefore, it is recommended that the channel be deepened on its existing side slopes as shown in Figure 24.

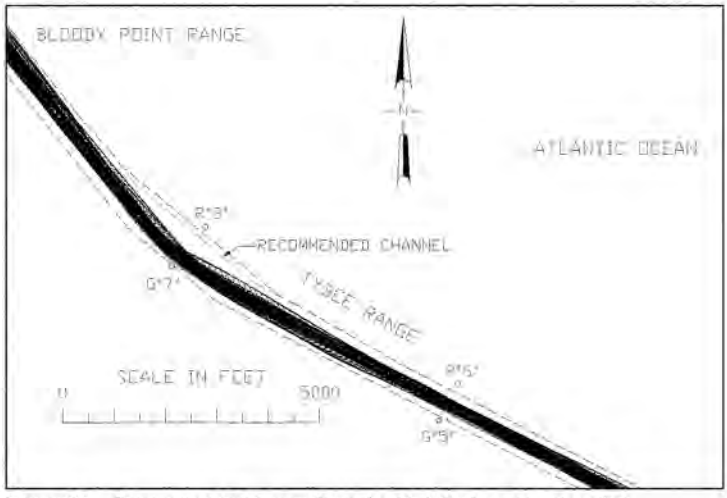


Figure 24. Recommended turn with tracks of all S-class containership simulations

The Bloody Point Range may be improved as per the Plan 1.

Plan 1 widened Jones Island Range on the south side. However, the simulated vessels showed a strong tendency to stay to the north side while making the turn

between Tybee Knoll Cut Range and Bloody Point Range (Figure 25). Therefore, it is recommended that the widening be shifted to the north side of Jones Island Range as shown in Figure 26.

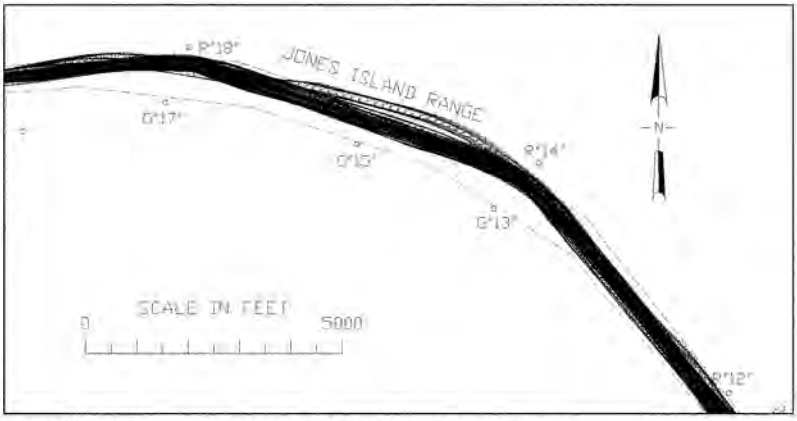


Figure 25. Jones Island Range, all S-class containership tracks

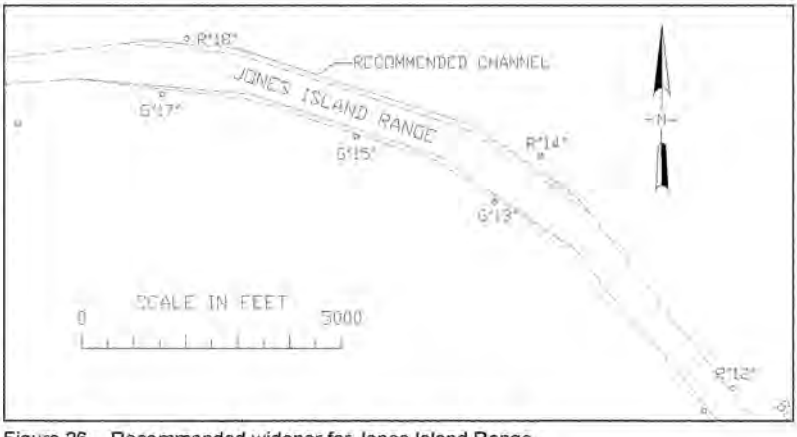


Figure 26. Recommended widener for Jones Island Range

The Tybee Knoll Cut Range and the New Channel Range may be deepened to 48 ft on their existing side slopes as simulated for Plan 1 conditions.

The wider Plan 2 channel is recommended for the Long Island Range. This is a long reach, fairly centrally located in the project. Providing the extra width will provide an excellent area for meeting of extremely large ships.

The Plan 1 channel is recommended for the Lower Flats Range. The pilots did not use the widenings on the west side of the turn between Lower and Upper Flats Ranges (previously shown in Figure 20) or on the west side of the Upper Flats Range or on the south side of The Bight Channel. Therefore, the 48-ft channel can be deepened on its existing side slopes in this area (Figure 27). Ships tended to stay to the north side of The Bight Channel. It is recommended that this area not be deepened on the existing side slopes, but be deepened on the existing limits.

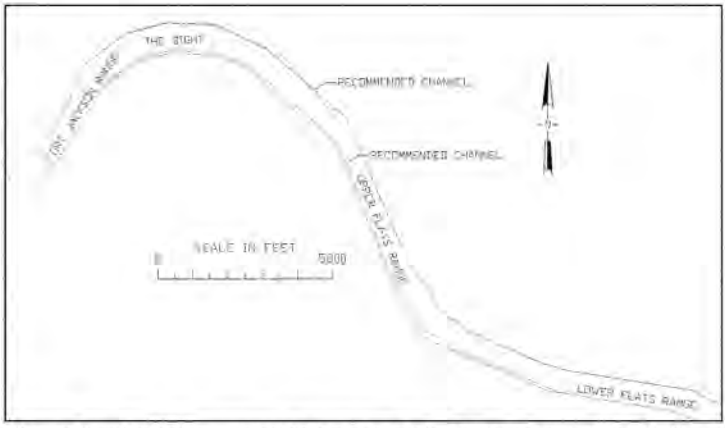


Figure 27. Channel recommendations Lower Flats Range through The Bight Channel

The Plan 2 channel is recommended for Fort Jackson Range. The additional 100 ft will provide a safe passing zone that the pilots can use with confidence. The pilots consistently relied upon the additional width for two-way traffic during the simulations. Fort Jackson Range is long enough that the pilots can easily coordinate meeting there if necessary.

Because of the ships' tendency to leave the channel a bit on the north side, it is recommended that the north side of Oglethorpe Range and Wrecks Channel not be deepened along the existing side slope but be deepened on the existing limits.

None of the wideners on the Wrecks Channel/City Front Channel area were used. They may be omitted from the 48-ft project.

The proposed 1,650-ft-diam Kings Island Turning Basin is adequate for turning the *Susan Maersk*. It is recommended that the basin be dredged as proposed.

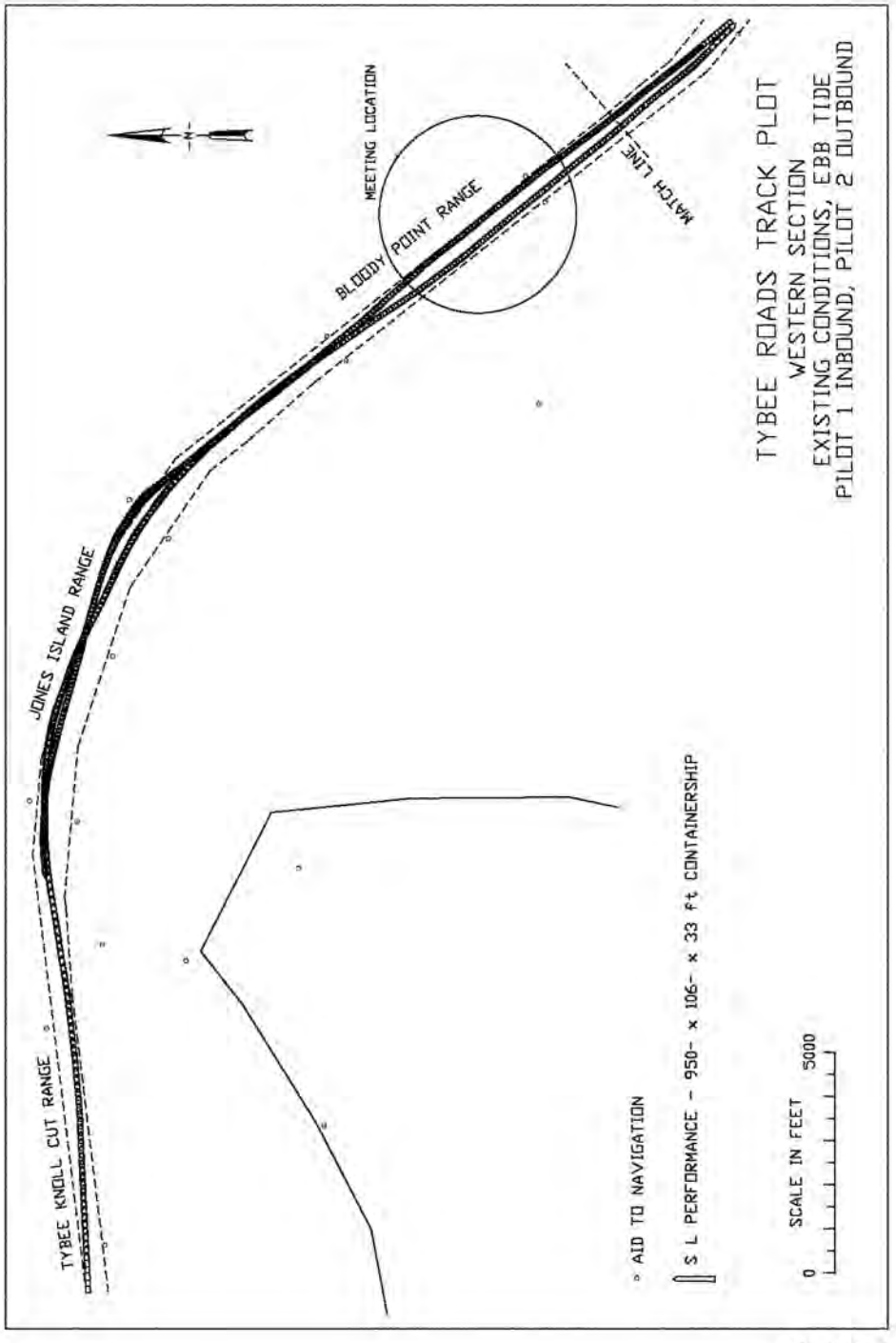

TYBEE ROADS TRACK PLOT
WESTERN SECTION
EXISTING CONDITIONS, EBB TIDE
PILOT 1 INBOUND, PILOT 2 OUTBOUND
TYBEE KNOLL CUT RANGE
JONES ISLAND RANGE
BLOODY POINT RANGE
MEETING LOCATION
MATCH LINE
AID TO NAVIGATION
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
0 SCALE IN FEET 5000

PLATE 1

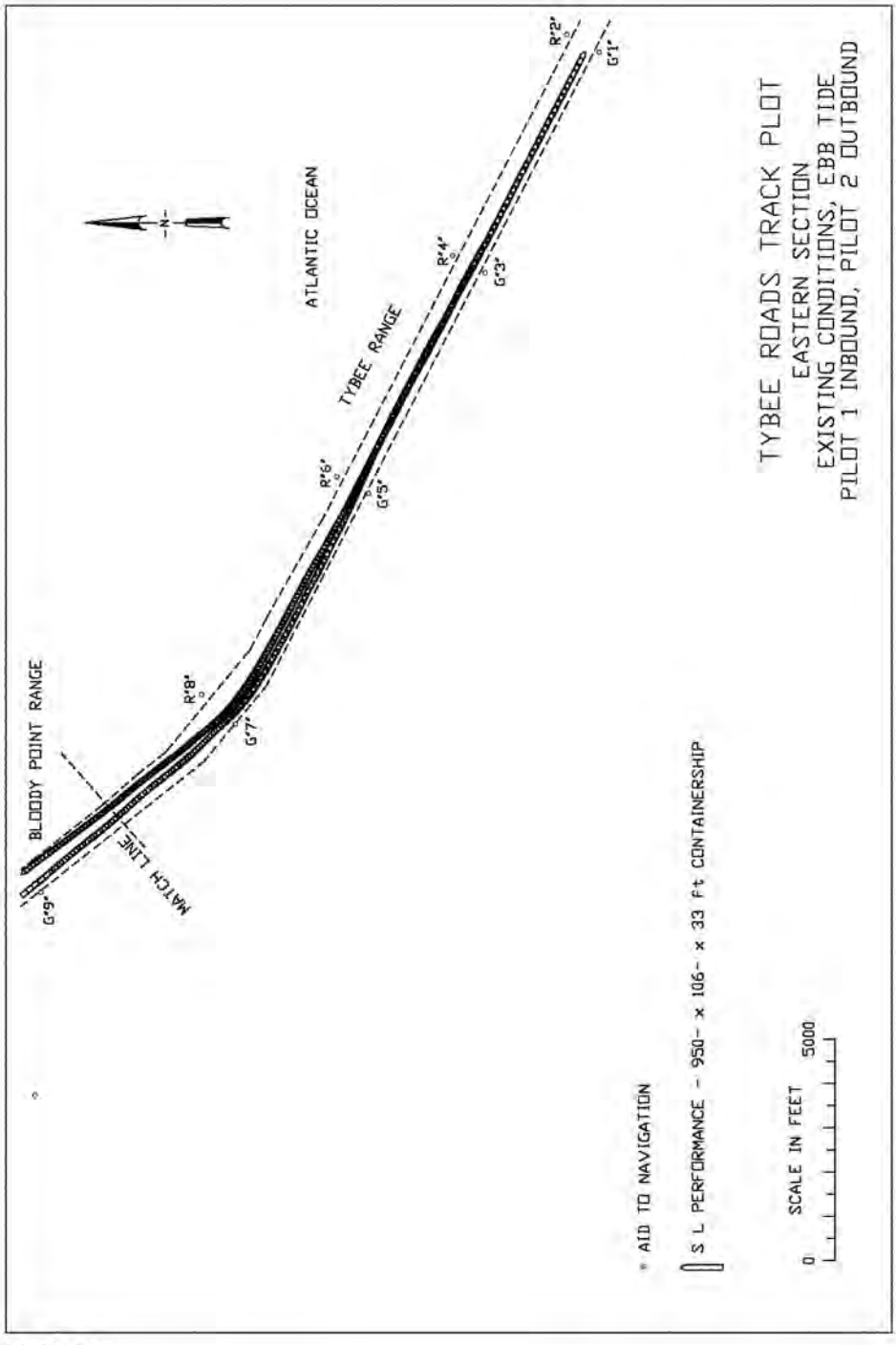

TYBEE ROADS TRACK PLOT
EASTERN SECTION
EXISTING CONDITIONS, EBB TIDE
PILOT 1 INBOUND, PILOT 2 OUTBOUND
ATLANTIC OCEAN
TYBEE RANGE
BLOODY POINT RANGE
MATCH LINE
R"8"
R"6"
R"4"
R"2"
G"7"
G"5"
G"3"
G"1"
G"9"
N
SCALE IN FEET
0
5000
S L PERFORMANCE - 950- x 106- x 33 Ft CONTAINERSHIP
AID TO NAVIGATION

PLATE 2

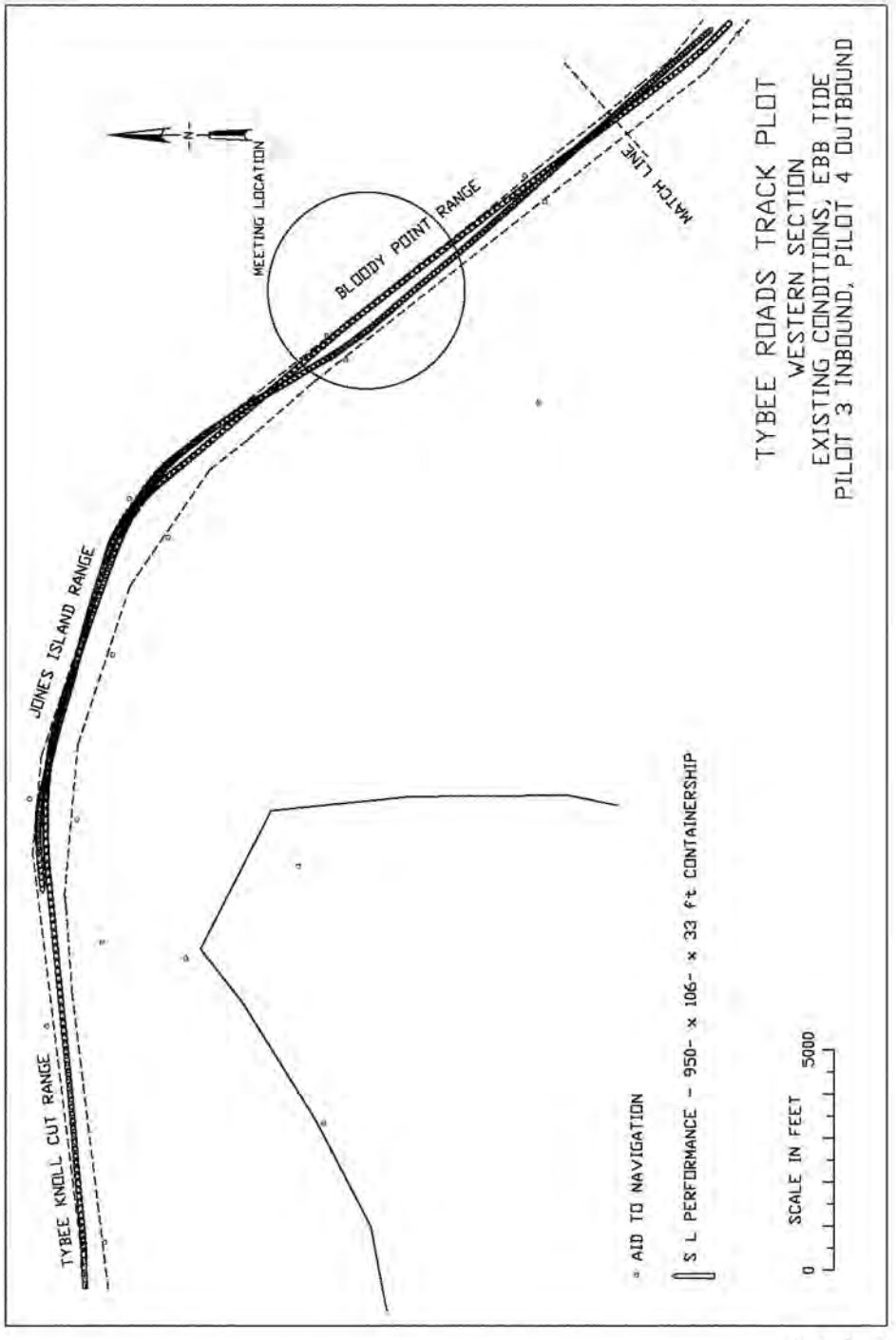

TYBEE ROADS TRACK PLOT
WESTERN SECTION
EXISTING CONDITIONS, EBB TIDE
PILOT 3 INBOUND, PILOT 4 OUTBOUND
TYBEE KNOLL CUT RANGE
JONES ISLAND RANGE
BLOODY POINT RANGE
MEETING LOCATION
MATCH LINE
AID TO NAVIGATION
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
0 SCALE IN FEET 5000

PLATE 3

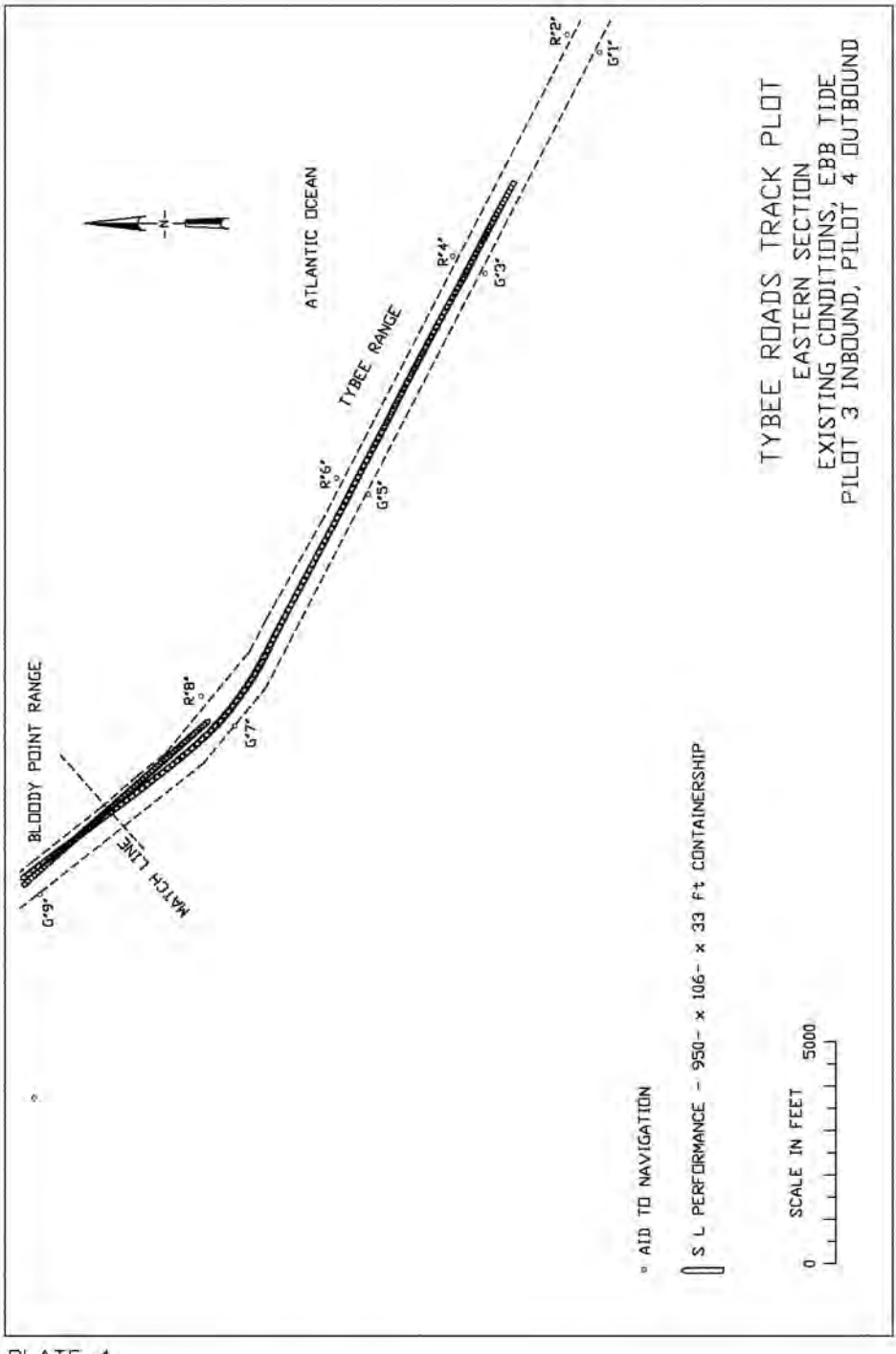

TYBEE ROADS TRACK PLOT
EASTERN SECTION
EXISTING CONDITIONS, EBB TIDE
PILOT 3 INBOUND, PILOT 4 OUTBOUND
ATLANTIC OCEAN
TYBEE RANGE
BLOODY POINT RANGE
MATCH LINE
R"8"
R"6"
R"4"
R"2"
G"7"
G"5"
G"3"
G"1"
G"9"
AID TO NAVIGATION
S L PERFORMANCE - 950- x 106- x 33 Ft CONTAINERSHIP
0 SCALE IN FEET 5000

PLATE 4

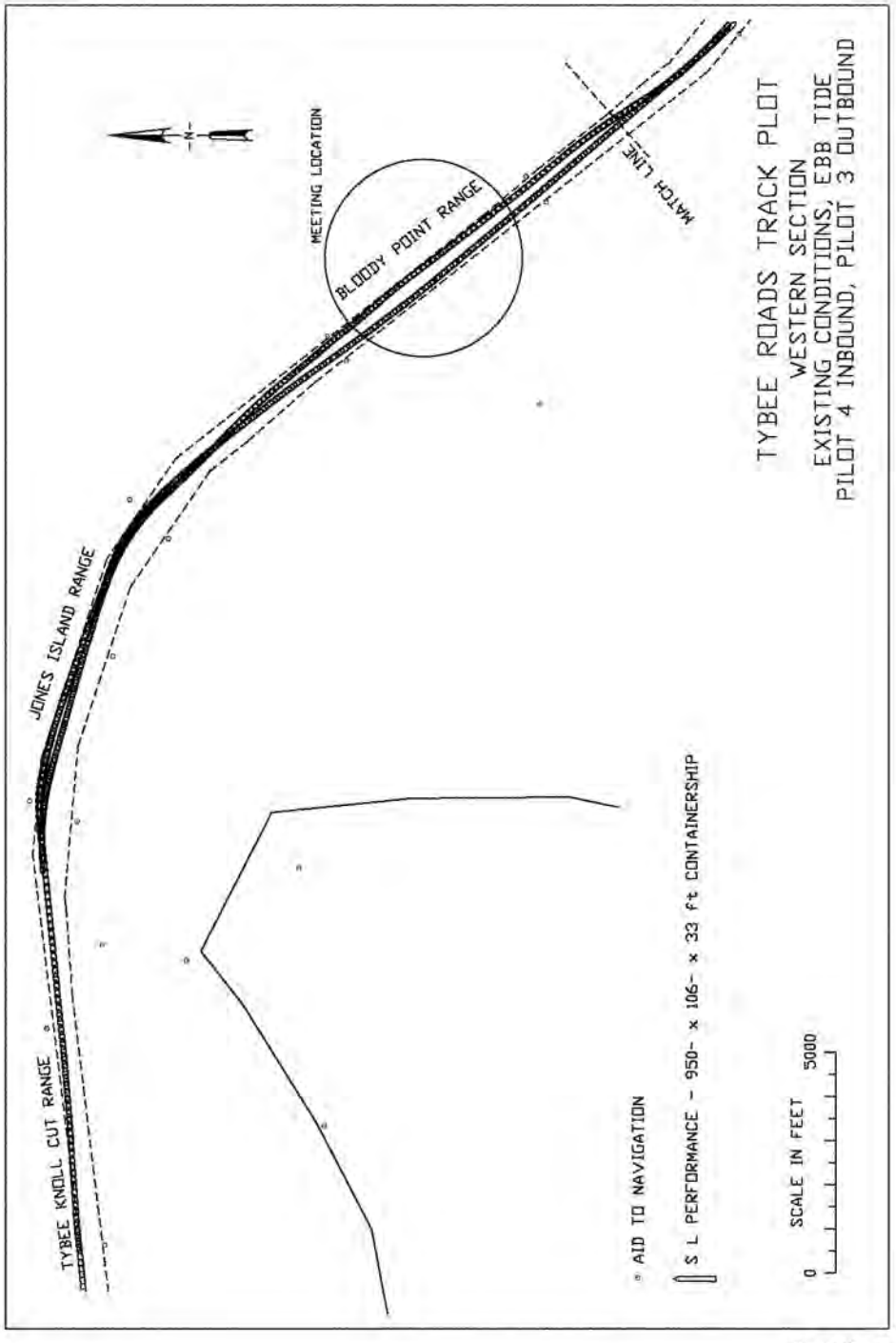

TYBEE ROADS TRACK PLOT
WESTERN SECTION
EXISTING CONDITIONS, EBB TIDE
PILOT 4 INBOUND, PILOT 3 OUTBOUND
TYBEE KNOLL CUT RANGE
JONES ISLAND RANGE
MEETING LOCATION
BLOODY POINT RANGE
MATCH LINE
N
AID TO NAVIGATION
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
0 SCALE IN FEET 5000

PLATE 5

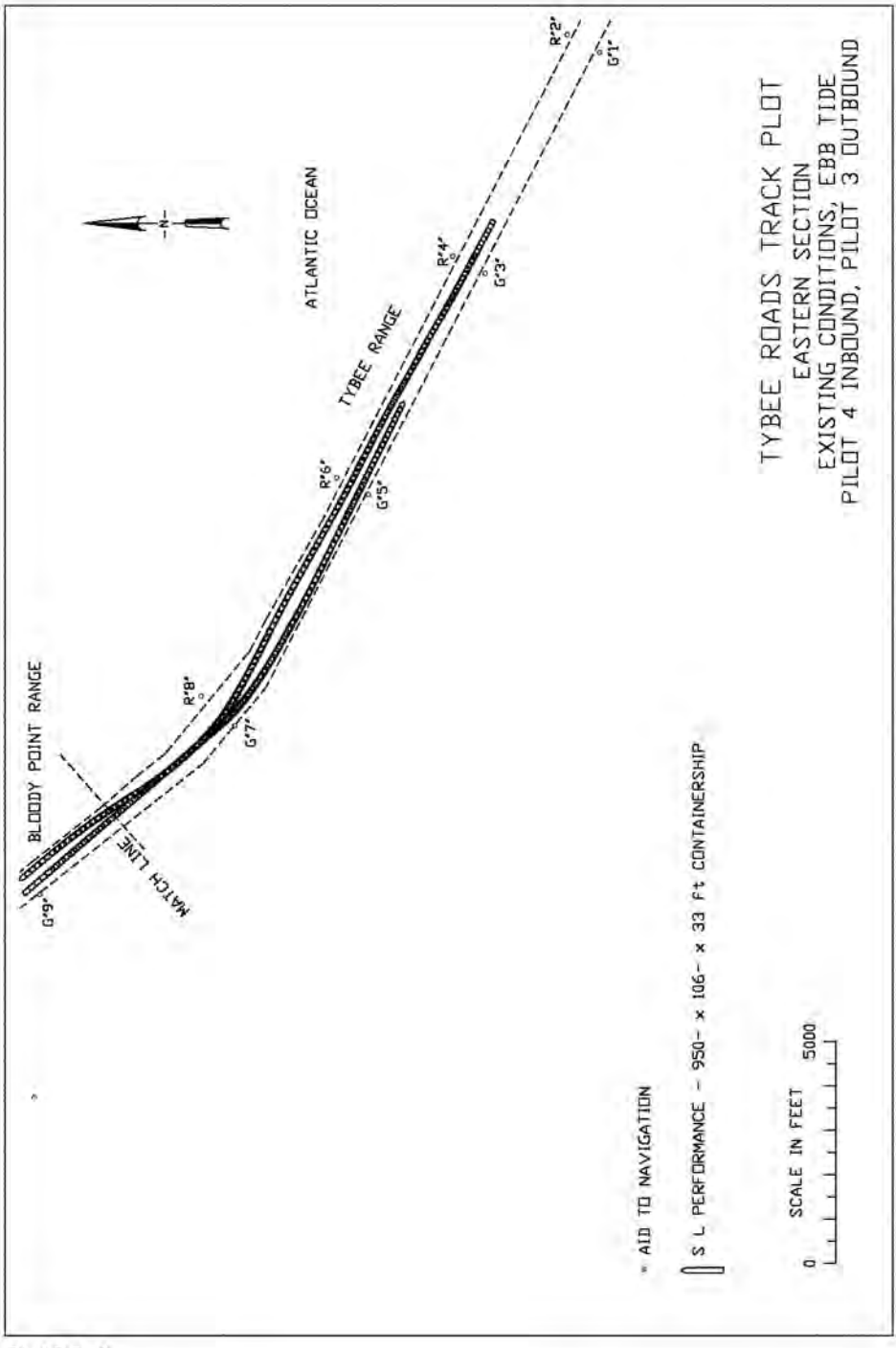

TYBEE ROADS TRACK PLOT
EASTERN SECTION
EXISTING CONDITIONS, EBB TIDE
PILOT 4 INBOUND, PILOT 3 OUTBOUND
ATLANTIC OCEAN
TYBEE RANGE
BLOODY POINT RANGE
MATCH LINE
R"2"
G"1"
R"4"
G"3"
R"6"
G"5"
R"8"
G"7"
G"9"
N
SCALE IN FEET
0
5000
S L PERFORMANCE - 950- x 106- x 33 Ft CONTAINERSHIP
= AID TO NAVIGATION

PLATE 6

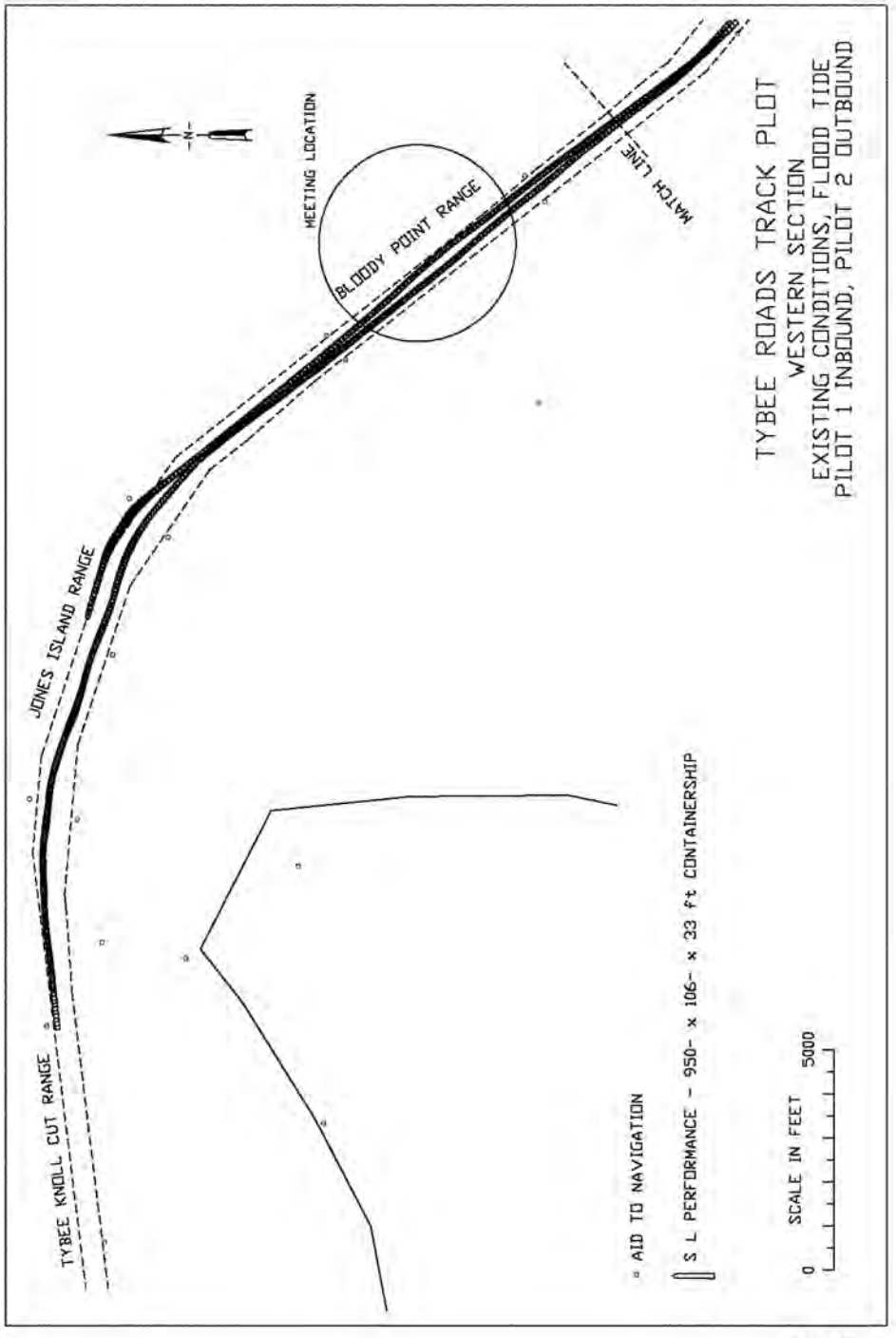

TYBEE ROADS TRACK PLOT
WESTERN SECTION
EXISTING CONDITIONS, FLOOD TIDE
PILOT 1 INBOUND, PILOT 2 OUTBOUND
TYBEE KNOLL CUT RANGE
JONES ISLAND RANGE
MEETING LOCATION
BLOODY POINT RANGE
MATCH LINE
N
AID TO NAVIGATION
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
0
SCALE IN FEET
5000

PLATE 7

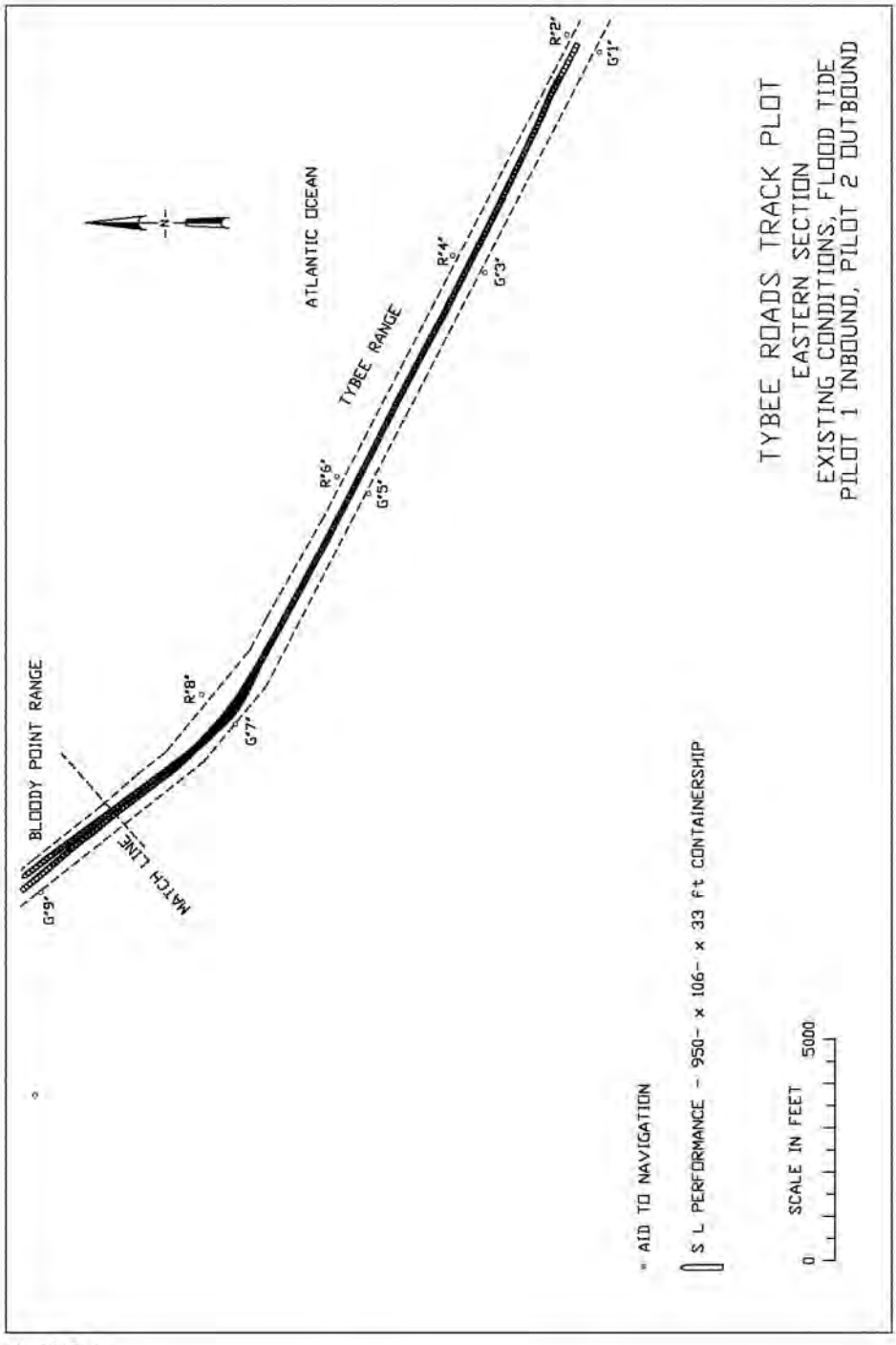

TYBEE ROADS TRACK PLOT
EASTERN SECTION
EXISTING CONDITIONS, FLOOD TIDE
PILOT 1 INBOUND, PILOT 2 OUTBOUND
BLOODY POINT RANGE
MATCH LINE
TYBEE RANGE
ATLANTIC OCEAN
R"8"
G"7"
R"6"
G"5"
R"4"
G"3"
R"2"
G"1"
G"9"
N
SCALE IN FEET
0
5000
= AID TO NAVIGATION
S L PERFORMANCE - 950- x 106- x 33 Ft CONTAINERSHIP

PLATE 8

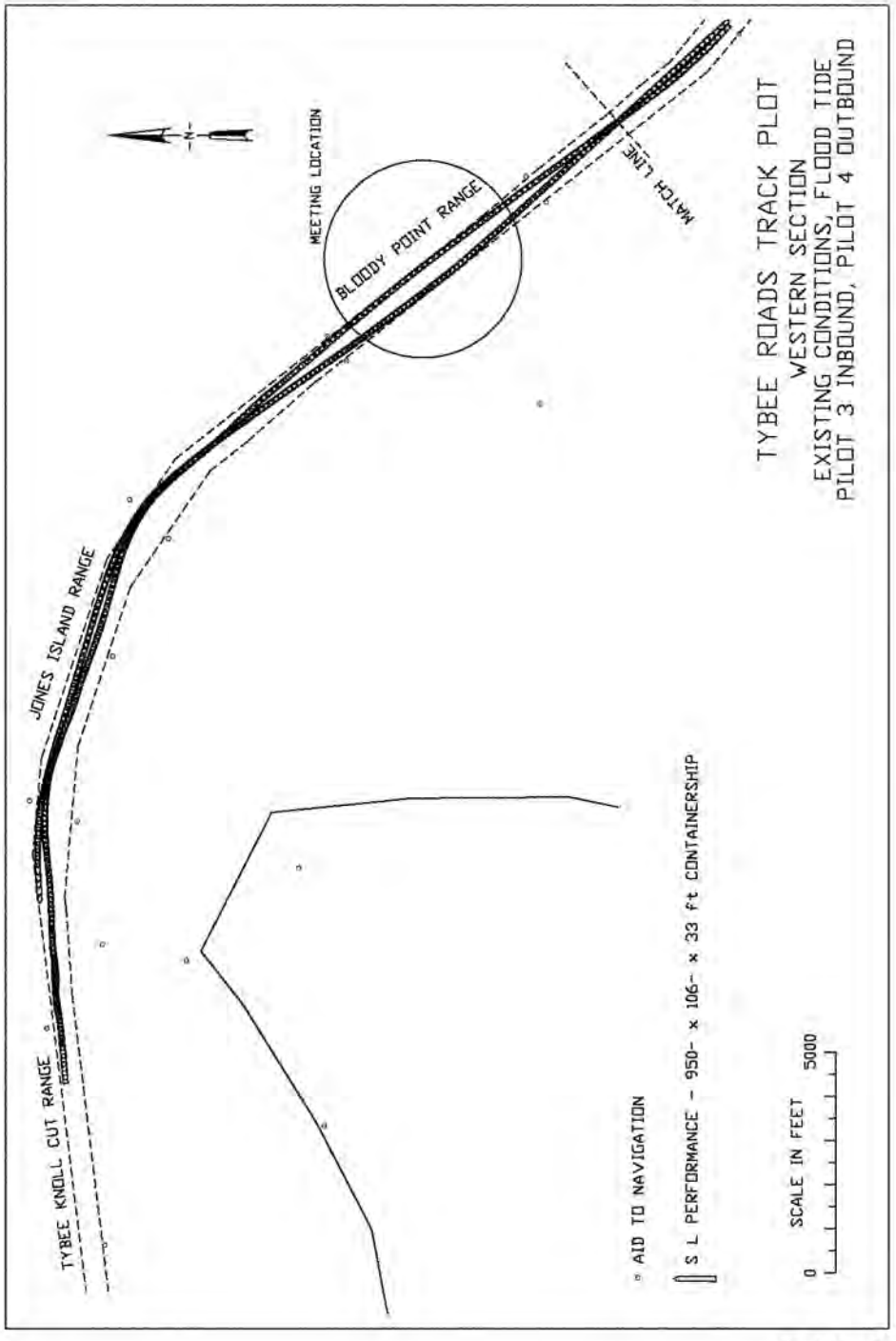

TYBEE ROADS TRACK PLOT
WESTERN SECTION
EXISTING CONDITIONS, FLOOD TIDE
PILOT 3 INBOUND, PILOT 4 OUTBOUND
TYBEE KNOLL CUT RANGE
JONES ISLAND RANGE
MEETING LOCATION
BLOODY POINT RANGE
MATCH LINE
N
AID TO NAVIGATION
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
0
SCALE IN FEET
5000

PLATE 9

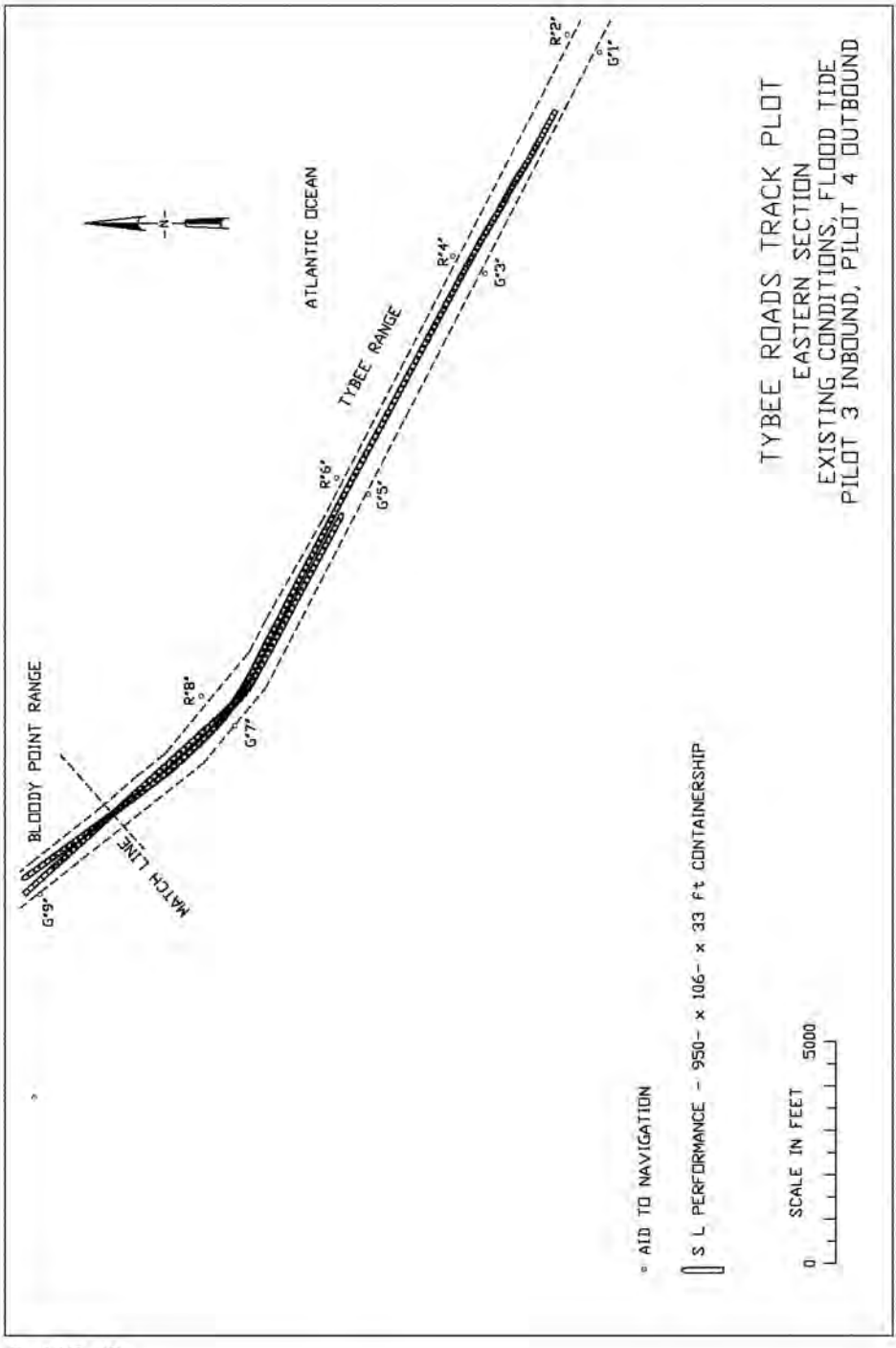

TYBEE ROADS TRACK PLOT
EASTERN SECTION
EXISTING CONDITIONS, FLOOD TIDE
PILOT 3 INBOUND, PILOT 4 OUTBOUND
ATLANTIC OCEAN
TYBEE RANGE
BLOODY POINT RANGE
MATCH LINE
R"2"
G"1"
R"4"
G"3"
R"6"
G"5"
R"8"
G"7"
G"9"
N
AID TO NAVIGATION
S L PERFORMANCE - 950- x 106- x 33 Ft CONTAINERSHIP
0
SCALE IN FEET
5000

PLATE 10

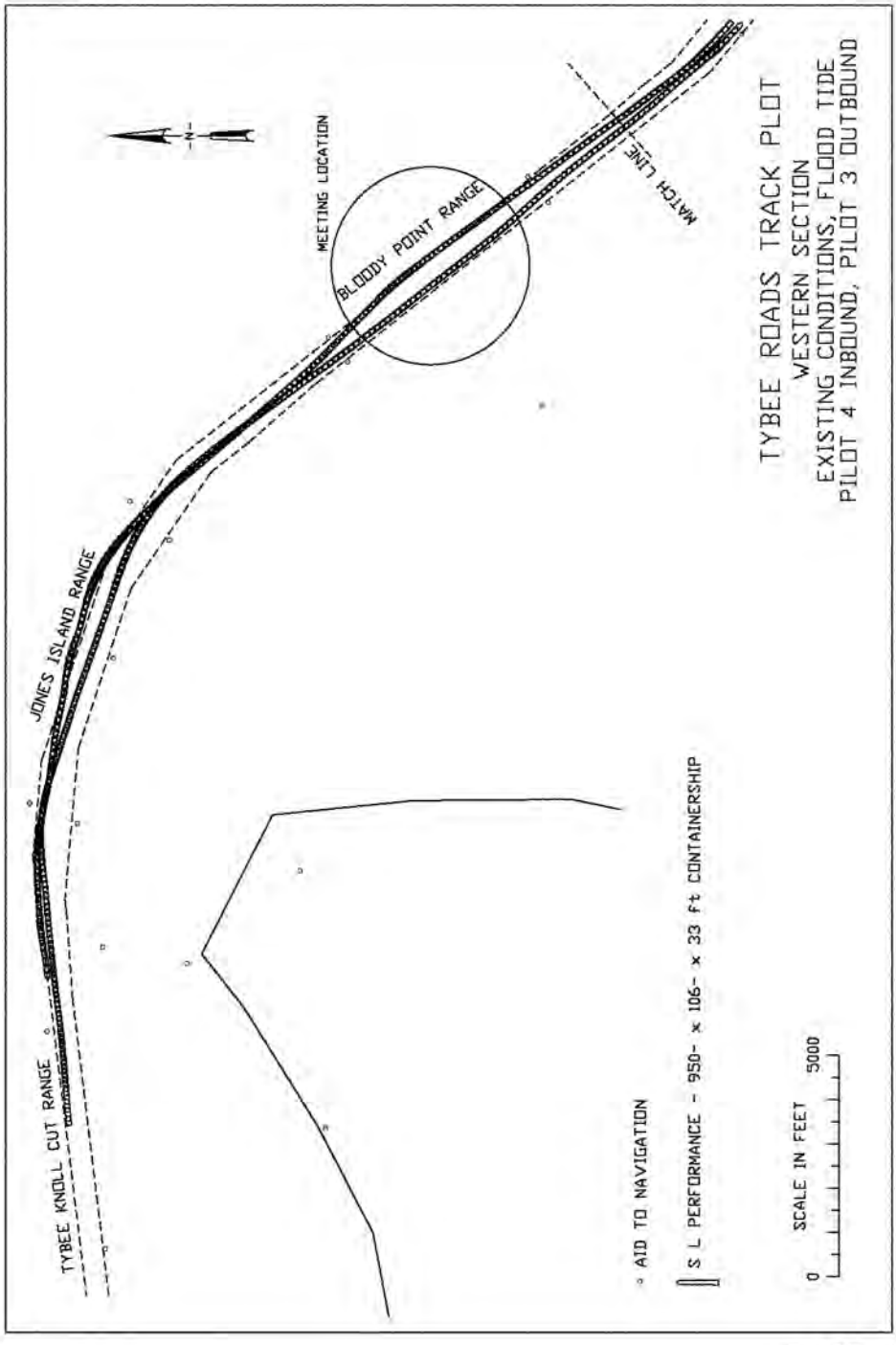

TYBEE ROADS TRACK PLOT
WESTERN SECTION
EXISTING CONDITIONS, FLOOD TIDE
PILOT 4 INBOUND, PILOT 3 OUTBOUND
TYBEE KNOLL CUT RANGE
JONES ISLAND RANGE
MEETING LOCATION
BLOODY POINT RANGE
MATCH LINE
N
AID TO NAVIGATION
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
0
SCALE IN FEET
5000

PLATE 11

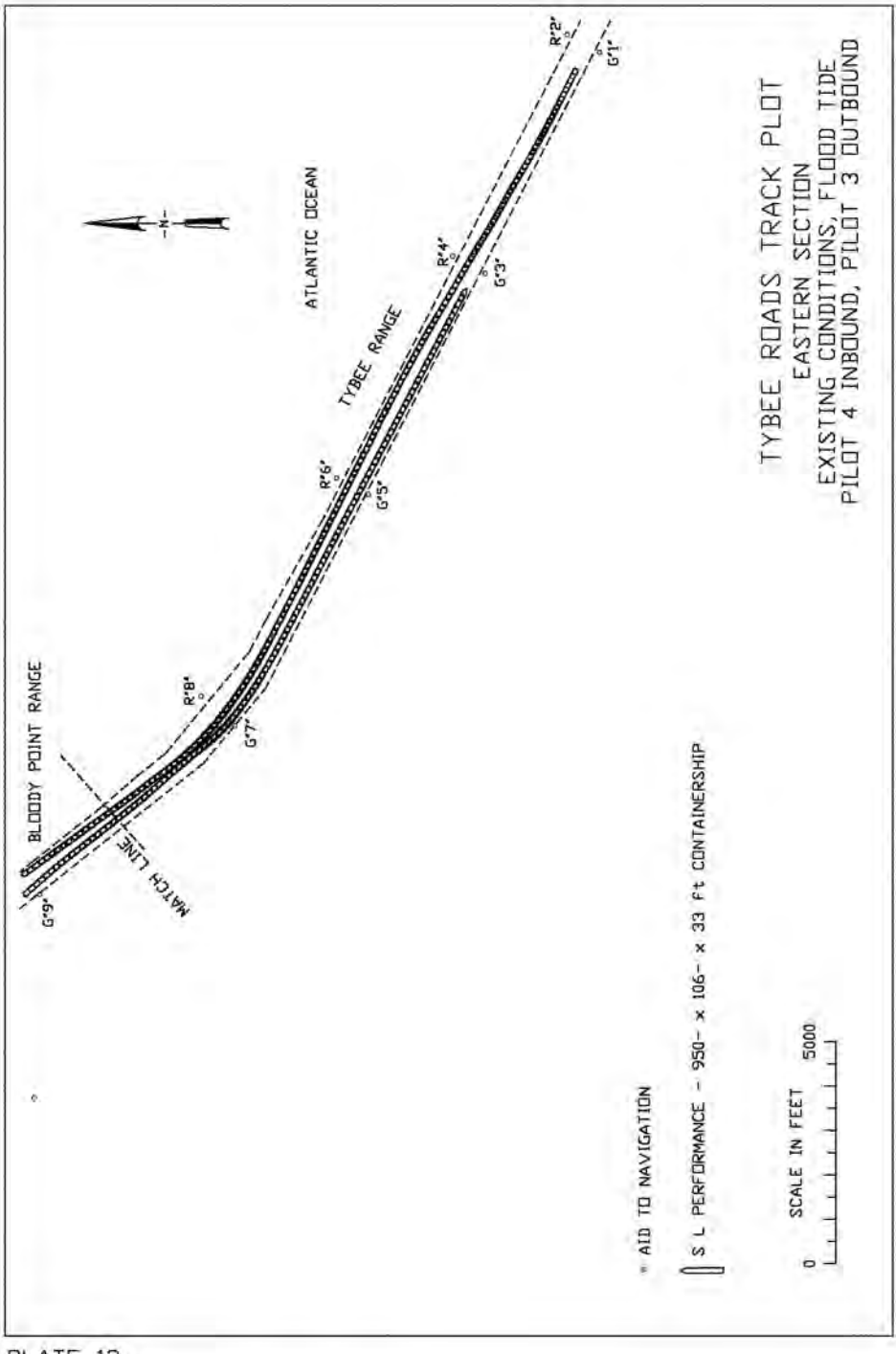

TYBEE ROADS TRACK PLOT
EASTERN SECTION
EXISTING CONDITIONS, FLOOD TIDE
PILOT 4 INBOUND, PILOT 3 OUTBOUND
ATLANTIC OCEAN
TYBEE RANGE
BLOODY POINT RANGE
MATCH LINE
R"2"
G"1"
R"4"
G"3"
R"6"
G"5"
R"8"
G"7"
G"9"
N
SCALE IN FEET
0
5000
S L PERFORMANCE - 950- x 106- x 33 Ft CONTAINERSHIP
= AID TO NAVIGATION

PLATE 12

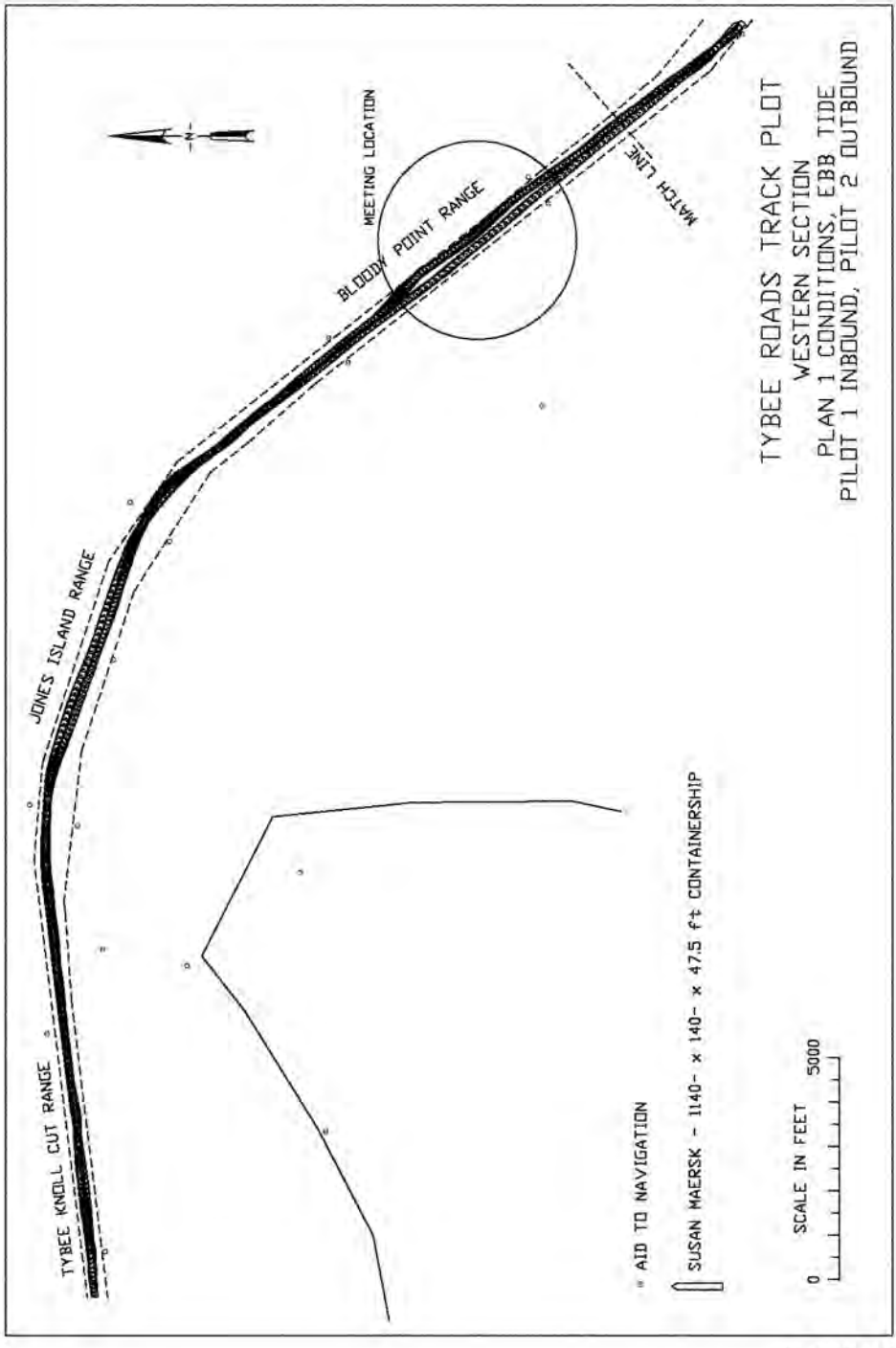

TYBEE ROADS TRACK PLOT
WESTERN SECTION
PLAN 1 CONDITIONS, EBB TIDE
PILOT 1 INBOUND, PILOT 2 OUTBOUND
TYBEE KNOLL CUT RANGE
JONES ISLAND RANGE
BLOODY POINT RANGE
MEETING LOCATION
MATCH LINE
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
= AID TO NAVIGATION
0 SCALE IN FEET 5000

PLATE 13

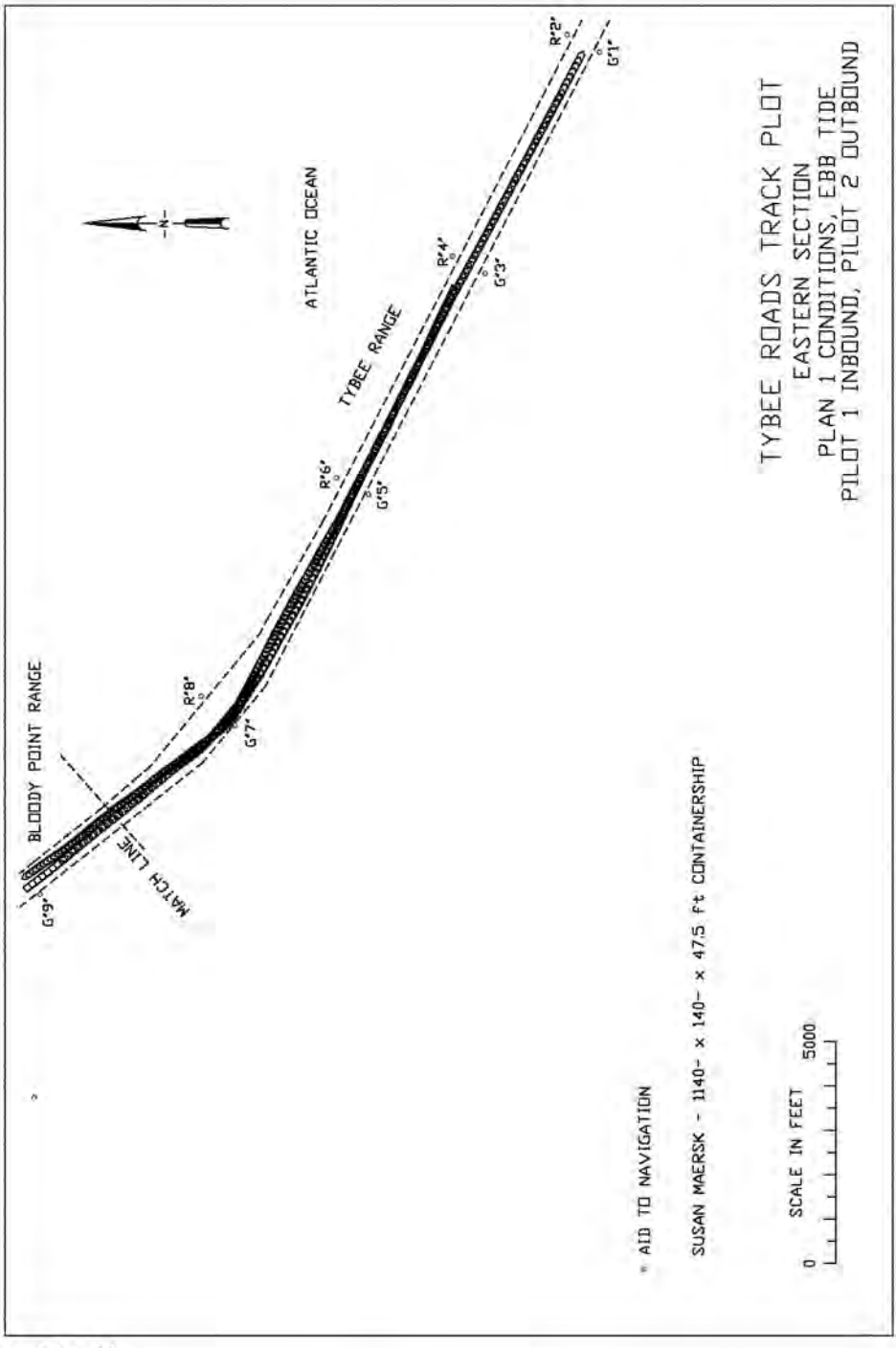

TYBEE ROADS TRACK PLOT
EASTERN SECTION
PLAN 1 CONDITIONS, EBB TIDE
PILOT 1 INBOUND, PILOT 2 OUTBOUND
ATLANTIC OCEAN
TYBEE RANGE
BLOODY POINT RANGE
MATCH LINE
R"8"
R"6"
R"4"
R"2"
G"9"
G"7"
G"5"
G"3"
G"1"
SCALE IN FEET
0
5000
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
* AID TO NAVIGATION

PLATE 14

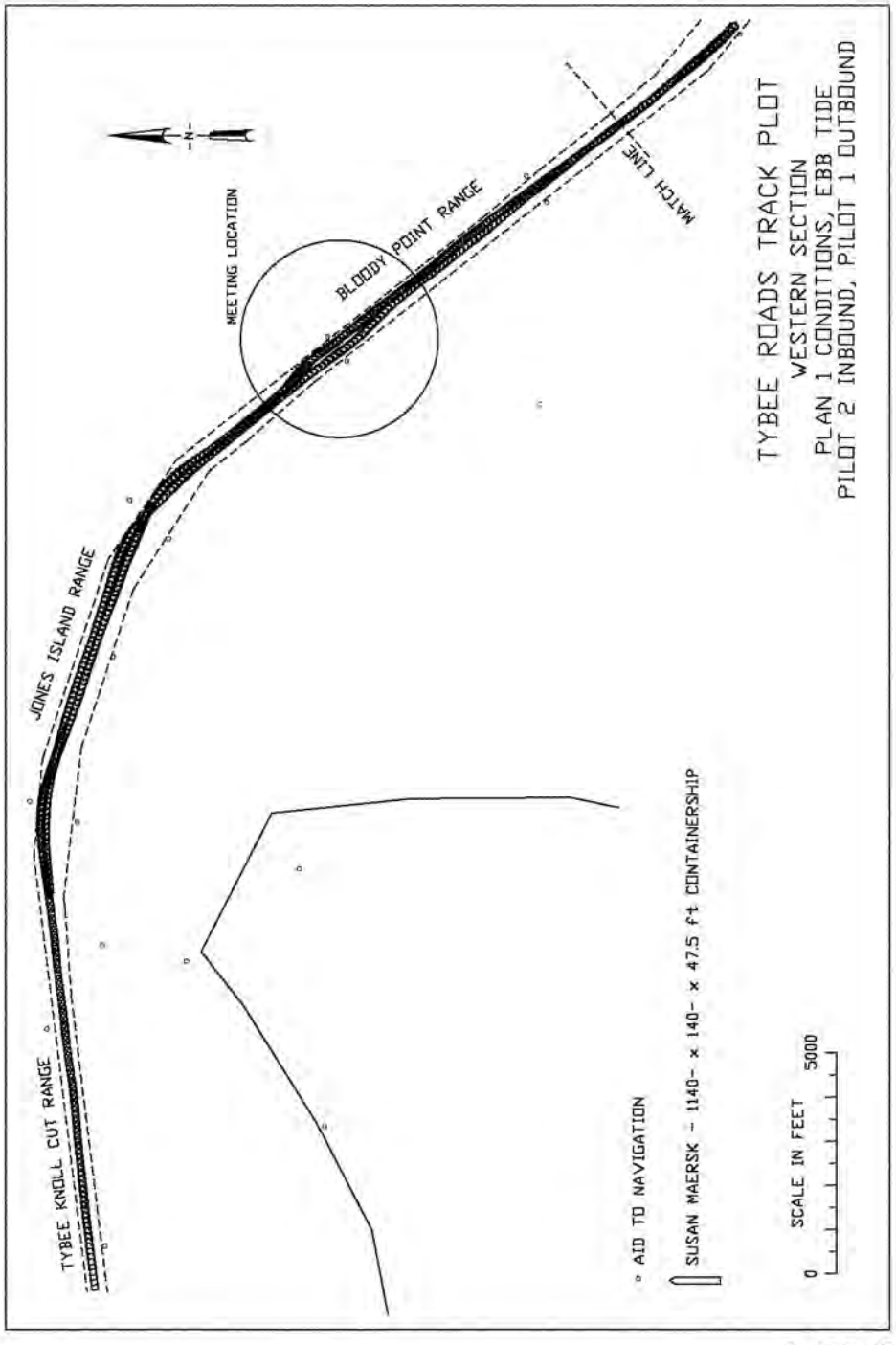

TYBEE ROADS TRACK PLOT
WESTERN SECTION
PLAN 1 CONDITIONS, EBB TIDE
PILOT 2 INBOUND, PILOT 1 OUTBOUND
TYBEE KNOLL CUT RANGE
JONES ISLAND RANGE
MEETING LOCATION
BLOODY POINT RANGE
MATCH LINE
N
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
0
SCALE IN FEET
5000

PLATE 15

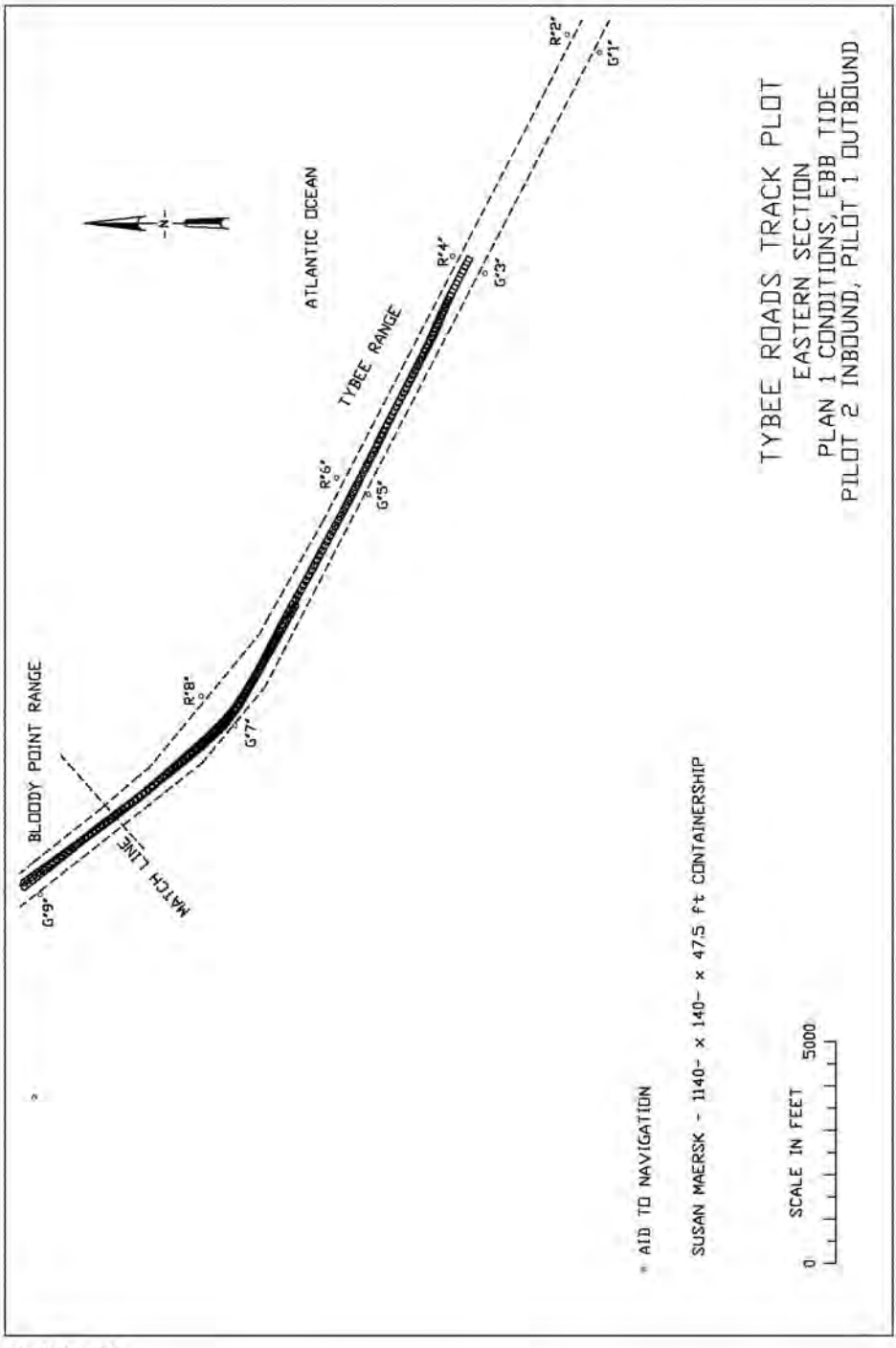

TYBEE ROADS TRACK PLOT
EASTERN SECTION
PLAN 1 CONDITIONS, EBB TIDE
PILOT 2 INBOUND, PILOT 1 OUTBOUND
ATLANTIC OCEAN
TYBEE RANGE
BLOODY POINT RANGE
MATCH LINE
R"8"
R"6"
R"4"
R"2"
G"7"
G"5"
G"3"
G"1"
G"9"
N
SCALE IN FEET
0
5000
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
* AID TO NAVIGATION

PLATE 16

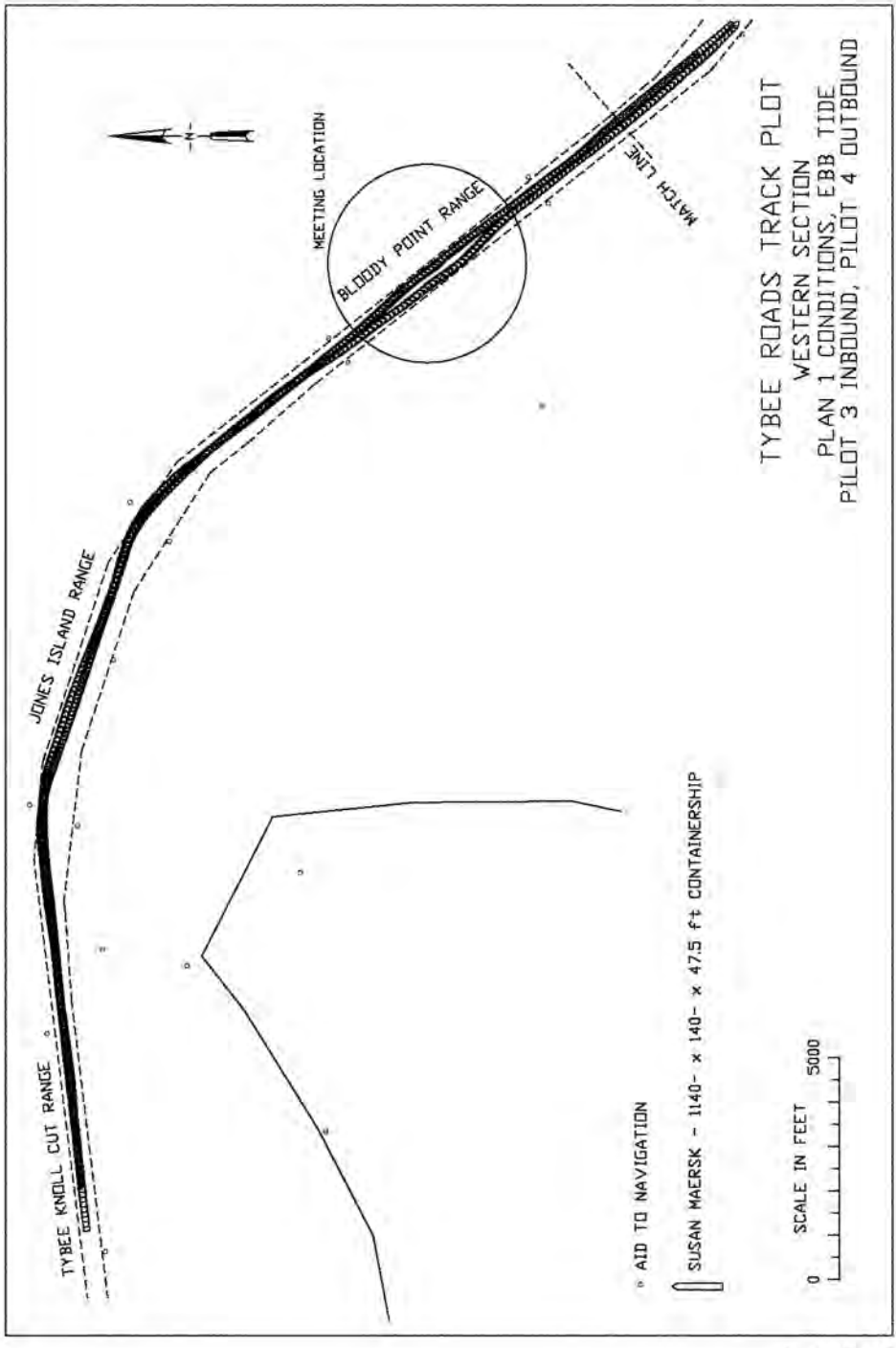

TYBEE ROADS TRACK PLOT
WESTERN SECTION
PLAN 1 CONDITIONS, EBB TIDE
PILOT 3 INBOUND, PILOT 4 OUTBOUND
TYBEE KNOLL CUT RANGE
JONES ISLAND RANGE
MEETING LOCATION
BLOODY POINT RANGE
MATCH LINE
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
0 SCALE IN FEET 5000

PLATE 17

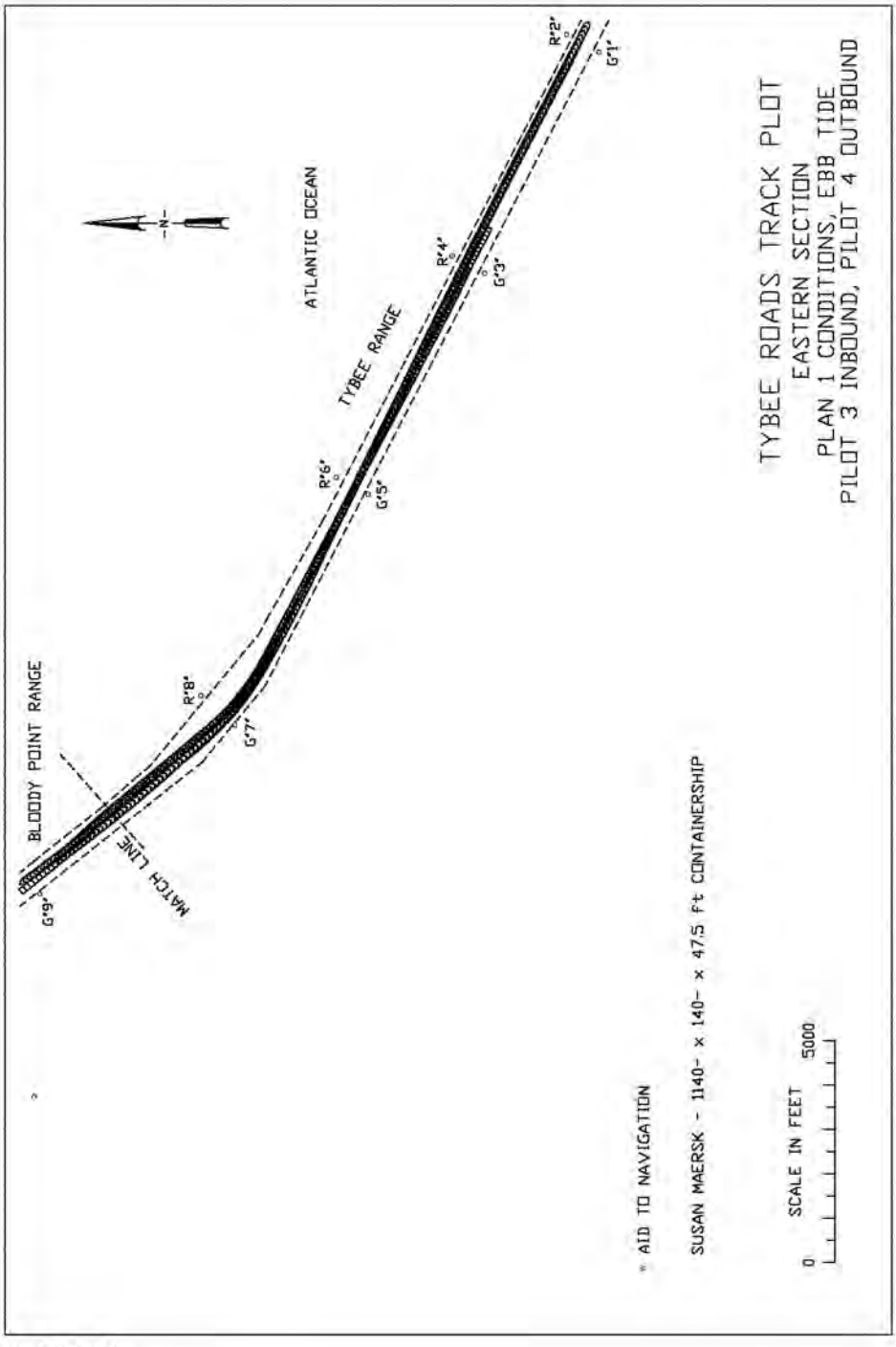

TYBEE ROADS TRACK PLOT
EASTERN SECTION
PLAN 1 CONDITIONS, EBB TIDE
PILOT 3 INBOUND, PILOT 4 OUTBOUND
ATLANTIC OCEAN
TYBEE RANGE
BLOODY POINT RANGE
MATCH LINE
R"2"
G"1"
R"4"
G"3"
R"6"
G"5"
R"8"
G"7"
G"9"
SCALE IN FEET
0
5000
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
* AID TO NAVIGATION

PLATE 18

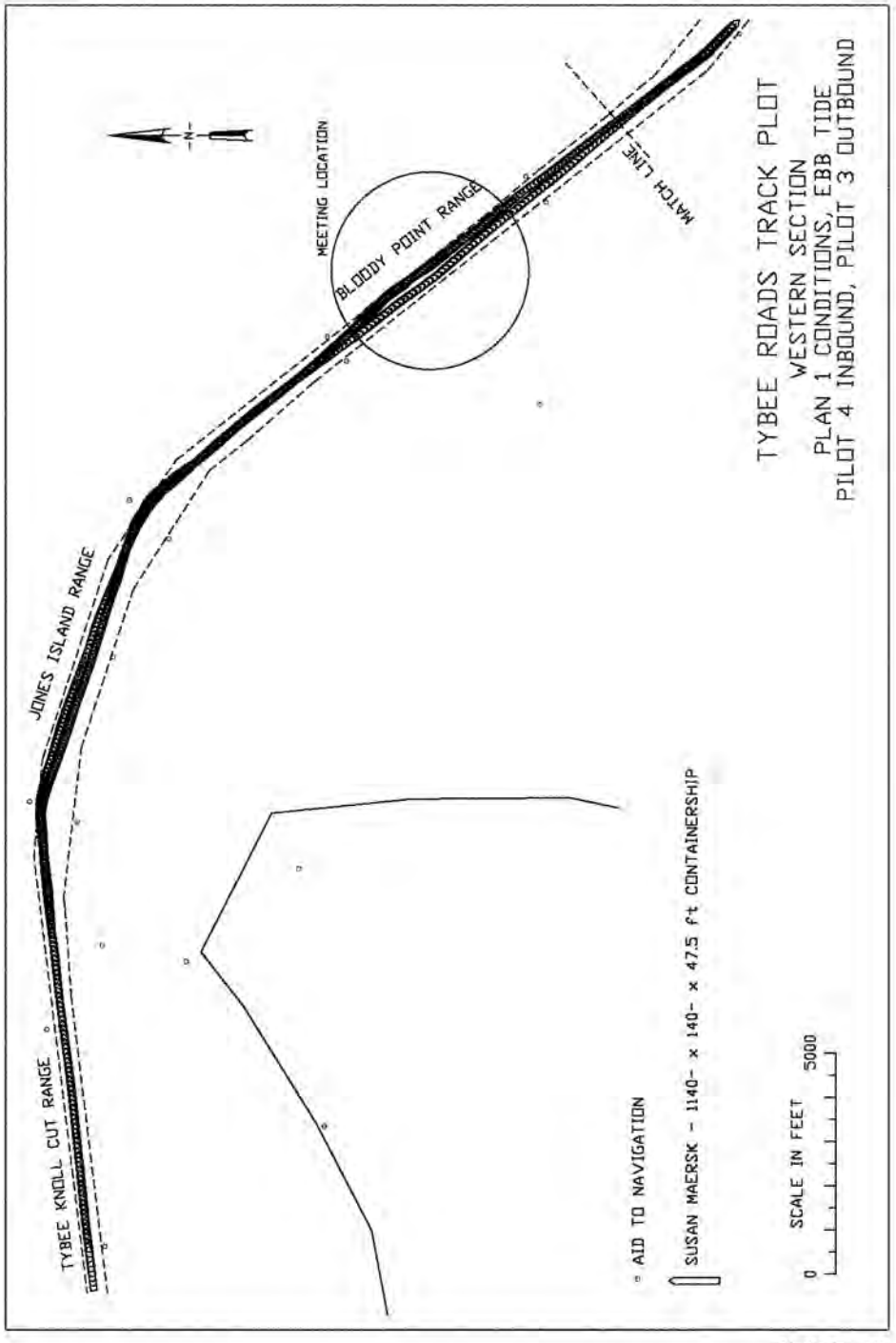

TYBEE ROADS TRACK PLOT
WESTERN SECTION
PLAN 1 CONDITIONS, EBB TIDE
PILOT 4 INBOUND, PILOT 3 OUTBOUND
TYBEE KNOLL CUT RANGE
JONES ISLAND RANGE
MEETING LOCATION
BLOODY POINT RANGE
MATCH LINE
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
0
SCALE IN FEET
5000

PLATE 19

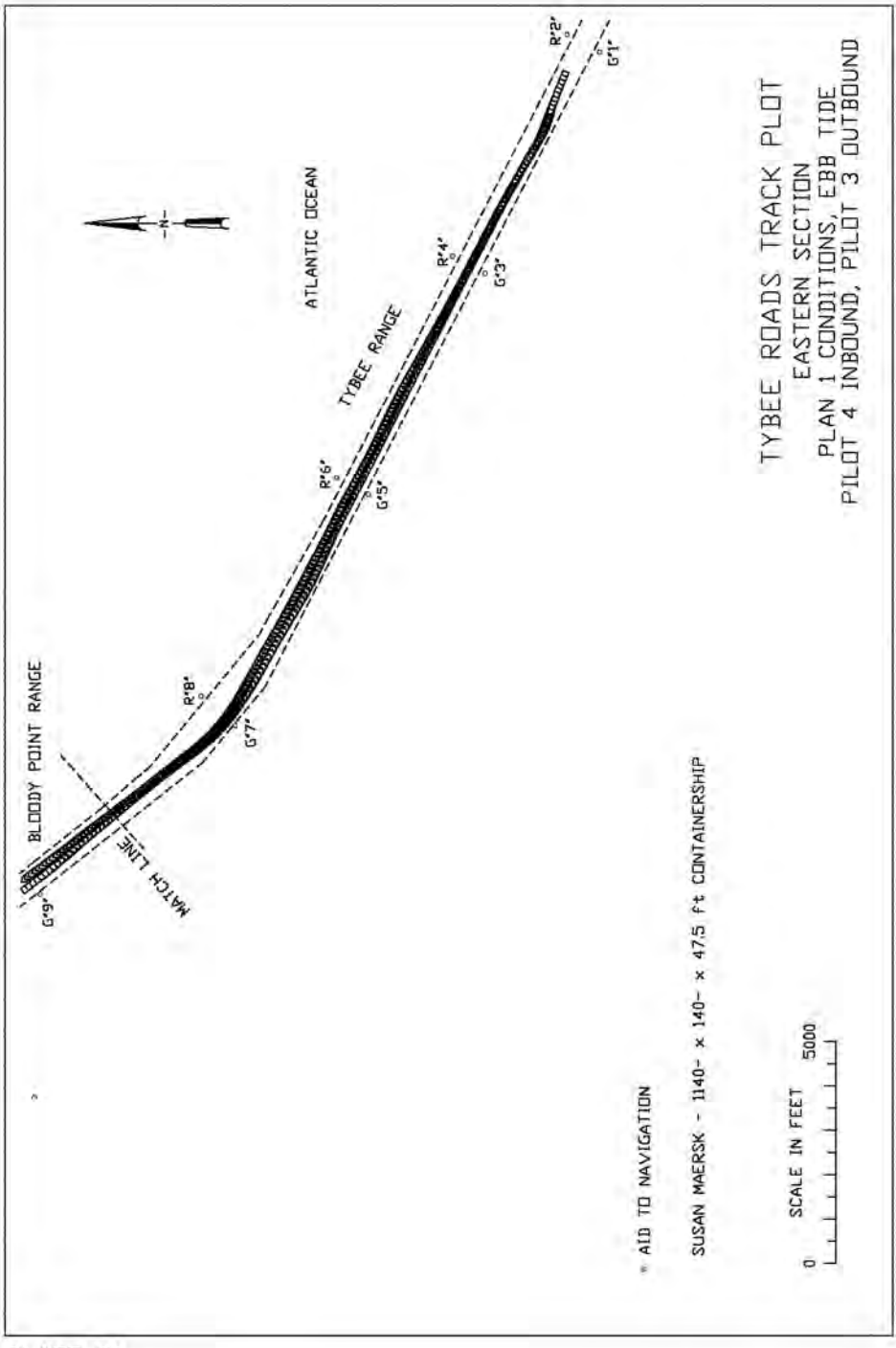

TYBEE ROADS TRACK PLOT
EASTERN SECTION
PLAN 1 CONDITIONS, EBB TIDE
PILOT 4 INBOUND, PILOT 3 OUTBOUND
ATLANTIC OCEAN
TYBEE RANGE
BLOODY POINT RANGE
MATCH LINE
R"8"
R"6"
R"4"
R"2"
G"9"
G"7"
G"5"
G"3"
G"1"
SCALE IN FEET
0
5000
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
* AID TO NAVIGATION

PLATE 20

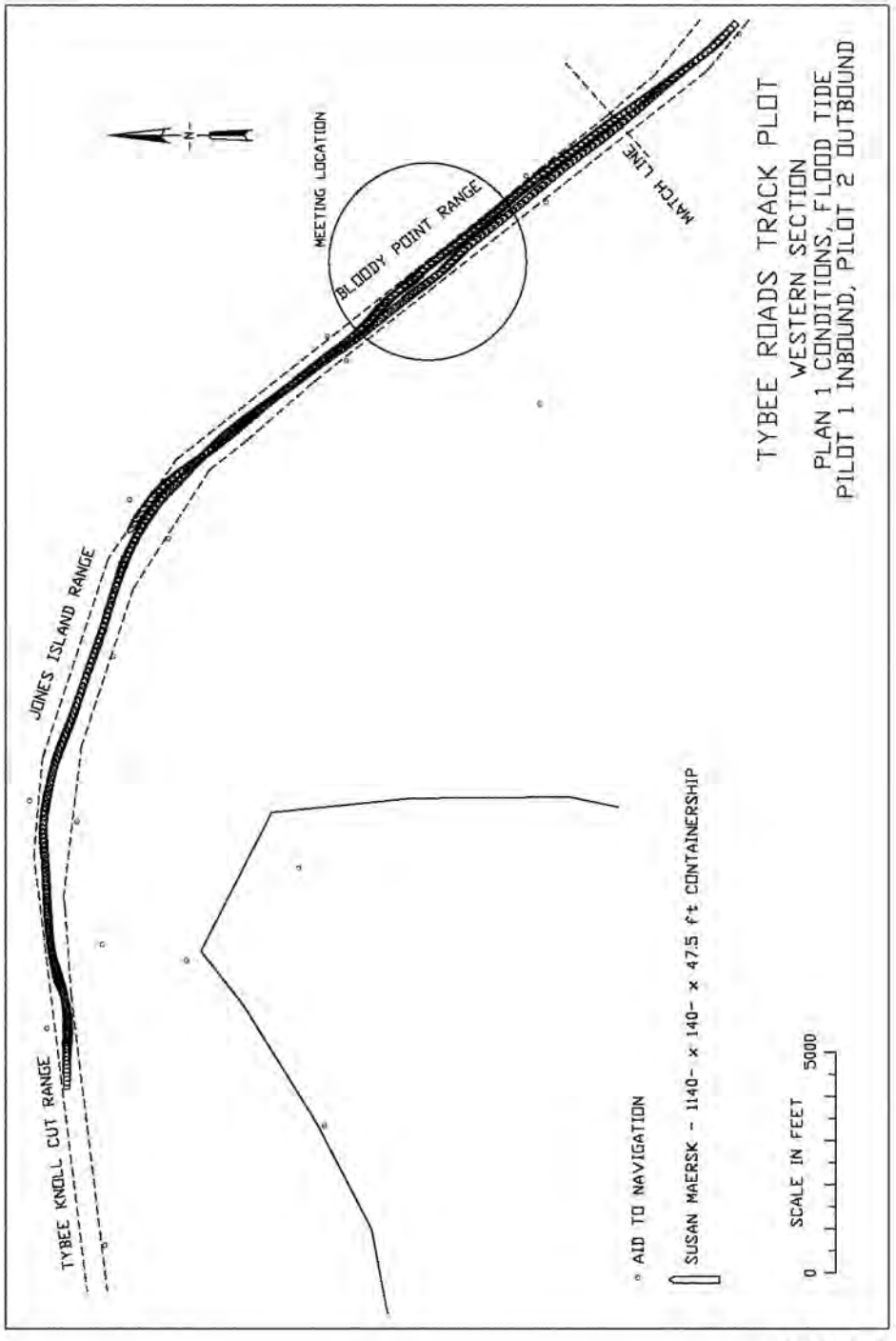

TYBEE ROADS TRACK PLOT
WESTERN SECTION
PLAN 1 CONDITIONS, FLOOD TIDE
PILOT 1 INBOUND, PILOT 2 OUTBOUND
JONES ISLAND RANGE
TYBEE KNOLL CUT RANGE
MEETING LOCATION
BLOODY POINT RANGE
MATCH LINE
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
0
SCALE IN FEET
5000

PLATE 21

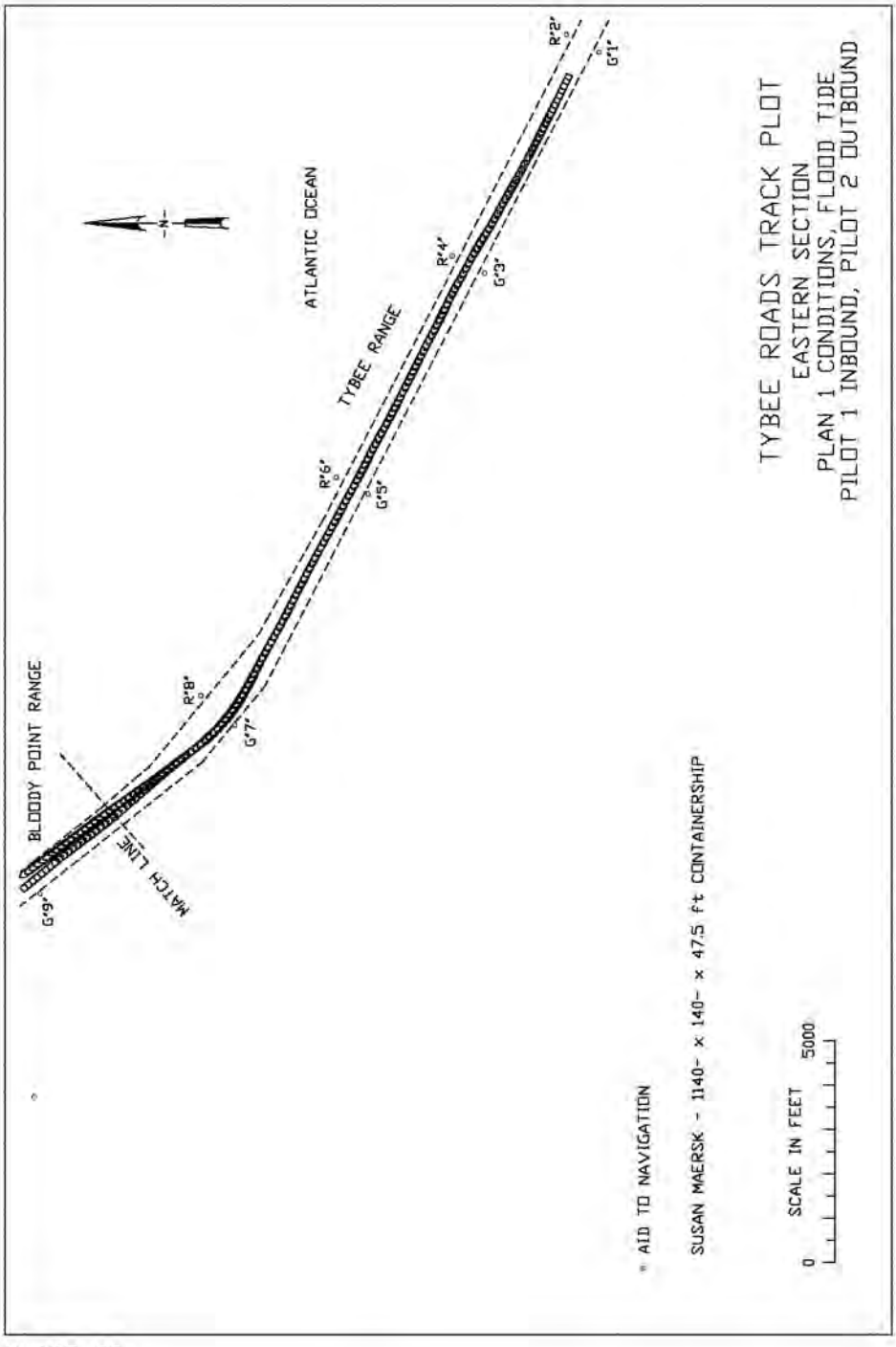

TYBEE ROADS TRACK PLOT
EASTERN SECTION
PLAN 1 CONDITIONS, FLOOD TIDE
PILOT 1 INBOUND, PILOT 2 OUTBOUND
ATLANTIC OCEAN
TYBEE RANGE
BLOODY POINT RANGE
MATCH LINE
R"8"
G"7"
R"6"
G"5"
R"4"
G"3"
R"2"
G"1"
G"9"
N
SCALE IN FEET
0
5000
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
* AID TO NAVIGATION

PLATE 22

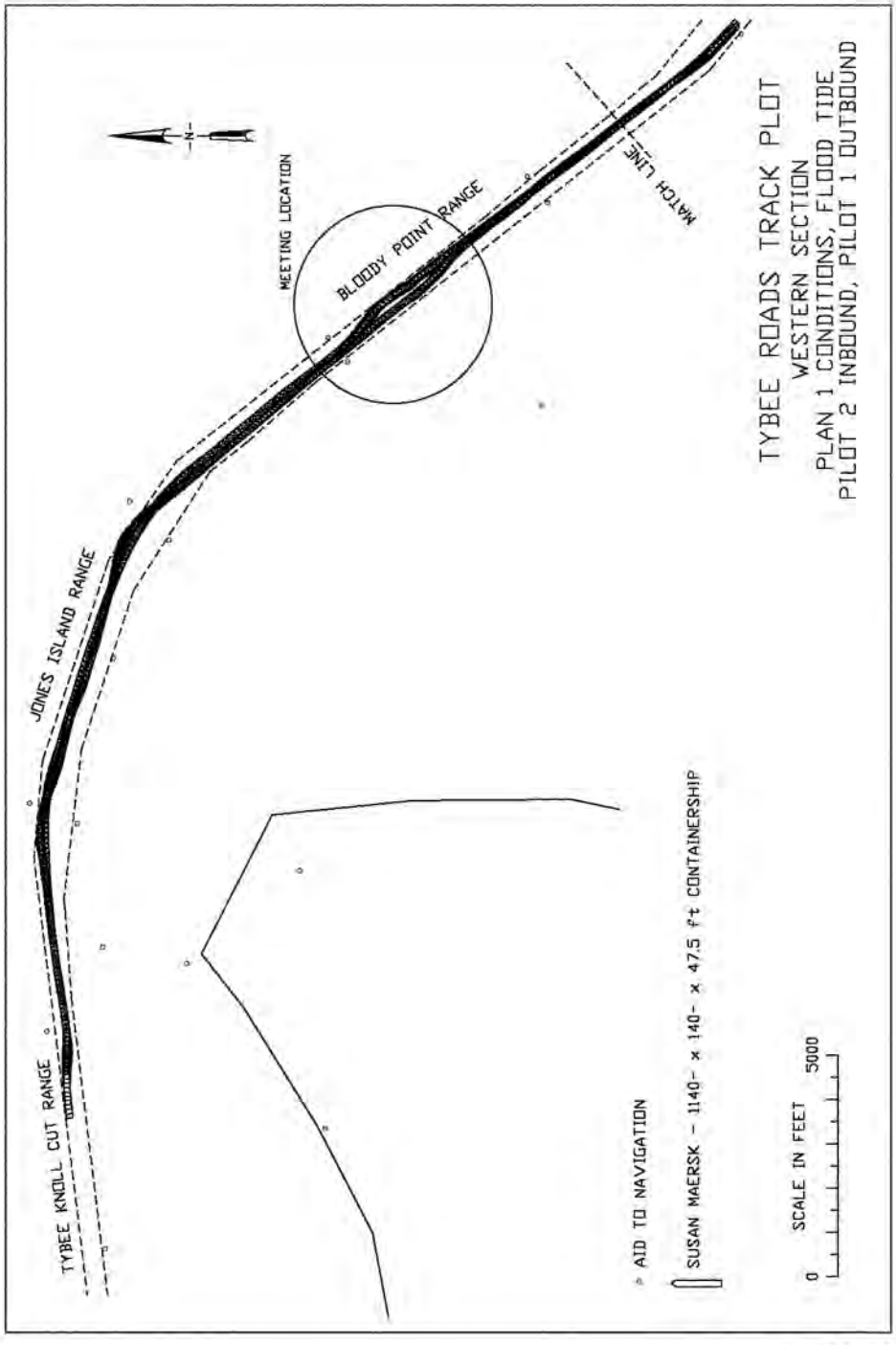

TYBEE ROADS TRACK PLOT
WESTERN SECTION
PLAN 1 CONDITIONS, FLOOD TIDE
PILOT 2 INBOUND, PILOT 1 OUTBOUND
JONES ISLAND RANGE
TYBEE KNOLL CUT RANGE
MEETING LOCATION
BLOODY POINT RANGE
MATCH LINE
N
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
0
SCALE IN FEET
5000

PLATE 23

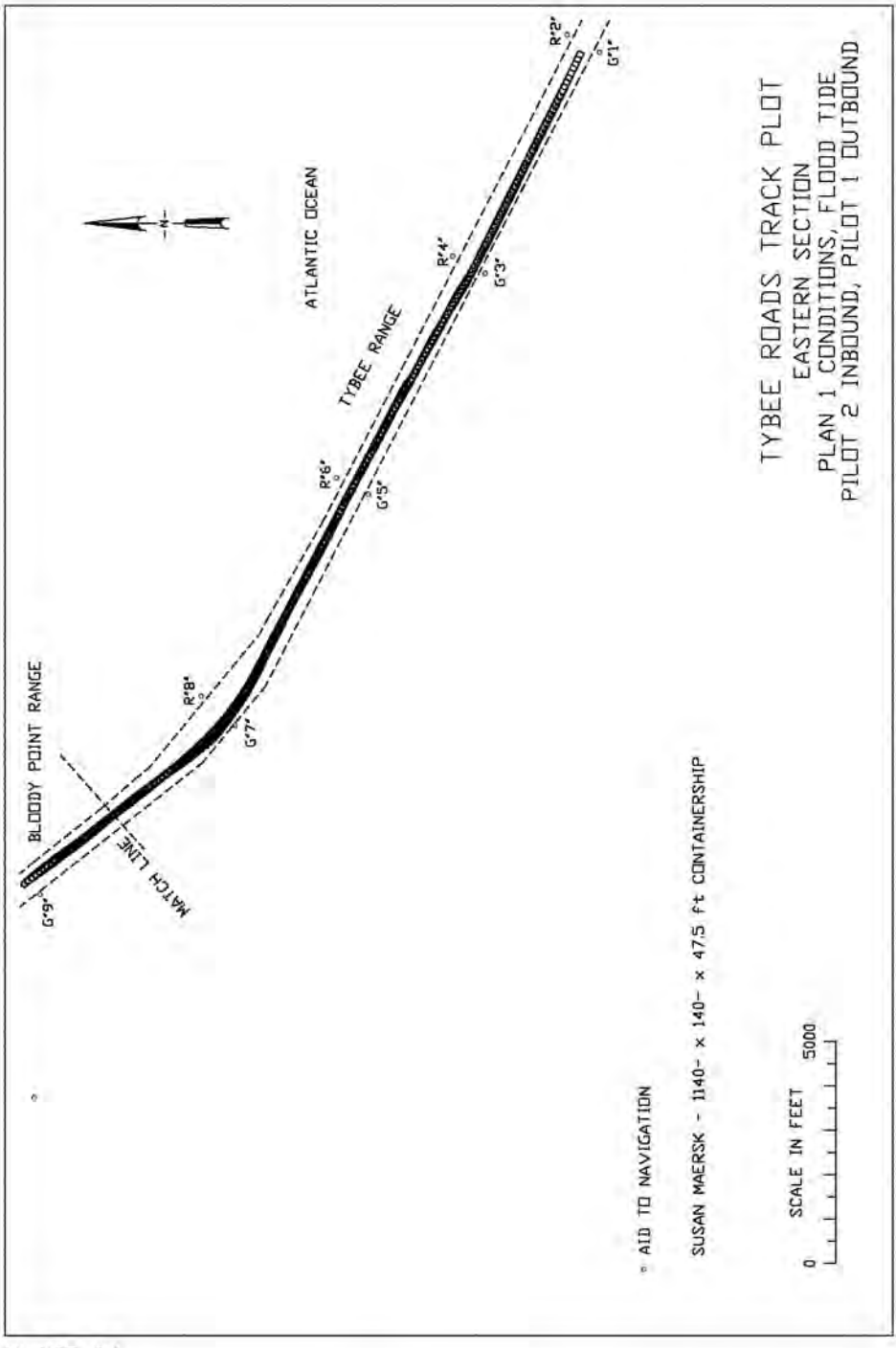

TYBEE ROADS TRACK PLOT
EASTERN SECTION
PLAN 1 CONDITIONS, FLOOD TIDE
PILOT 2 INBOUND, PILOT 1 OUTBOUND
ATLANTIC OCEAN
TYBEE RANGE
BLOODY POINT RANGE
MATCH LINE
R"8"
G"7"
R"6"
G"5"
R"4"
G"3"
R"2"
G"1"
G"9"
N
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
0 SCALE IN FEET 5000

PLATE 24

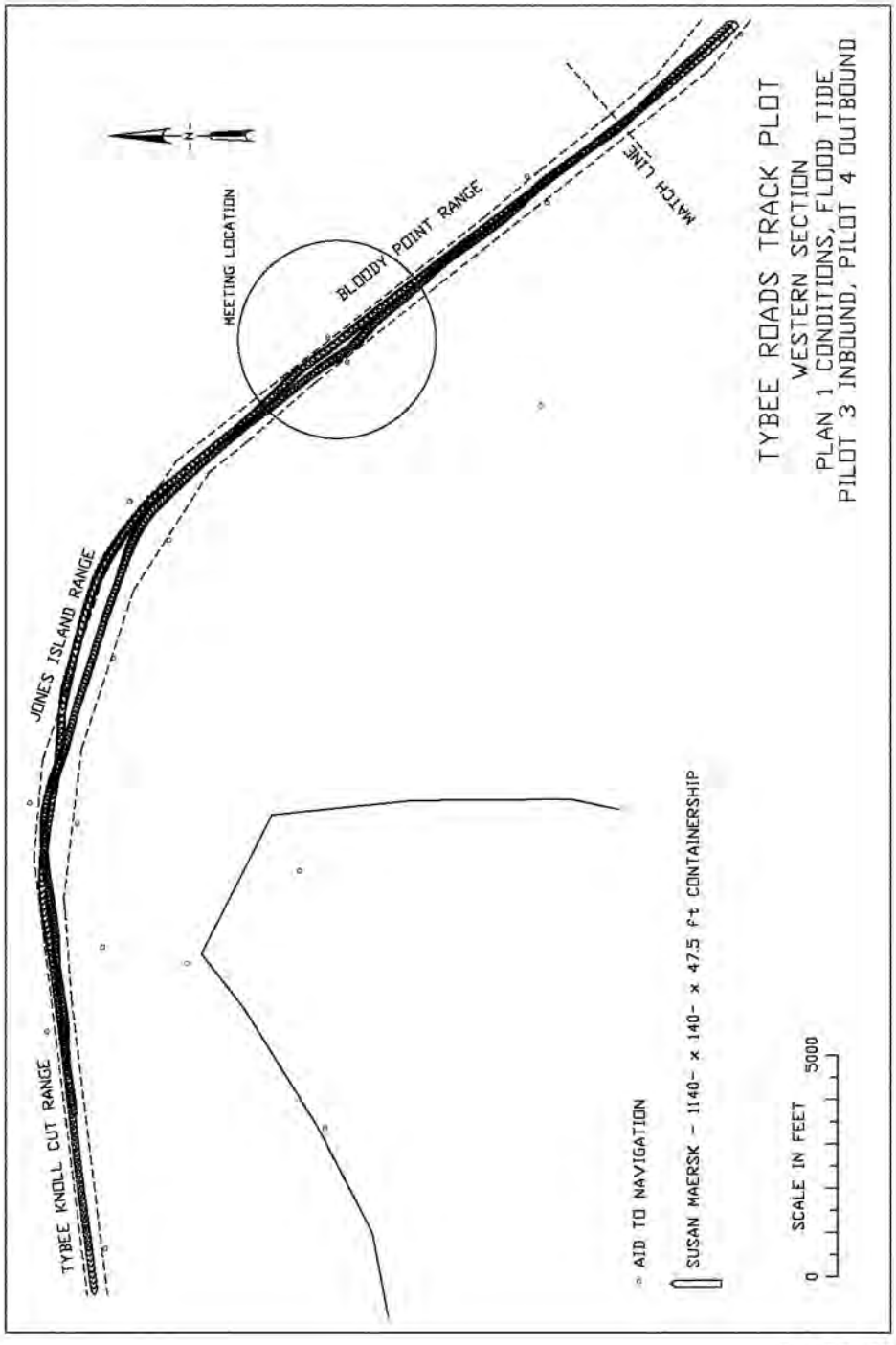
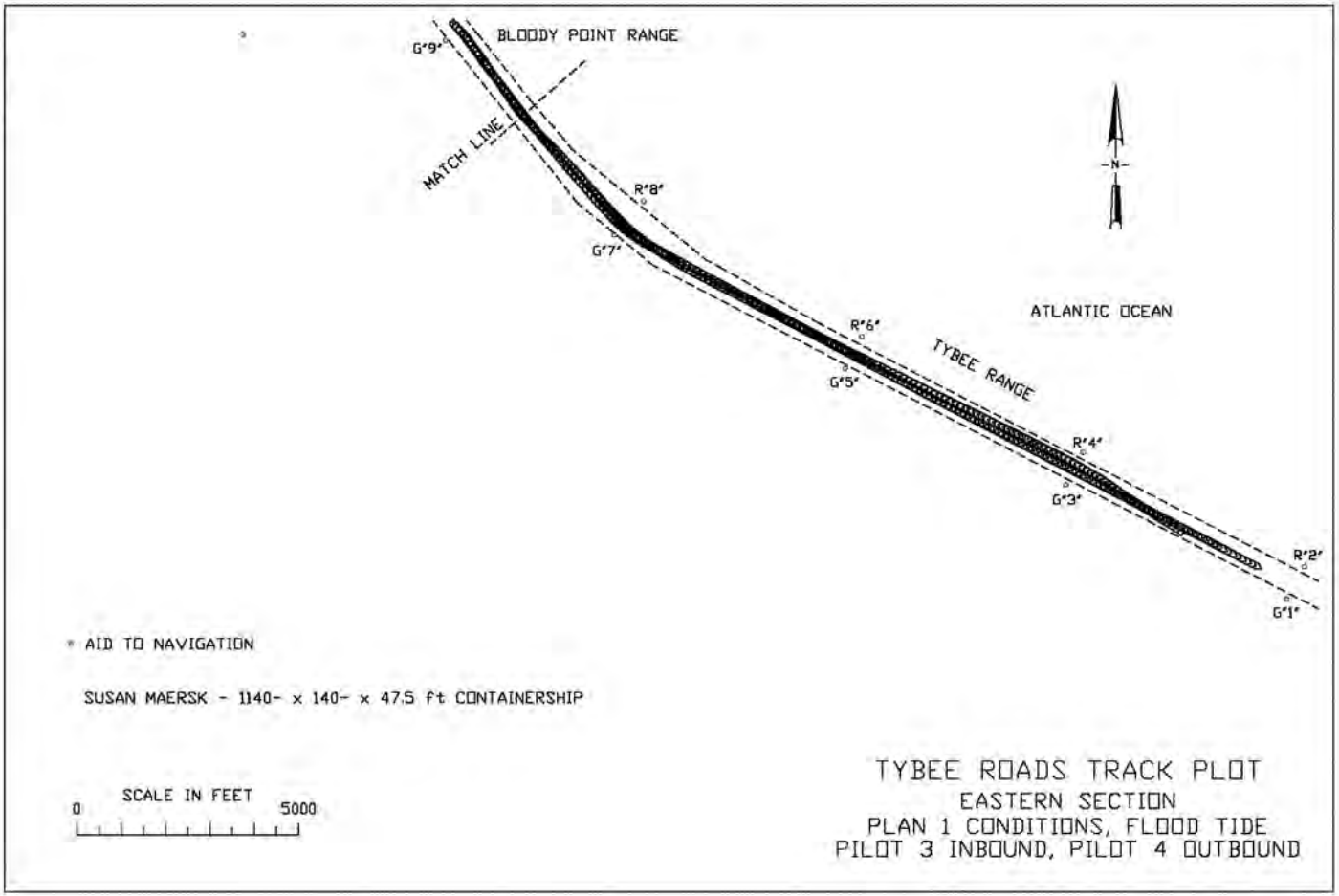

TYBEE ROADS TRACK PLOT
WESTERN SECTION
PLAN 1 CONDITIONS, FLOOD TIDE
PILOT 3 INBOUND, PILOT 4 OUTBOUND
TYBEE KNOLL CUT RANGE
JONES ISLAND RANGE
MEETING LOCATION
BLOODY POINT RANGE
MATCH LINE
N
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
0
SCALE IN FEET
5000

PLATE 25

PLATE 26


BLOODY POINT RANGE
G"9"
MATCH LINE
R"8"
G"7"
R"6"
G"5"
TYBEE RANGE
R"4"
G"3"
R"2"
G"1"
ATLANTIC OCEAN
N
* AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
SCALE IN FEET
0
5000
TYBEE ROADS TRACK PLOT
EASTERN SECTION
PLAN 1 CONDITIONS, FLOOD TIDE
PILOT 3 INBOUND, PILOT 4 OUTBOUND

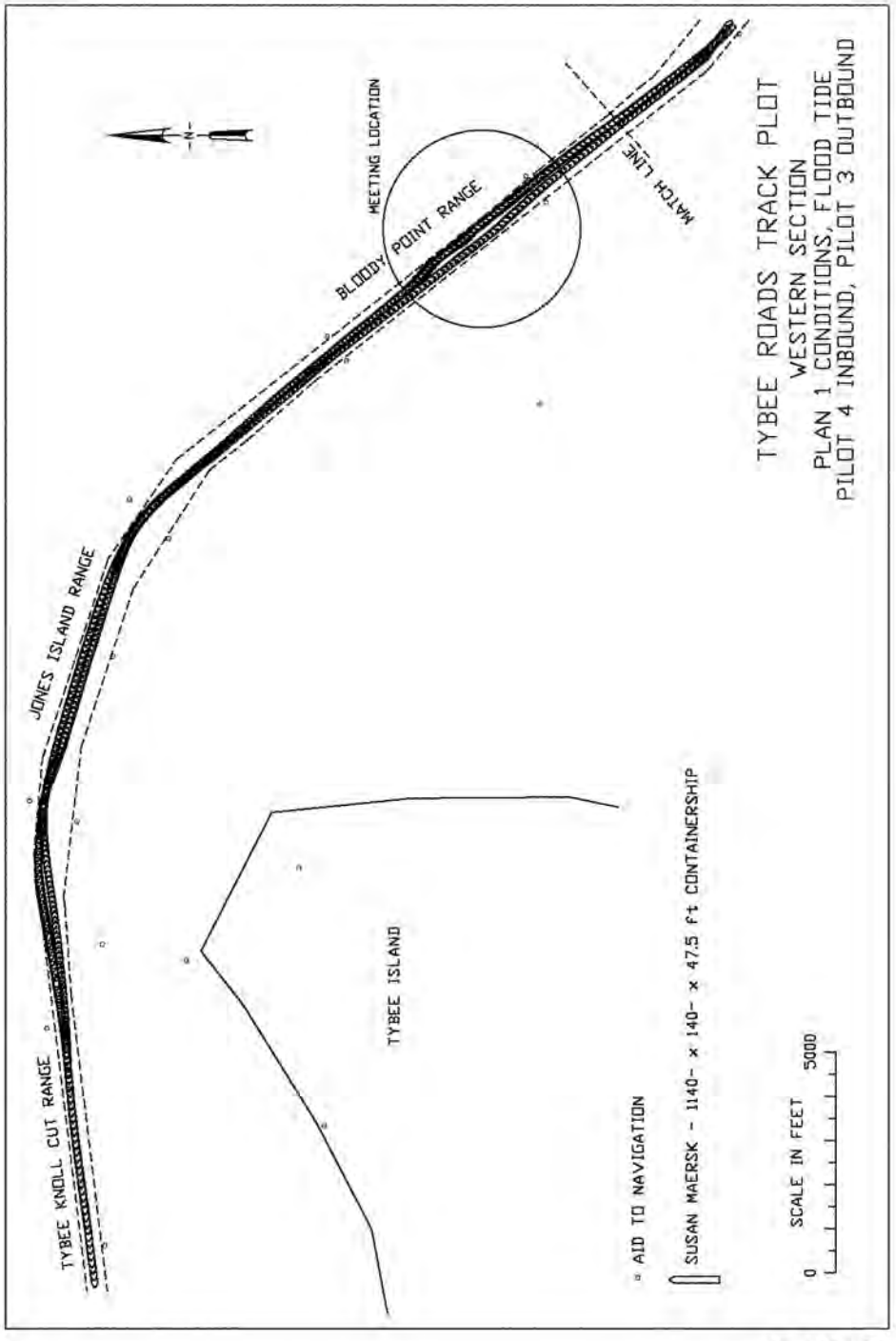

TYBEE ROADS TRACK PLOT
WESTERN SECTION
PLAN 1 CONDITIONS, FLOOD TIDE
PILOT 4 INBOUND, PILOT 3 OUTBOUND
TYBEE KNOLL CUT RANGE
JONES ISLAND RANGE
BLOODY POINT RANGE
MEETING LOCATION
MATCH LINE
TYBEE ISLAND
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
0 SCALE IN FEET 5000
N

PLATE 27

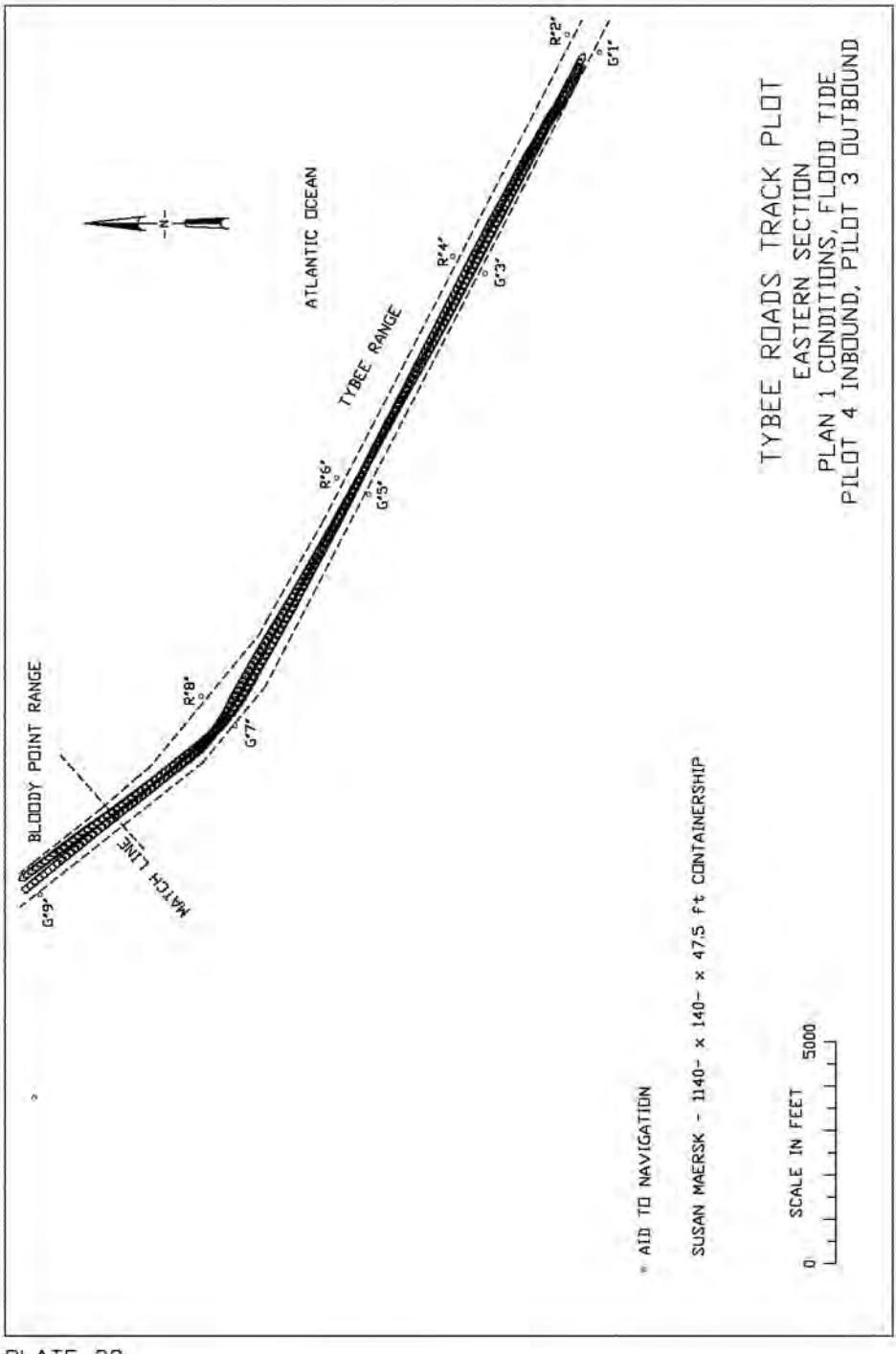

TYBEE ROADS TRACK PLOT
EASTERN SECTION
PLAN 1 CONDITIONS, FLOOD TIDE
PILOT 4 INBOUND, PILOT 3 OUTBOUND
SCALE IN FEET
0
5000
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
* AID TO NAVIGATION
BLOODY POINT RANGE
MATCH LINE
TYBEE RANGE
ATLANTIC OCEAN
N
R"8"
G"7"
R"6"
G"5"
R"4"
G"3"
R"2"
G"1"
G"9"

PLATE 28

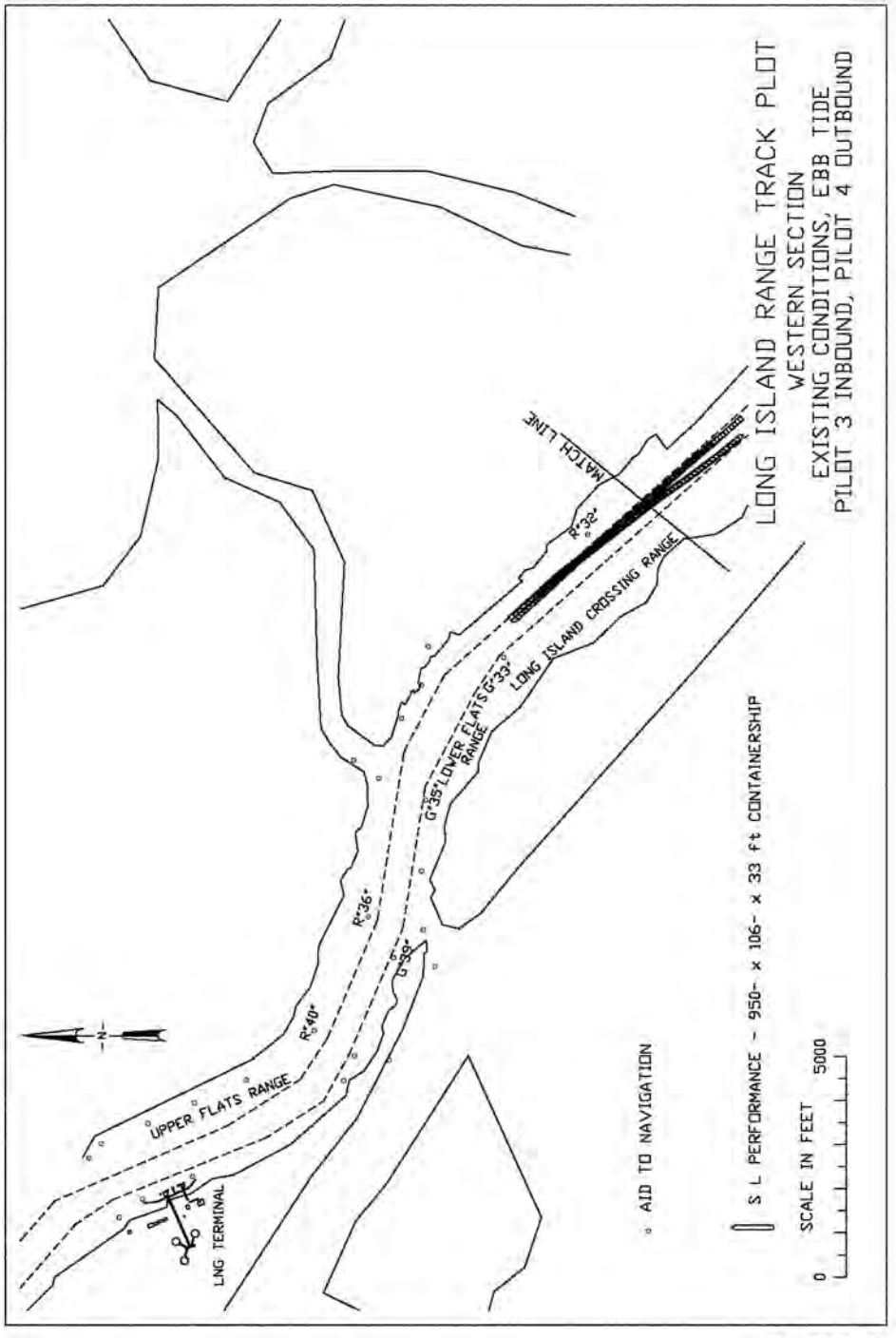

LONG ISLAND RANGE TRACK PLOT
WESTERN SECTION
EXISTING CONDITIONS, EBB TIDE
PILOT 3 INBOUND, PILOT 4 OUTBOUND
MATCH LINE
R°32°
LONG ISLAND CROSSING RANGE
G°35°LOWER FLATS RANGE
R°36°
G°33°
R°40°
UPPER FLATS RANGE
LNG TERMINAL
AID TO NAVIGATION
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
0 SCALE IN FEET 5000

PLATE 29

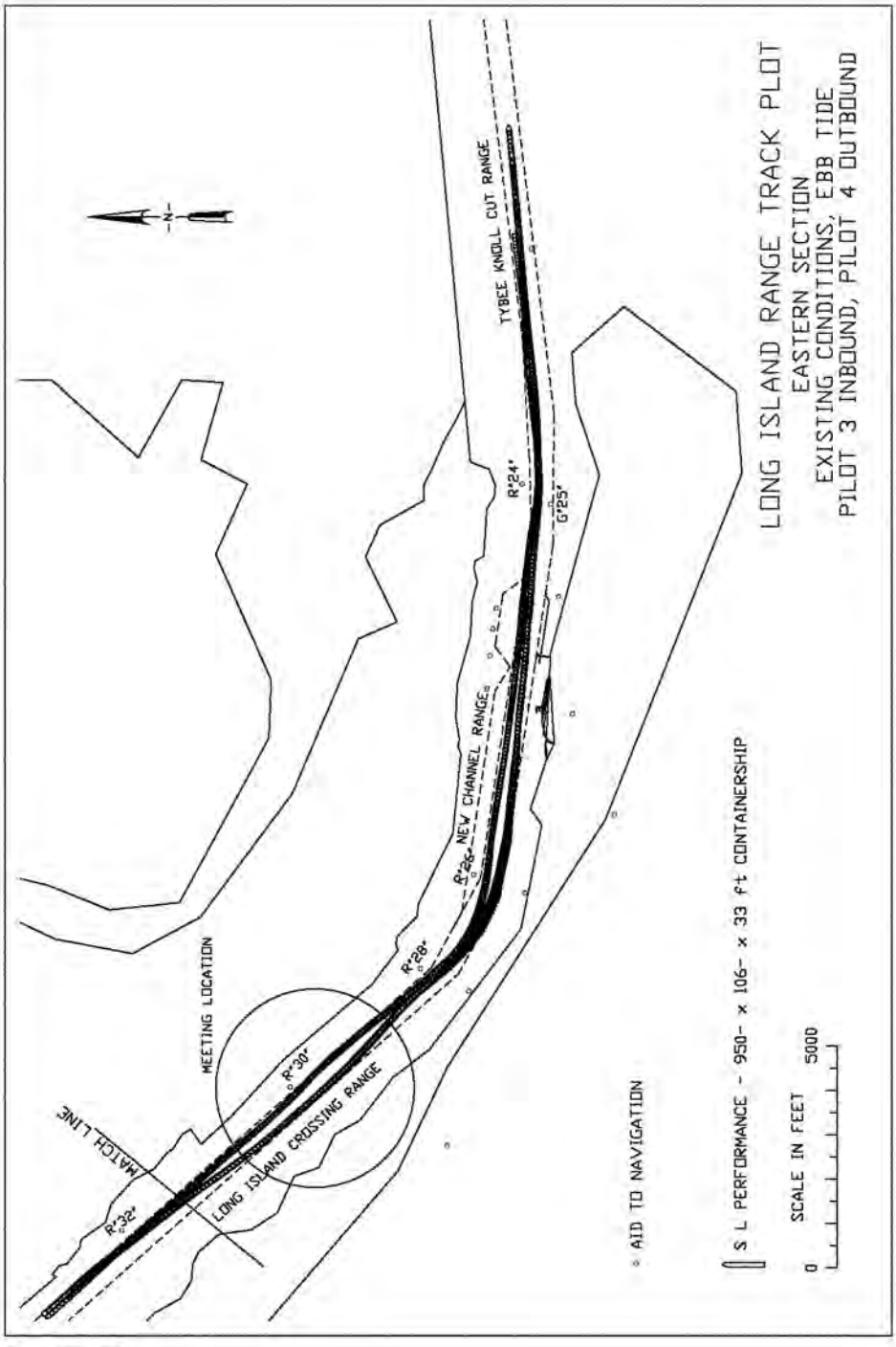

LONG ISLAND RANGE TRACK PLOT
EASTERN SECTION
EXISTING CONDITIONS, EBB TIDE
PILOT 3 INBOUND, PILOT 4 OUTBOUND
TYBEE KNOLL CUT RANGE
NEW CHANNEL RANGE
LONG ISLAND CROSSING RANGE
MEETING LOCATION
MATCH LINE
R"24"
G"25"
R"26"
R"28"
R"30"
R"32"
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
SCALE IN FEET 5000
0
AID TO NAVIGATION

PLATE 30

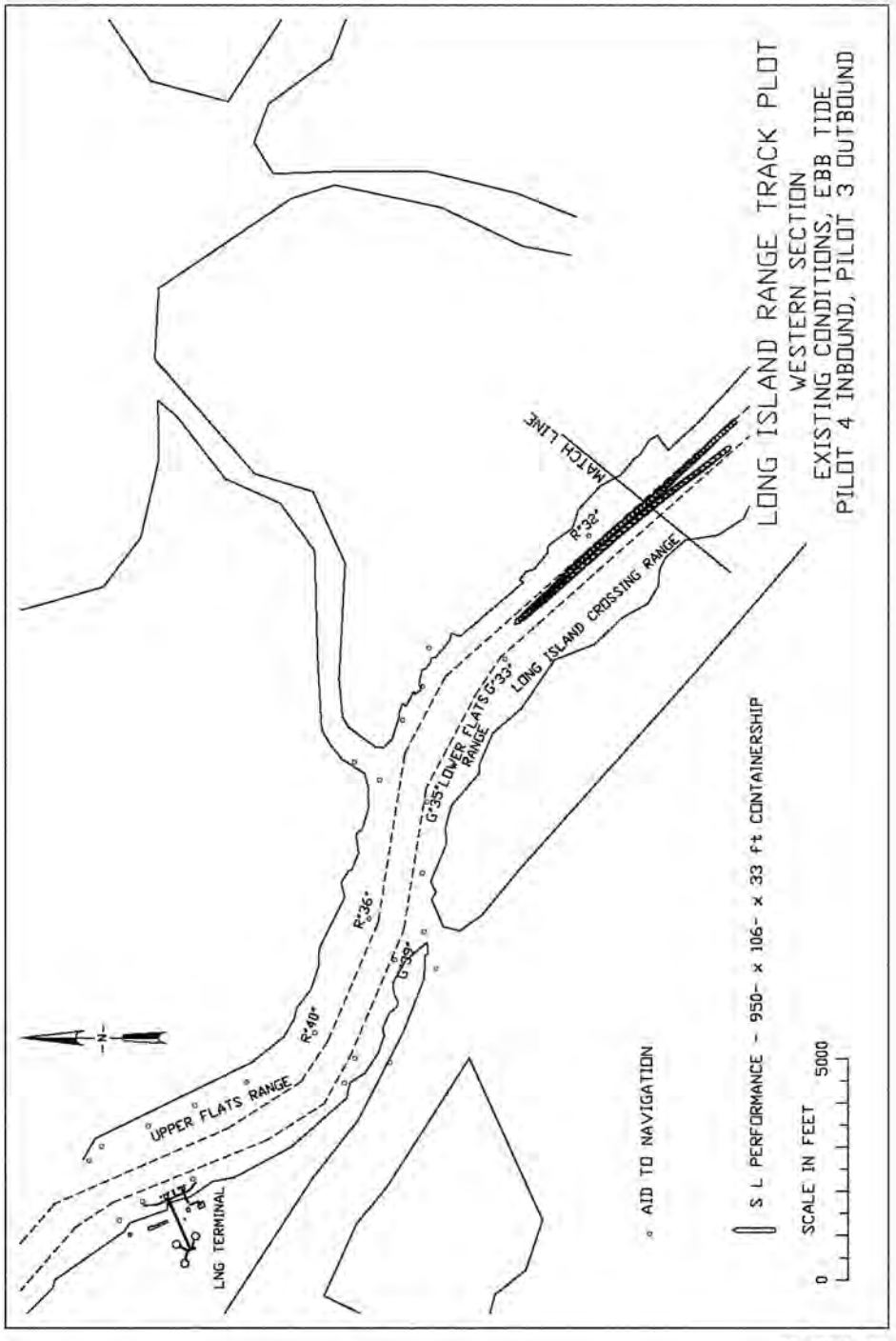

LONG ISLAND RANGE TRACK PLOT
WESTERN SECTION
EXISTING CONDITIONS, EBB TIDE
PILOT 4 INBOUND, PILOT 3 OUTBOUND
MATCH LINE
R°32'
LONG ISLAND CROSSING RANGE
G°33'
LOWER FLATS RANGE
G°33'
R°36'
G°33'
R°40'
UPPER FLATS RANGE
LNG TERMINAL
AID TO NAVIGATION
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
0 SCALE IN FEET 5000

PLATE 31

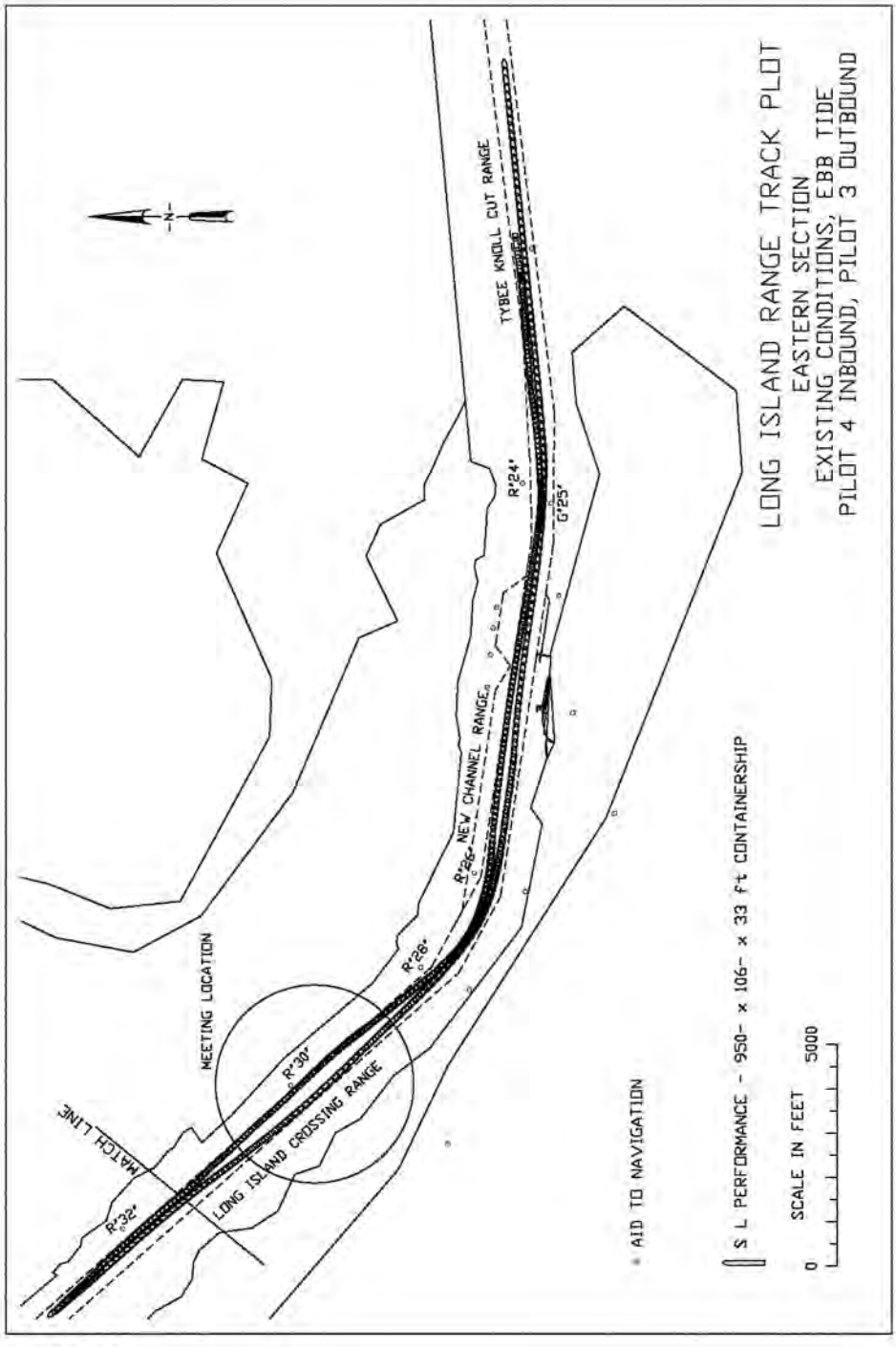

LONG ISLAND RANGE TRACK PLOT
EASTERN SECTION
EXISTING CONDITIONS, EBB TIDE
PILOT 4 INBOUND, PILOT 3 OUTBOUND
TYBEE KNOLL CUT RANGE
R°24'
G°25'
NEW CHANNEL RANGE
R°26'
R°28'
R°30'
R°32'
MEETING LOCATION
LONG ISLAND CROSSING RANGE
MATCH LINE
* AID TO NAVIGATION
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
0 SCALE IN FEET 5000

PLATE 32

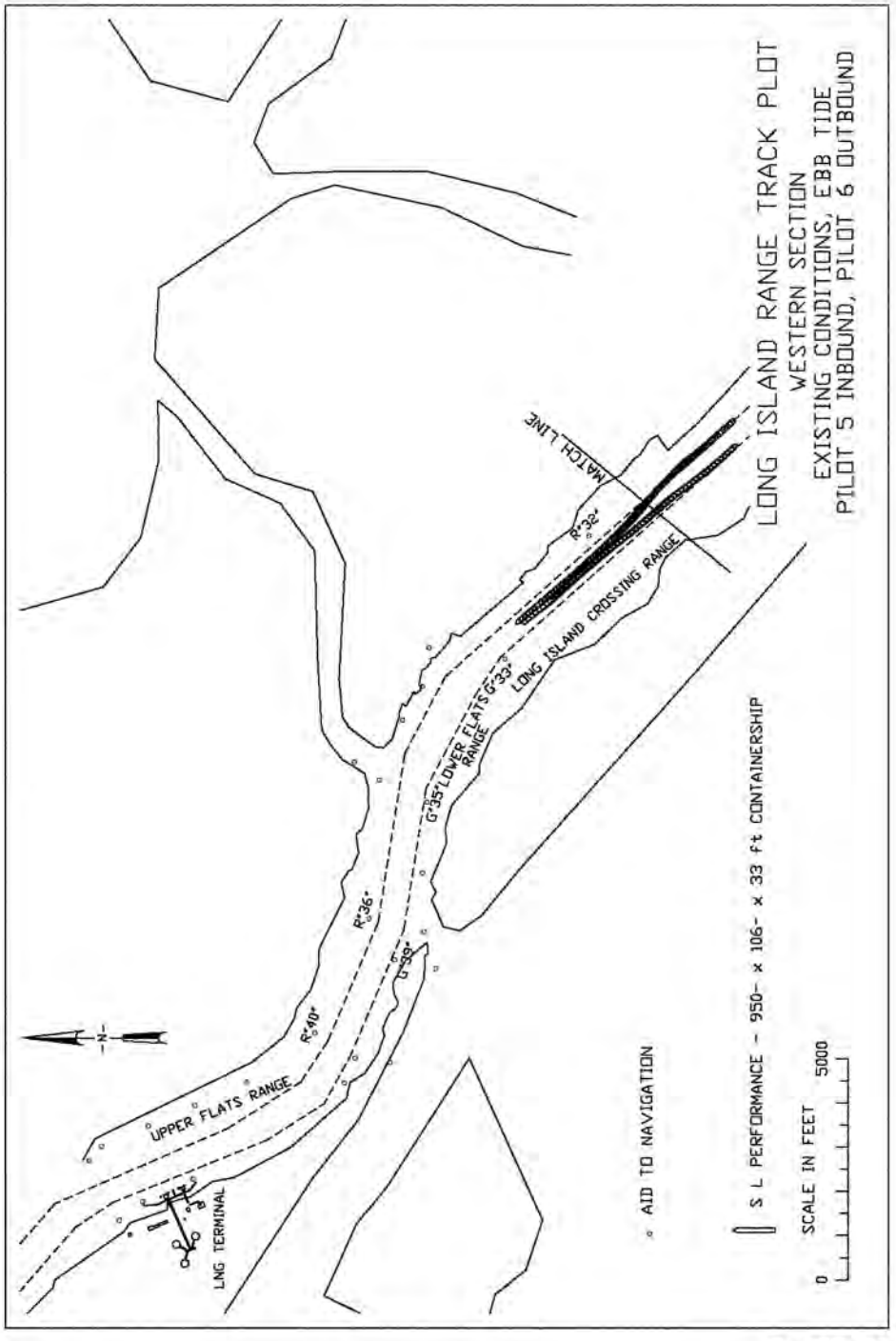

LONG ISLAND RANGE TRACK PLOT
WESTERN SECTION
EXISTING CONDITIONS, EBB TIDE
PILOT 5 INBOUND, PILOT 6 OUTBOUND
MATCH LINE
R°32°
LONG ISLAND CROSSING RANGE
G°33°
LOWER FLATS RANGE
G°35°
R°36°
R°40°
UPPER FLATS RANGE
LNG TERMINAL
N
AID TO NAVIGATION
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
0 SCALE IN FEET 5000

PLATE 33

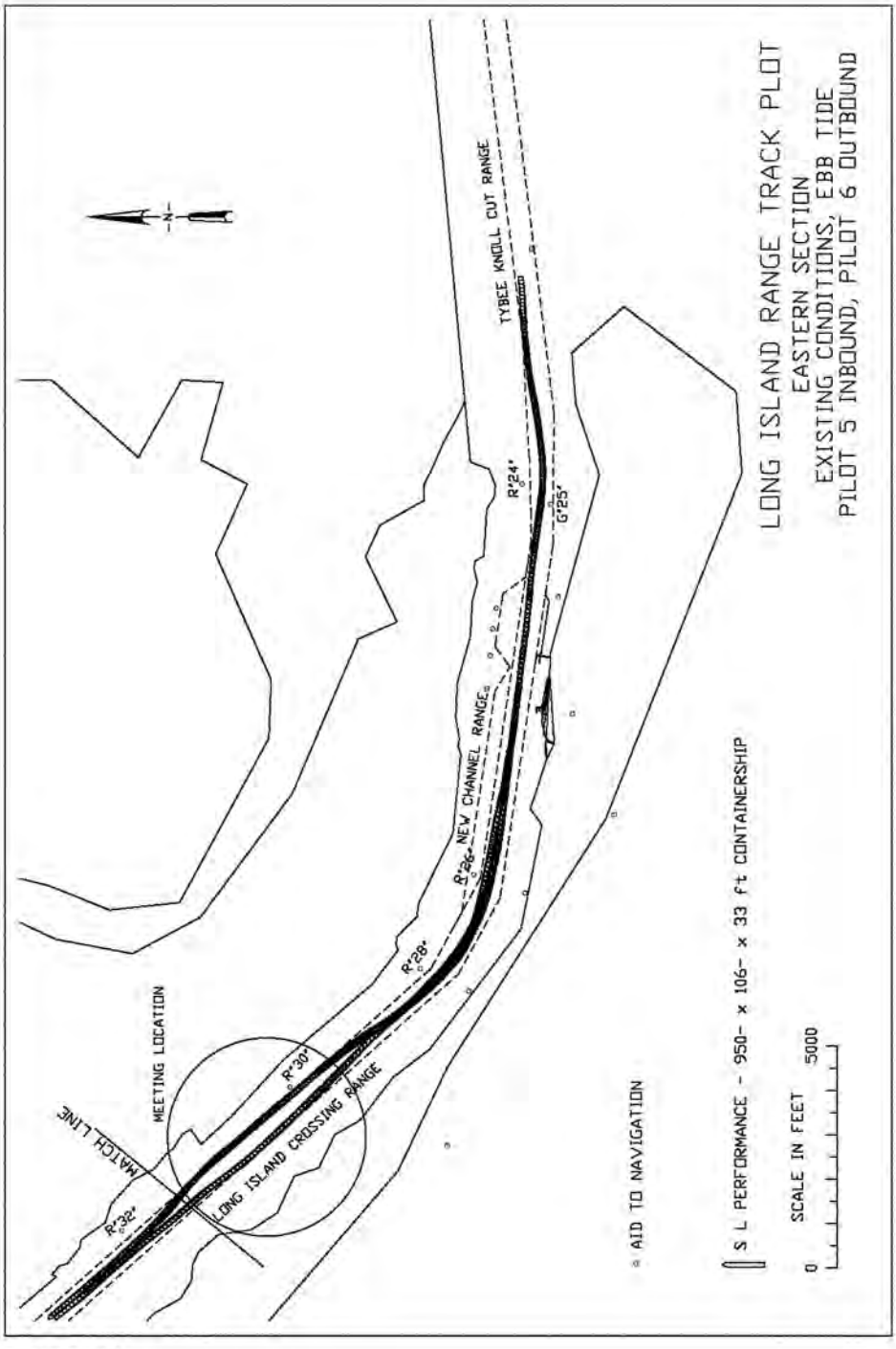

LONG ISLAND RANGE TRACK PLOT
EASTERN SECTION
EXISTING CONDITIONS, EBB TIDE
PILOT 5 INBOUND, PILOT 6 OUTBOUND
TYBEE KNOLL CUT RANGE
NEW CHANNEL RANGE
LONG ISLAND CROSSING RANGE
MEETING LOCATION
MATCH LINE
R"24"
G"25"
R"26"
R"28"
R"30"
R"32"
AID TO NAVIGATION
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
0 SCALE IN FEET 5000

PLATE 34

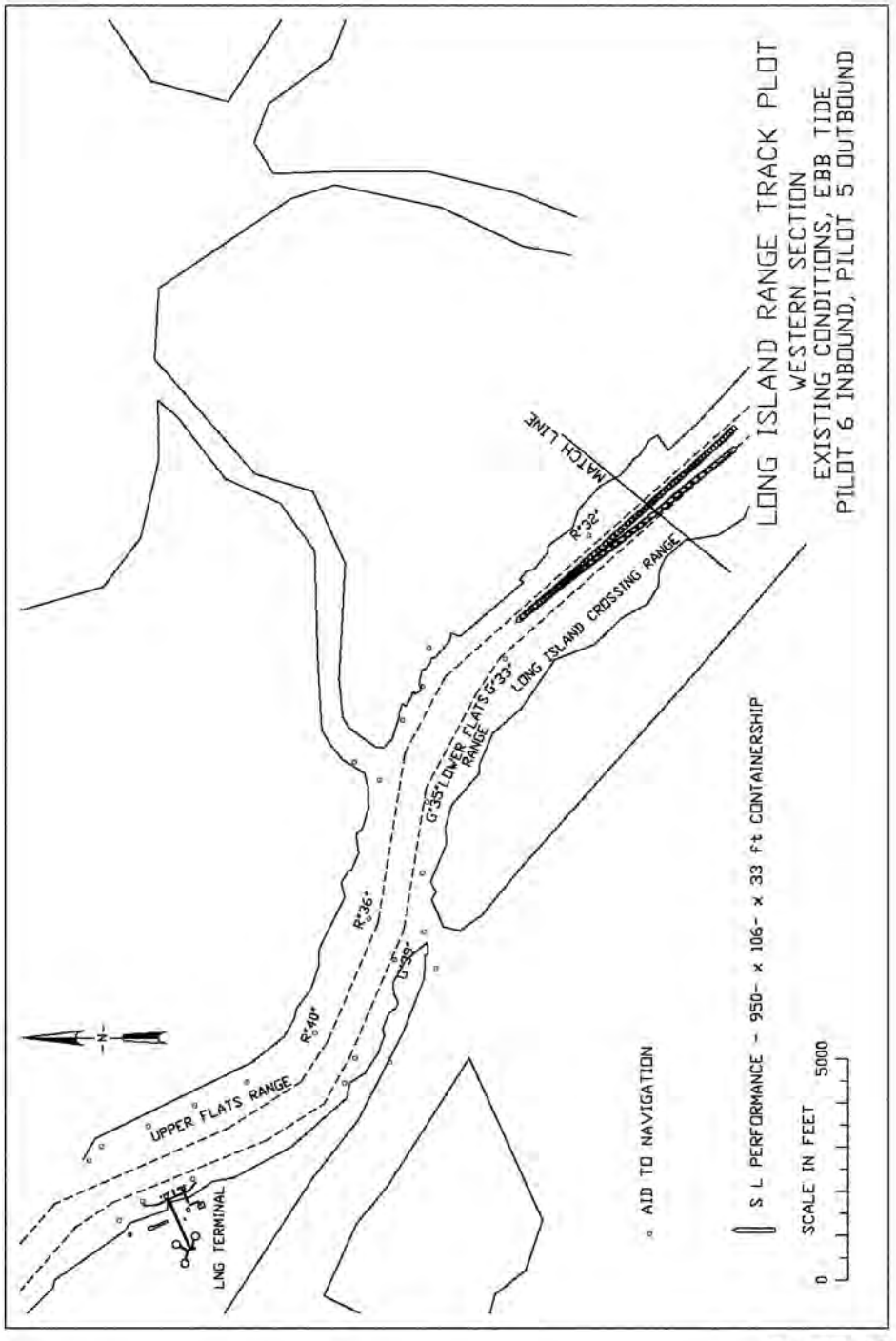

LONG ISLAND RANGE TRACK PLOT
WESTERN SECTION
EXISTING CONDITIONS, EBB TIDE
PILOT 6 INBOUND, PILOT 5 OUTBOUND
MATCH LINE
R°32'
LONG ISLAND CROSSING RANGE
G°33'
LOWER FLATS RANGE
G°33'
R°36'
R°40'
UPPER FLATS RANGE
LNG TERMINAL
N
AID TO NAVIGATION
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
0 SCALE IN FEET 5000

PLATE 35

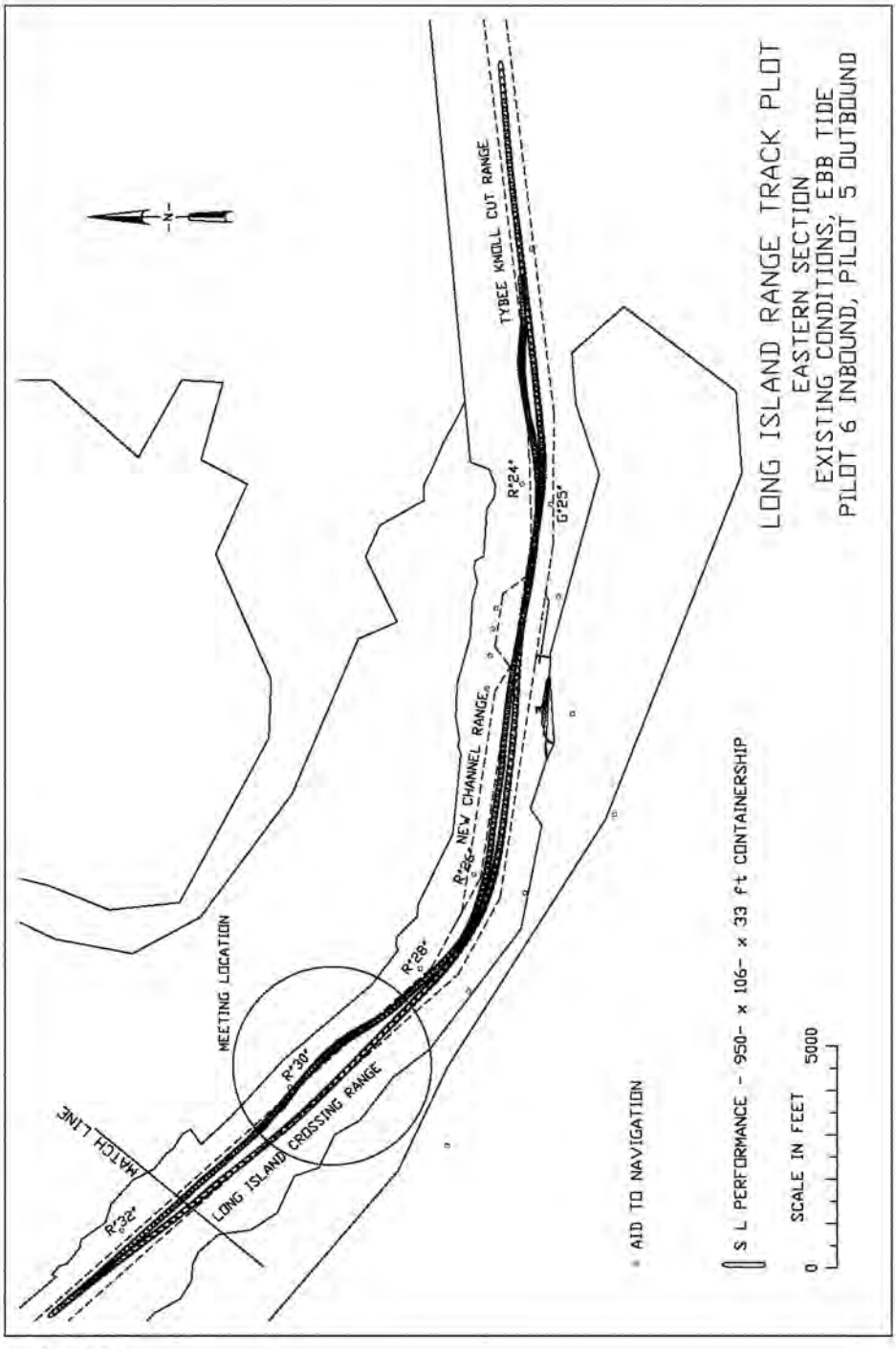

LONG ISLAND RANGE TRACK PLOT
EASTERN SECTION
EXISTING CONDITIONS, EBB TIDE
PILOT 6 INBOUND, PILOT 5 OUTBOUND
TYBEE KNOLL CUT RANGE
NEW CHANNEL RANGE
LONG ISLAND CROSSING RANGE
MEETING LOCATION
MATCH LINE
R°24'
G°25'
R°28'
R°30'
R°32'
N
AID TO NAVIGATION
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
0 SCALE IN FEET 5000

PLATE 36

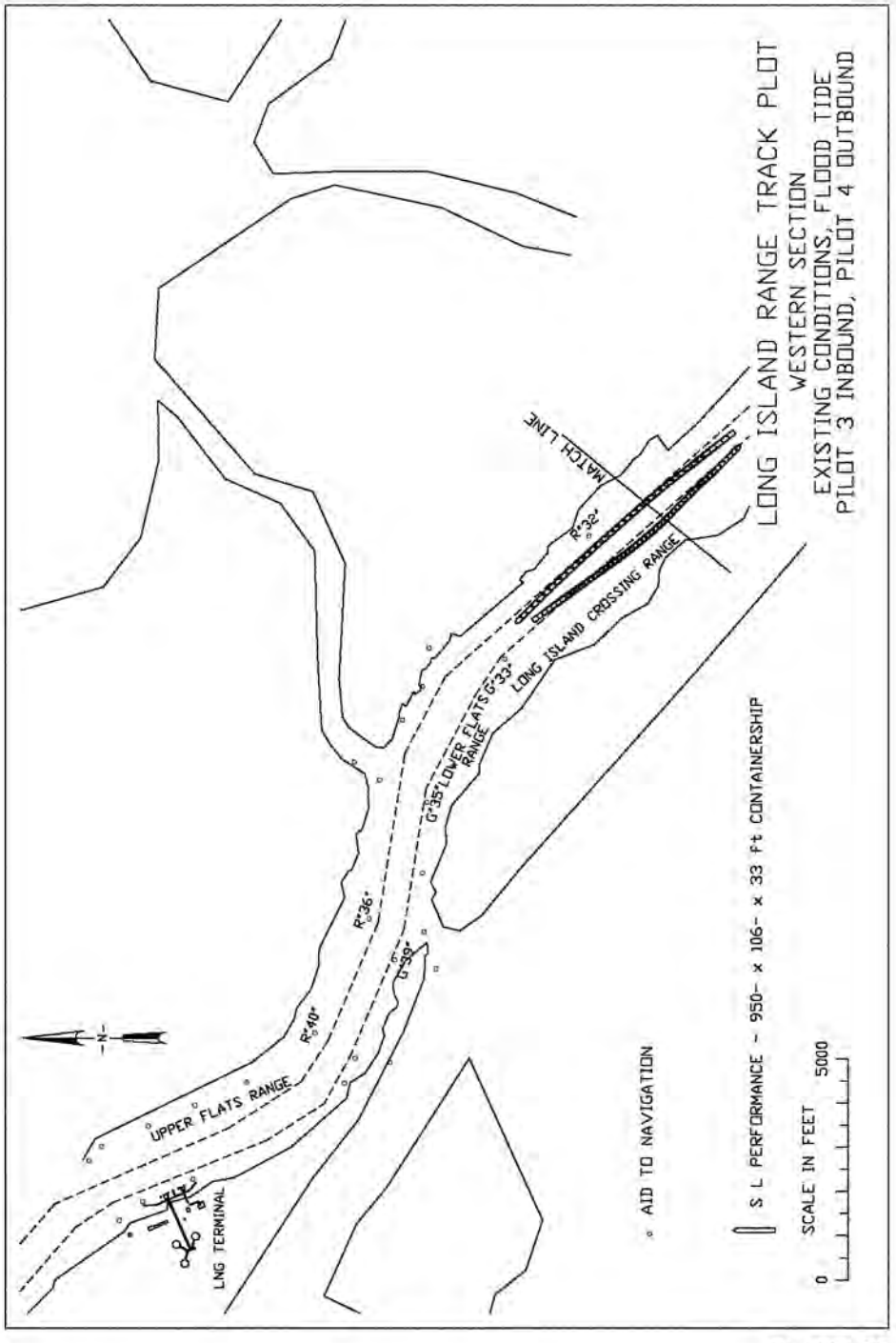

LONG ISLAND RANGE TRACK PLOT
WESTERN SECTION
EXISTING CONDITIONS, FLOOD TIDE
PILOT 3 INBOUND, PILOT 4 OUTBOUND
MATCH LINE
R°32'
LONG ISLAND CROSSING RANGE
G°35' LOWER FLATS G°33' RANGE
R°36'
G°39'
R°40'
UPPER FLATS RANGE
LNG TERMINAL
AID TO NAVIGATION
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
0 SCALE IN FEET 5000

PLATE 37

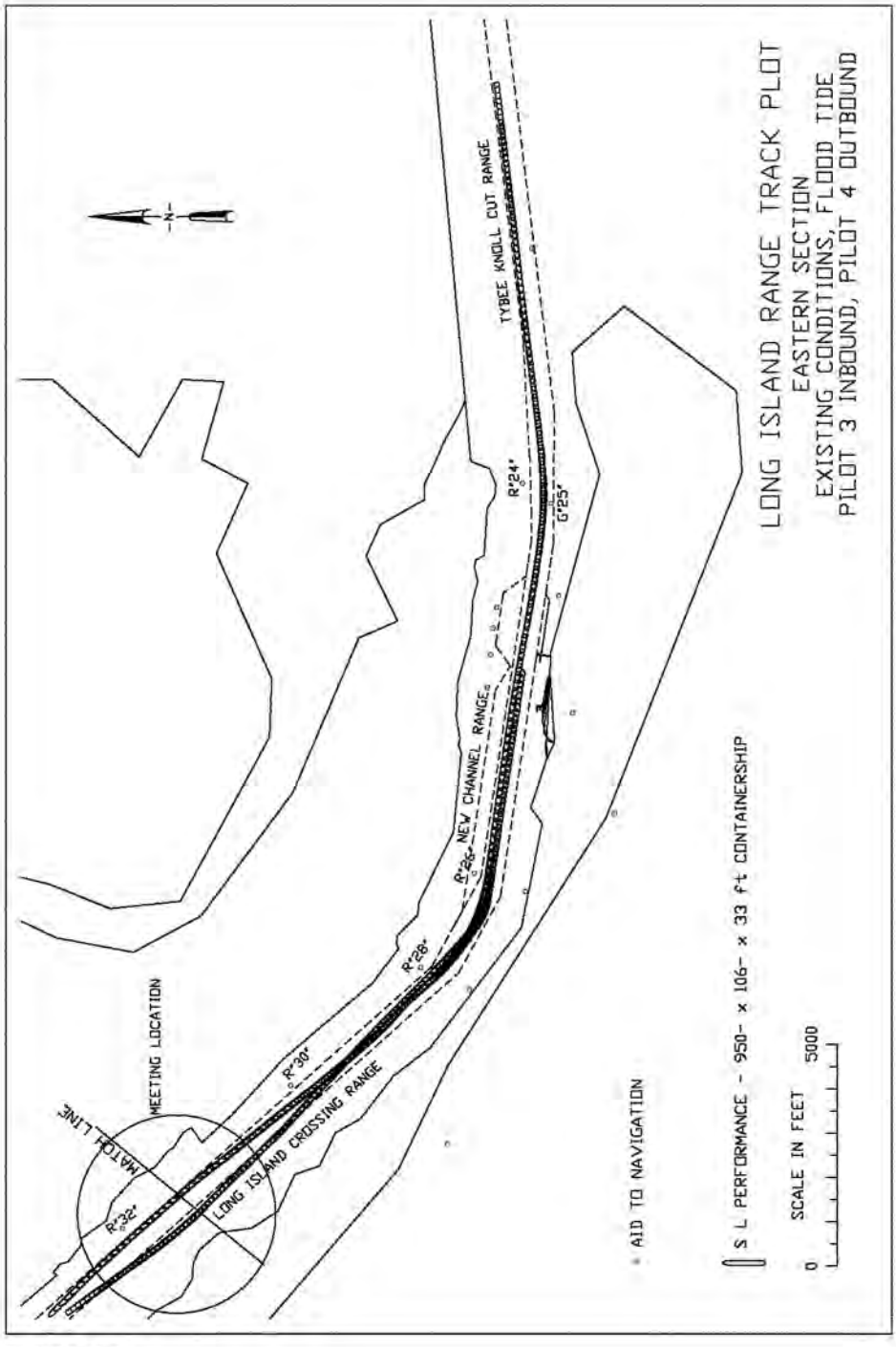

LONG ISLAND RANGE TRACK PLOT
EASTERN SECTION
EXISTING CONDITIONS, FLOOD TIDE
PILOT 3 INBOUND, PILOT 4 OUTBOUND
TYBEE KNOLL CUT RANGE
NEW CHANNEL RANGE
LONG ISLAND CROSSING RANGE
MEETING LOCATION
MATCH LINE
R°24'
G°25'
R°26'
R°28'
R°30'
R°32'
AID TO NAVIGATION
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
SCALE IN FEET
0
5000

PLATE 38

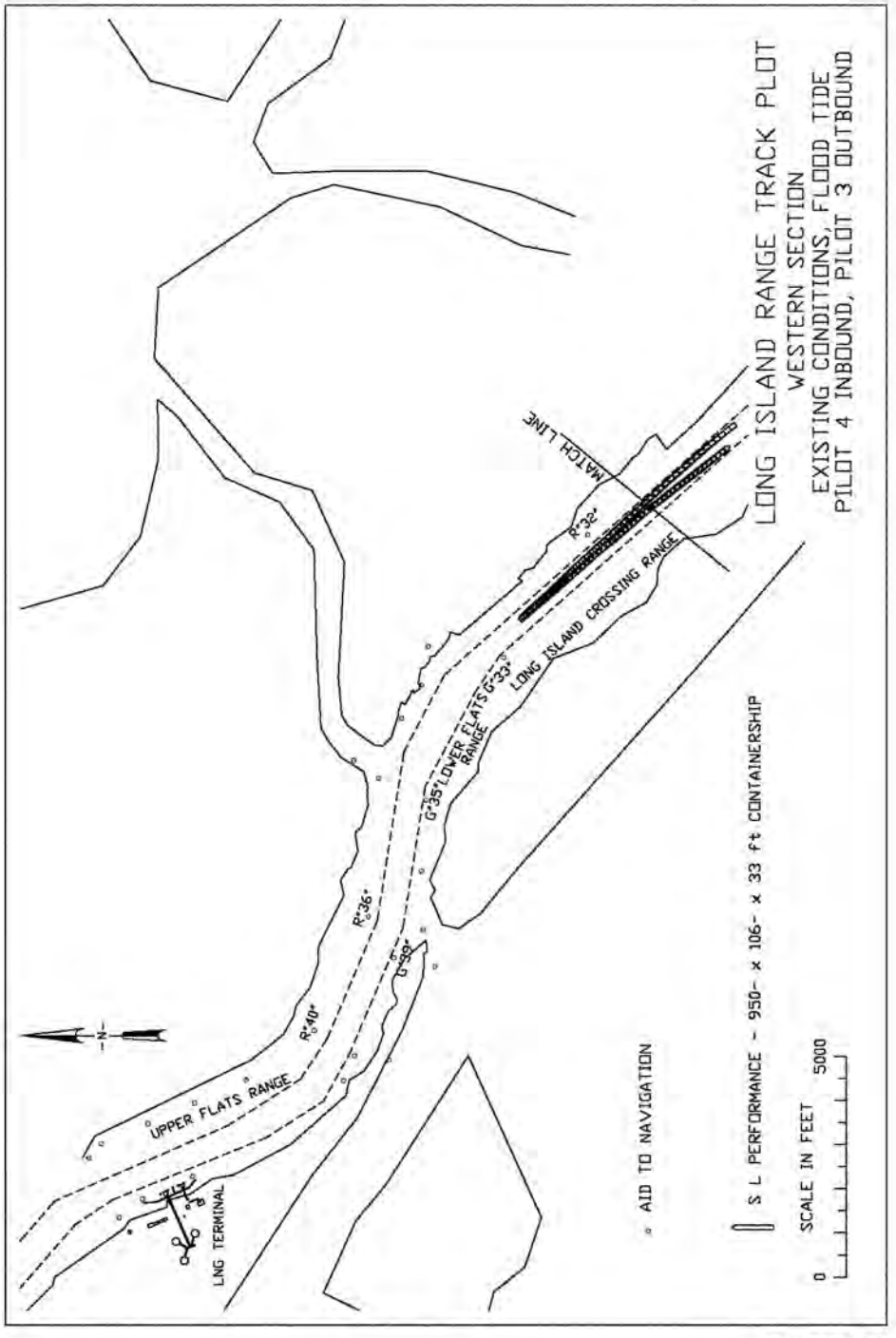

LONG ISLAND RANGE TRACK PLOT
WESTERN SECTION
EXISTING CONDITIONS, FLOOD TIDE
PILOT 4 INBOUND, PILOT 3 OUTBOUND
MATCH LINE
R°32'
LONG ISLAND CROSSING RANGE
G°33'
LOWER FLATS RANGE
G°33'
R°36'
R°40'
UPPER FLATS RANGE
LNG TERMINAL
N
AID TO NAVIGATION
S L PERFORMANCE - 950- x 106- x 33 ft. CONTAINERSHIP
0 SCALE IN FEET 5000

PLATE 39

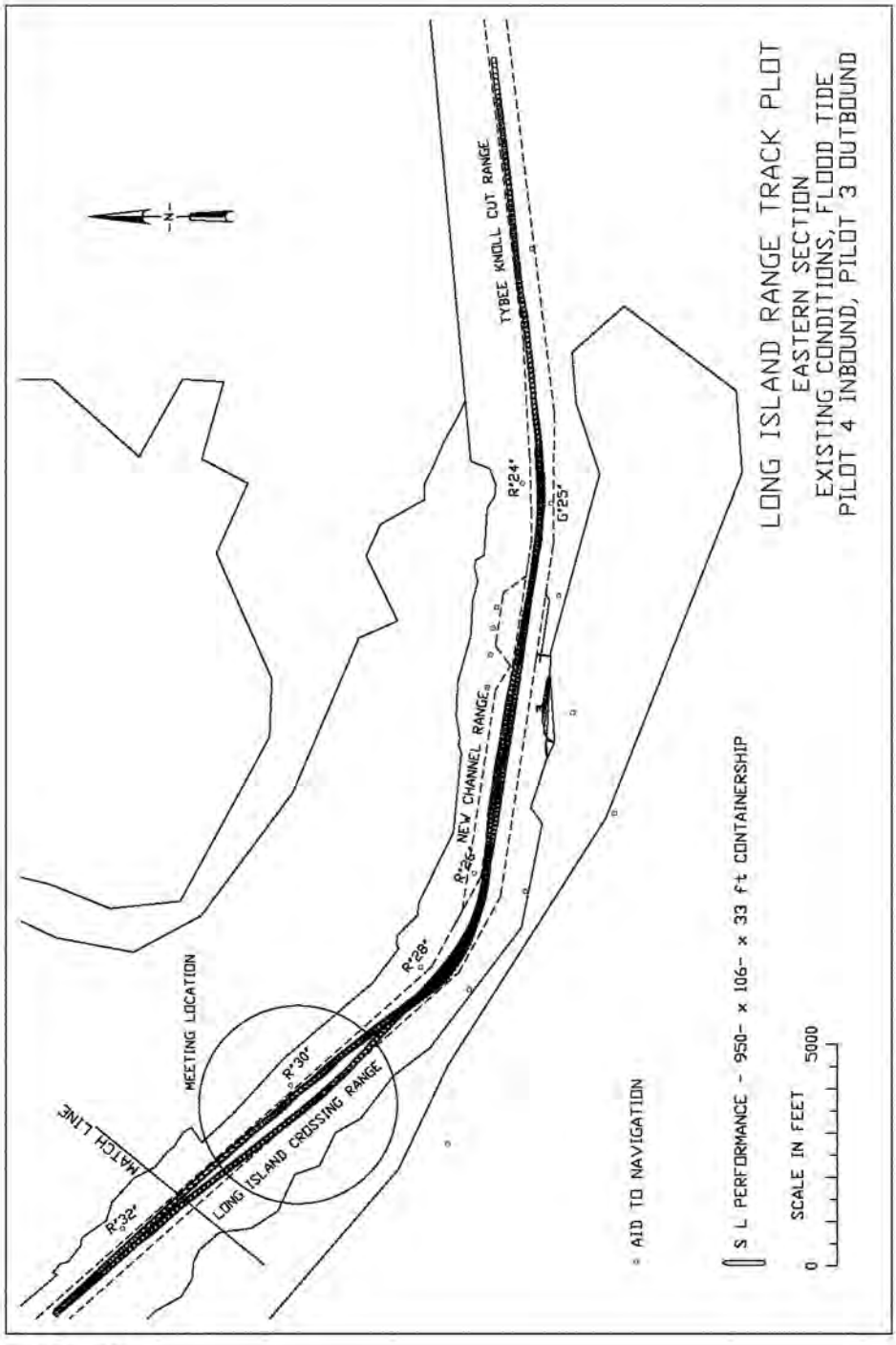

LONG ISLAND RANGE TRACK PLOT
EASTERN SECTION
EXISTING CONDITIONS, FLOOD TIDE
PILOT 4 INBOUND, PILOT 3 OUTBOUND
TYBEE KNOLL CUT RANGE
NEW CHANNEL RANGE
LONG ISLAND CROSSING RANGE
MEETING LOCATION
MATCH LINE
R°24'
G°25'
R°26'
R°28'
R°30'
R°32'
N
AID TO NAVIGATION
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
SCALE IN FEET
0
5000

PLATE 40

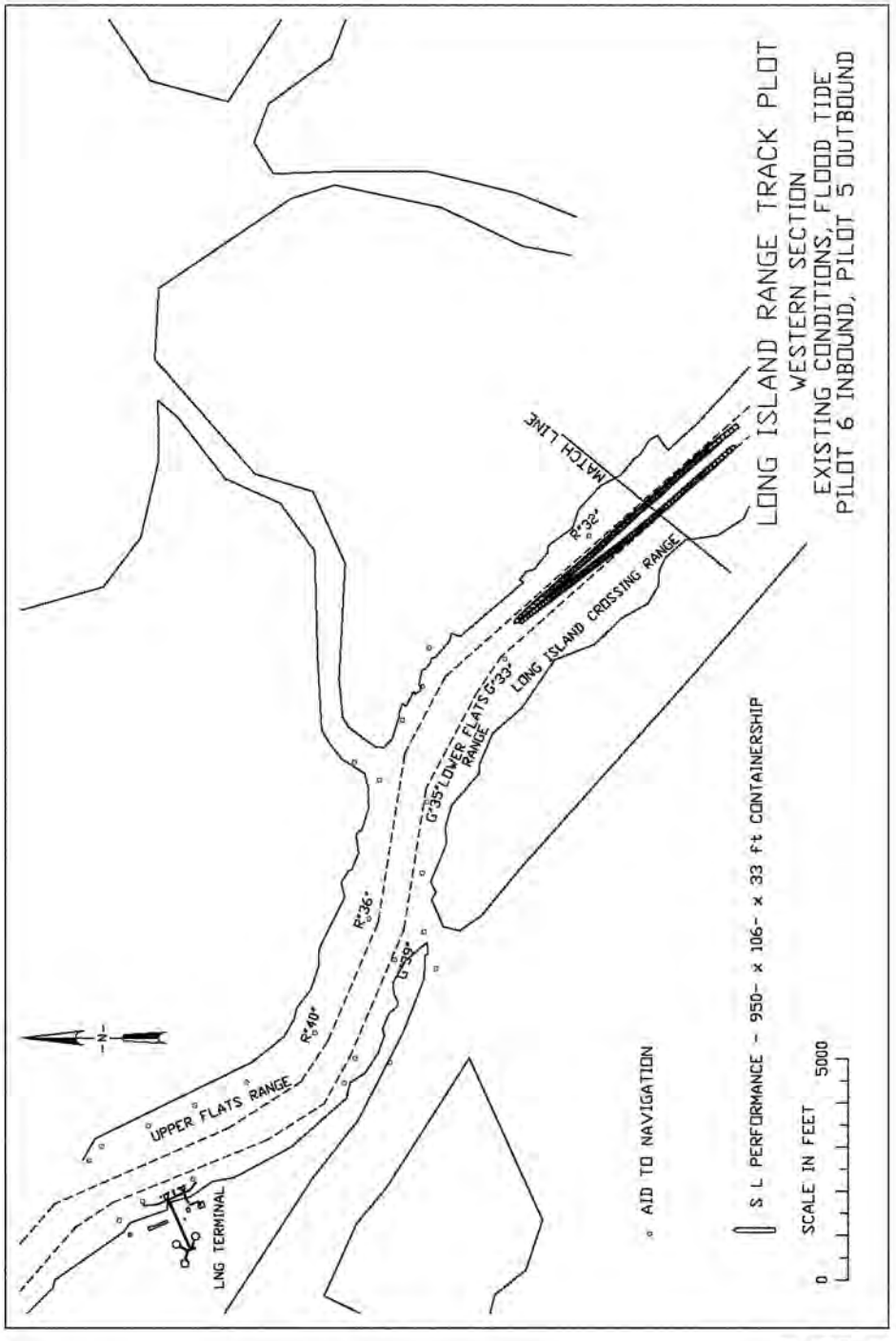

LONG ISLAND RANGE TRACK PLOT
WESTERN SECTION
EXISTING CONDITIONS, FLOOD TIDE
PILOT 6 INBOUND, PILOT 5 OUTBOUND
MATCH LINE
R°32'
LONG ISLAND CROSSING RANGE
G°33'
LOWER FLATS RANGE
G°35'
R°36'
G°39'
R°40'
UPPER FLATS RANGE
LNG TERMINAL
N
AID TO NAVIGATION
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
0 SCALE IN FEET 5000

PLATE 41

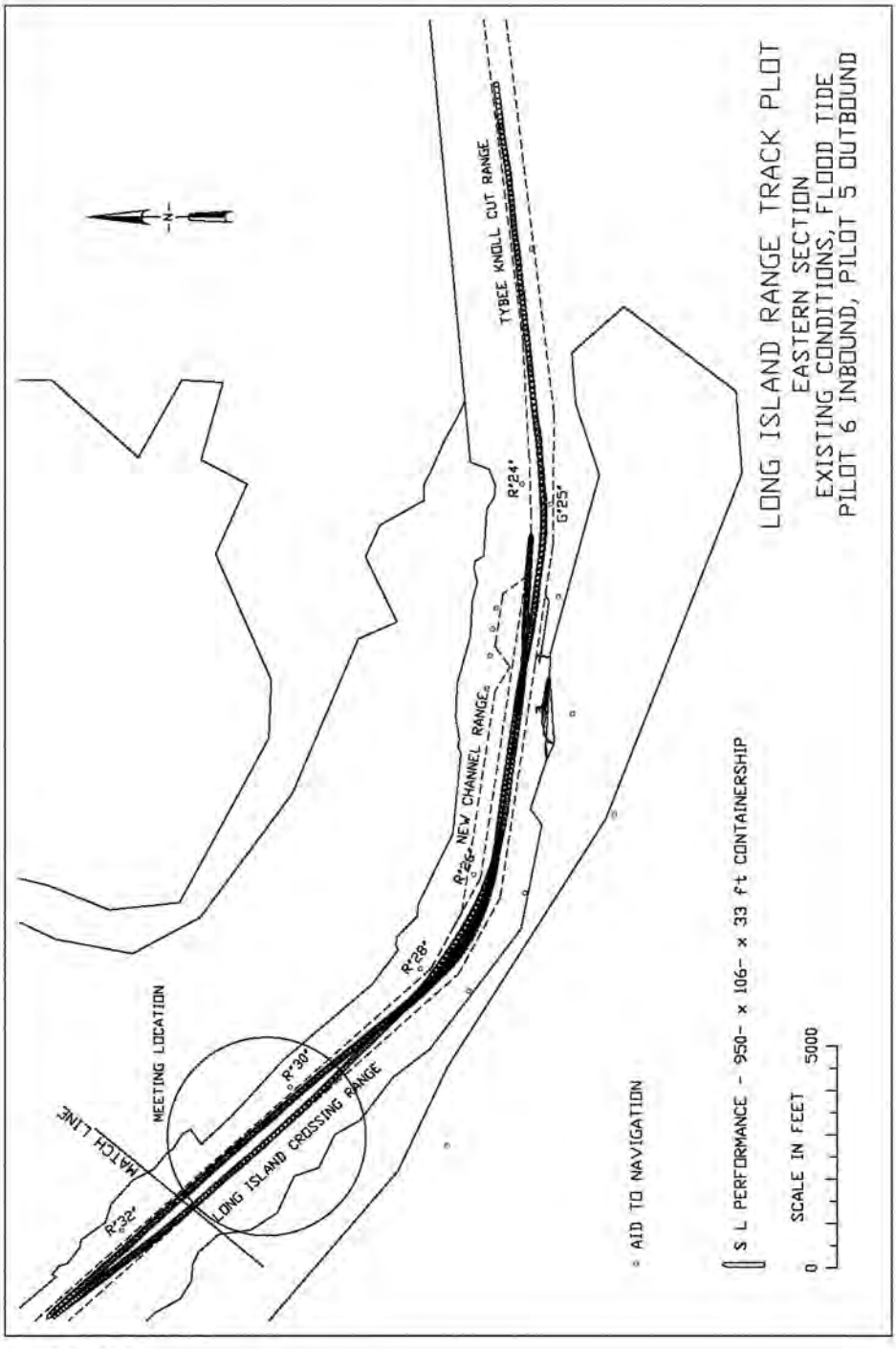

LONG ISLAND RANGE TRACK PLOT
EASTERN SECTION
EXISTING CONDITIONS, FLOOD TIDE
PILOT 6 INBOUND, PILOT 5 OUTBOUND
TYBEE KNOLL CUT RANGE
NEW CHANNEL RANGE
R°24'
G°25'
R°26'
R°28'
R°30'
R°32'
MEETING LOCATION
MATCH LINE
LONG ISLAND CROSSING RANGE
AID TO NAVIGATION
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
SCALE IN FEET
0
5000
N

PLATE 42

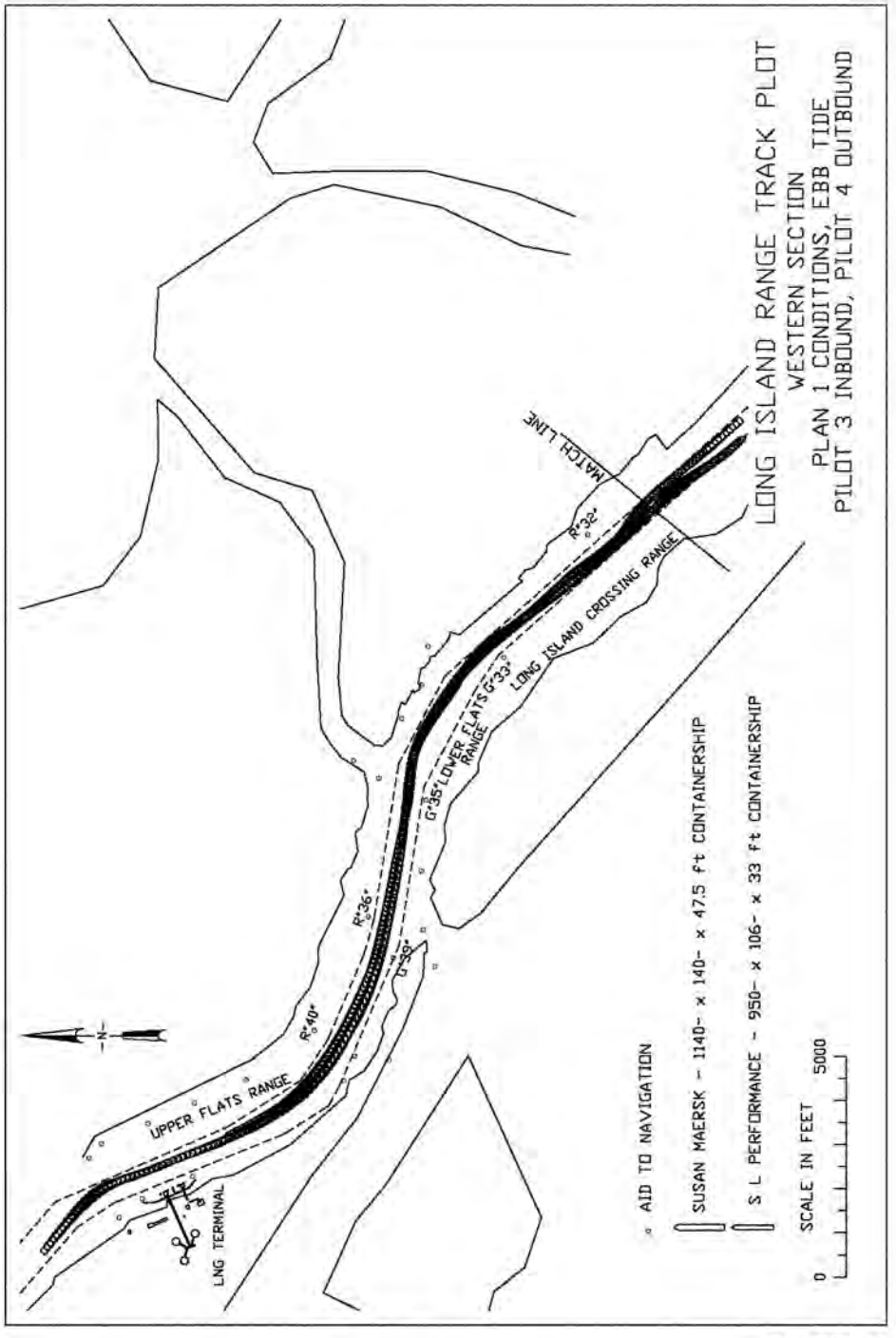

LONG ISLAND RANGE TRACK PLOT
WESTERN SECTION
PLAN 1 CONDITIONS, EBB TIDE
PILOT 3 INBOUND, PILOT 4 OUTBOUND
MATCH LINE
R°32'
LONG ISLAND CROSSING RANGE
G°35' LOWER FLATS RANGE G°33'
R°36'
G°38'
R°40'
UPPER FLATS RANGE
LNG TERMINAL
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
0 SCALE IN FEET 5000

PLATE 43

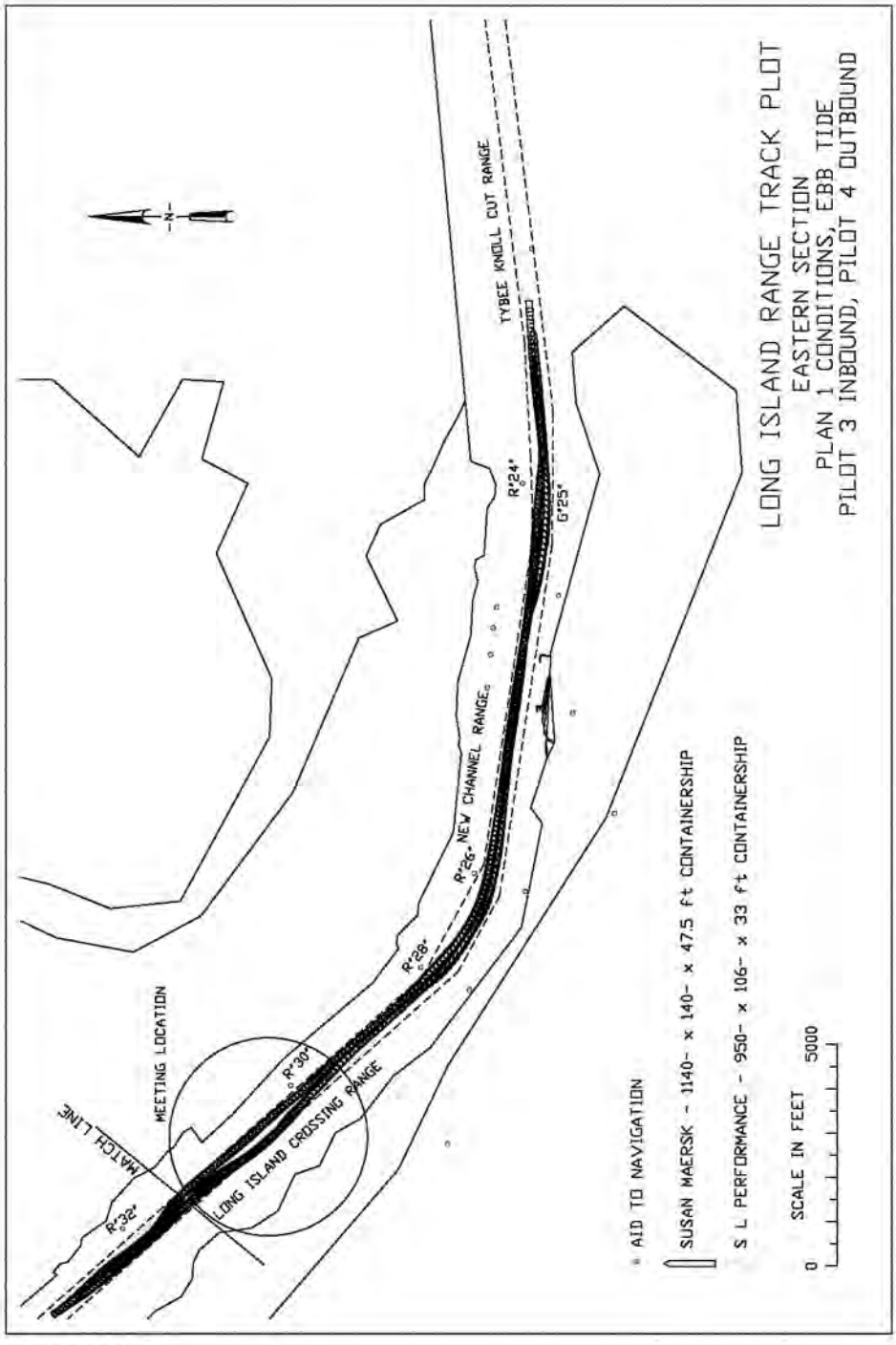

LONG ISLAND RANGE TRACK PLOT
EASTERN SECTION
PLAN 1 CONDITIONS, EBB TIDE
PILOT 3 INBOUND, PILOT 4 OUTBOUND
TYBEE KNOLL CUT RANGE
R°24'
G°25'
R°26' NEW CHANNEL RANGE
R°28'
R°30'
R°32'
MEETING LOCATION
MATCH LINE
LONG ISLAND CROSSING RANGE
N
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
0 SCALE IN FEET 5000

PLATE 44

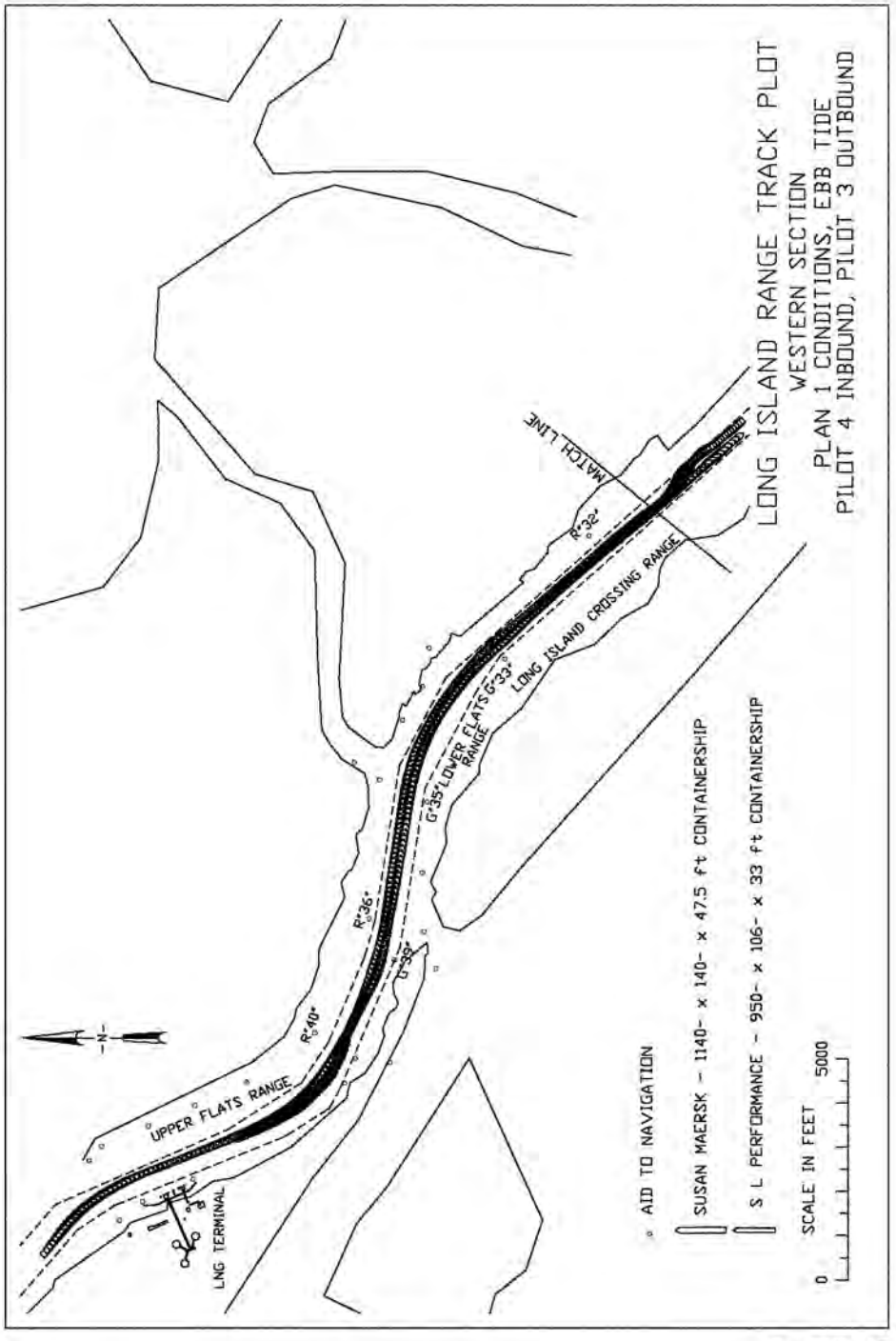

LONG ISLAND RANGE TRACK PLOT
WESTERN SECTION
PLAN 1 CONDITIONS, EBB TIDE
PILOT 4 INBOUND, PILOT 3 OUTBOUND
MATCH LINE
R°32'
LONG ISLAND CROSSING RANGE
G°33'
LOWER FLATS RANGE
G°33'
R°36'
G°33'
R°40'
UPPER FLATS RANGE
LNG TERMINAL
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
0 SCALE IN FEET 5000

PLATE 45

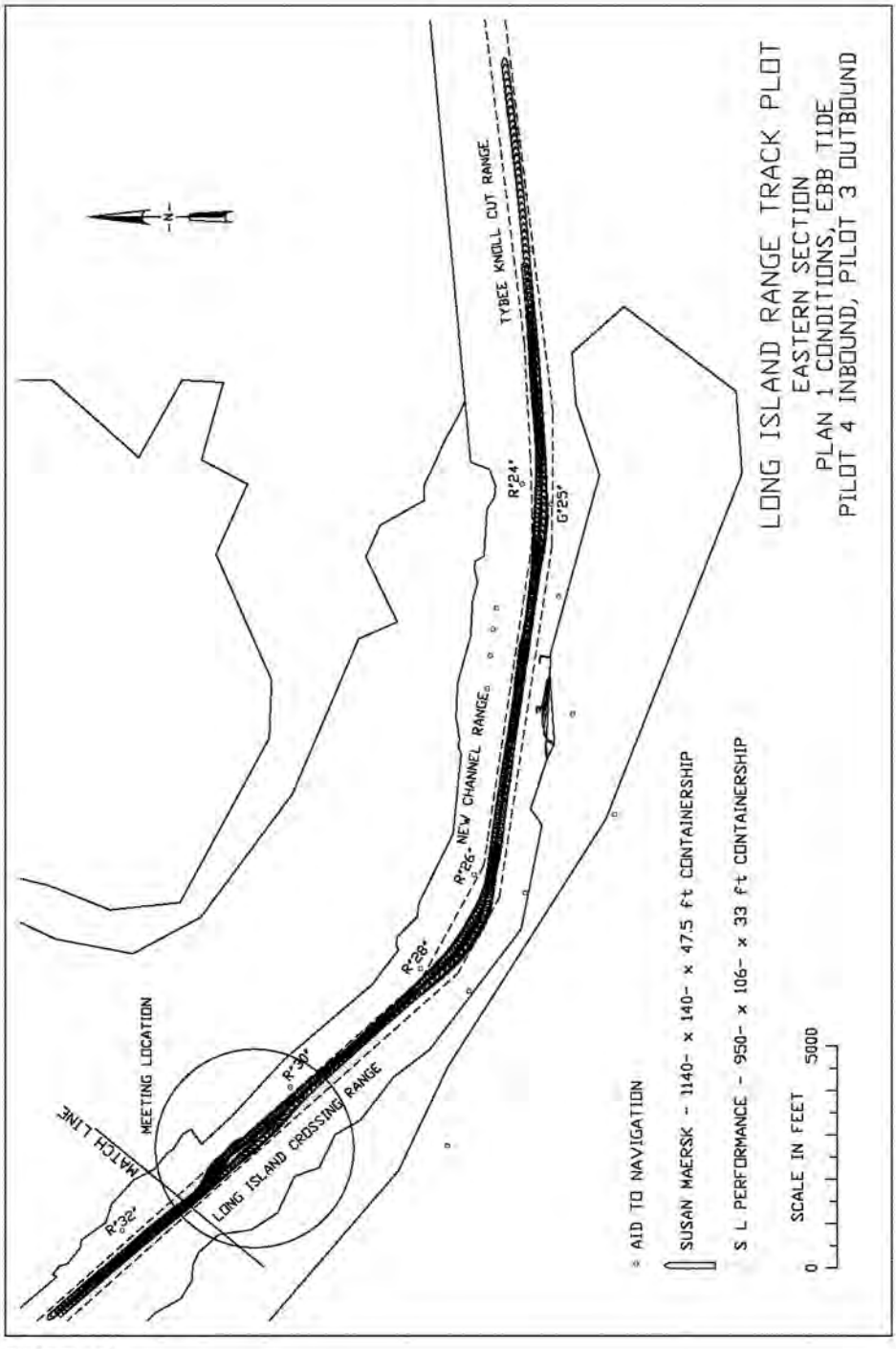

LONG ISLAND RANGE TRACK PLOT
EASTERN SECTION
PLAN 1 CONDITIONS, EBB TIDE
PILOT 4 INBOUND, PILOT 3 OUTBOUND
TYBEE KNOLL CUT RANGE
NEW CHANNEL RANGE
LONG ISLAND CROSSING RANGE
MEETING LOCATION
MATCH LINE
R°24'
G°25'
R°26'
R°28'
R°30'
R°32'
N
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
SCALE IN FEET
0
5000

PLATE 46

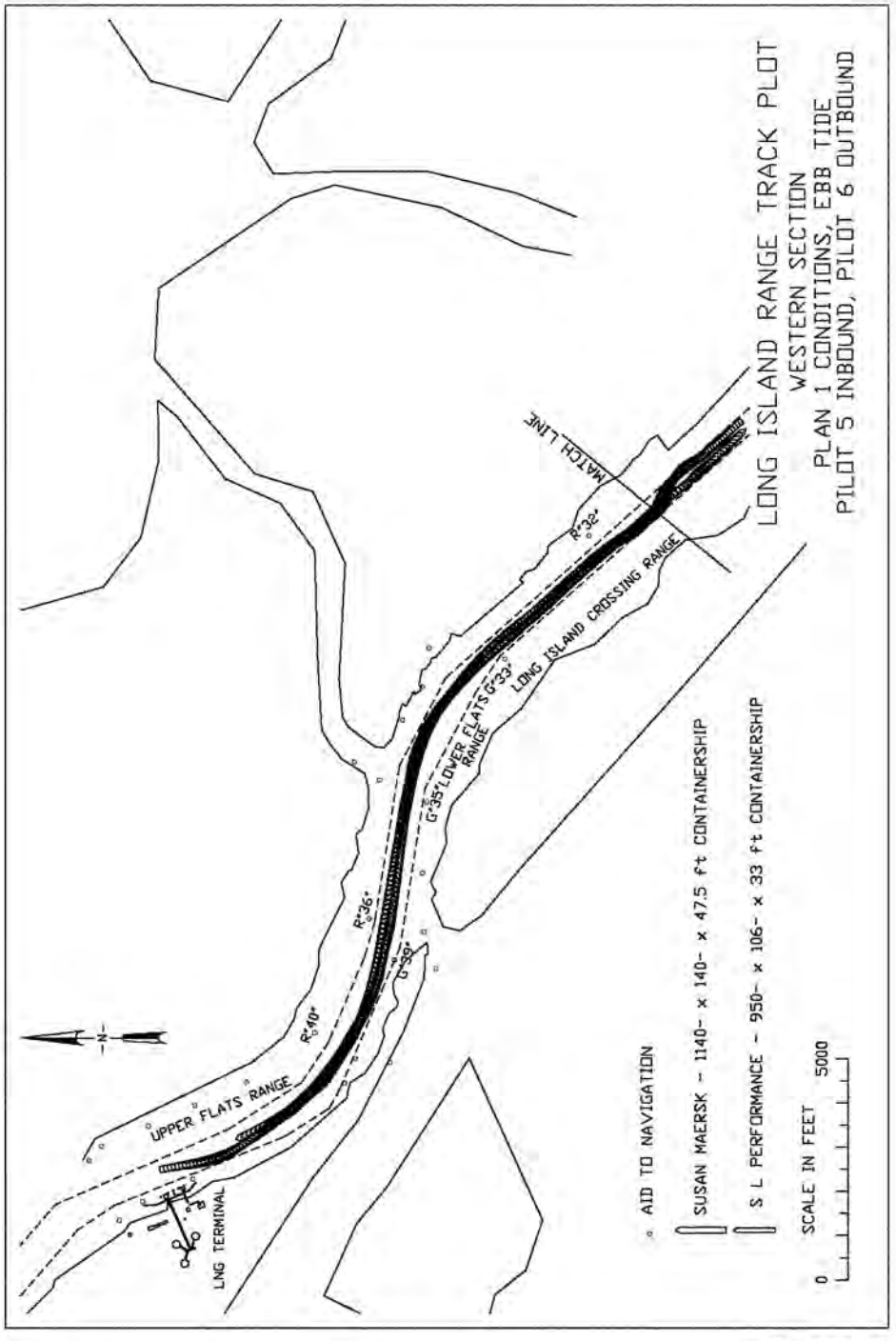

LONG ISLAND RANGE TRACK PLOT
WESTERN SECTION
PLAN 1 CONDITIONS, EBB TIDE
PILOT 5 INBOUND, PILOT 6 OUTBOUND
MATCH LINE
R°32'
LONG ISLAND CROSSING RANGE
G°33'
LOWER FLATS RANGE
G°35'
G°33'
R°36'
R°40'
UPPER FLATS RANGE
LNG TERMINAL
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
0 SCALE IN FEET 5000

PLATE 47

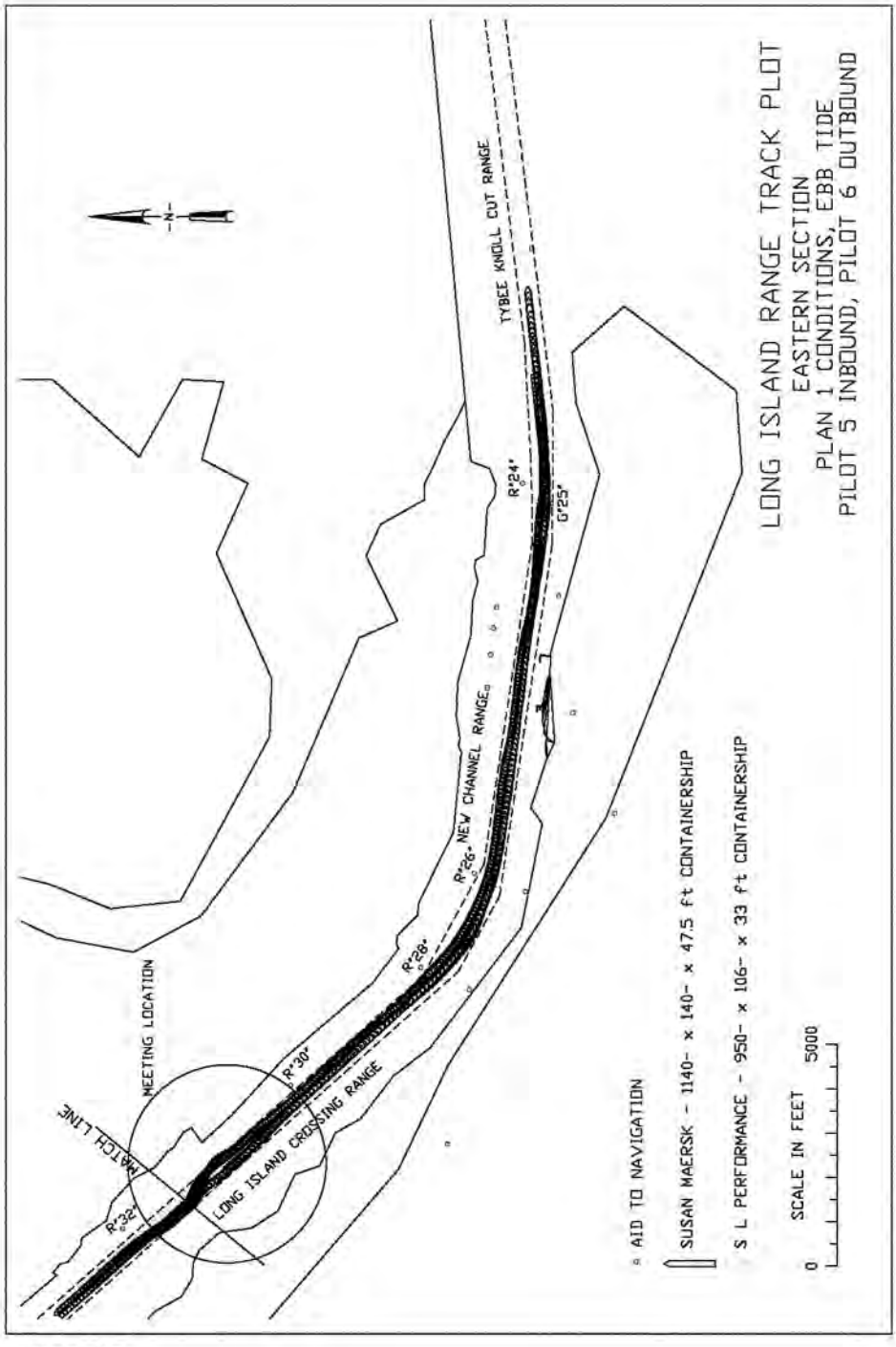

LONG ISLAND RANGE TRACK PLOT
EASTERN SECTION
PLAN 1 CONDITIONS, EBB TIDE
PILOT 5 INBOUND, PILOT 6 OUTBOUND
TYBEE KNOLL CUT RANGE
R°24'
G°25'
R°26' NEW CHANNEL RANGE
R°28'
R°30'
R°32'
MEETING LOCATION
MATCH LINE
LONG ISLAND CROSSING RANGE
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
0 SCALE IN FEET 5000
N

PLATE 48

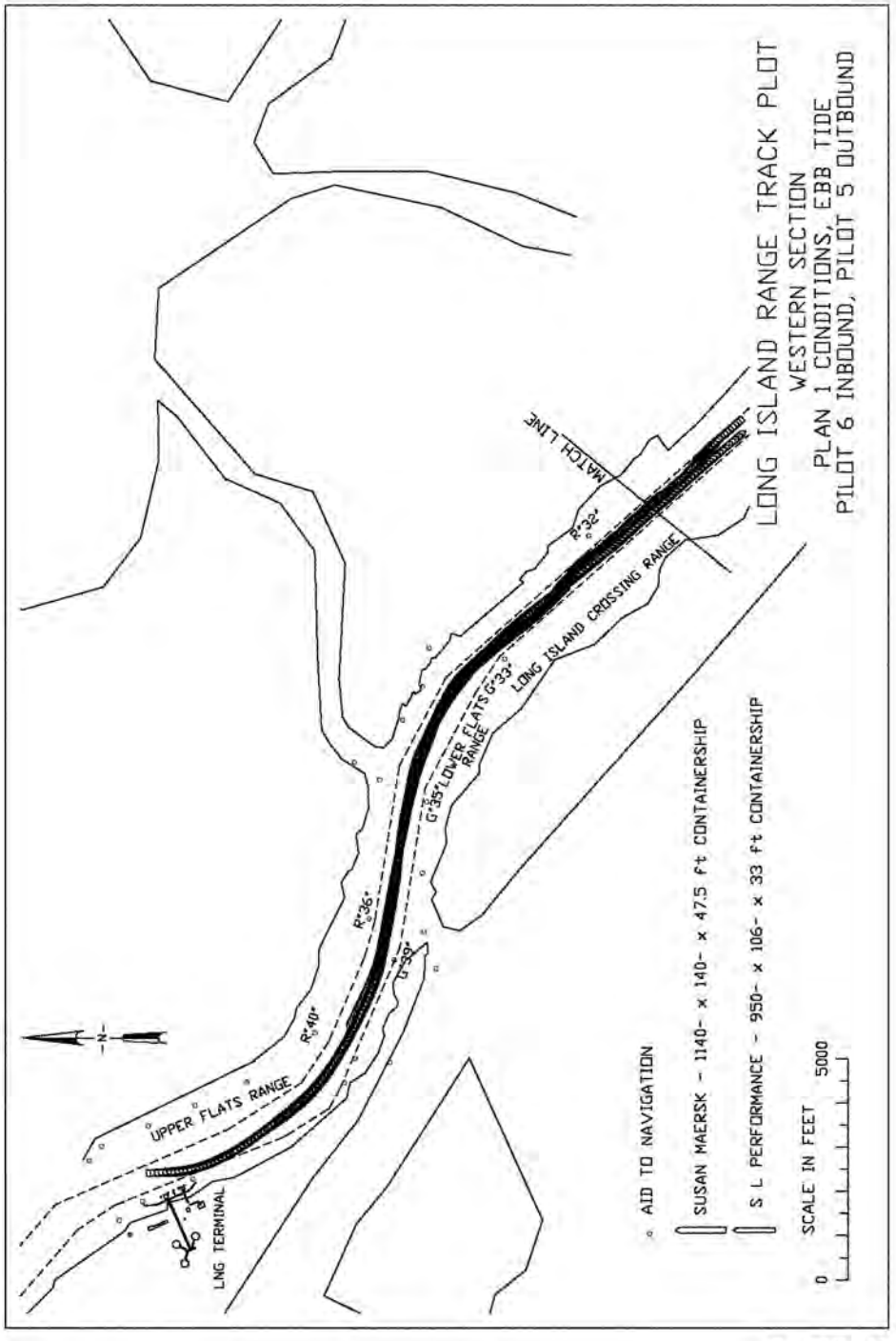

LONG ISLAND RANGE TRACK PLOT
WESTERN SECTION
PLAN 1 CONDITIONS, EBB TIDE
PILOT 6 INBOUND, PILOT 5 OUTBOUND
MATCH LINE
R°32'
LONG ISLAND CROSSING RANGE
G°33'
LOWER FLATS RANGE
G°33'
G°33'
R°36'
R°40'
UPPER FLATS RANGE
LNG TERMINAL
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
0 SCALE IN FEET 5000

PLATE 49

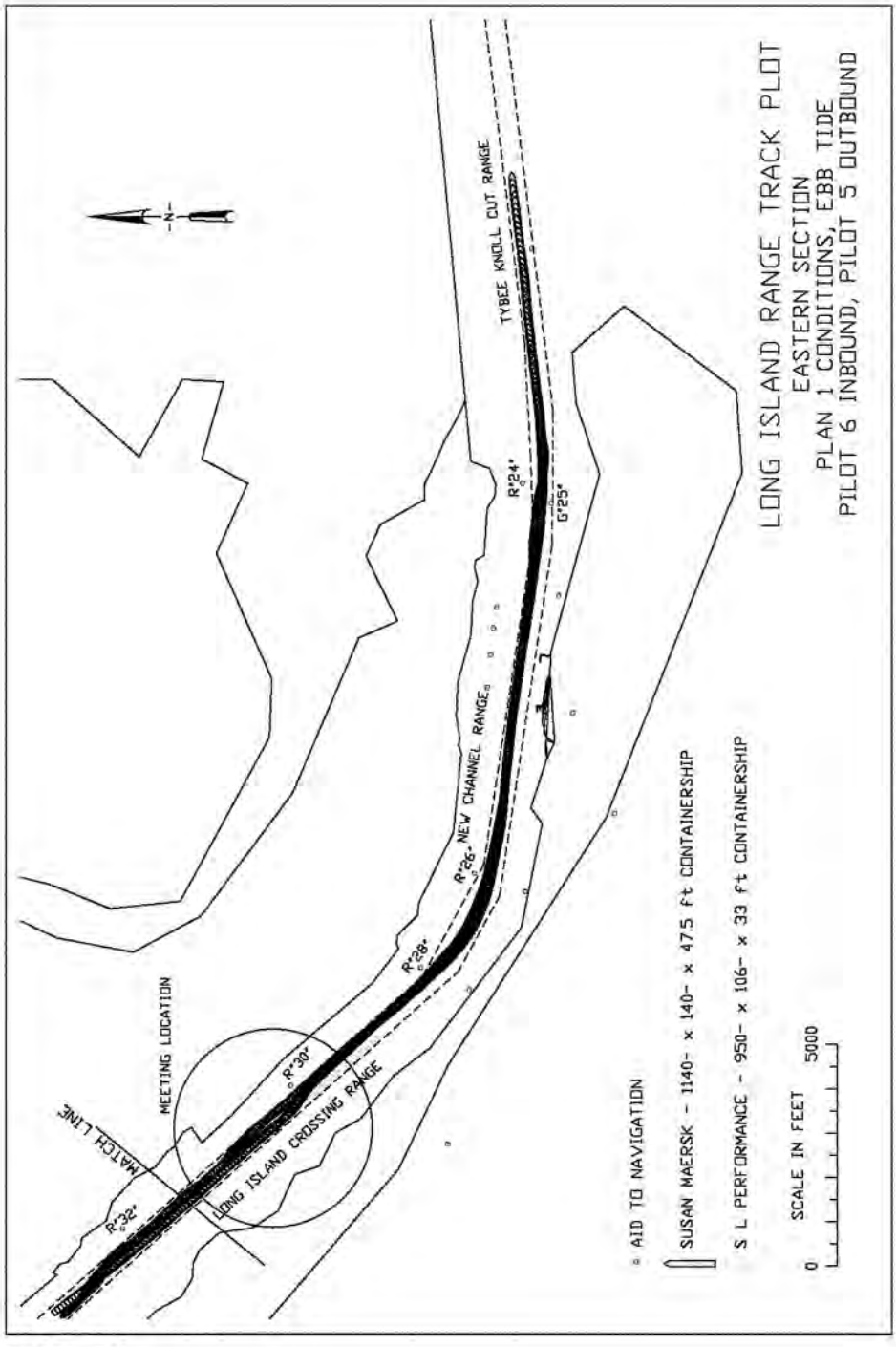

LONG ISLAND RANGE TRACK PLOT
EASTERN SECTION
PLAN 1 CONDITIONS, EBB TIDE
PILOT 6 INBOUND, PILOT 5 OUTBOUND
TYBEE KNOLL CUT RANGE
R°24'
G°25'
R°26' NEW CHANNEL RANGE
R°28'
R°30'
R°32'
MEETING LOCATION
MATCH LINE
LONG ISLAND CROSSING RANGE
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
0 SCALE IN FEET 5000
N

PLATE 50

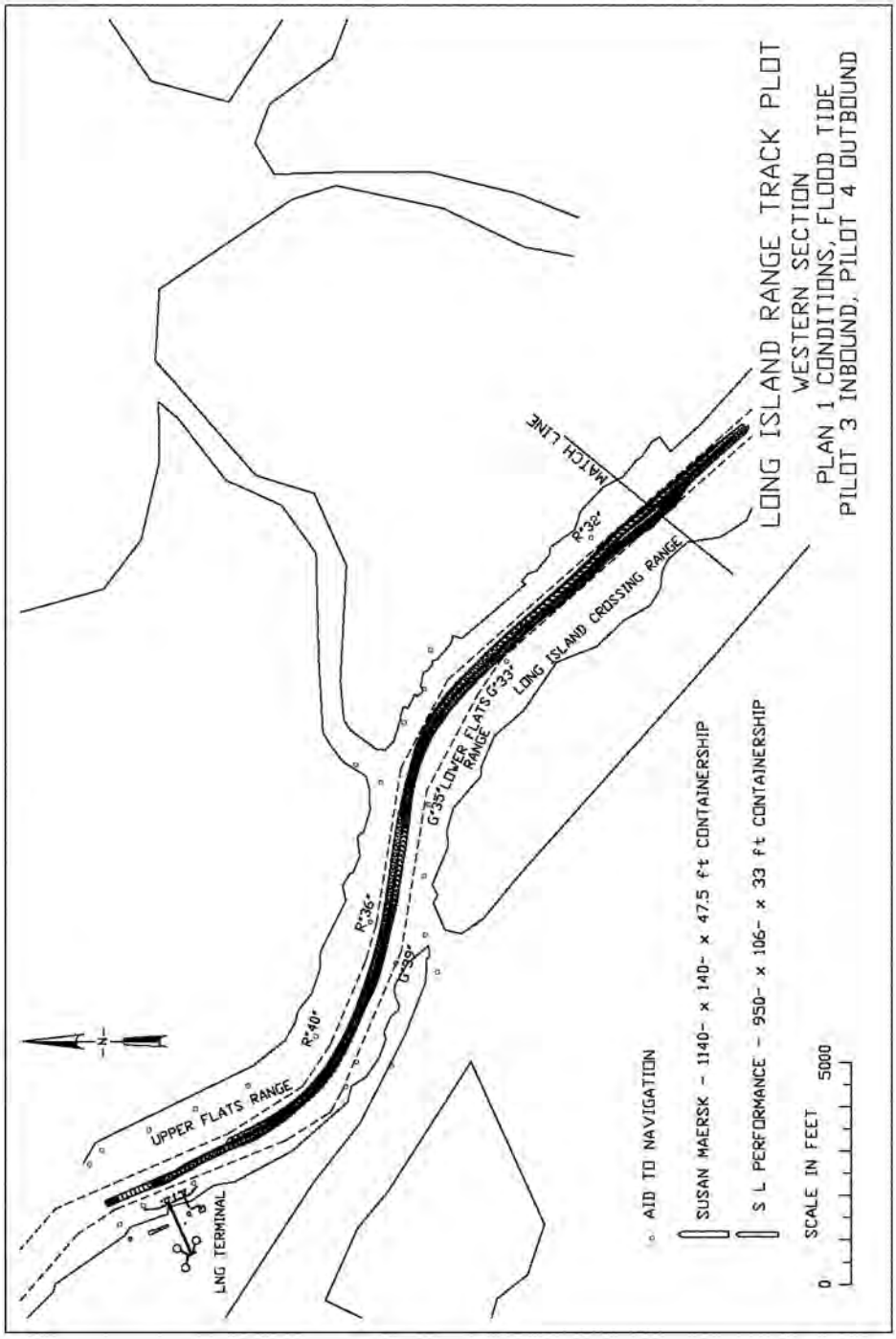

LONG ISLAND RANGE TRACK PLOT
WESTERN SECTION
PLAN 1 CONDITIONS, FLOOD TIDE
PILOT 3 INBOUND, PILOT 4 OUTBOUND
MATCH LINE
R°32'
LONG ISLAND CROSSING RANGE
G°33'
LOWER FLATS RANGE
G°33'
G°35'
R°36'
G°39'
R°40'
UPPER FLATS RANGE
LNG TERMINAL
AID TO NAVIGATION
SUSAN MAERSK - 1140' x 140' x 47.5 ft CONTAINERSHIP
S L PERFORMANCE - 950' x 106' x 33 ft CONTAINERSHIP
0
SCALE IN FEET
5000

PLATE 51

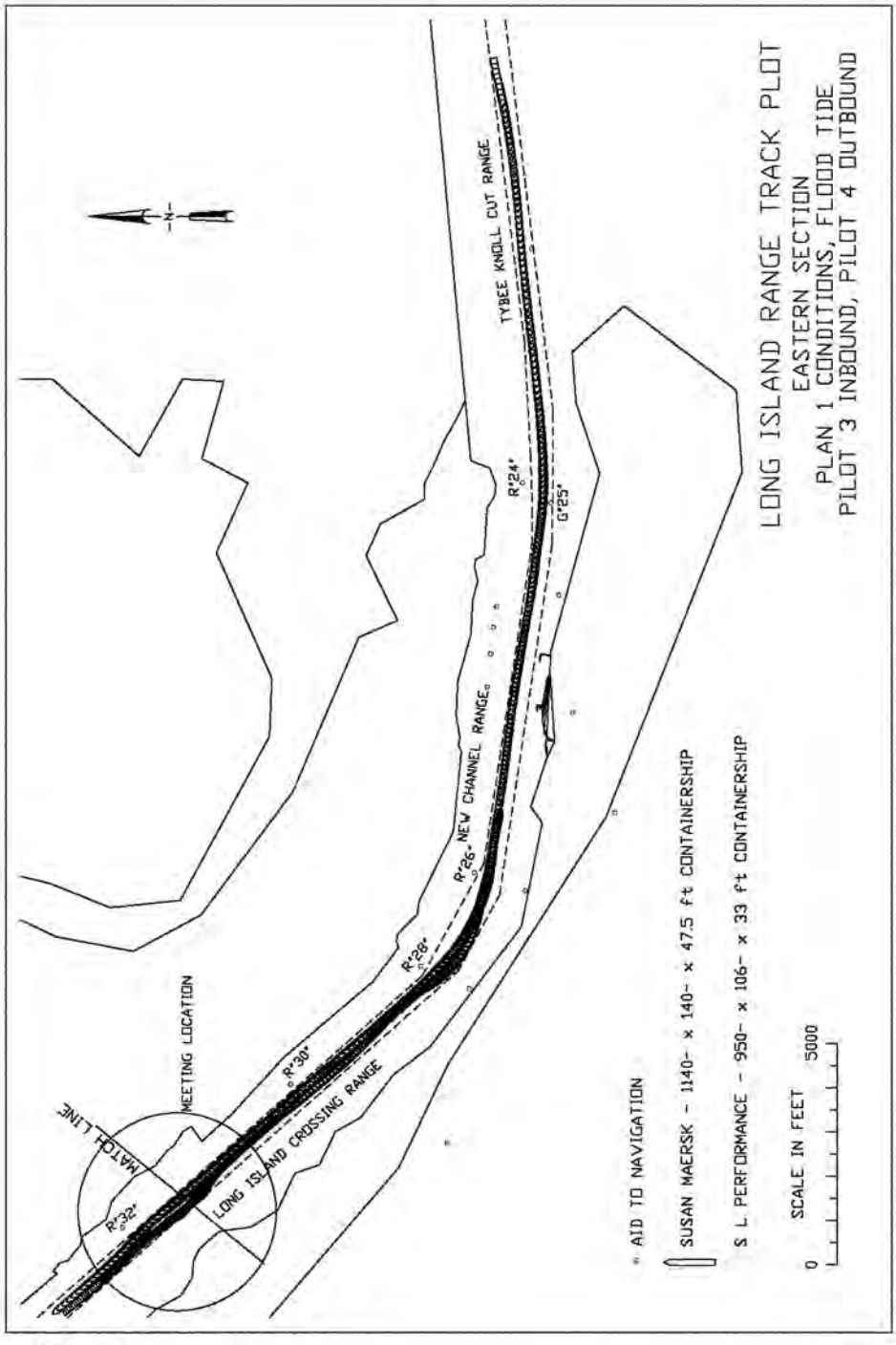

LONG ISLAND RANGE TRACK PLOT
EASTERN SECTION
PLAN 1 CONDITIONS, FLOOD TIDE
PILOT 3 INBOUND, PILOT 4 OUTBOUND
TYBEE KNOLL CUT RANGE
NEW CHANNEL RANGE
LONG ISLAND CROSSING RANGE
MEETING LOCATION
MATCH LINE
R°24'
G°25'
R°26'
R°28'
R°30'
R°32'
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
SCALE IN FEET
0
5000
N

PLATE 52

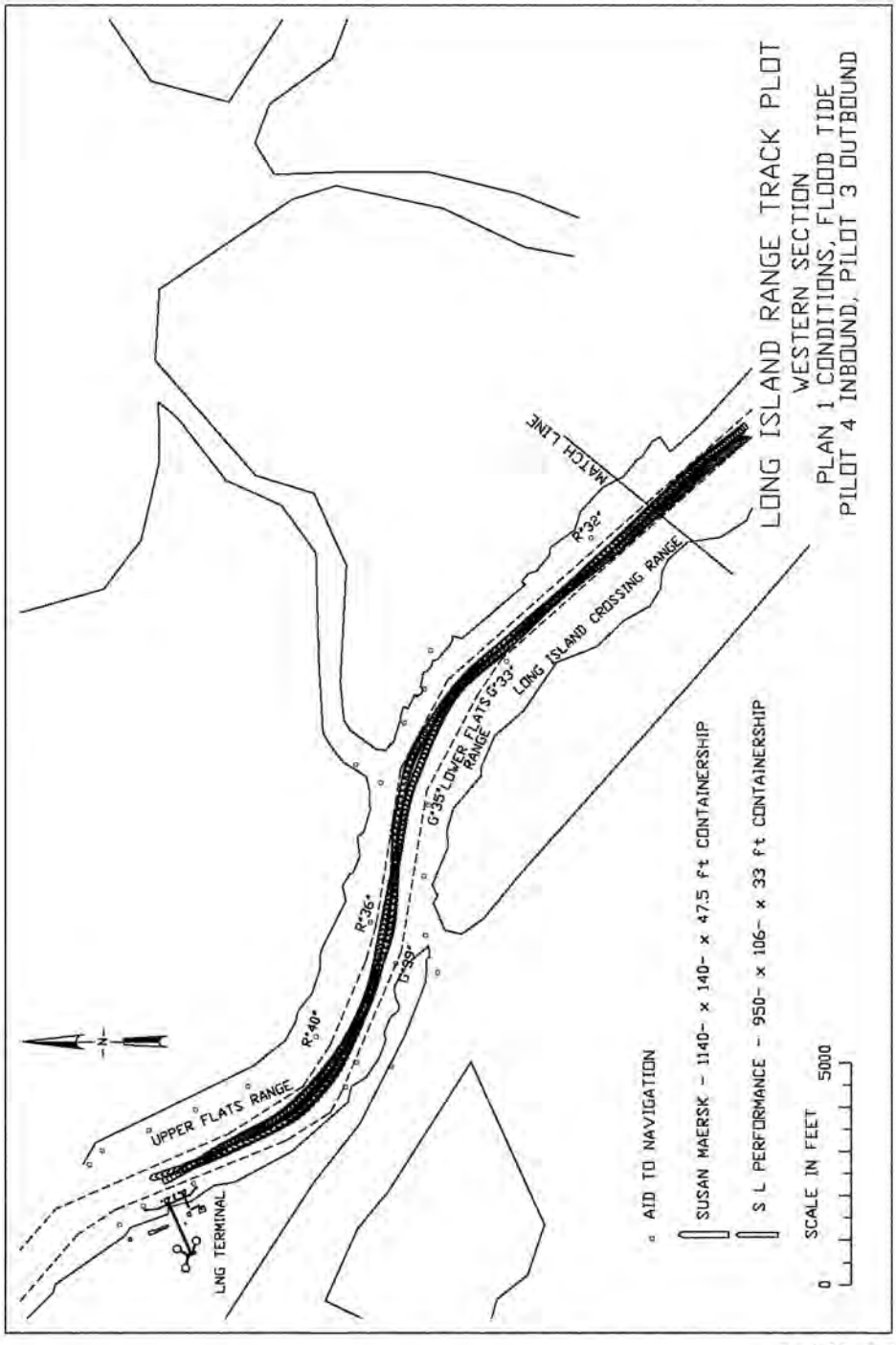

LONG ISLAND RANGE TRACK PLOT
WESTERN SECTION
PLAN 1 CONDITIONS, FLOOD TIDE
PILOT 4 INBOUND, PILOT 3 OUTBOUND
LNG TERMINAL
UPPER FLATS RANGE
LOWER FLATS RANGE
LONG ISLAND CROSSING RANGE
MATCH LINE
R°40°
R°36°
G°35'
G°33'
R°32°
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
0 SCALE IN FEET 5000

PLATE 53

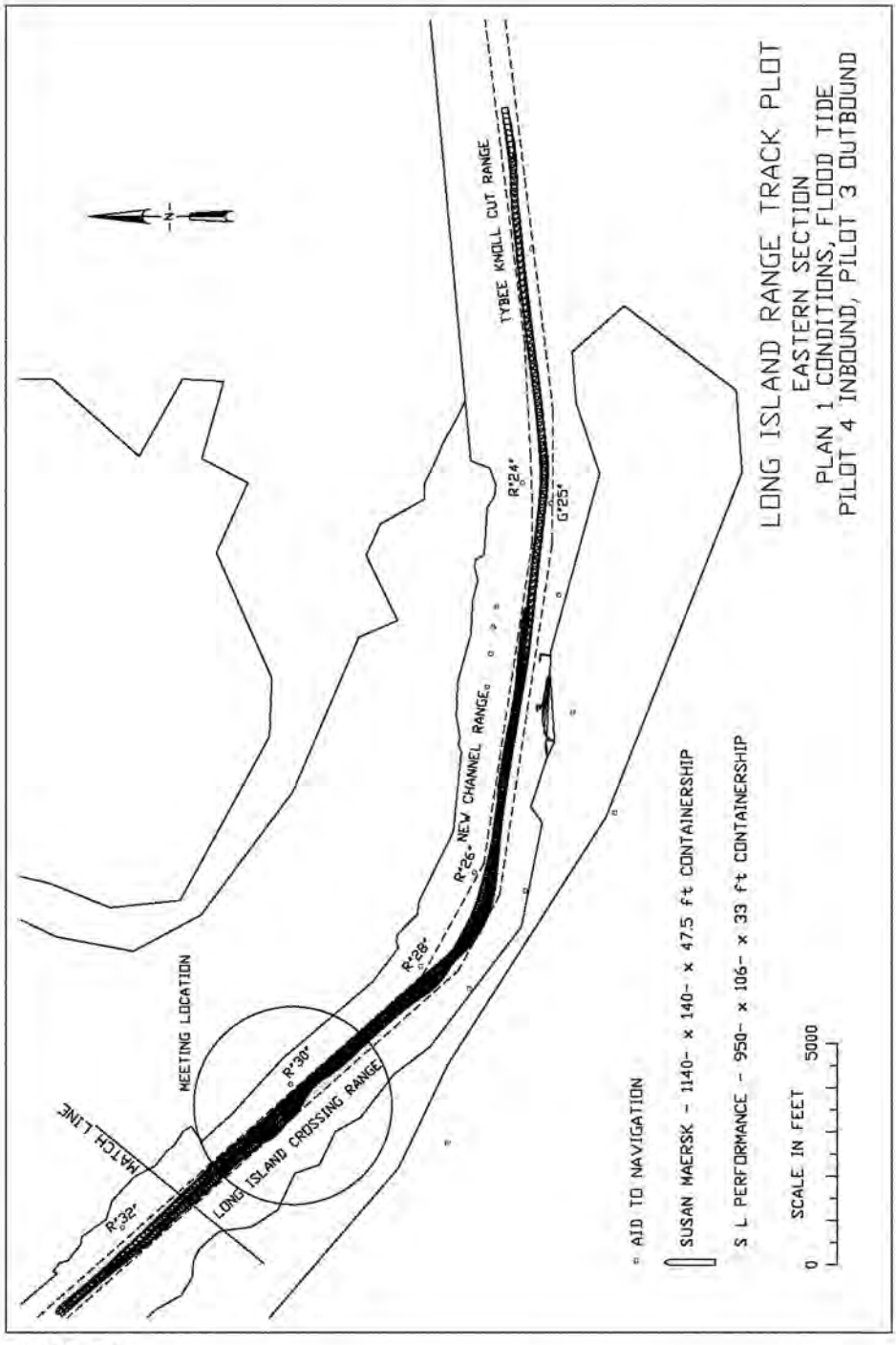

LONG ISLAND RANGE TRACK PLOT
EASTERN SECTION
PLAN 1 CONDITIONS, FLOOD TIDE
PILOT 4 INBOUND, PILOT 3 OUTBOUND
TYBEE KNOLL CUT RANGE
NEW CHANNEL RANGE
LONG ISLAND CROSSING RANGE
MEETING LOCATION
MATCH LINE
R"24"
G"25"
R"26"
R"28"
R"30"
R"32"
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
SCALE IN FEET
0
5000

PLATE 54

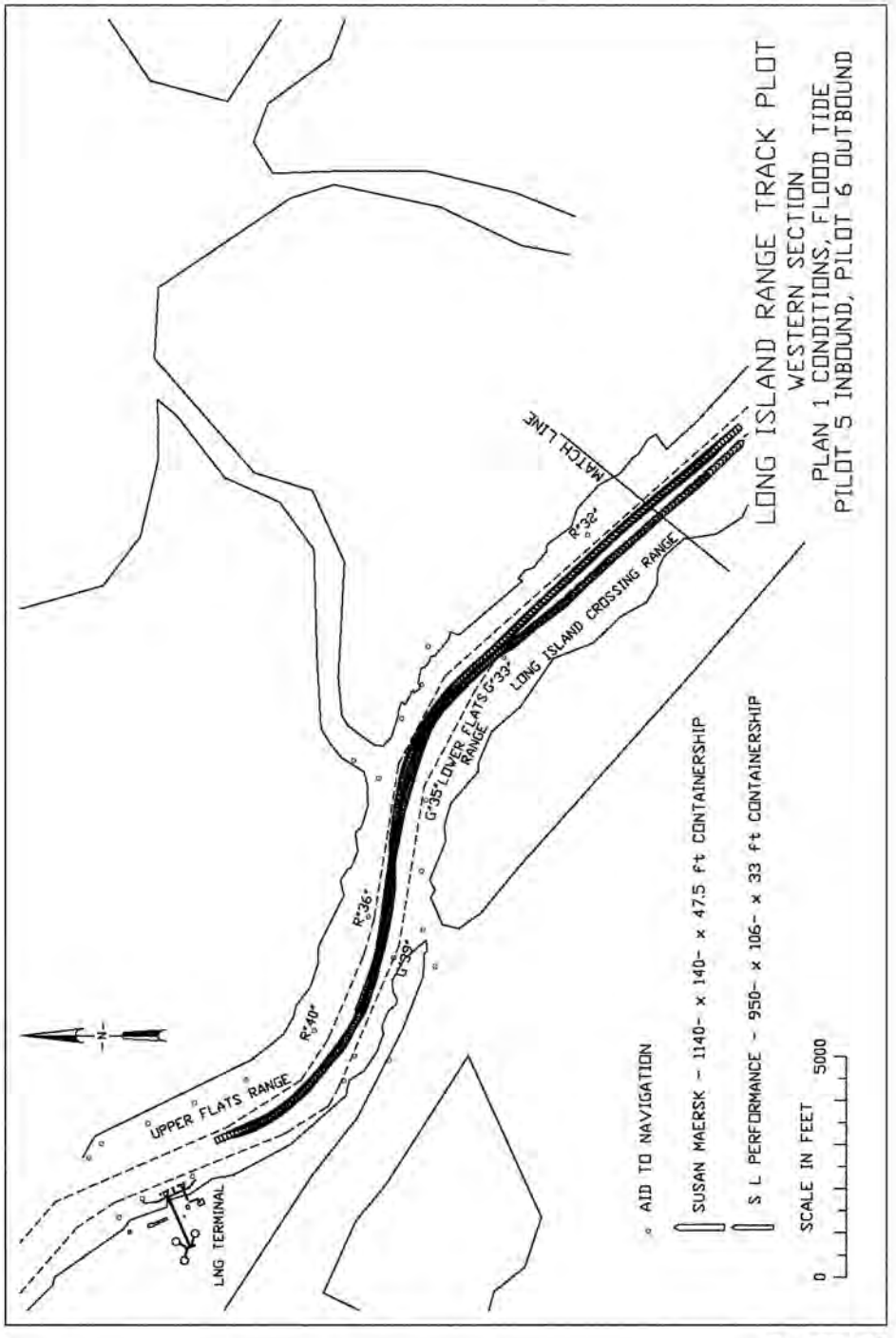

LONG ISLAND RANGE TRACK PLOT
WESTERN SECTION
PLAN 1 CONDITIONS, FLOOD TIDE
PILOT 5 INBOUND, PILOT 6 OUTBOUND
MATCH LINE
R"32"
LONG ISLAND CROSSING RANGE
G"33"
G"35" LOWER FLATS RANGE
R"36"
G"39"
R"40"
UPPER FLATS RANGE
LNG TERMINAL
N
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
SCALE IN FEET
0
5000

PLATE 55

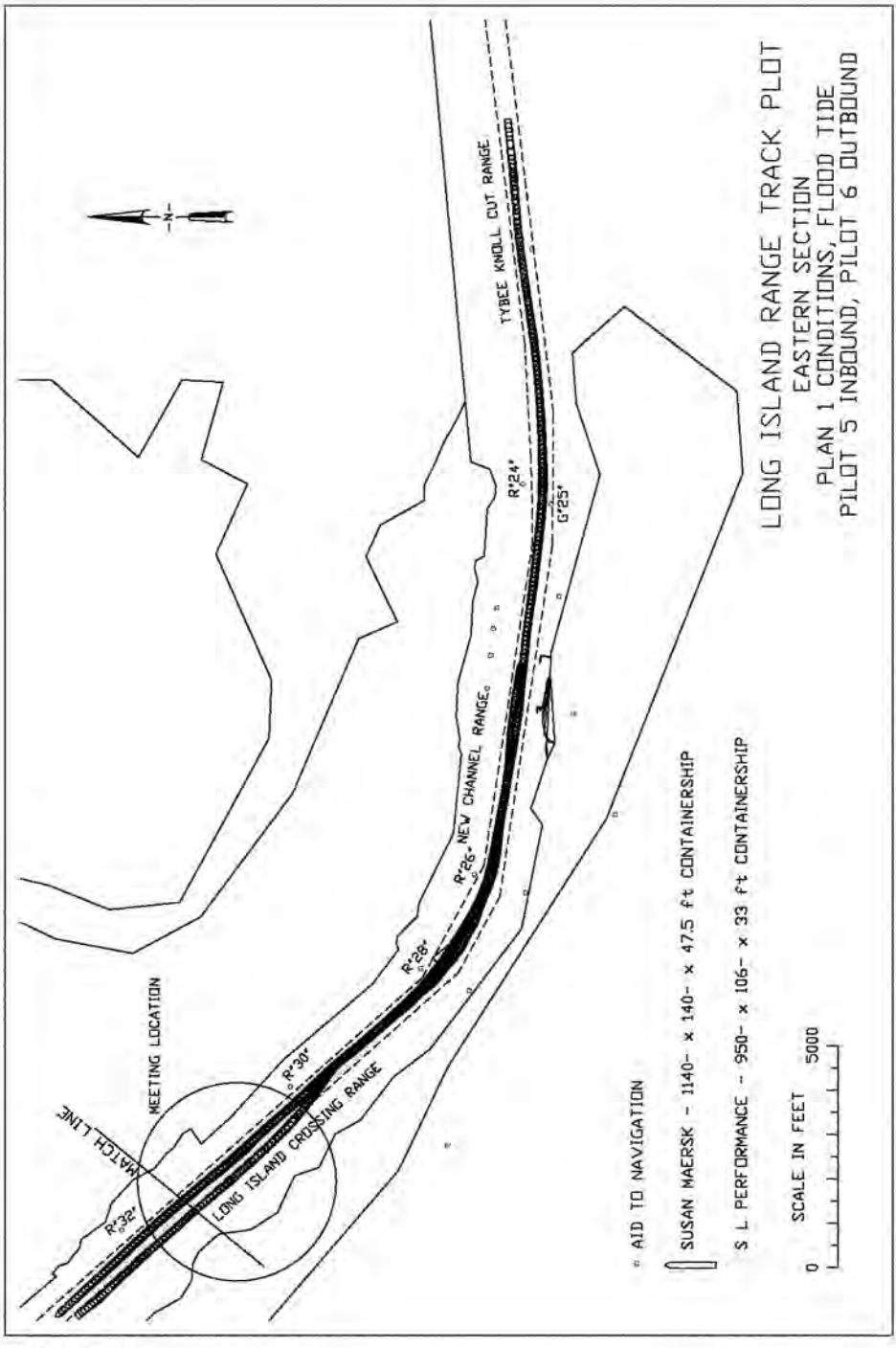

LONG ISLAND RANGE TRACK PLOT
EASTERN SECTION
PLAN 1 CONDITIONS, FLOOD TIDE
PILOT 5 INBOUND, PILOT 6 OUTBOUND
TYBEE KNOLL CUT RANGE
R"24"
G"25"
R"26" NEW CHANNEL RANGE
R"28"
R"30"
R"32"
MEETING LOCATION
MATCH LINE
LONG ISLAND CROSSING RANGE
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
S L PERFORMANCE -- 950- x 106- x 33 ft CONTAINERSHIP
0 SCALE IN FEET 5000
N

PLATE 56

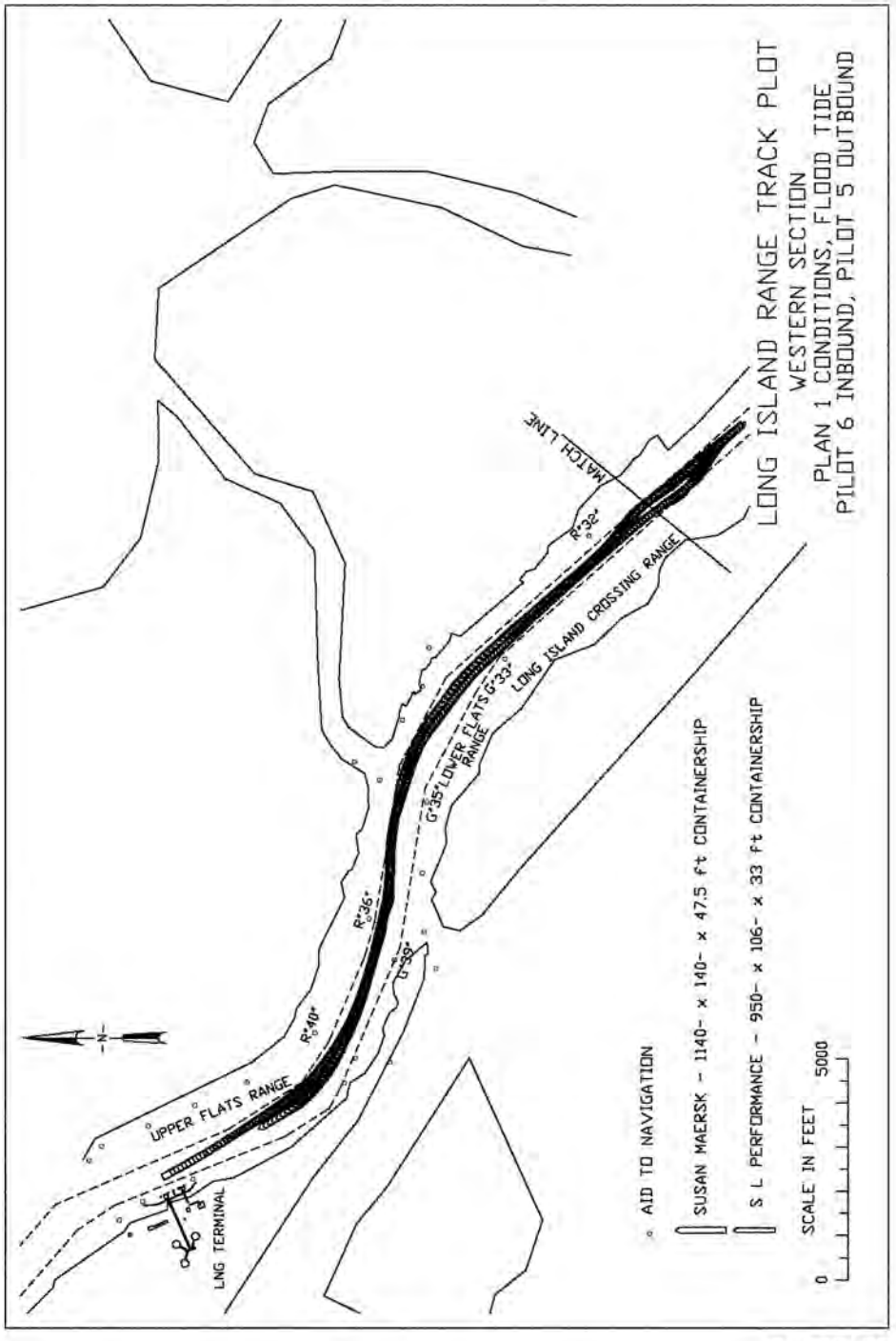

LONG ISLAND RANGE TRACK PLOT
WESTERN SECTION
PLAN 1 CONDITIONS, FLOOD TIDE
PILOT 6 INBOUND, PILOT 5 OUTBOUND
MATCH LINE
LONG ISLAND CROSSING RANGE
LOWER FLATS RANGE
UPPER FLATS RANGE
LNG TERMINAL
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
SCALE IN FEET 5000
0

PLATE 57

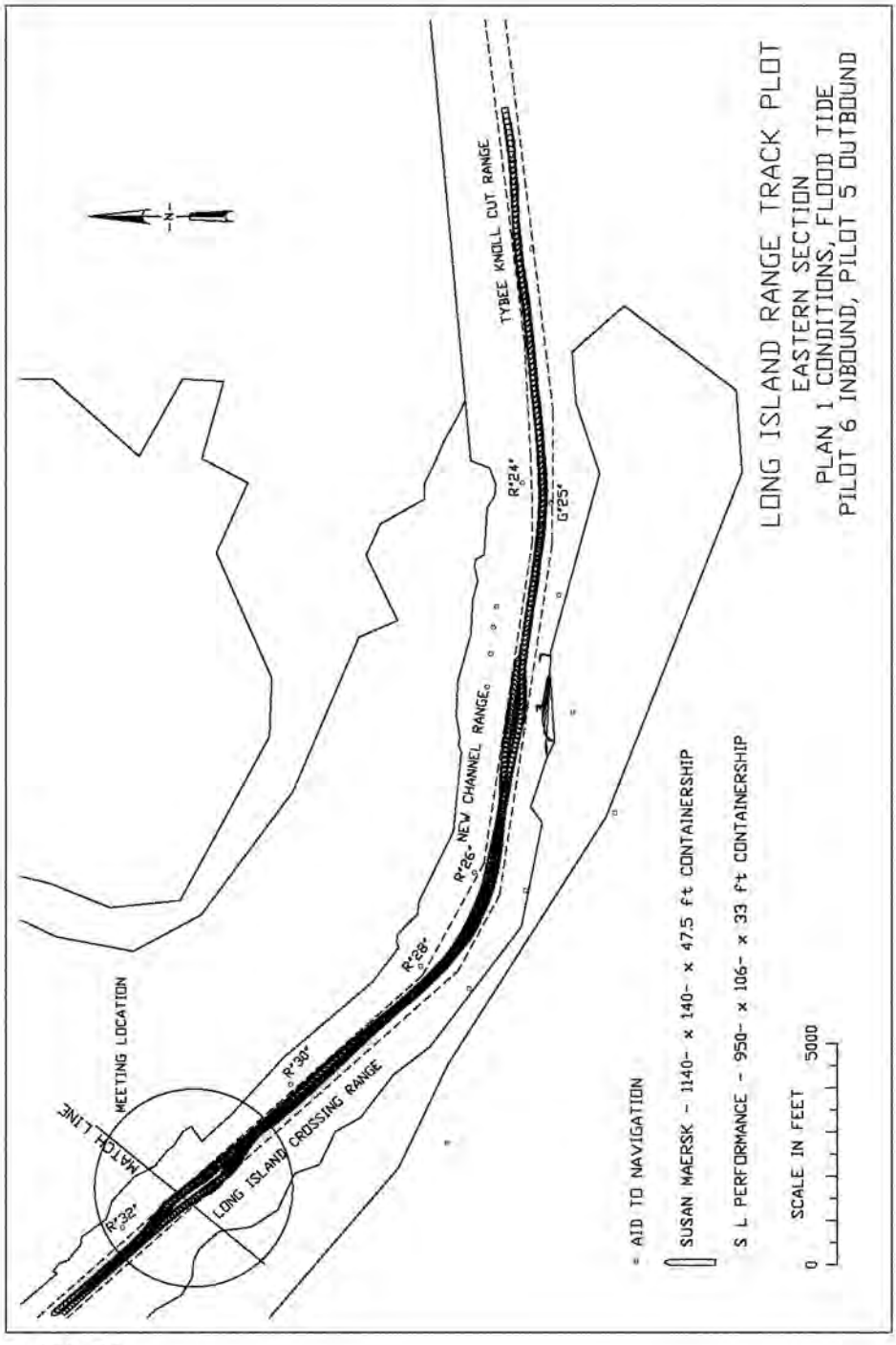

LONG ISLAND RANGE TRACK PLOT
EASTERN SECTION
PLAN 1 CONDITIONS, FLOOD TIDE
PILOT 6 INBOUND, PILOT 5 OUTBOUND
TYBEE KNOLL CUT RANGE
R°24'
G°25'
R°26' NEW CHANNEL RANGE
R°28'
R°30'
R°32'
LONG ISLAND CROSSING RANGE
MEETING LOCATION
MATCH LINE
N
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
0 SCALE IN FEET 5000

PLATE 58

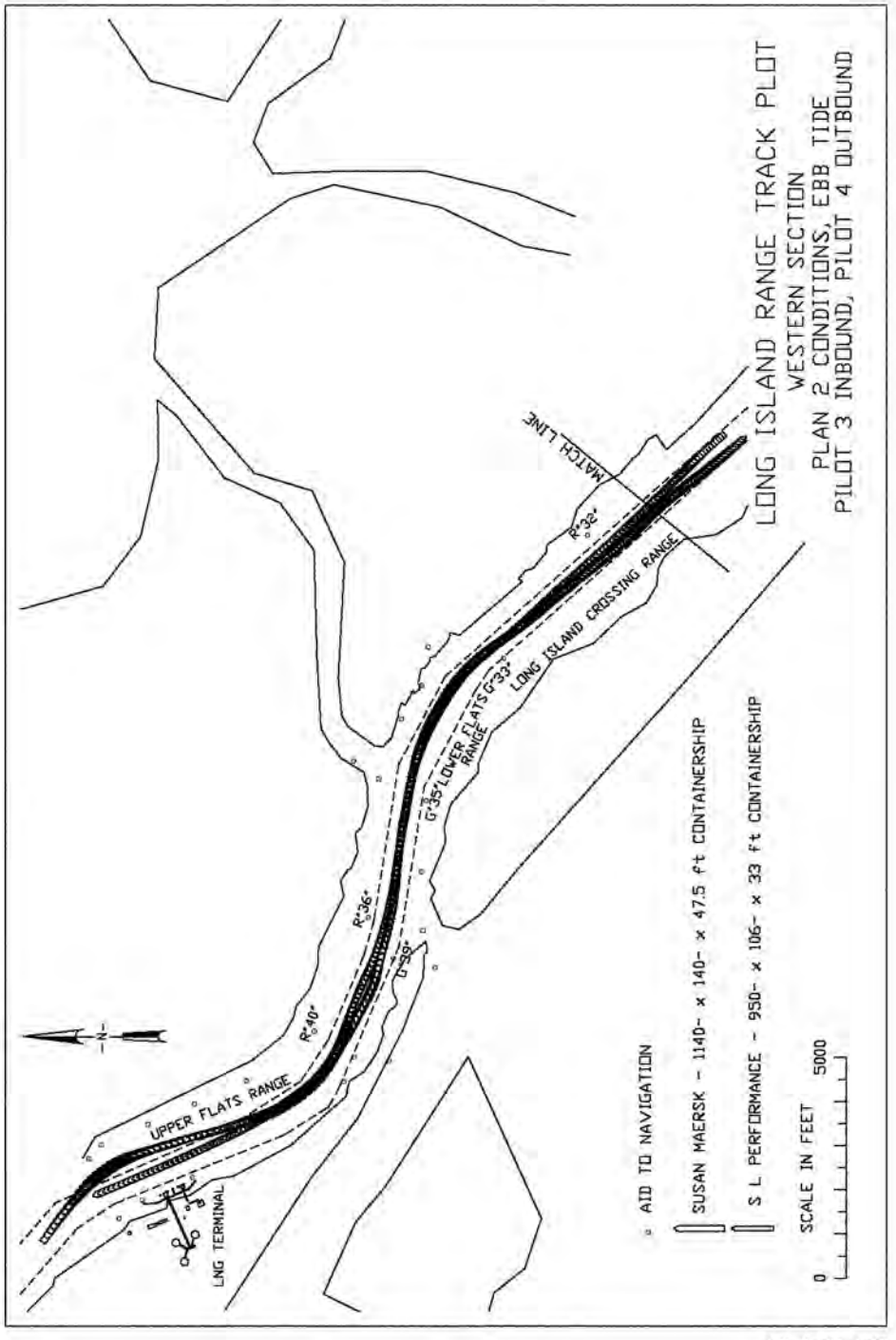

LONG ISLAND RANGE TRACK PLOT
WESTERN SECTION
PLAN 2 CONDITIONS, EBB TIDE
PILOT 3 INBOUND, PILOT 4 OUTBOUND
MATCH LINE
LONG ISLAND CROSSING RANGE
LOWER FLATS RANGE
UPPER FLATS RANGE
LNG TERMINAL
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
SCALE IN FEET 5000

PLATE 59

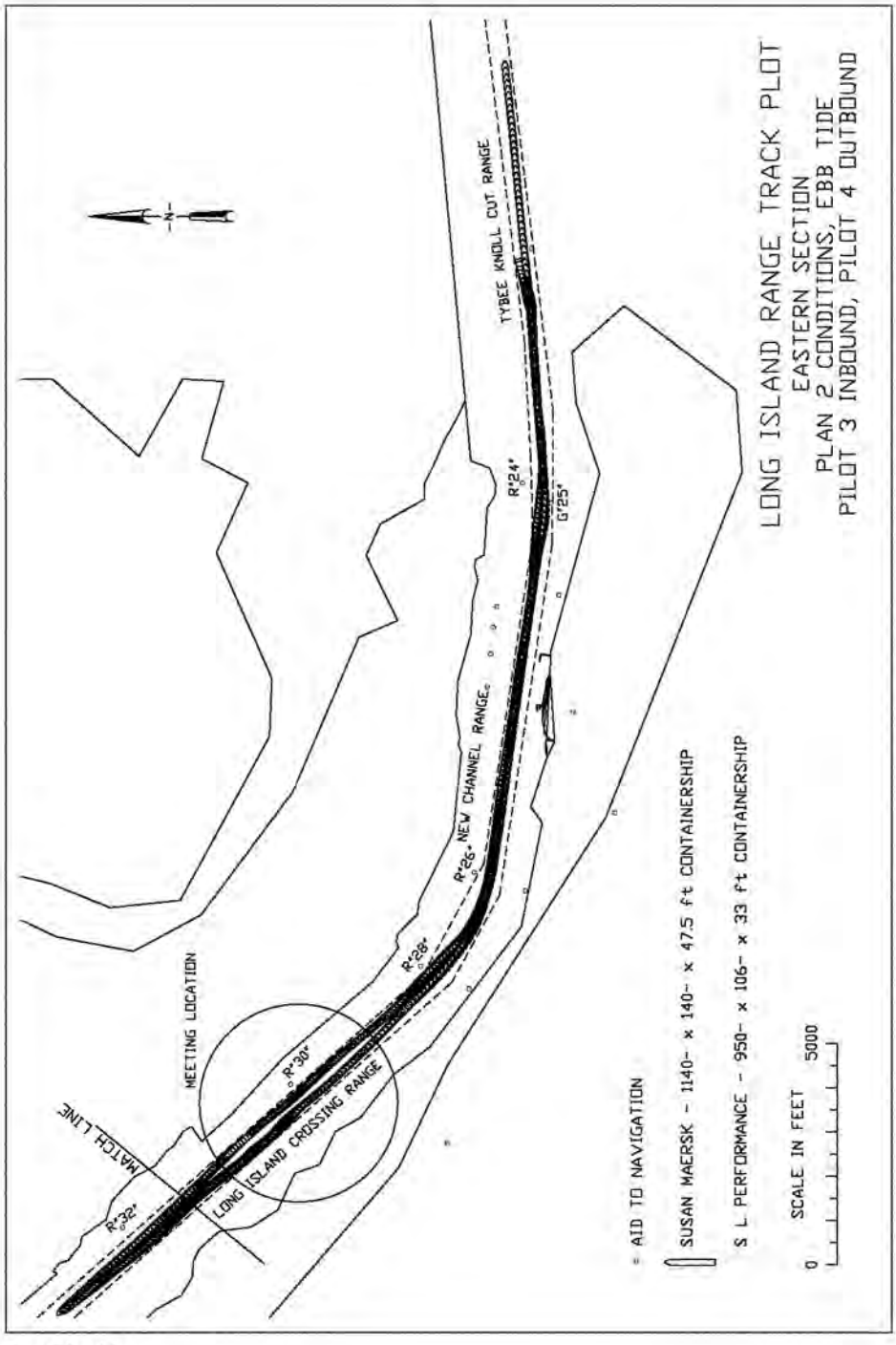

LONG ISLAND RANGE TRACK PLOT
EASTERN SECTION
PLAN 2 CONDITIONS, EBB TIDE
PILOT 3 INBOUND, PILOT 4 OUTBOUND
TYBEE KNOLL CUT RANGE
R°24'
G°25'
R°26' NEW CHANNEL RANGE
R°28'
R°30'
LONG ISLAND CROSSING RANGE
MEETING LOCATION
MATCH LINE
R°32'
N
= AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
0 SCALE IN FEET 5000

PLATE 60

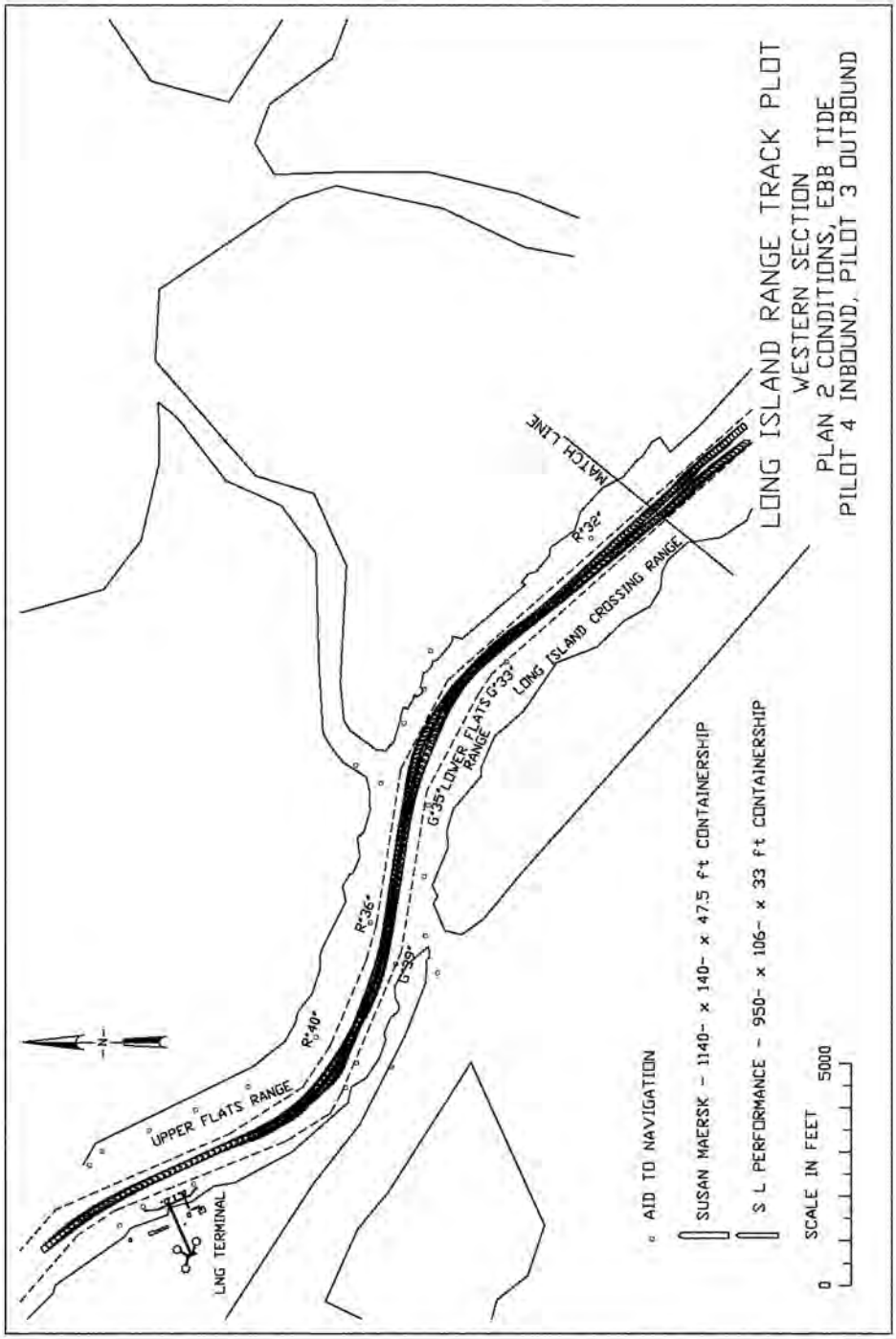

LONG ISLAND RANGE TRACK PLOT
WESTERN SECTION
PLAN 2 CONDITIONS, EBB TIDE
PILOT 4 INBOUND, PILOT 3 OUTBOUND
MATCH LINE
R°32'
LONG ISLAND CROSSING RANGE
G°33'
LOWER FLATS RANGE
G°35'
G°39'
R°36'
R°40'
UPPER FLATS RANGE
LNG TERMINAL
AID TO NAVIGATION
SUSAN MAERSK - 1140' x 140' x 47.5 ft CONTAINERSHIP
S L PERFORMANCE - 950' x 106' x 33 ft CONTAINERSHIP
0 SCALE IN FEET 5000

PLATE 61

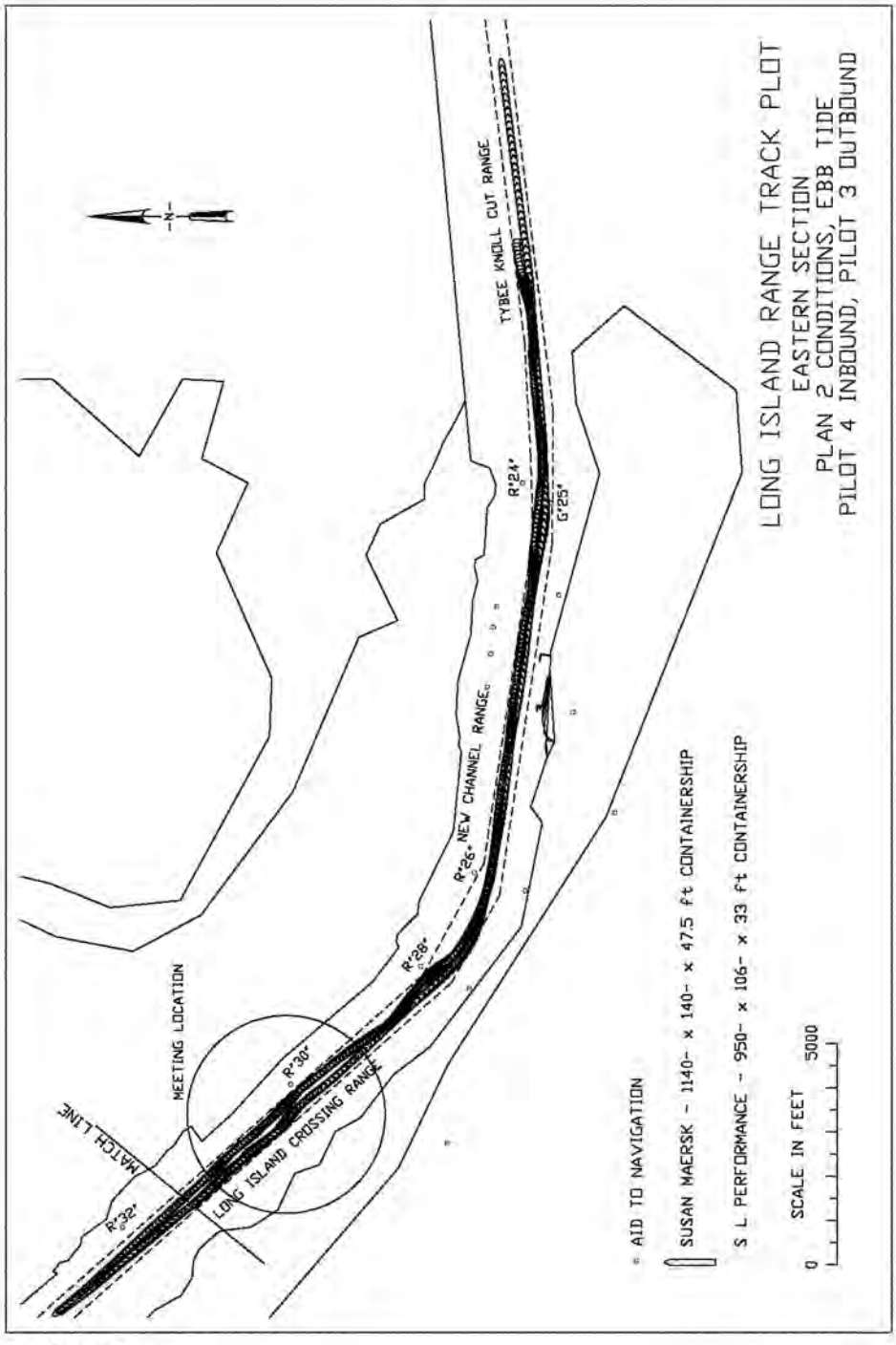

LONG ISLAND RANGE TRACK PLOT
EASTERN SECTION
PLAN 2 CONDITIONS, EBB TIDE
PILOT 4 INBOUND, PILOT 3 OUTBOUND
TYBEE KNOLL CUT RANGE
R°24'
G°25'
R°26' NEW CHANNEL RANGE
R°28'
R°30'
R°32'
MEETING LOCATION
LONG ISLAND CROSSING RANGE
MATCH LINE
-N-
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
0 SCALE IN FEET 5000

PLATE 62

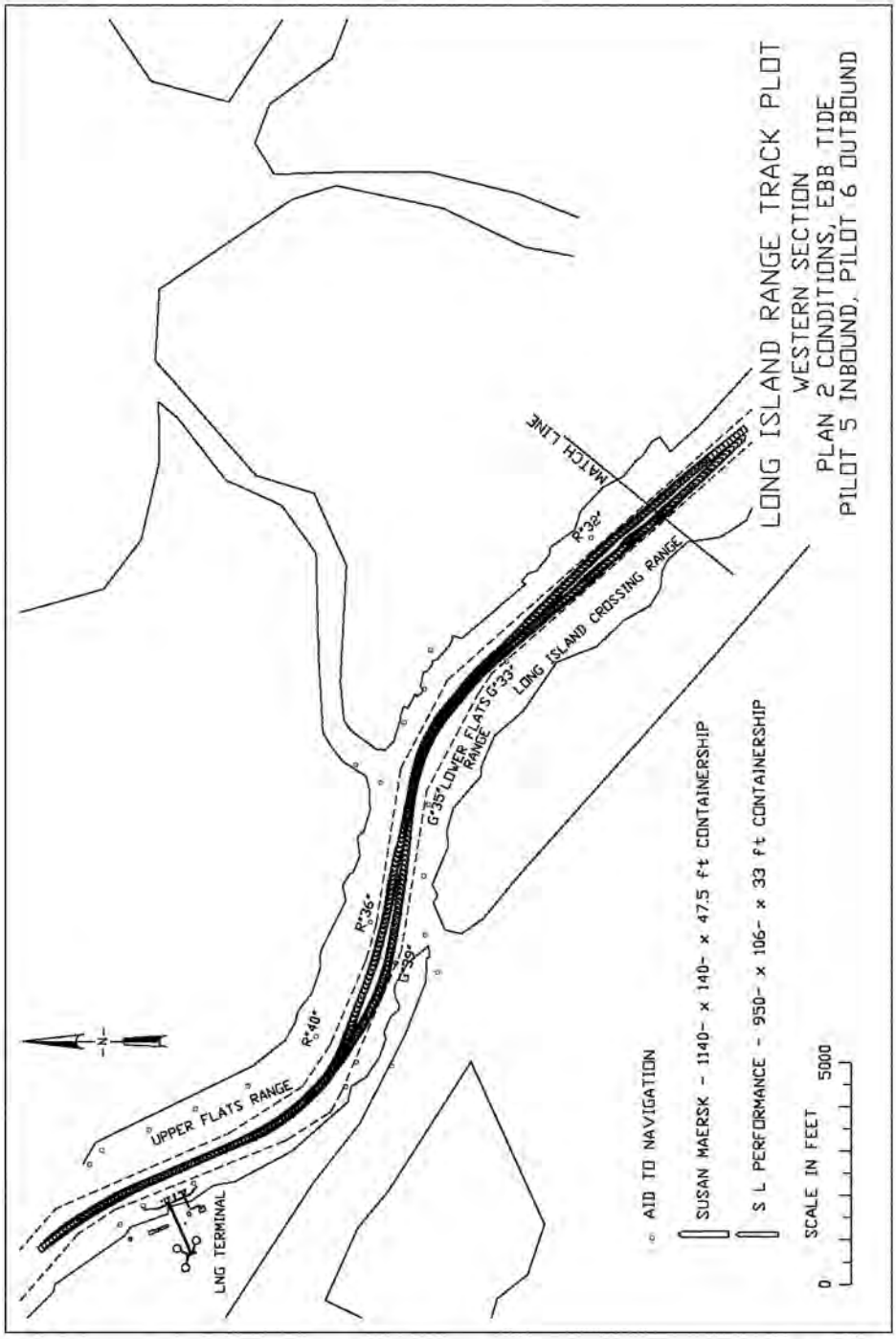

LONG ISLAND RANGE TRACK PLOT
WESTERN SECTION
PLAN 2 CONDITIONS, EBB TIDE
PILOT 5 INBOUND, PILOT 6 OUTBOUND
MATCH LINE
R°32'
LONG ISLAND CROSSING RANGE
G°33'
LOWER FLATS RANGE
G°35'
G°39'
R°36'
R°40'
UPPER FLATS RANGE
LNG TERMINAL
AID TO NAVIGATION
SUSAN MAERSK - 1140' x 140' x 47.5 ft CONTAINERSHIP
S L PERFORMANCE - 950' x 106' x 33 ft CONTAINERSHIP
0
SCALE IN FEET
5000

PLATE 63

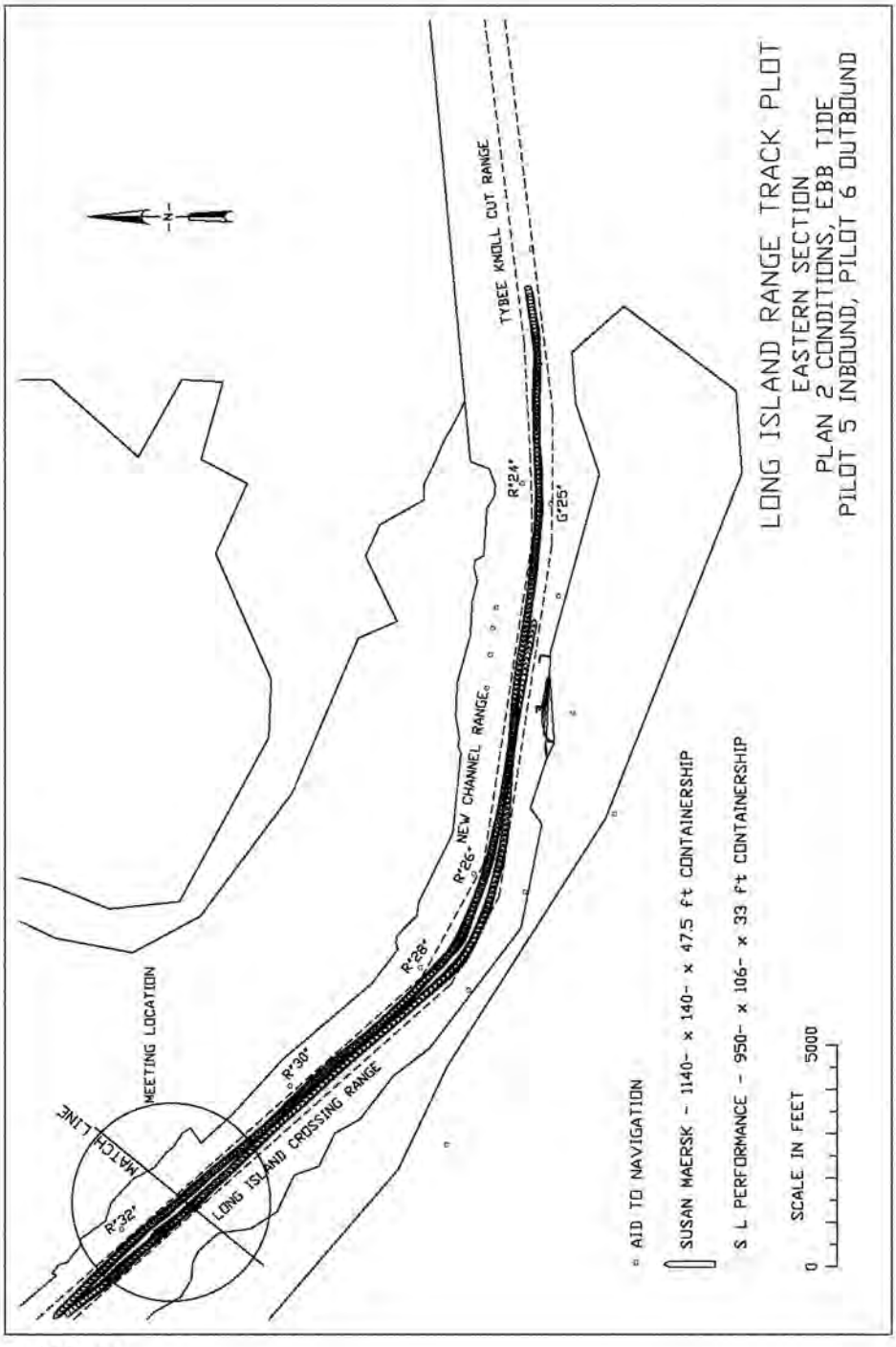

LONG ISLAND RANGE TRACK PLOT
EASTERN SECTION
PLAN 2 CONDITIONS, EBB TIDE
PILOT 5 INBOUND, PILOT 6 OUTBOUND
TYBEE KNOLL CUT RANGE
R°24°
G°25°
R°26° NEW CHANNEL RANGE
R°28°
R°30°
R°32°
MEETING LOCATION
MATCH LINE
LONG ISLAND CROSSING RANGE
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
SCALE IN FEET
0
5000
N

PLATE 64

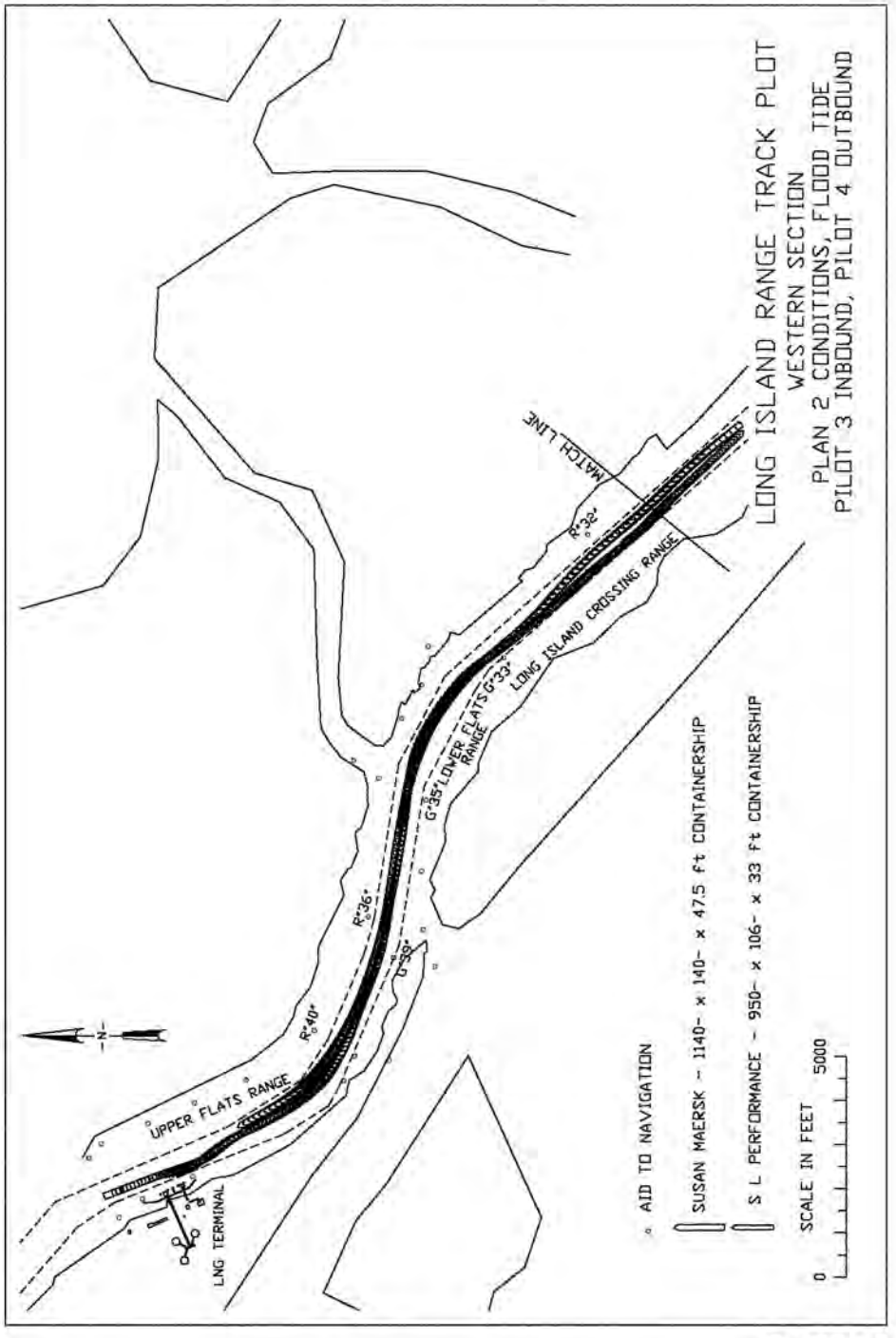

LONG ISLAND RANGE TRACK PLOT
WESTERN SECTION
PLAN 2 CONDITIONS, FLOOD TIDE
PILOT 3 INBOUND, PILOT 4 OUTBOUND
MATCH LINE
R°32'
LONG ISLAND CROSSING RANGE
G°33'
LOWER FLATS RANGE
G°33'
G°33'
R°36'
R°40'
UPPER FLATS RANGE
LNG TERMINAL
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
0 SCALE IN FEET 5000

PLATE 65

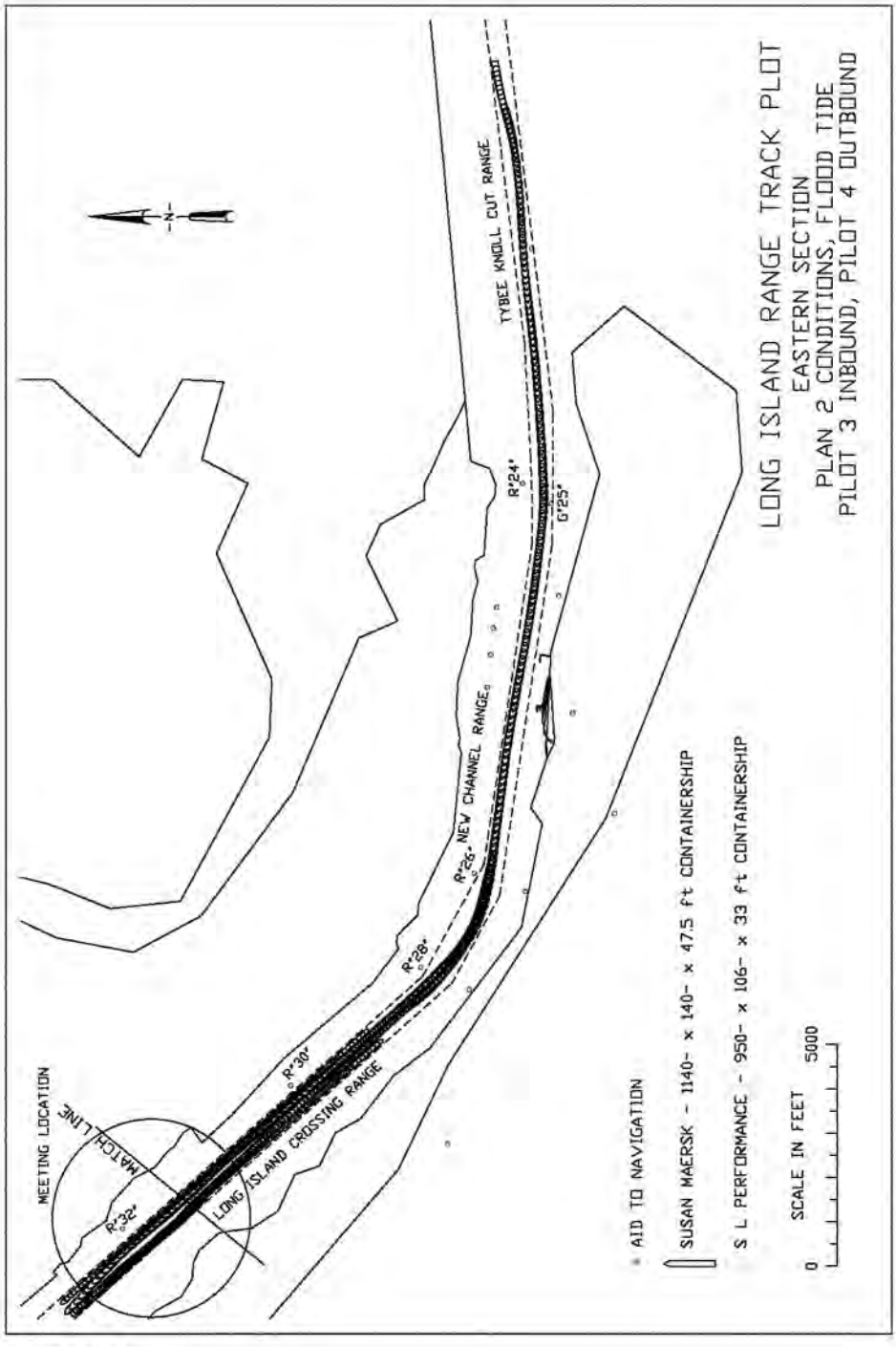

LONG ISLAND RANGE TRACK PLOT
EASTERN SECTION
PLAN 2 CONDITIONS, FLOOD TIDE
PILOT 3 INBOUND, PILOT 4 OUTBOUND
MEETING LOCATION
MATCH LINE
LONG ISLAND CROSSING RANGE
NEW CHANNEL RANGE
TYBEE KNOLL CUT RANGE
R°32'
R°30'
R°28'
R°26'
R°24'
G°25'
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
SCALE IN FEET
0
5000

PLATE 66

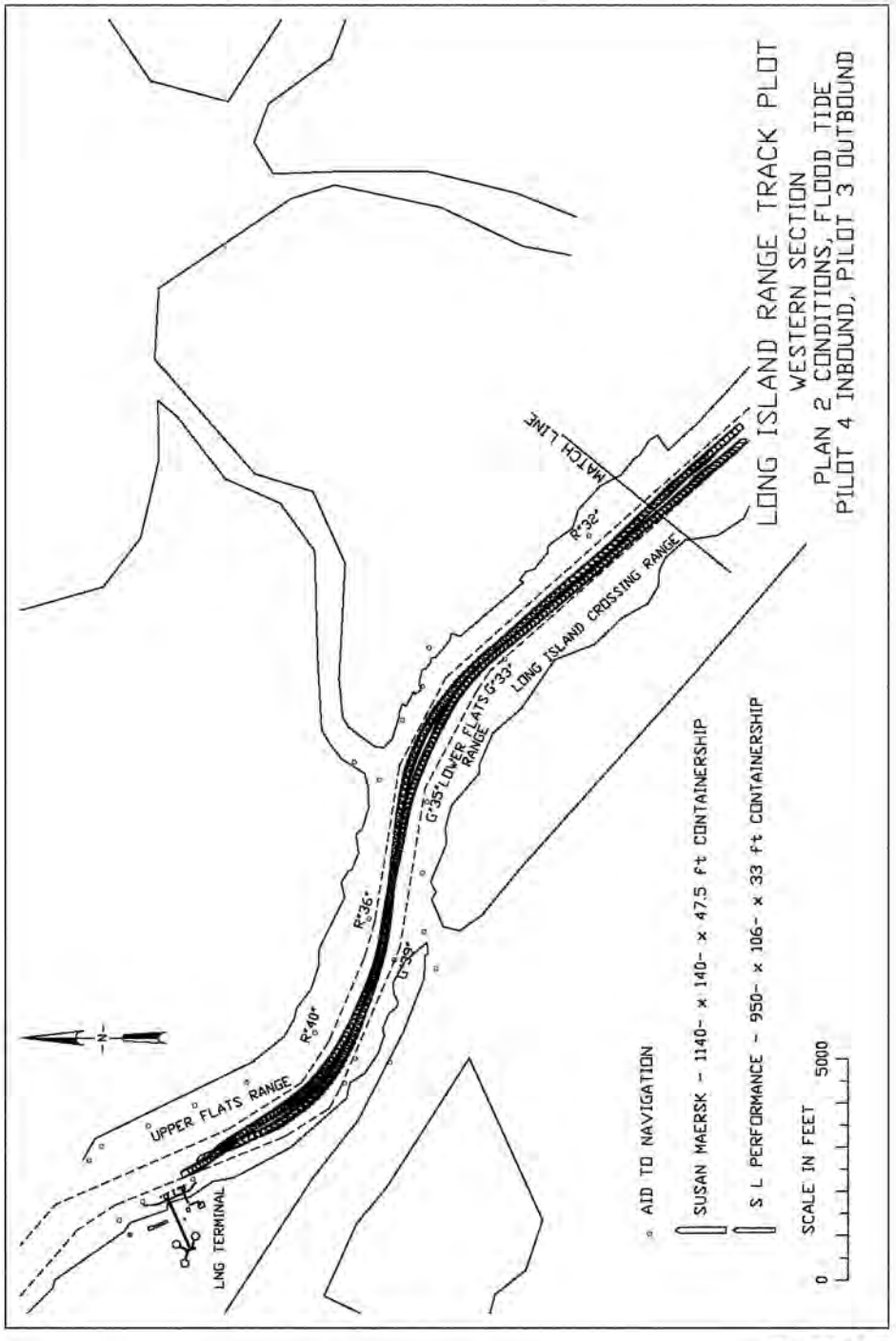

LONG ISLAND RANGE TRACK PLOT
WESTERN SECTION
PLAN 2 CONDITIONS, FLOOD TIDE
PILOT 4 INBOUND, PILOT 3 OUTBOUND
MATCH LINE
R°32'
LONG ISLAND CROSSING RANGE
G°33'
LOWER FLATS RANGE
G°35'
R°36'
G°33'
R°40'
UPPER FLATS RANGE
LNG TERMINAL
N
AID TO NAVIGATION
SUSAN MAERSK - 1140' x 140' x 47.5 ft CONTAINERSHIP
S L PERFORMANCE - 950' x 106' x 33 ft CONTAINERSHIP
0 SCALE IN FEET 5000

PLATE 67

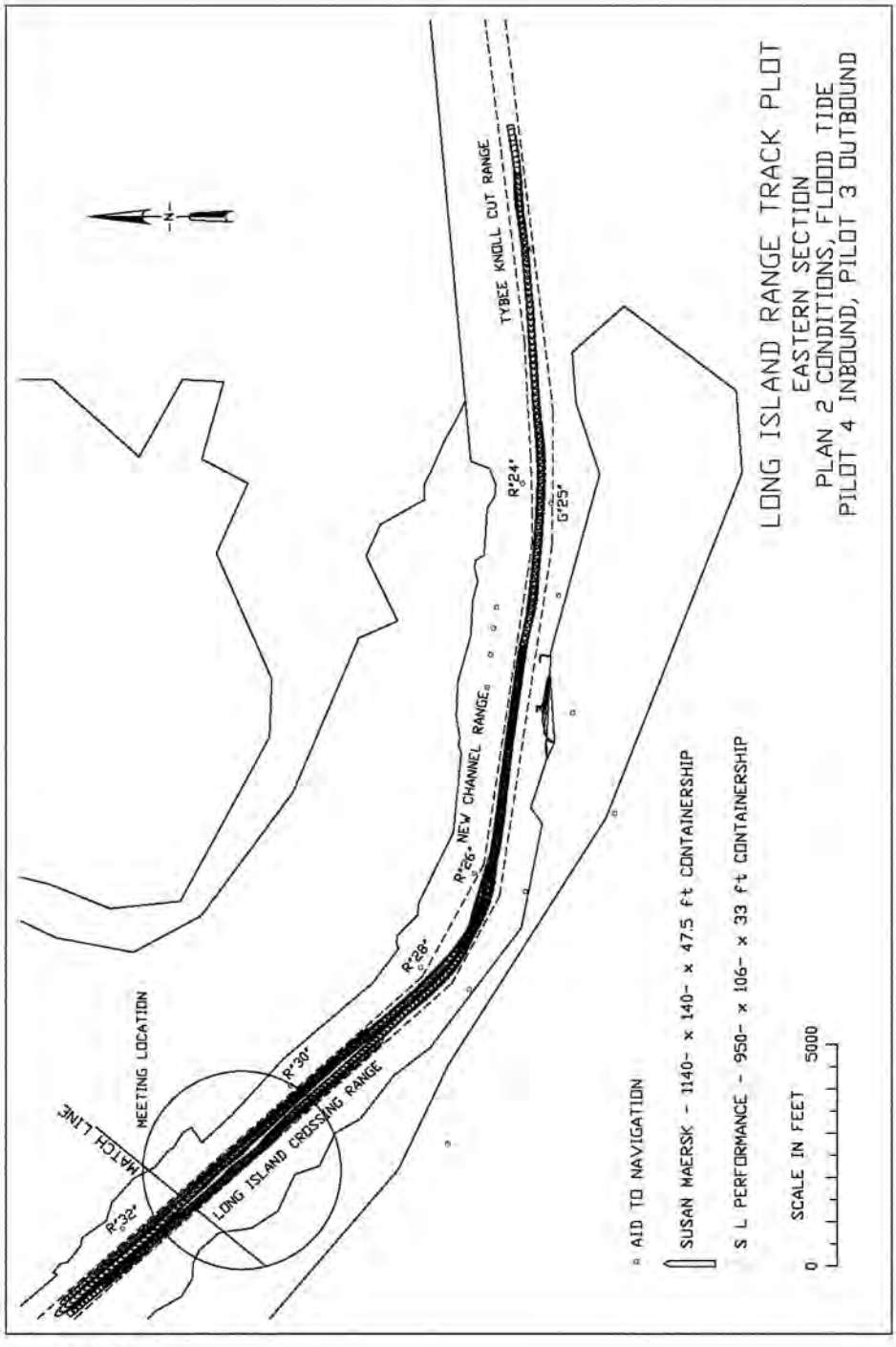

LONG ISLAND RANGE TRACK PLOT
EASTERN SECTION
PLAN 2 CONDITIONS, FLOOD TIDE
PILOT 4 INBOUND, PILOT 3 OUTBOUND
TYBEE KNOLL CUT RANGE
R°24'
G°25'
R°26' NEW CHANNEL RANGE
R°28'
R°30'
R°32'
MEETING LOCATION
MATCH LINE
LONG ISLAND CROSSING RANGE
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
0 SCALE IN FEET 5000

PLATE 68

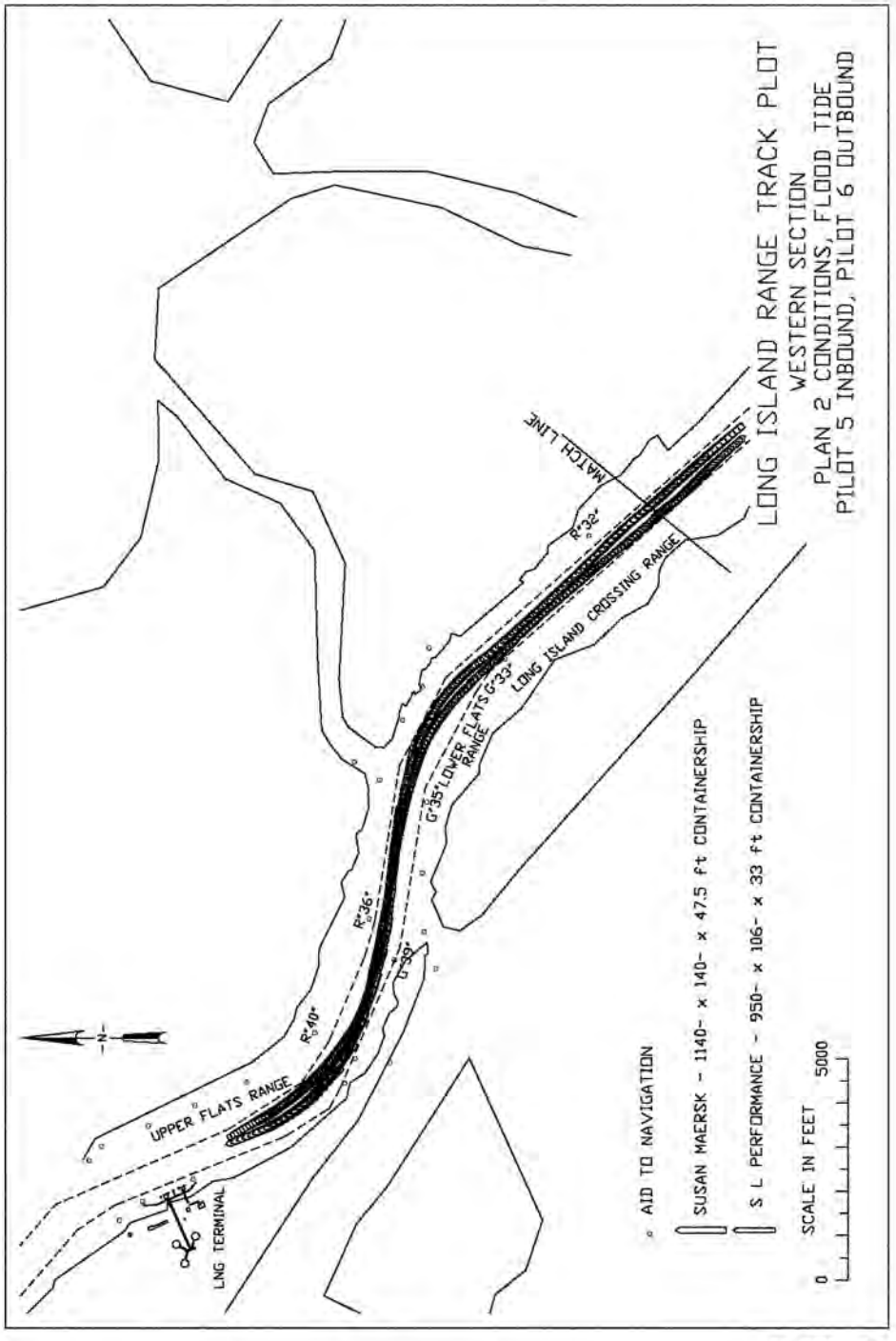

LONG ISLAND RANGE TRACK PLOT
WESTERN SECTION
PLAN 2 CONDITIONS, FLOOD TIDE
PILOT 5 INBOUND, PILOT 6 OUTBOUND
MATCH LINE
R°32'
G°33'
LONG ISLAND CROSSING RANGE
G°35'
LOWER FLATS RANGE
R°36'
G°39'
R°40'
UPPER FLATS RANGE
LNG TERMINAL
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
SCALE IN FEET
0
5000

PLATE 69

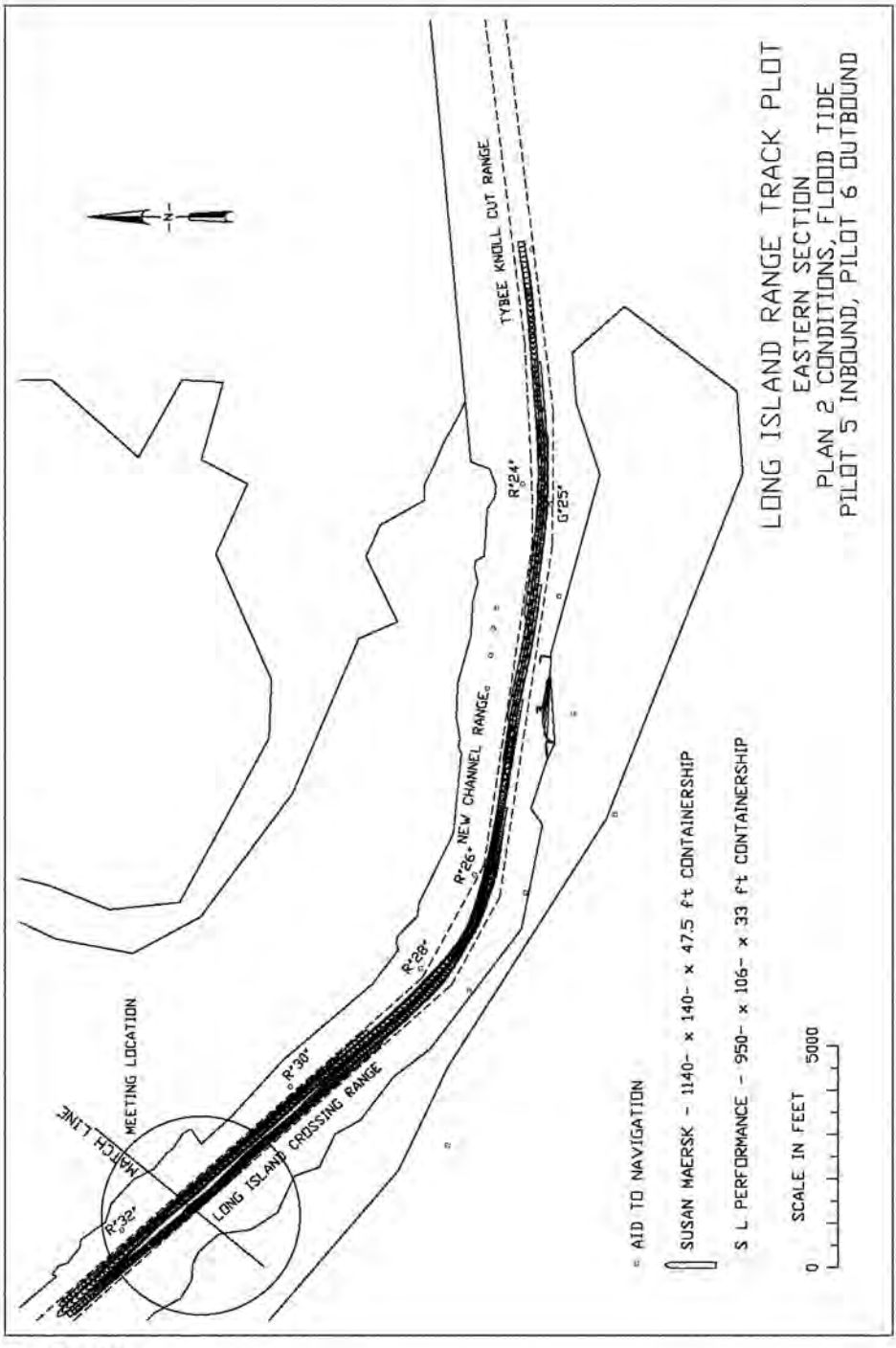

LONG ISLAND RANGE TRACK PLOT
EASTERN SECTION
PLAN 2 CONDITIONS, FLOOD TIDE
PILOT 5 INBOUND, PILOT 6 OUTBOUND
TYBEE KNOLL CUT RANGE
R°24'
G°25'
R°26' NEW CHANNEL RANGE
R°26'
R°30'
R°32'
LONG ISLAND CROSSING RANGE
MEETING LOCATION
MATCH LINE
N
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
0 SCALE IN FEET 5000

PLATE 70

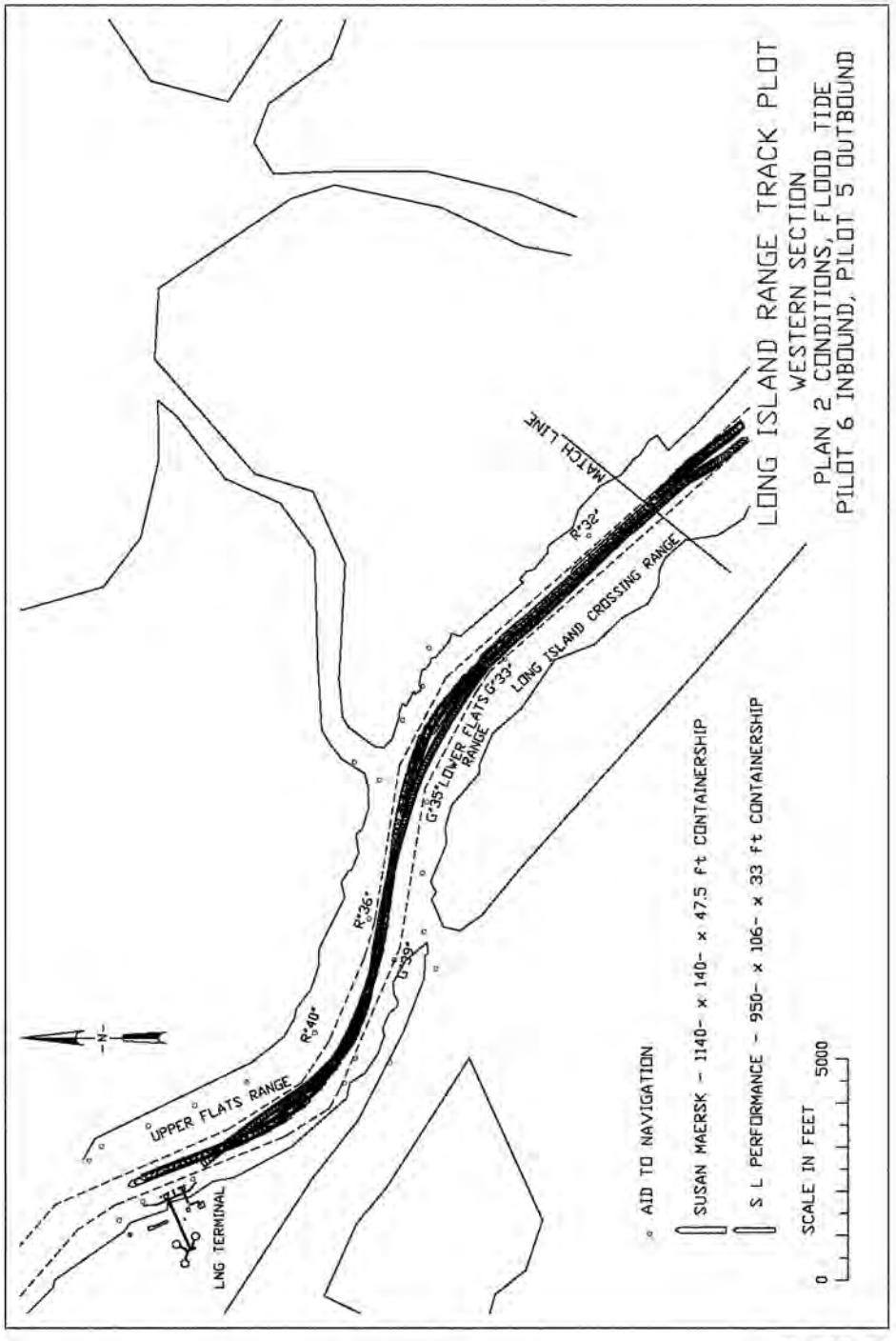

LONG ISLAND RANGE TRACK PLOT
WESTERN SECTION
PLAN 2 CONDITIONS, FLOOD TIDE
PILOT 6 INBOUND, PILOT 5 OUTBOUND
MATCH LINE
LONG ISLAND CROSSING RANGE
LOWER FLATS RANGE
UPPER FLATS RANGE
LNG TERMINAL
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
SCALE IN FEET 5000
0

PLATE 71

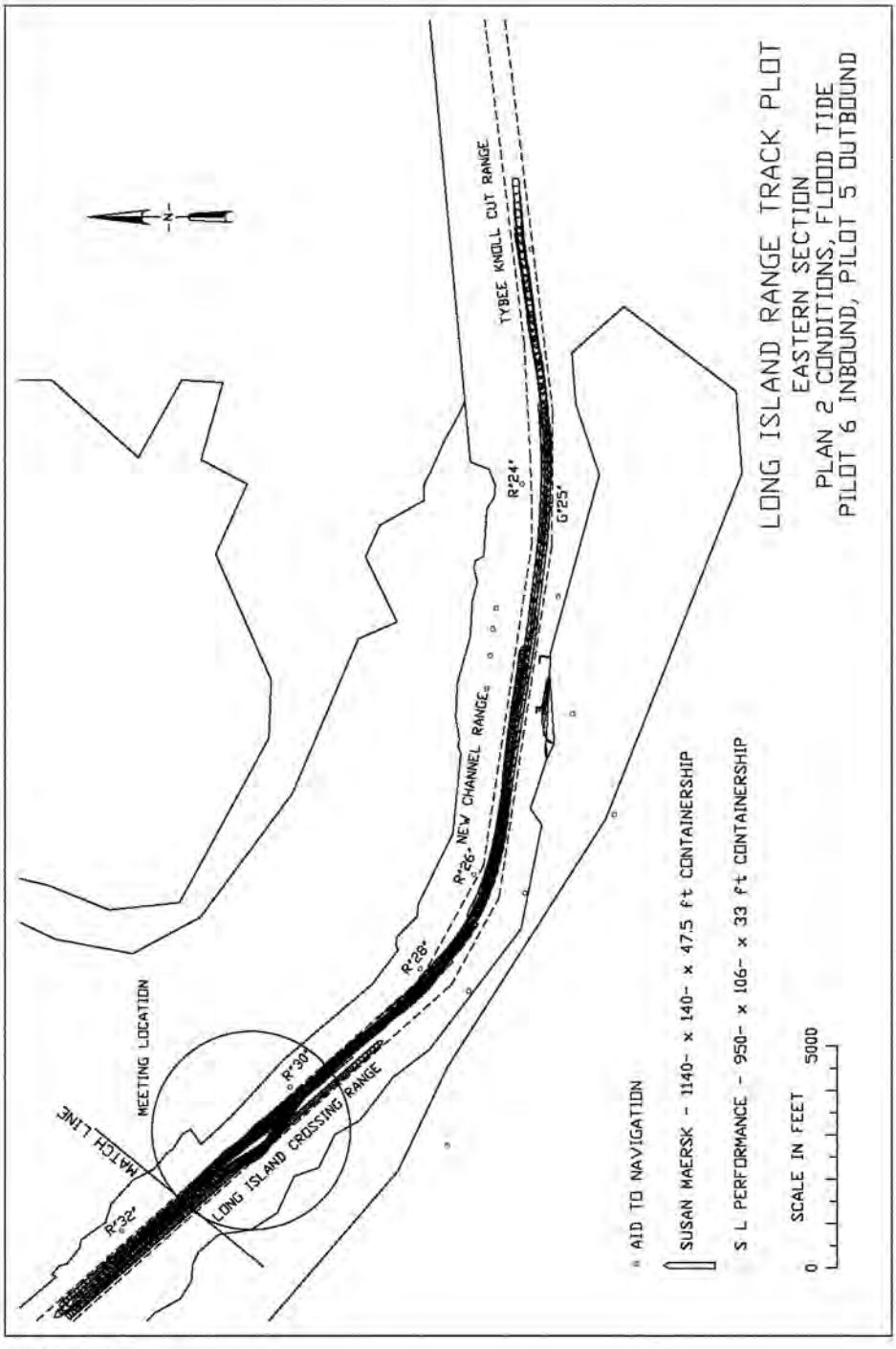

LONG ISLAND RANGE TRACK PLOT
EASTERN SECTION
PLAN 2 CONDITIONS, FLOOD TIDE
PILOT 6 INBOUND, PILOT 5 OUTBOUND
TYBEE KNOLL CUT RANGE
NEW CHANNEL RANGE
LONG ISLAND CROSSING RANGE
MEETING LOCATION
MATCH LINE
R°24'
G°25'
R°26'
R°28'
R°30'
R°32'
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
0 SCALE IN FEET 5000

PLATE 72

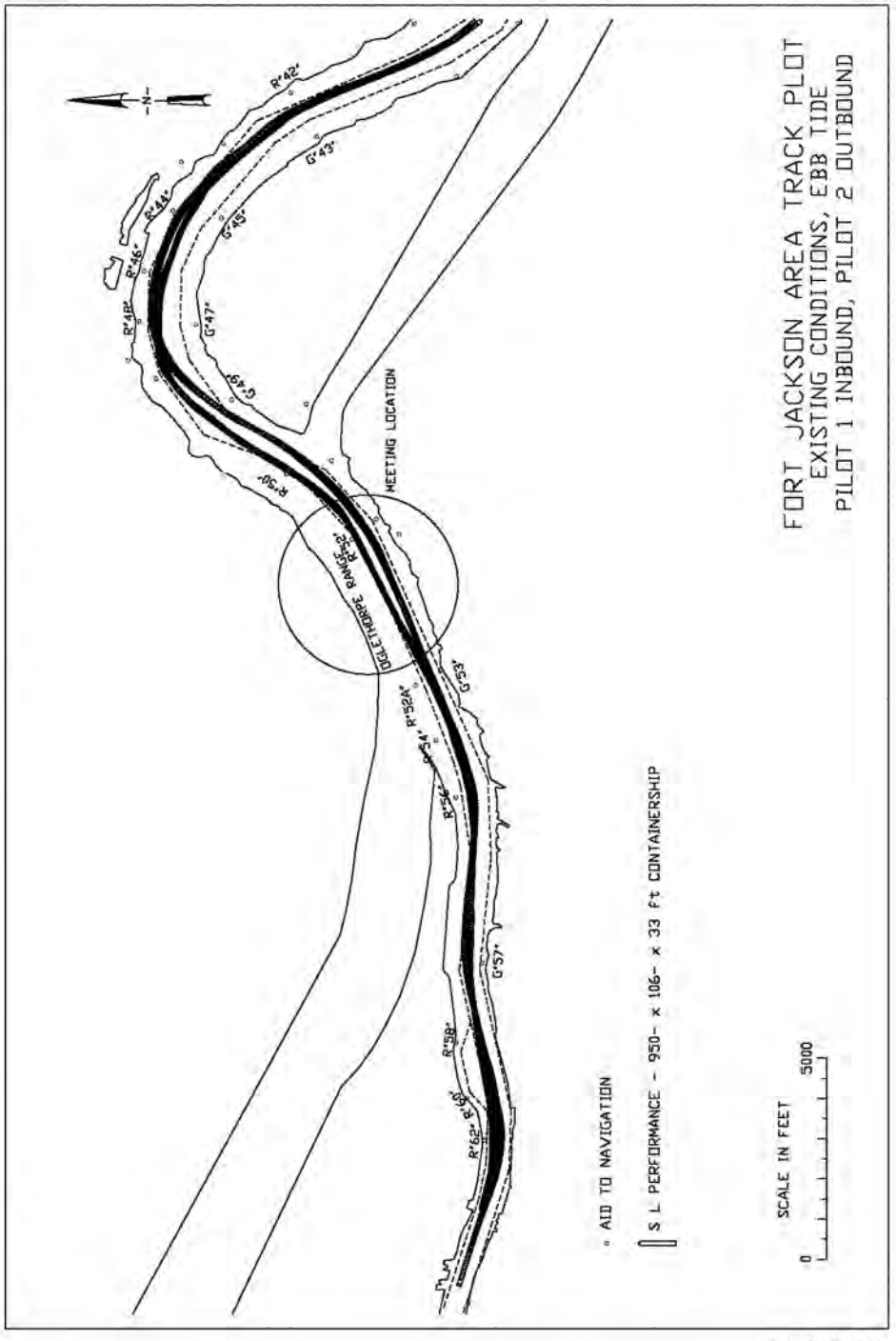

FORT JACKSON AREA TRACK PLOT
EXISTING CONDITIONS, EBB TIDE
PILOT 1 INBOUND, PILOT 2 OUTBOUND
SCALE IN FEET
0
5000
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
AID TO NAVIGATION
MEETING LOCATION
DOLETHORPE RANGE
R'42'
G'43'
R'44'
R'46'
R'48'
G'45'
G'47'
G'49'
R'50'
R'52'
R'54'
R'52A'
G'53'
G'57'
R'58'
R'60'
R'62'

PLATE 73

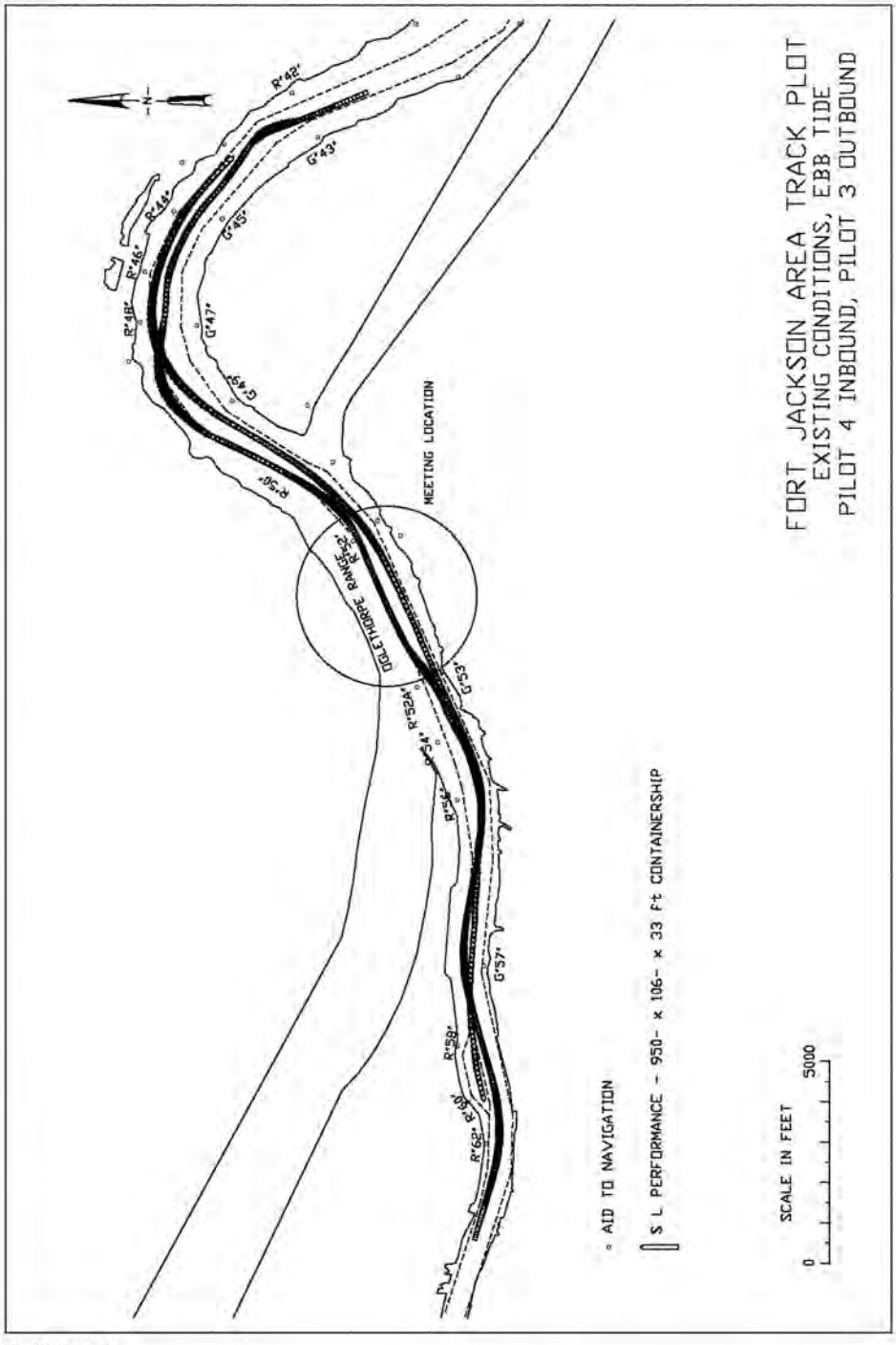

FORT JACKSON AREA TRACK PLOT
EXISTING CONDITIONS, EBB TIDE
PILOT 4 INBOUND, PILOT 3 OUTBOUND
MEETING LOCATION
DELTHORPE RANGE
AID TO NAVIGATION
S L PERFORMANCE - 950- x 106- x 33 Ft CONTAINERSHIP
SCALE IN FEET
0
5000

PLATE 74

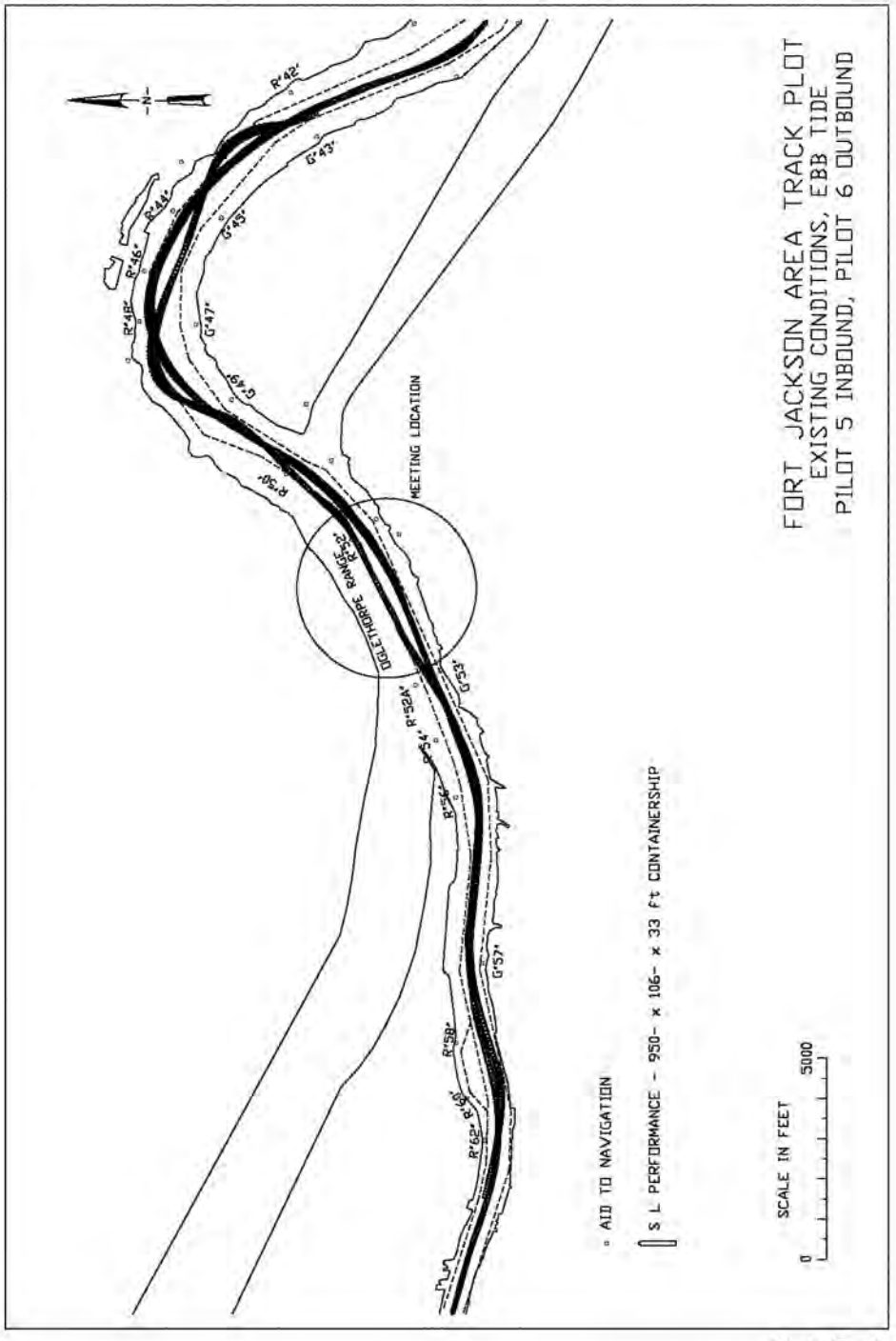

FORT JACKSON AREA TRACK PLOT
EXISTING CONDITIONS, EBB TIDE
PILOT 5 INBOUND, PILOT 6 OUTBOUND
MEETING LOCATION
DOLETHORPE RANGE
AID TO NAVIGATION
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
SCALE IN FEET
0
5000

PLATE 75

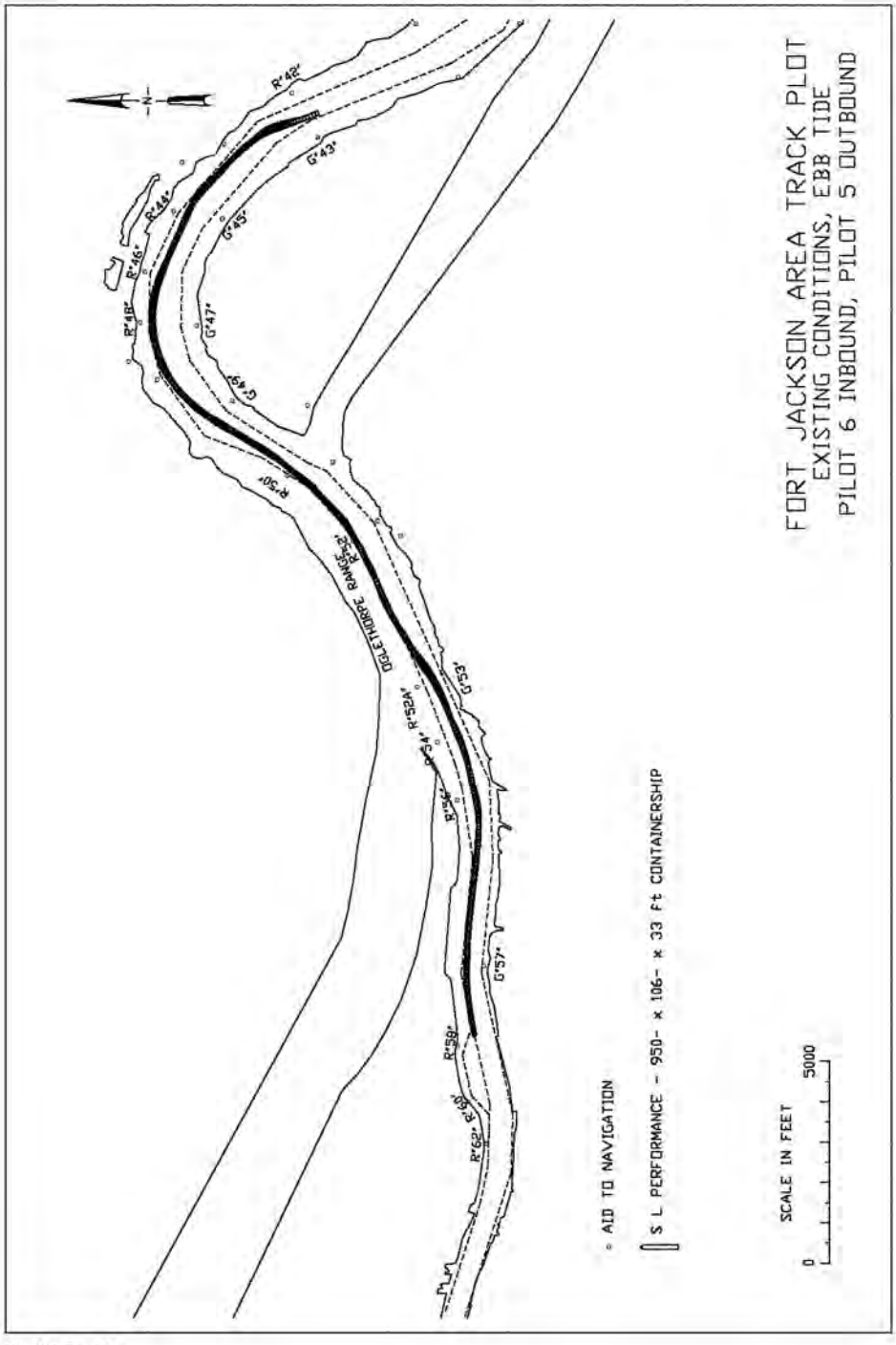

FORT JACKSON AREA TRACK PLOT
EXISTING CONDITIONS, EBB TIDE
PILOT 6 INBOUND, PILOT 5 OUTBOUND
DELTHORNE RANGE
AID TO NAVIGATION
S L PERFORMANCE - 950- x 106- x 33 Ft CONTAINERSHIP
SCALE IN FEET
0
5000

PLATE 76

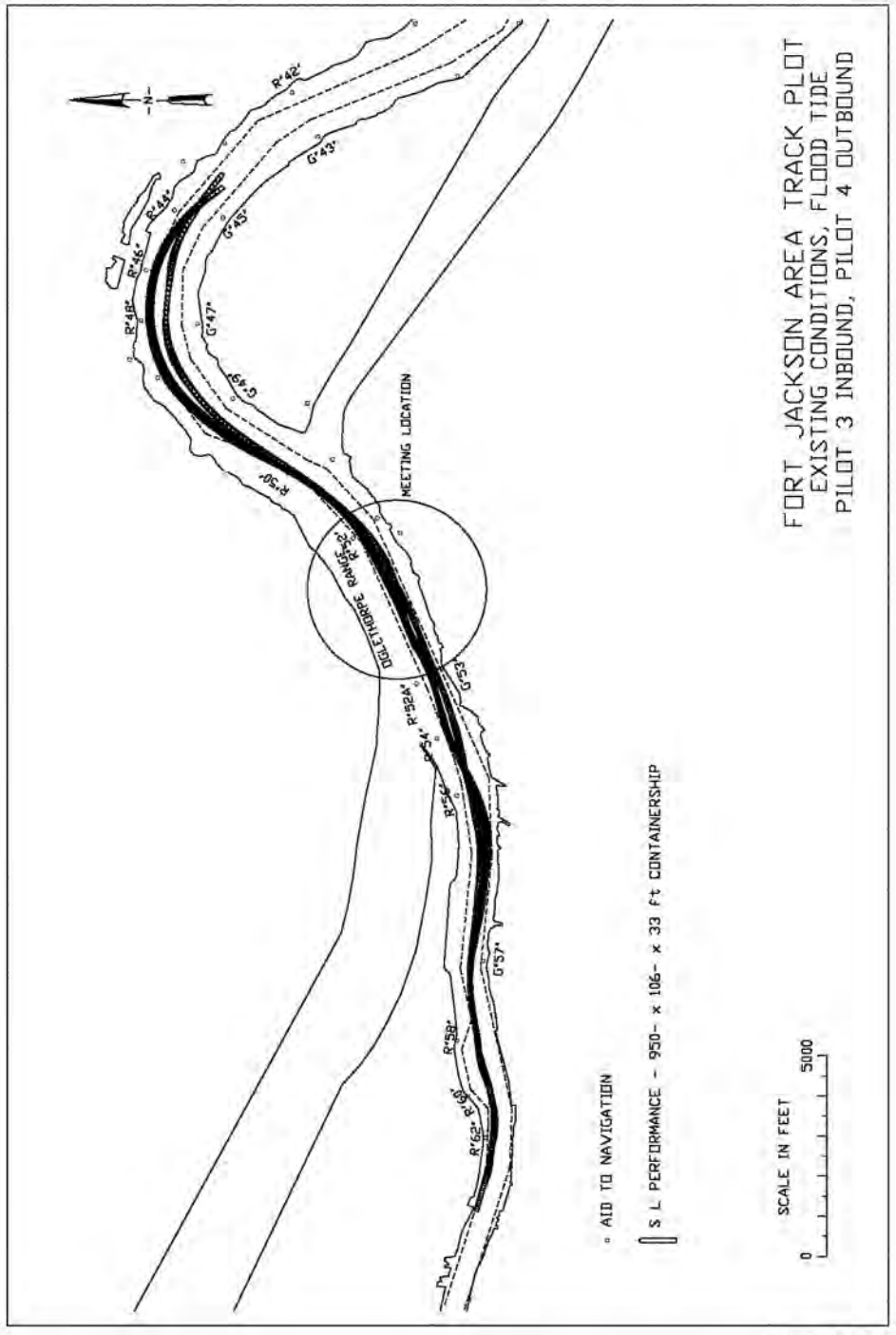

FORT JACKSON AREA TRACK PLOT
EXISTING CONDITIONS, FLOOD TIDE
PILOT 3 INBOUND, PILOT 4 OUTBOUND
MEETING LOCATION
DOLETHORPE RANGE
AID TO NAVIGATION
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
SCALE IN FEET
0
5000

PLATE 77

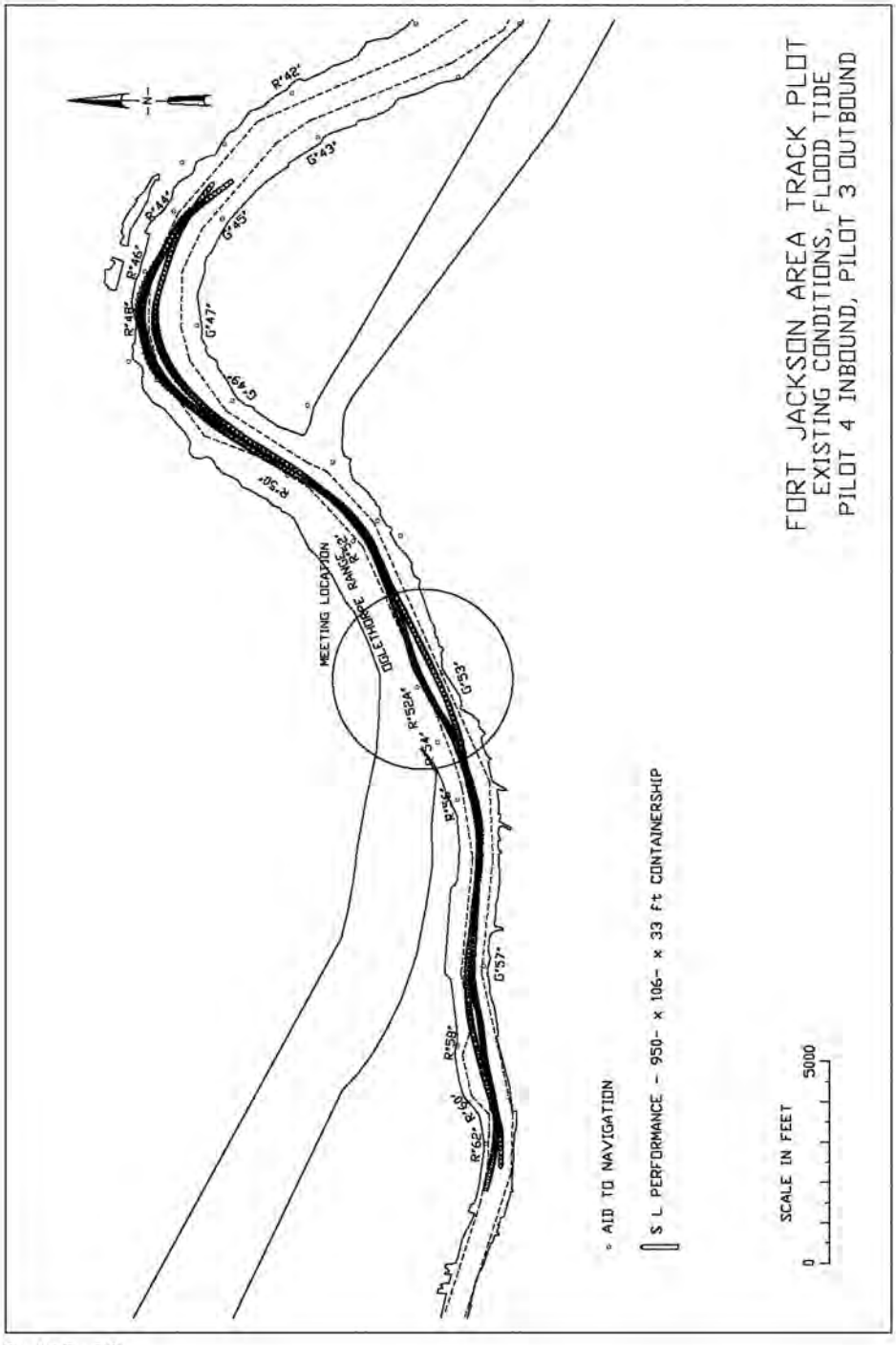

FORT JACKSON AREA TRACK PLOT
EXISTING CONDITIONS, FLOOD TIDE
PILOT 4 INBOUND, PILOT 3 OUTBOUND
SCALE IN FEET
0
5000
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
AID TO NAVIGATION
MEETING LOCATION
DELTHORPE RANGE
R°42'
R°43'
R°44'
R°45'
R°46'
R°47'
R°48'
R°49'
R°50'
R°52'
R°53'
R°54'
R°56'
R°57'
R°58'
R°60'
R°62'

PLATE 78

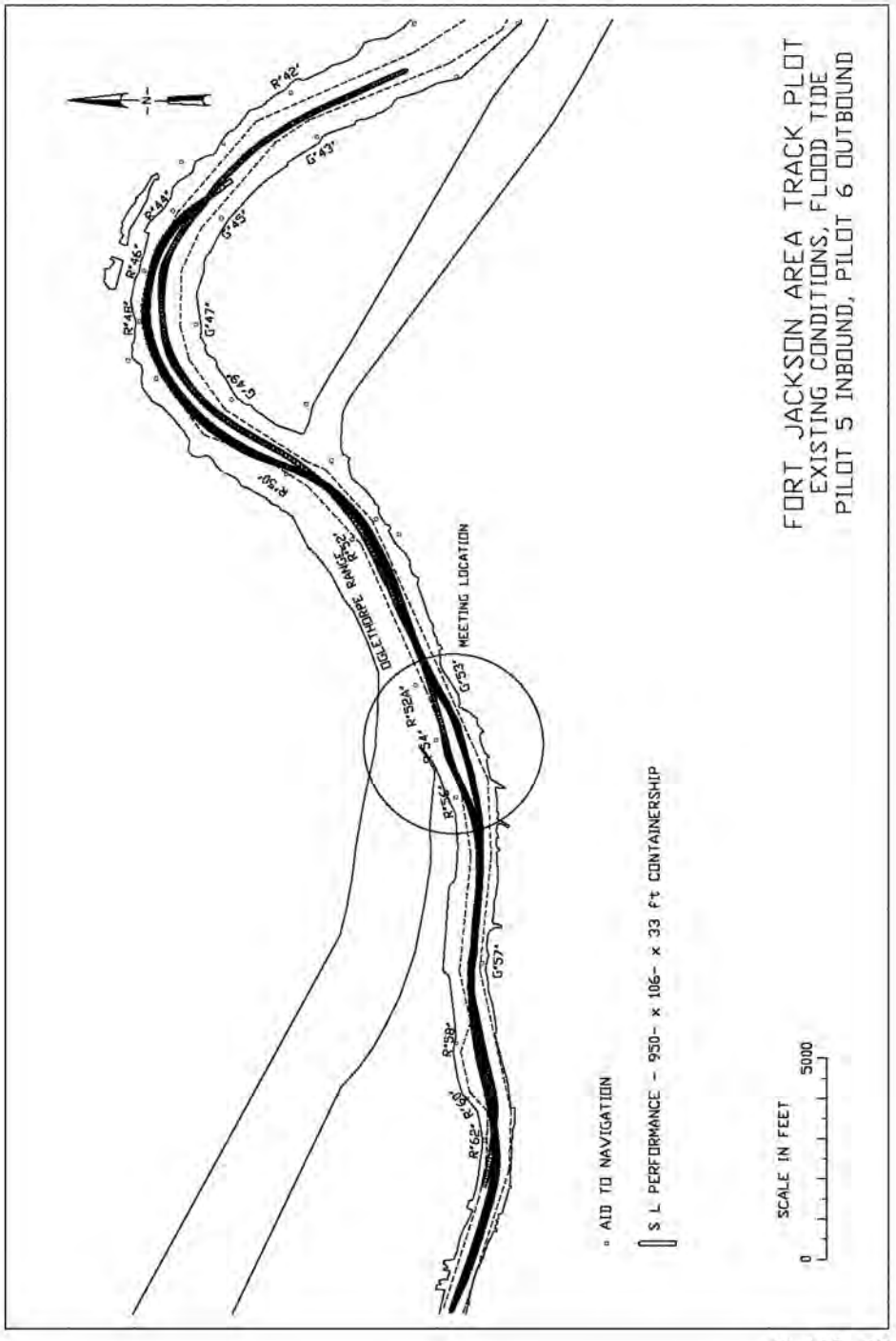

FORT JACKSON AREA TRACK PLOT
EXISTING CONDITIONS, FLOOD TIDE
PILOT 5 INBOUND, PILOT 6 OUTBOUND
MEETING LOCATION
DOLETHORPE RANGE
AID TO NAVIGATION
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
SCALE IN FEET
0
5000

PLATE 79

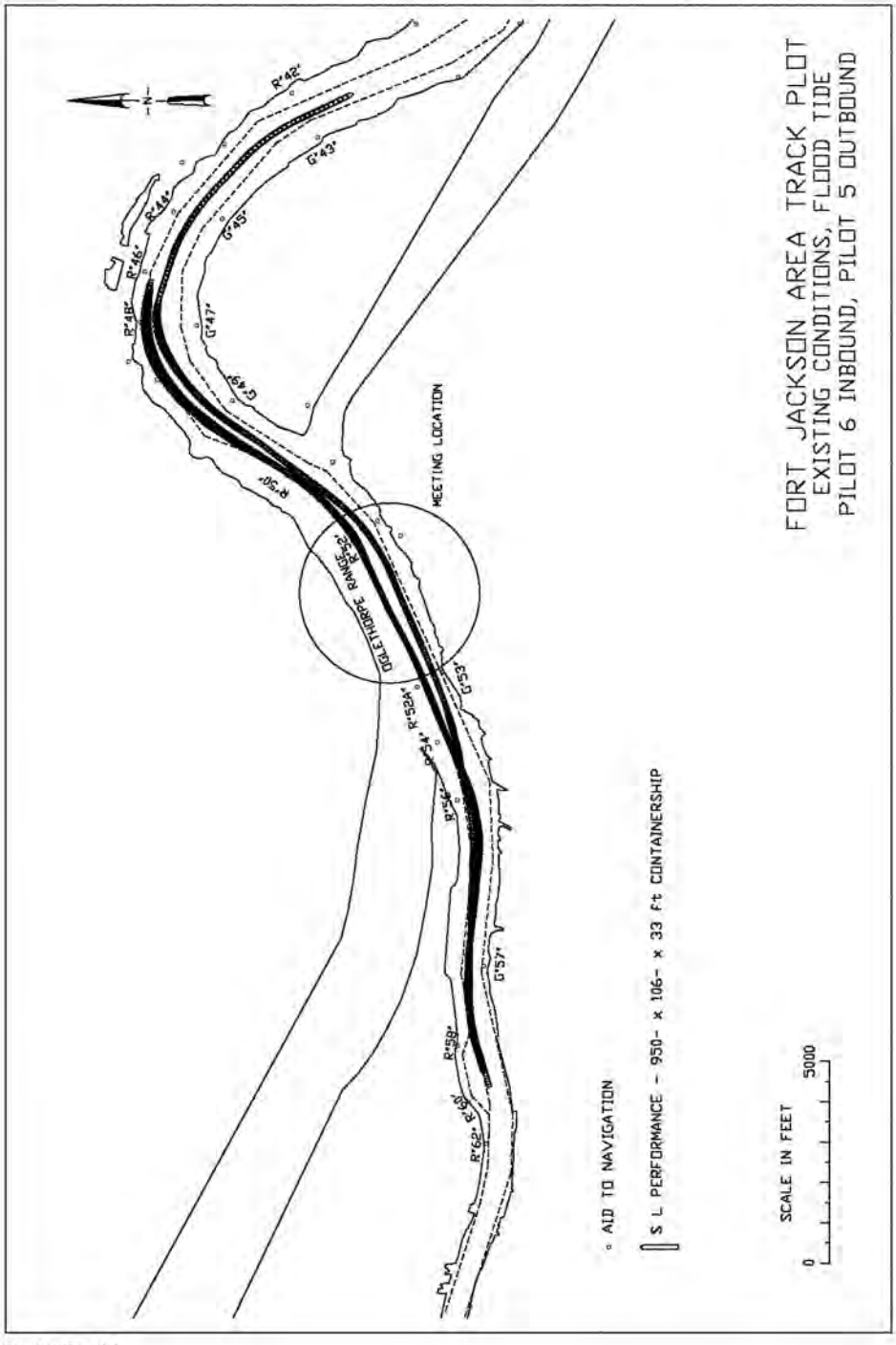

FORT JACKSON AREA TRACK PLOT
EXISTING CONDITIONS, FLOOD TIDE
PILOT 6 INBOUND, PILOT 5 OUTBOUND
SCALE IN FEET
0
5000
S L PERFORMANCE - 950- x 106- x 33 ft CONTAINERSHIP
AID TO NAVIGATION
MEETING LOCATION
ODLETHORPE RANGE
R"42"
G"43"
R"43"
G"45"
R"46"
R"48"
G"47"
G"49"
R"50"
R"52A"
G"53"
R"54"
R"56"
G"57"
R"58"
R"60"
R"62"

PLATE 80

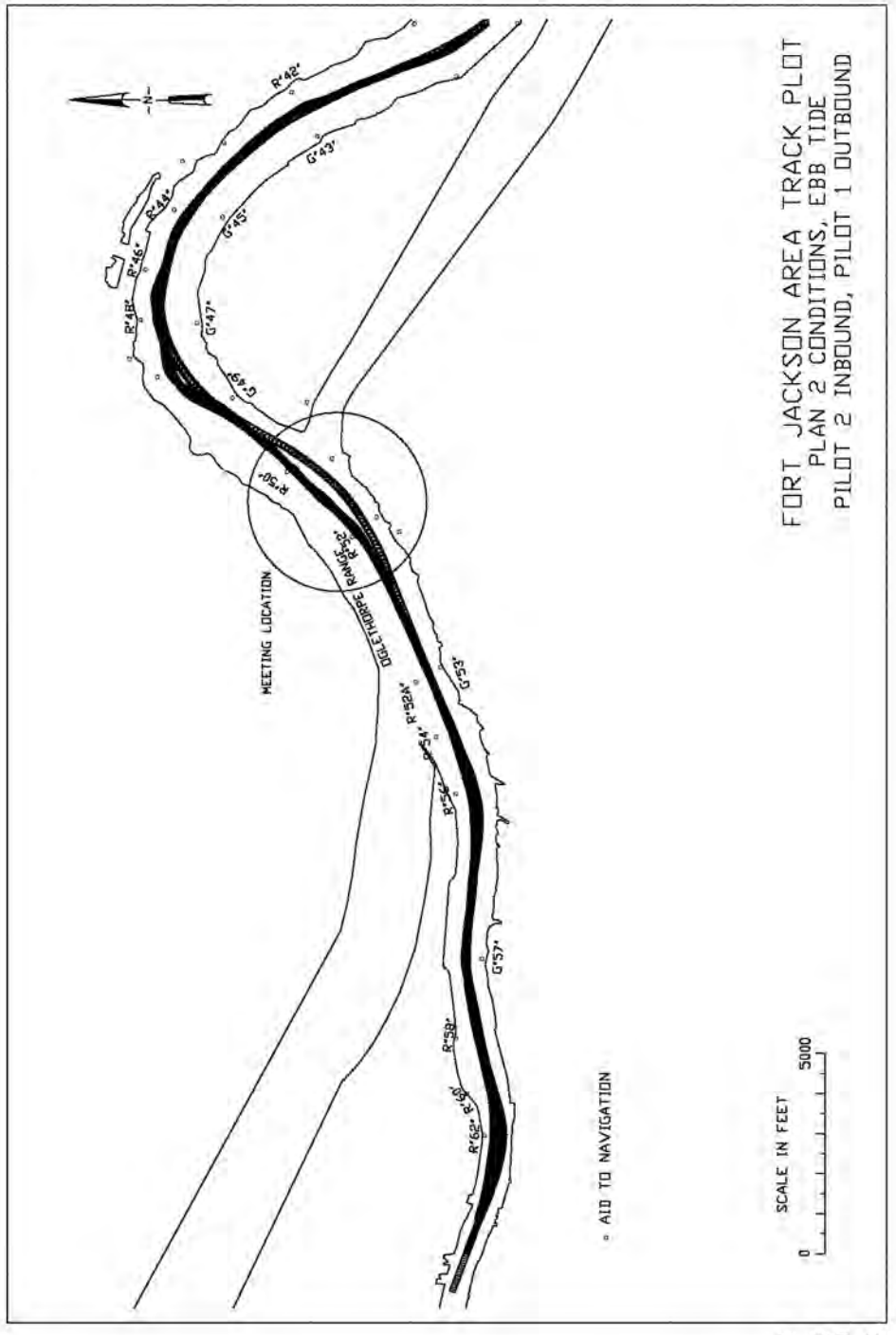

FORT JACKSON AREA TRACK PLOT
PLAN 2 CONDITIONS, EBB TIDE
PILOT 2 INBOUND, PILOT 1 OUTBOUND
N
R"42"
G"43"
R"44"
G"45"
R"46"
R"48"
G"47"
G"49"
R"50"
MEETING LOCATION
R"52"
DELTHORPE RANGE
R"52A"
G"53"
R"54"
R"54A"
G"57"
R"58"
R"60"
R"62"
AID TO NAVIGATION
SCALE IN FEET
0
5000

PLATE 81

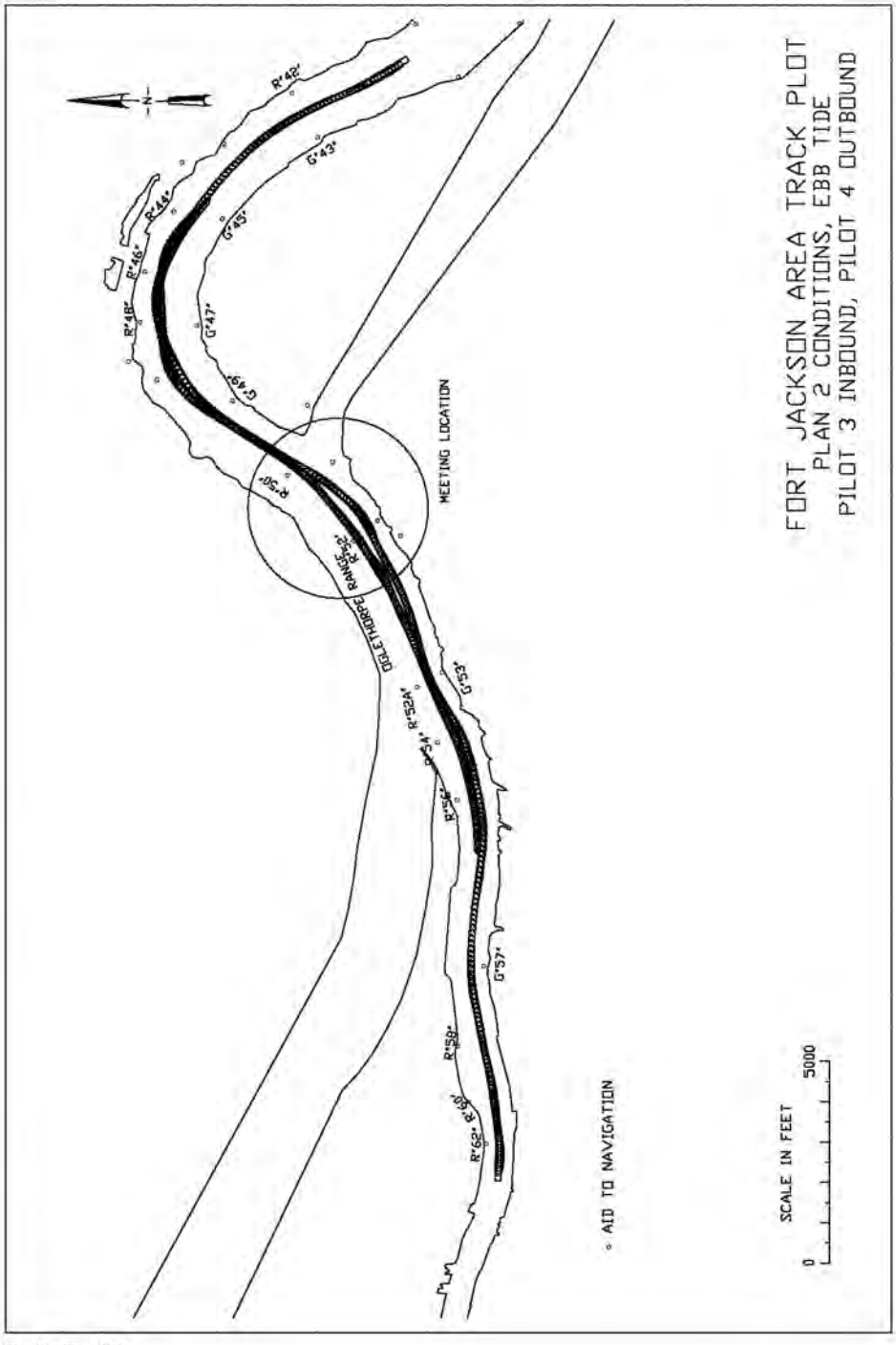

FORT JACKSON AREA TRACK PLOT
PLAN 2 CONDITIONS, EBB TIDE
PILOT 3 INBOUND, PILOT 4 OUTBOUND
MEETING LOCATION
OGLETHORPE RANGE
R"42"
G"43"
R"44"
G"45"
R"46"
R"48"
G"47"
G"49"
R"50"
R"52"
G"53"
R"52A"
R"54"
R"56"
G"57"
R"58"
R"60"
R"62"
AID TO NAVIGATION
SCALE IN FEET
0
5000

PLATE 82

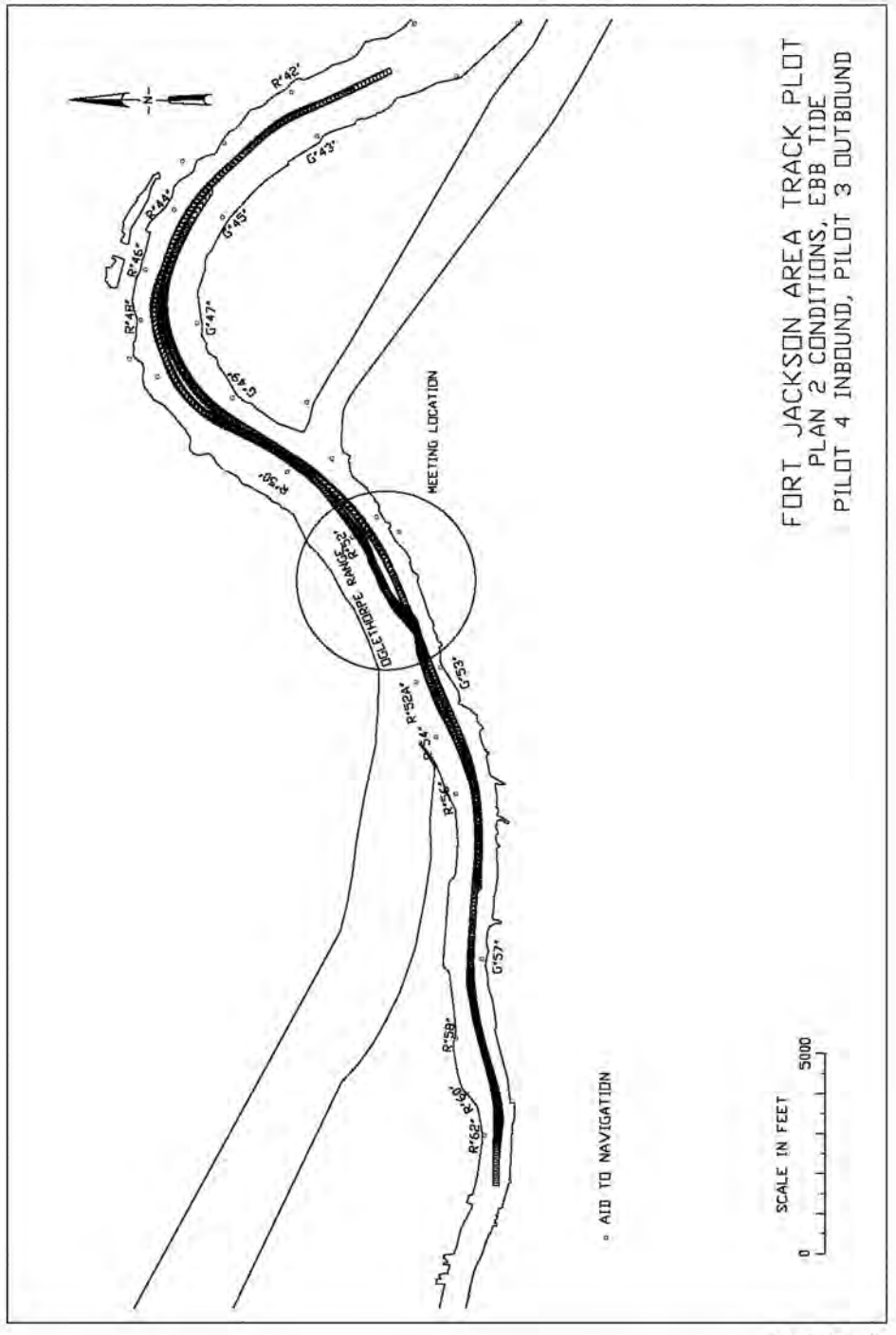

FORT JACKSON AREA TRACK PLOT
PLAN 2 CONDITIONS, EBB TIDE
PILOT 4 INBOUND, PILOT 3 OUTBOUND
MEETING LOCATION
DOLETHORPE RANGE
AID TO NAVIGATION
SCALE IN FEET
0
5000
R"42"
G"43"
R"44"
G"45"
R"46"
R"48"
G"47"
G"49"
R"50"
R"52"
R"52A"
G"53"
R"54"
R"54A"
G"57"
R"58"
R"60"
R"62"

PLATE 83

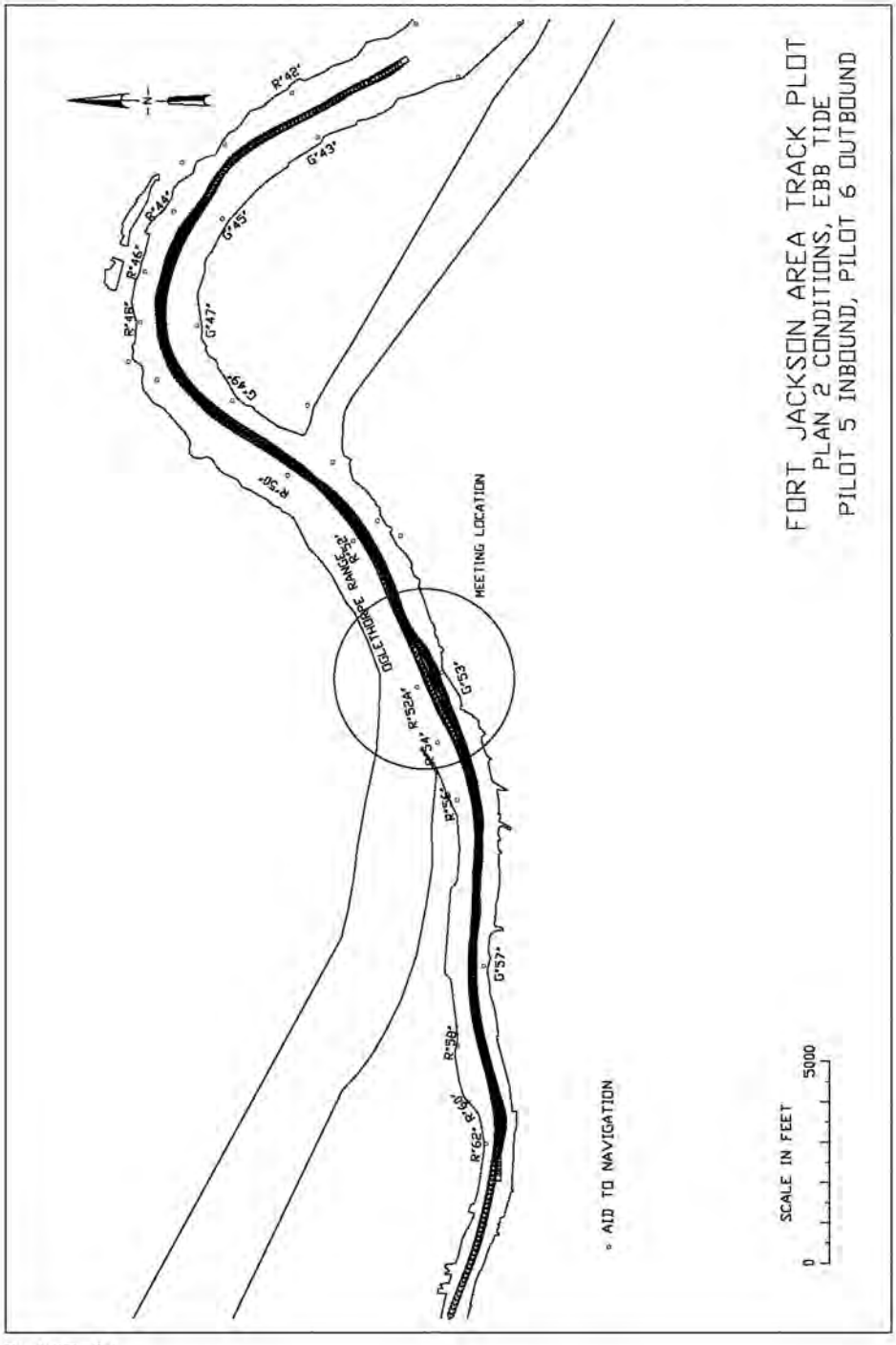

FORT JACKSON AREA TRACK PLOT
PLAN 2 CONDITIONS, EBB TIDE
PILOT 5 INBOUND, PILOT 6 OUTBOUND
N
R"42"
G"43"
R"44"
G"45"
R"46"
R"48"
G"47"
G"49"
R"50"
OGLETHORPE RANGE
R"52"
MEETING LOCATION
G"53"
R"52A"
R"54"
R"56"
G"57"
R"58"
R"60"
R"62"
AID TO NAVIGATION
SCALE IN FEET
0
5000

PLATE 84

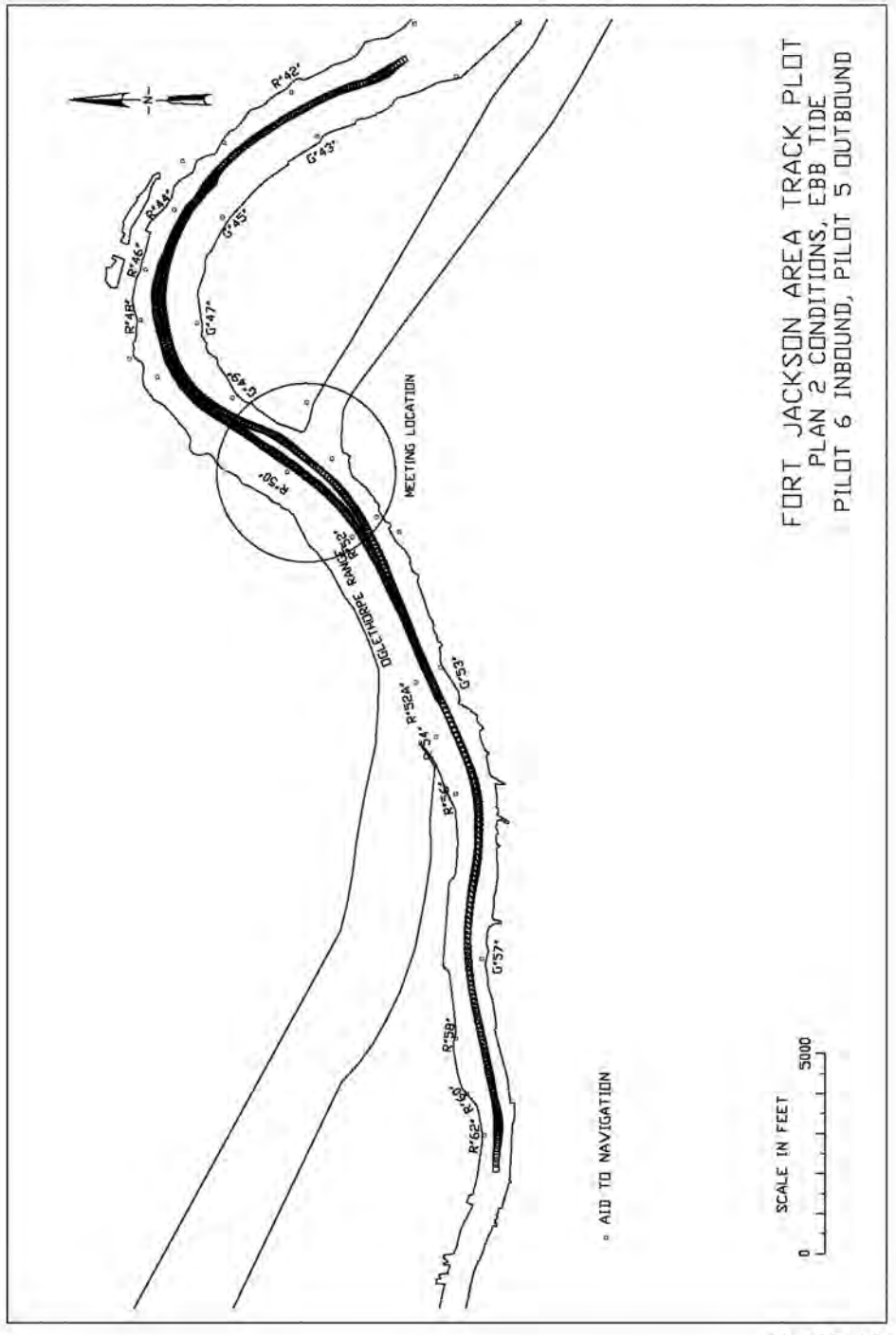

FORT JACKSON AREA TRACK PLOT
PLAN 2 CONDITIONS, EBB TIDE
PILOT 6 INBOUND, PILOT 5 OUTBOUND
N
R"42"
G"43"
R"44"
G"45"
R"46"
R"48"
G"47"
G"49"
R"50"
MEETING LOCATION
OGLETHORPE RANGE
R"52"
G"53"
R"52A"
R"54"
R"56"
G"57"
R"58"
R"60"
R"62"
AID TO NAVIGATION
SCALE IN FEET
0
5000

PLATE 85

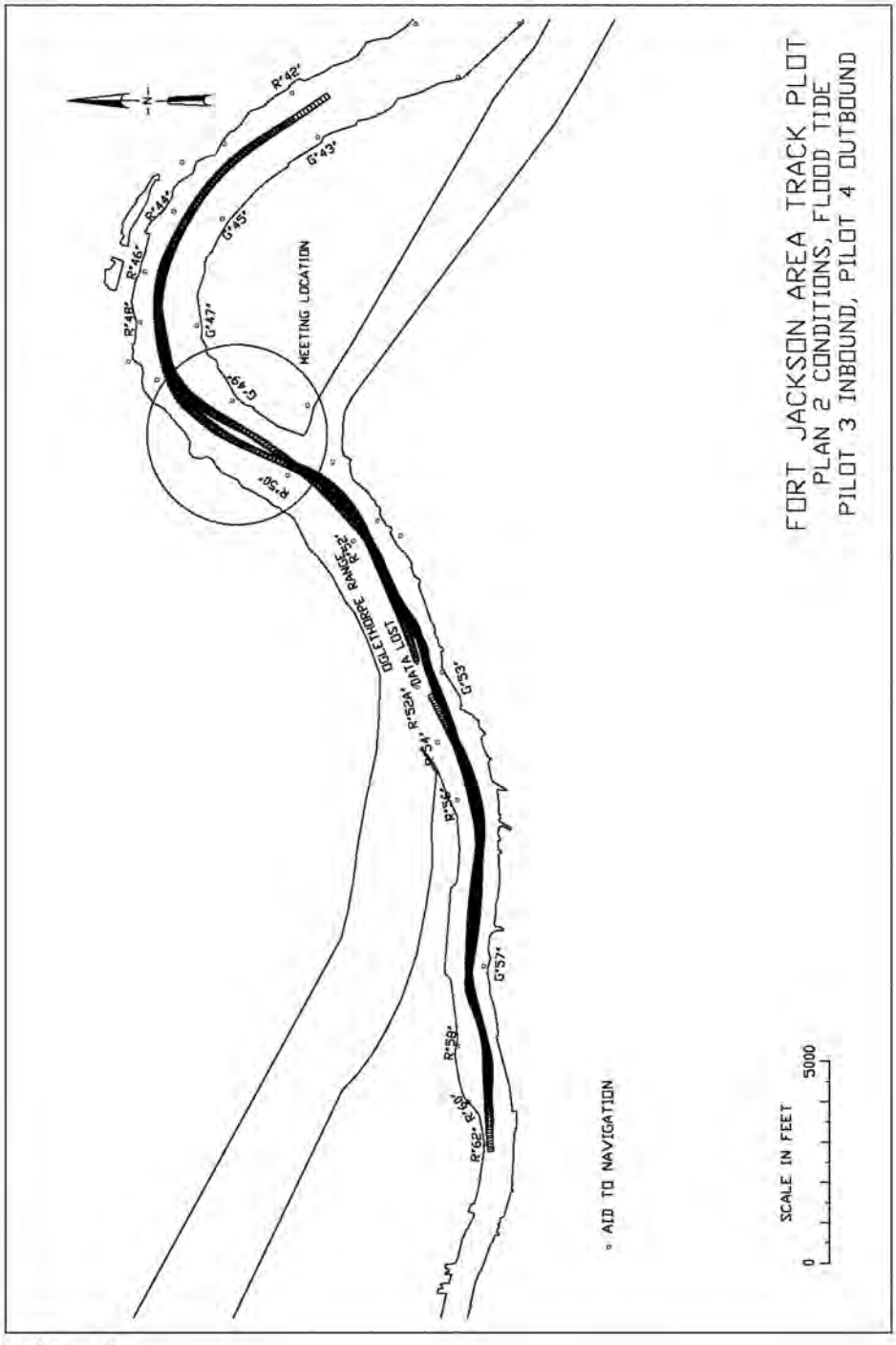

FORT JACKSON AREA TRACK PLOT
PLAN 2 CONDITIONS, FLOOD TIDE
PILOT 3 INBOUND, PILOT 4 OUTBOUND
N
MEETING LOCATION
OGLETHORPE RANGE
DATA LOST
R"42"
G"43"
G"45"
R"44"
R"46"
R"48"
G"47"
G"49"
R"50"
R"52"
R"52A"
R"54"
R"56"
G"53"
G"57"
R"58"
R"60"
R"62"
AID TO NAVIGATION
SCALE IN FEET
0
5000

PLATE 86

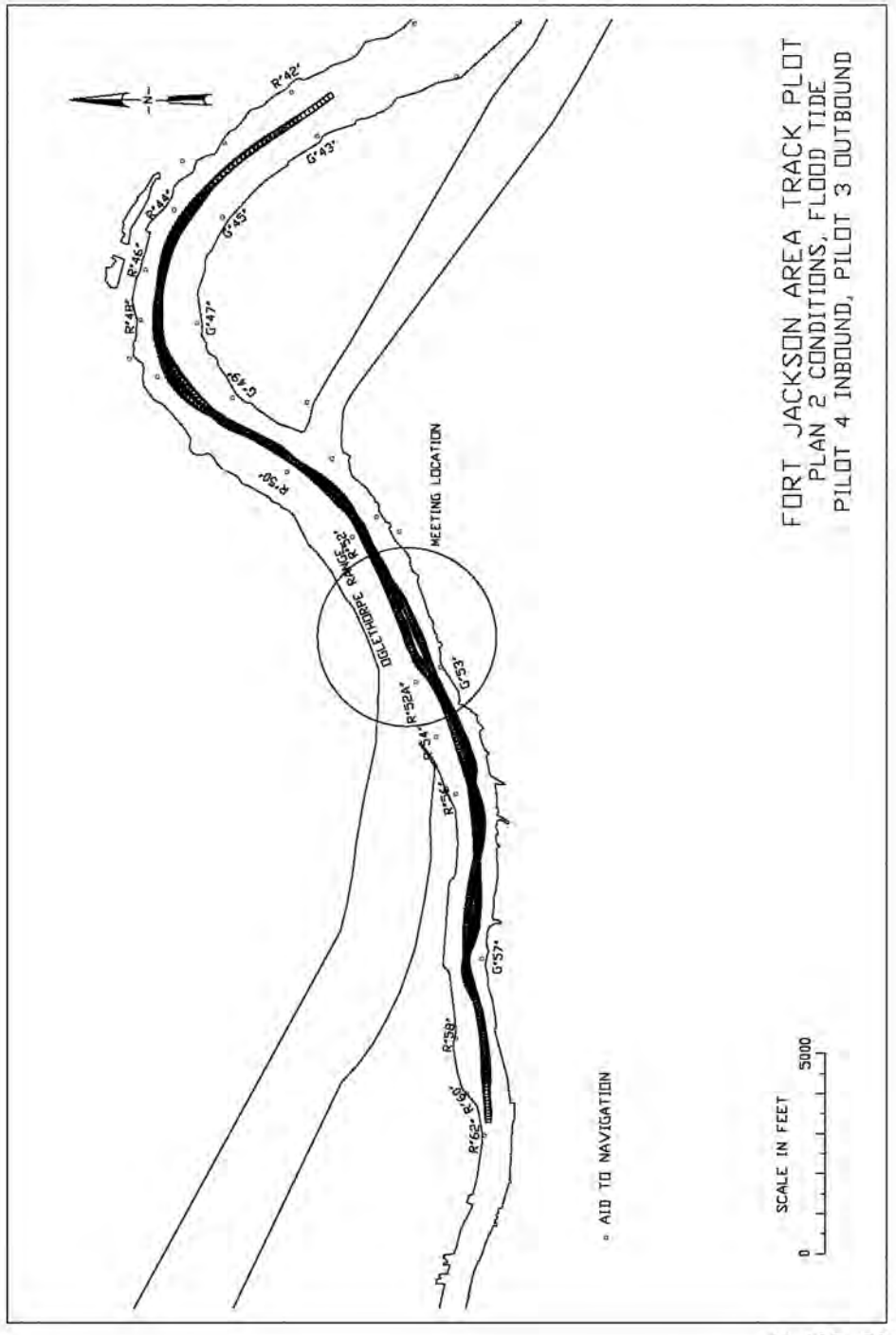

FORT JACKSON AREA TRACK PLOT
PLAN 2 CONDITIONS, FLOOD TIDE
PILOT 4 INBOUND, PILOT 3 OUTBOUND
MEETING LOCATION
DILETHARBOR RANGE
AID TO NAVIGATION
SCALE IN FEET
0
5000
R"42"
G"43"
R"44"
R"46"
R"48"
G"45"
G"47"
G"49"
R"50"
R"52A"
G"53"
R"54"
G"57"
R"58"
R"60"
R"62"

PLATE 87

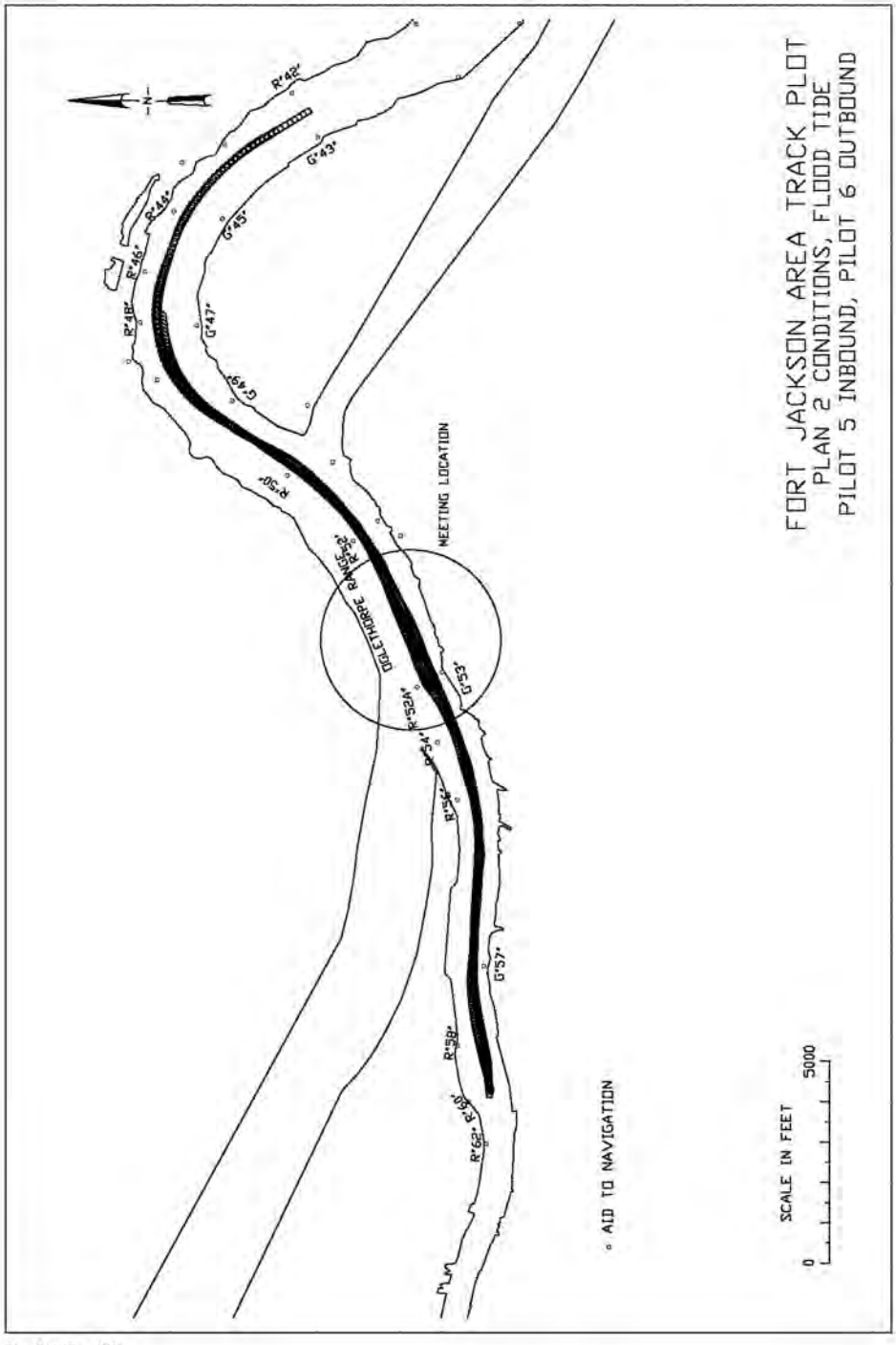

FORT JACKSON AREA TRACK PLOT
PLAN 2 CONDITIONS, FLOOD TIDE
PILOT 5 INBOUND, PILOT 6 OUTBOUND
N
R"42"
G"43"
R"44"
G"45"
R"46"
R"48"
G"47"
G"49"
R"50"
MEETING LOCATION
OGLETHORPE RANGE
R"52"
G"53"
R"52A"
R"54"
R"56"
G"57"
R"58"
R"60"
R"62"
AID TO NAVIGATION
SCALE IN FEET
0
5000

PLATE 88

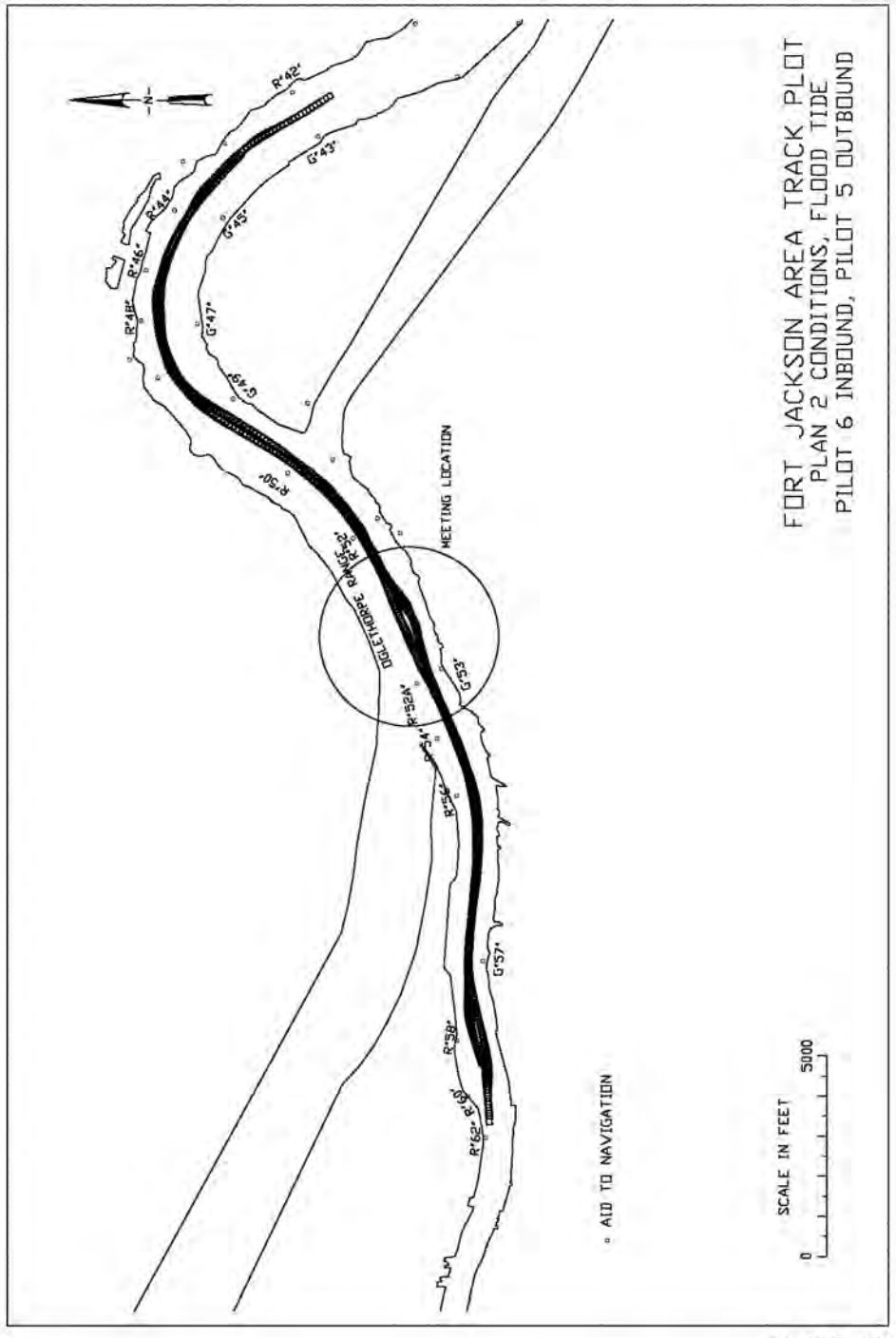

FORT JACKSON AREA TRACK PLOT
PLAN 2 CONDITIONS, FLOOD TIDE
PILOT 6 INBOUND, PILOT 5 OUTBOUND
MEETING LOCATION
DOLETHORPE RANGE
AID TO NAVIGATION
SCALE IN FEET
0
5000
R"42'
G"43'
R"44'
G"45'
R"46'
R"48'
G"47'
G"49'
R"50'
R"52A'
G"53'
R"54'
R"54A'
G"57'
R"58'
R"60'
R"62'

PLATE 89

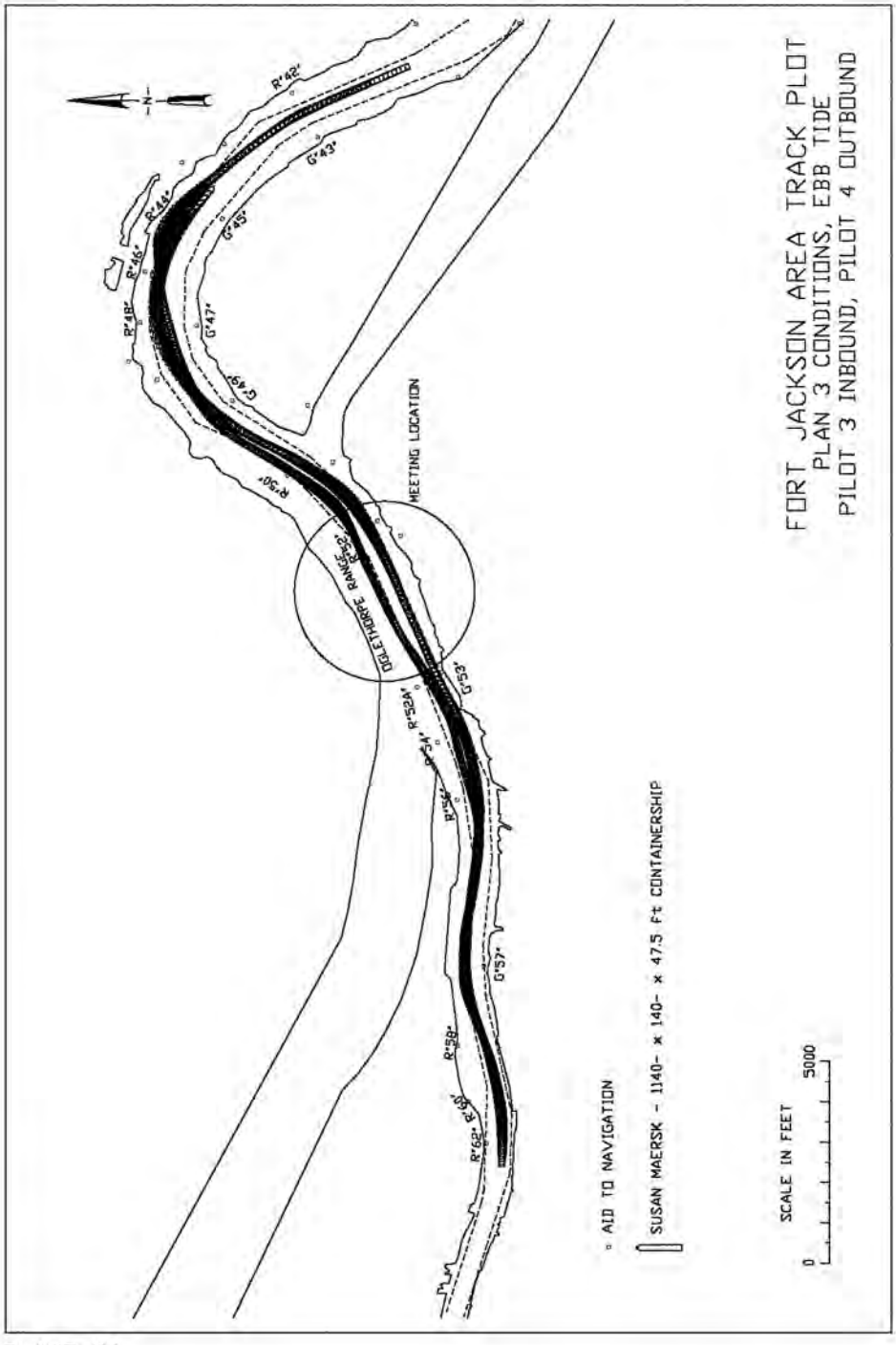

FORT JACKSON AREA TRACK PLOT
PLAN 3 CONDITIONS, EBB TIDE
PILOT 3 INBOUND, PILOT 4 OUTBOUND
MEETING LOCATION
DELETHORPE RANGE
SUSAN MAERSK - 1140- x 140- x 47.5 Ft CONTAINERSHIP
AID TO NAVIGATION
SCALE IN FEET
0
5000

PLATE 90

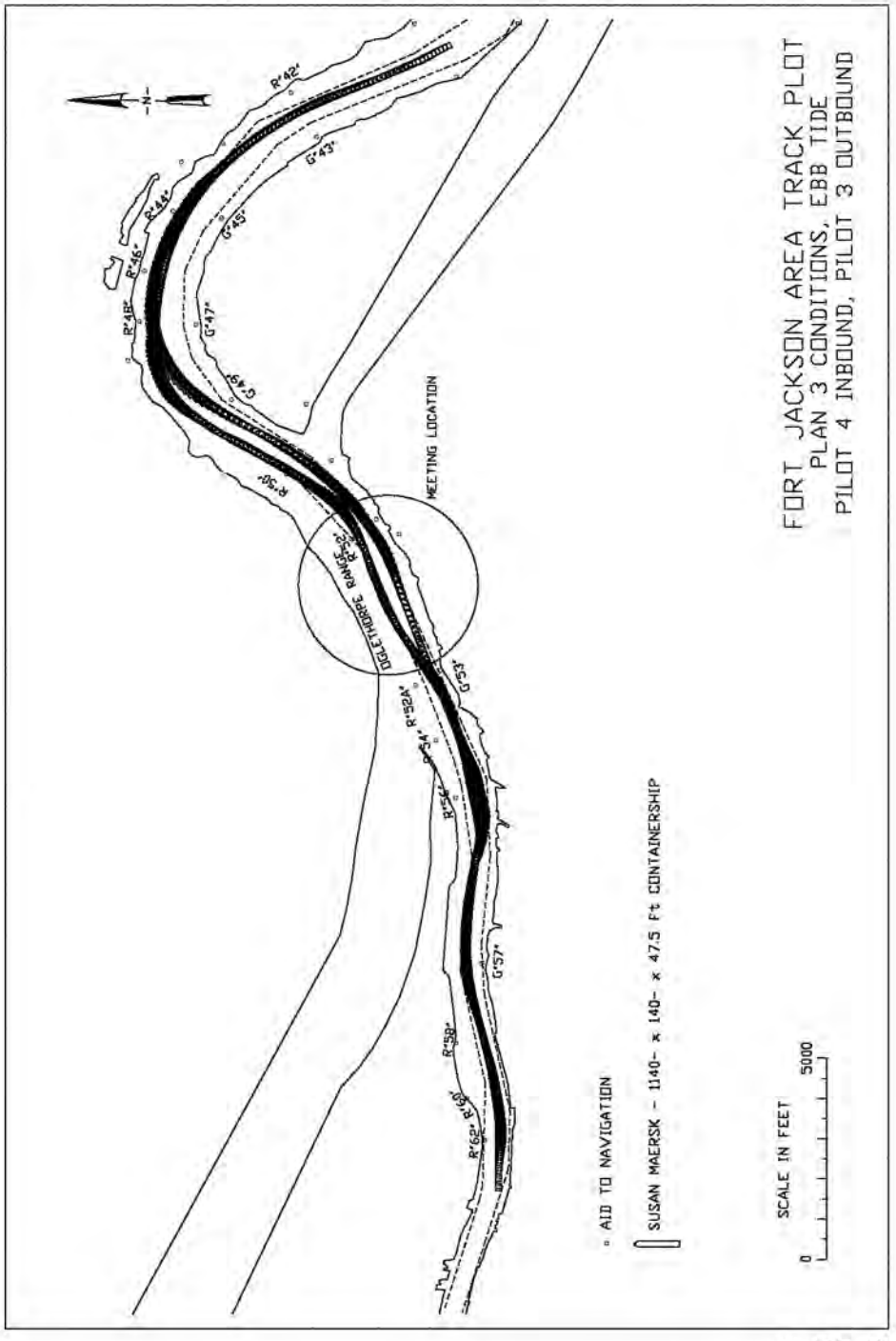

FORT JACKSON AREA TRACK PLOT
PLAN 3 CONDITIONS, EBB TIDE
PILOT 4 INBOUND, PILOT 3 OUTBOUND
MEETING LOCATION
DOLETHORPE RANGE
SUSAN MAERSK - 1140- x 140- x 47.5 Ft CONTAINERSHIP
AID TO NAVIGATION
SCALE IN FEET
0
5000

PLATE 91

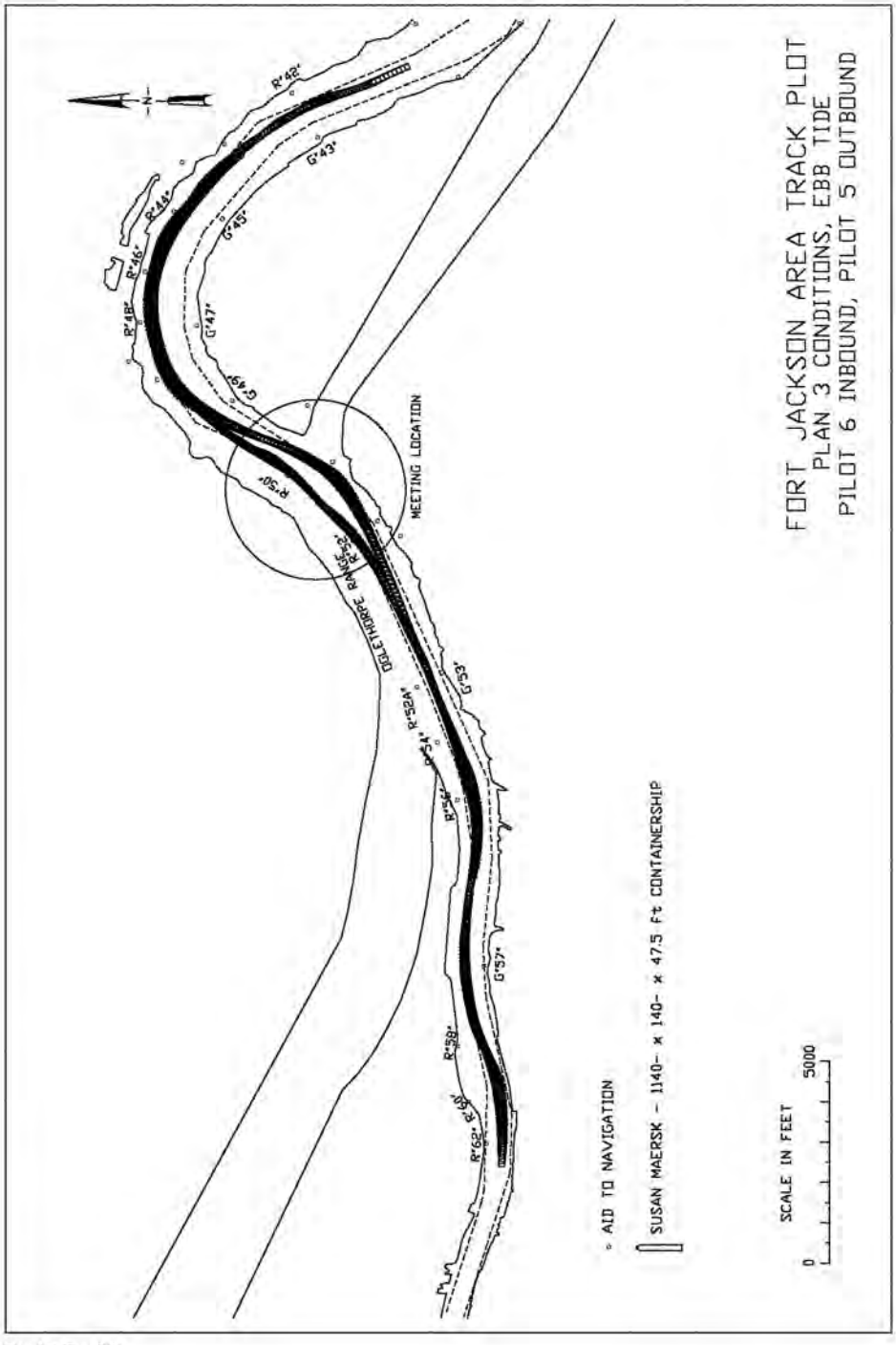

FORT JACKSON AREA TRACK PLOT
PLAN 3 CONDITIONS, EBB TIDE
PILOT 6 INBOUND, PILOT 5 OUTBOUND
MEETING LOCATION
DELTHORPE RANGE
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
AID TO NAVIGATION
SCALE IN FEET
0
5000

PLATE 92

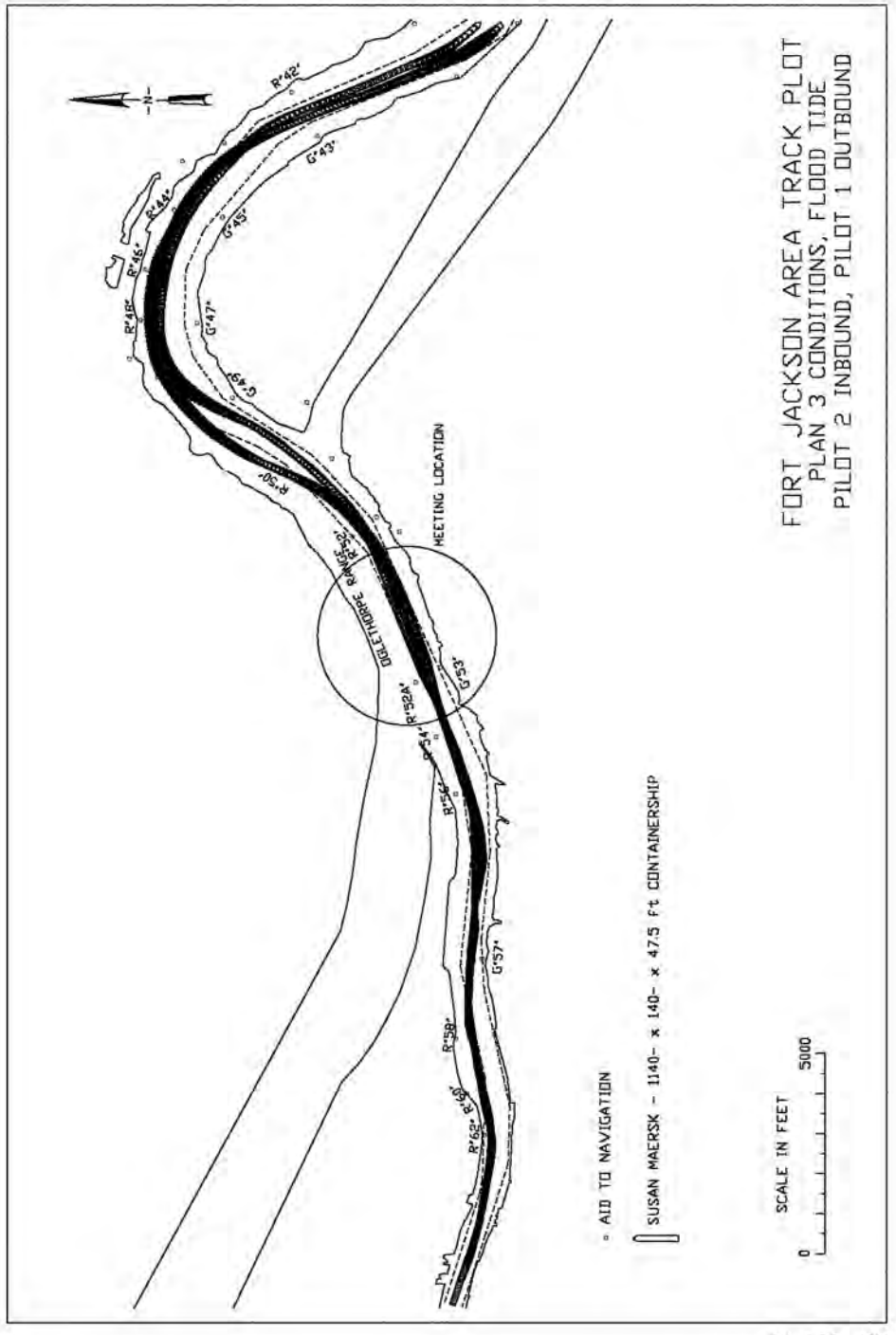

FORT JACKSON AREA TRACK PLOT
PLAN 3 CONDITIONS, FLOOD TIDE
PILOT 2 INBOUND, PILOT 1 OUTBOUND
N
R"42"
G"43"
R"44"
G"45"
R"46"
R"48"
G"47"
G"49"
R"50"
MEETING LOCATION
OGLETHORPE RANGE
R"52"
G"53"
R"52A"
R"54"
R"56"
G"57"
R"58"
R"60"
R"62"
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
SCALE IN FEET
0
5000

PLATE 93

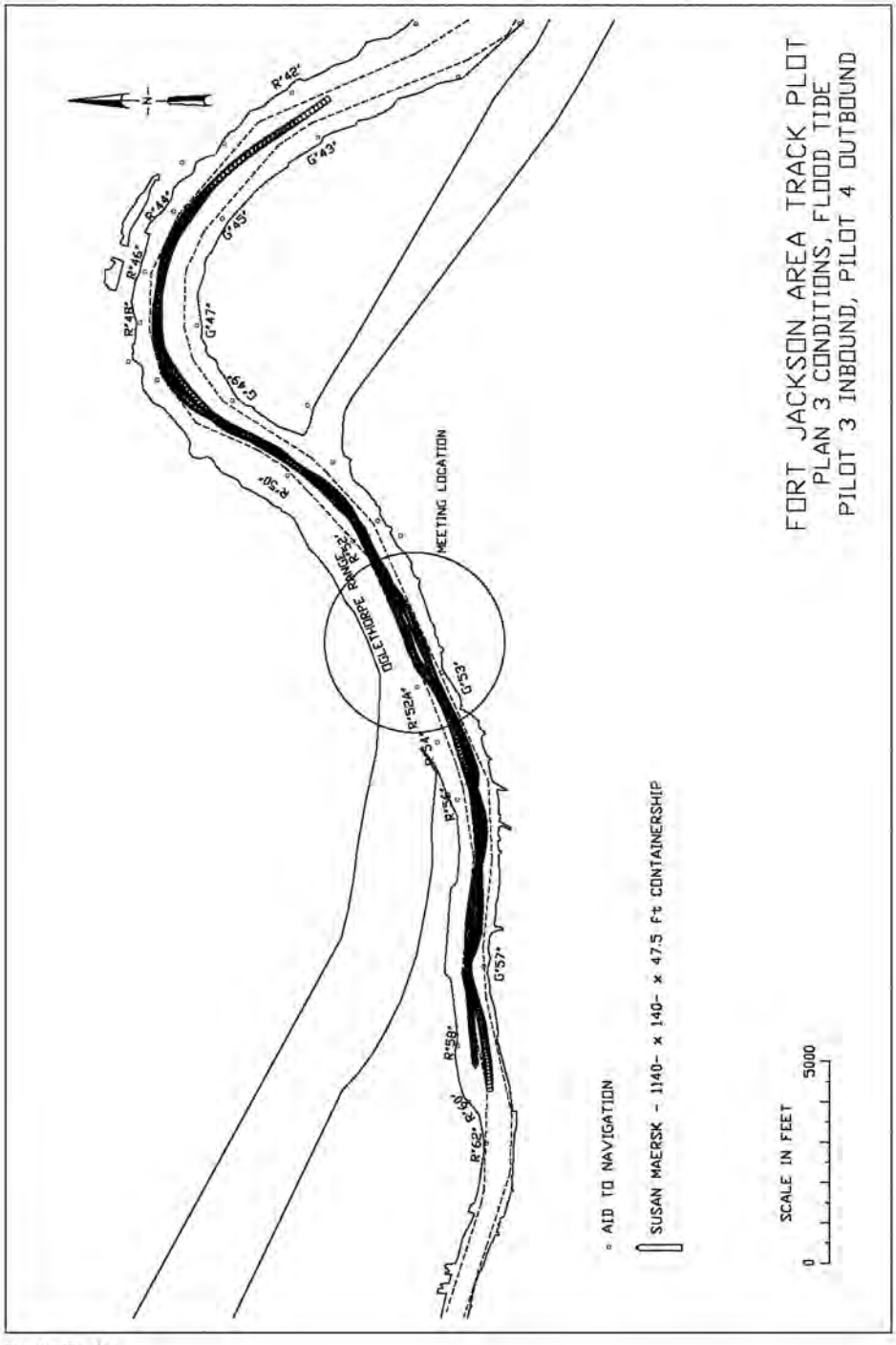

FORT JACKSON AREA TRACK PLOT
PLAN 3 CONDITIONS, FLOOD TIDE
PILOT 3 INBOUND, PILOT 4 OUTBOUND
N
R'42'
G'43'
R'44'
R'46'
R'48'
G'45'
G'47'
G'49'
R'50'
MEETING LOCATION
OGLETHORPE RANGE
R'52'
G'53'
R'52A'
R'54'
R'56'
G'57'
R'58'
R'60'
R'62'
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
SCALE IN FEET
0
5000

PLATE 94

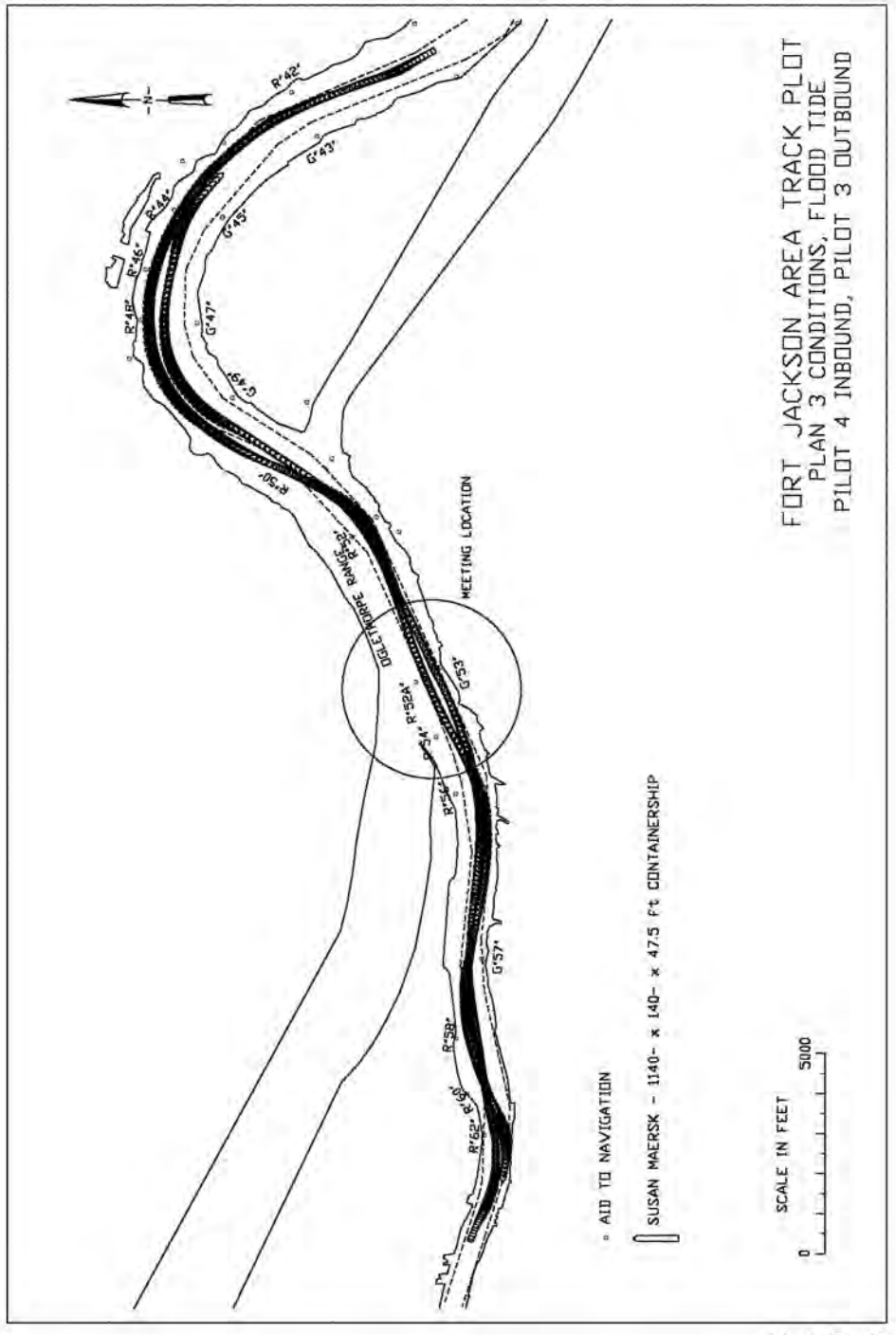

FORT JACKSON AREA TRACK PLOT
PLAN 3 CONDITIONS, FLOOD TIDE
PILOT 4 INBOUND, PILOT 3 OUTBOUND
N
R"42"
G"43"
R"44"
G"45"
R"46"
R"48"
G"47"
G"49"
R"50"
R"52"
OGLETHORPE RANGE
MEETING LOCATION
G"53"
R"52A"
R"54"
R"56"
G"57"
R"58"
R"60"
R"62"
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
SCALE IN FEET
0
5000

PLATE 95

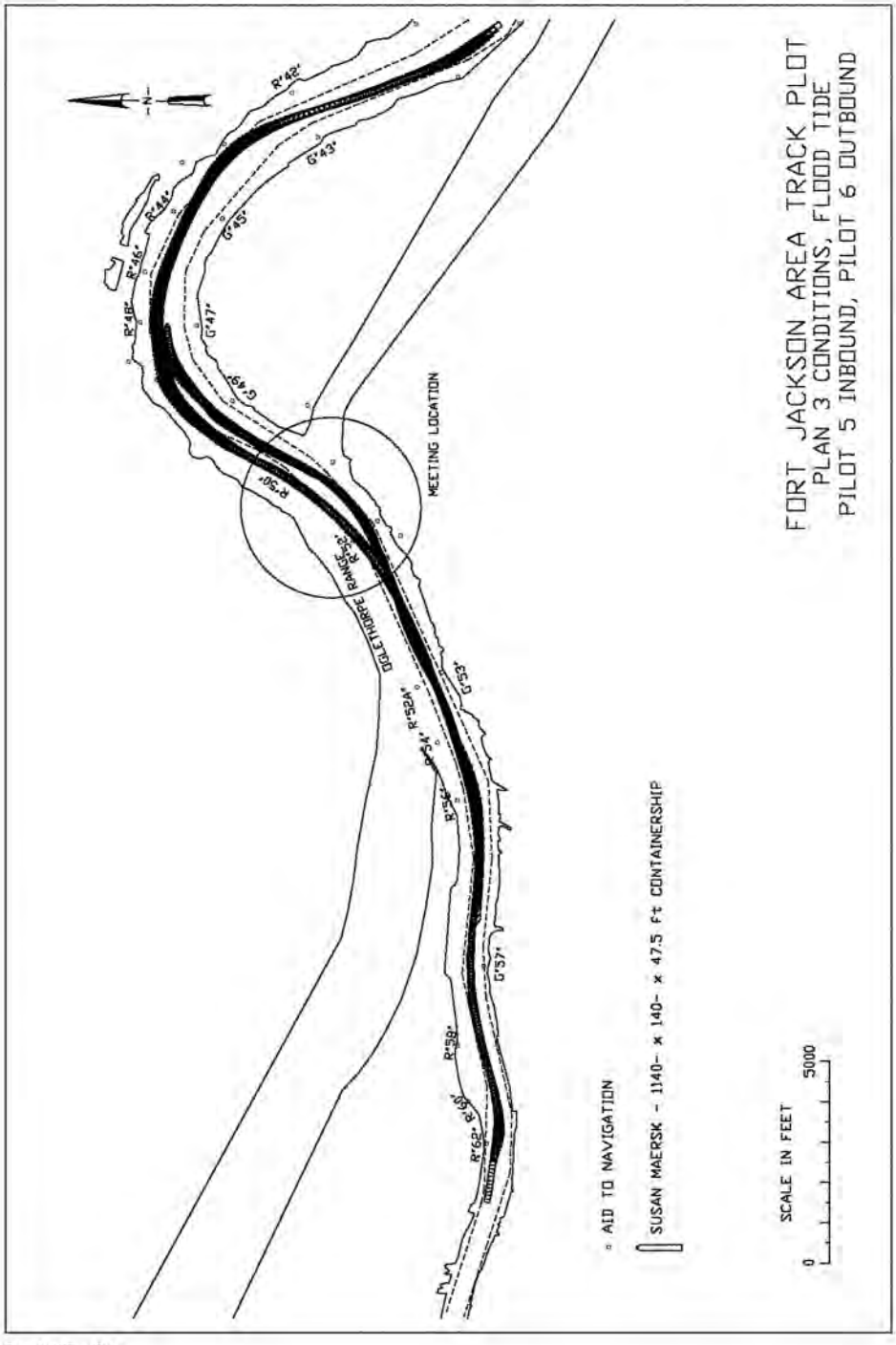

FORT JACKSON AREA TRACK PLOT
PLAN 3 CONDITIONS, FLOOD TIDE
PILOT 5 INBOUND, PILOT 6 OUTBOUND
N
MEETING LOCATION
OGLETHORPE RANGE
R"42"
G"43"
G"45"
R"44"
R"46"
R"48"
G"47"
G"49"
R"50"
R"52"
R"52A"
R"54"
R"56"
G"53"
G"57"
R"58"
R"60"
R"62"
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
SCALE IN FEET
0
5000

PLATE 96

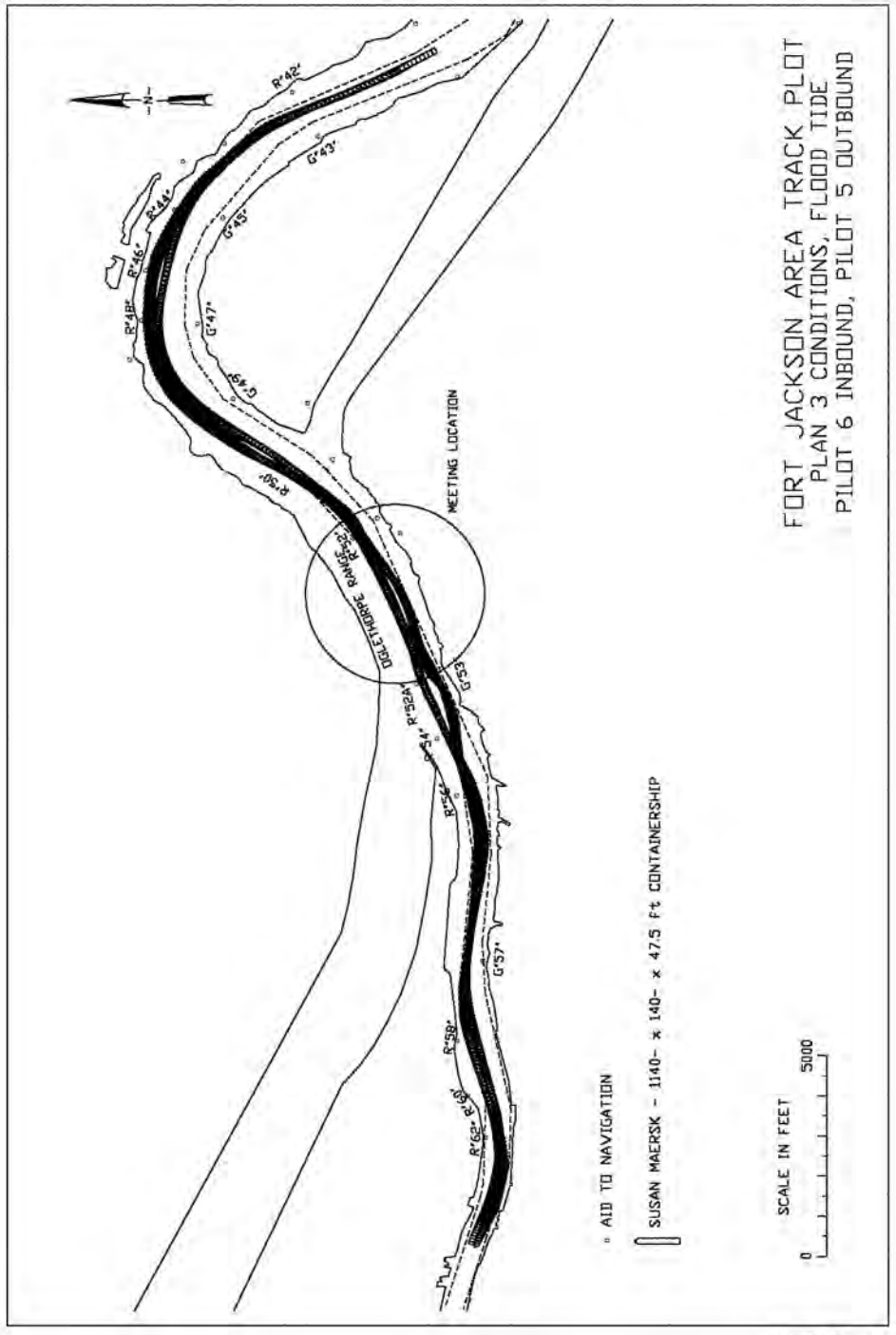

FORT JACKSON AREA TRACK PLOT
PLAN 3 CONDITIONS, FLOOD TIDE
PILOT 6 INBOUND, PILOT 5 OUTBOUND
MEETING LOCATION
DELTAHARBOR RANGE
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 Ft CONTAINERSHIP
SCALE IN FEET
0
5000

PLATE 97

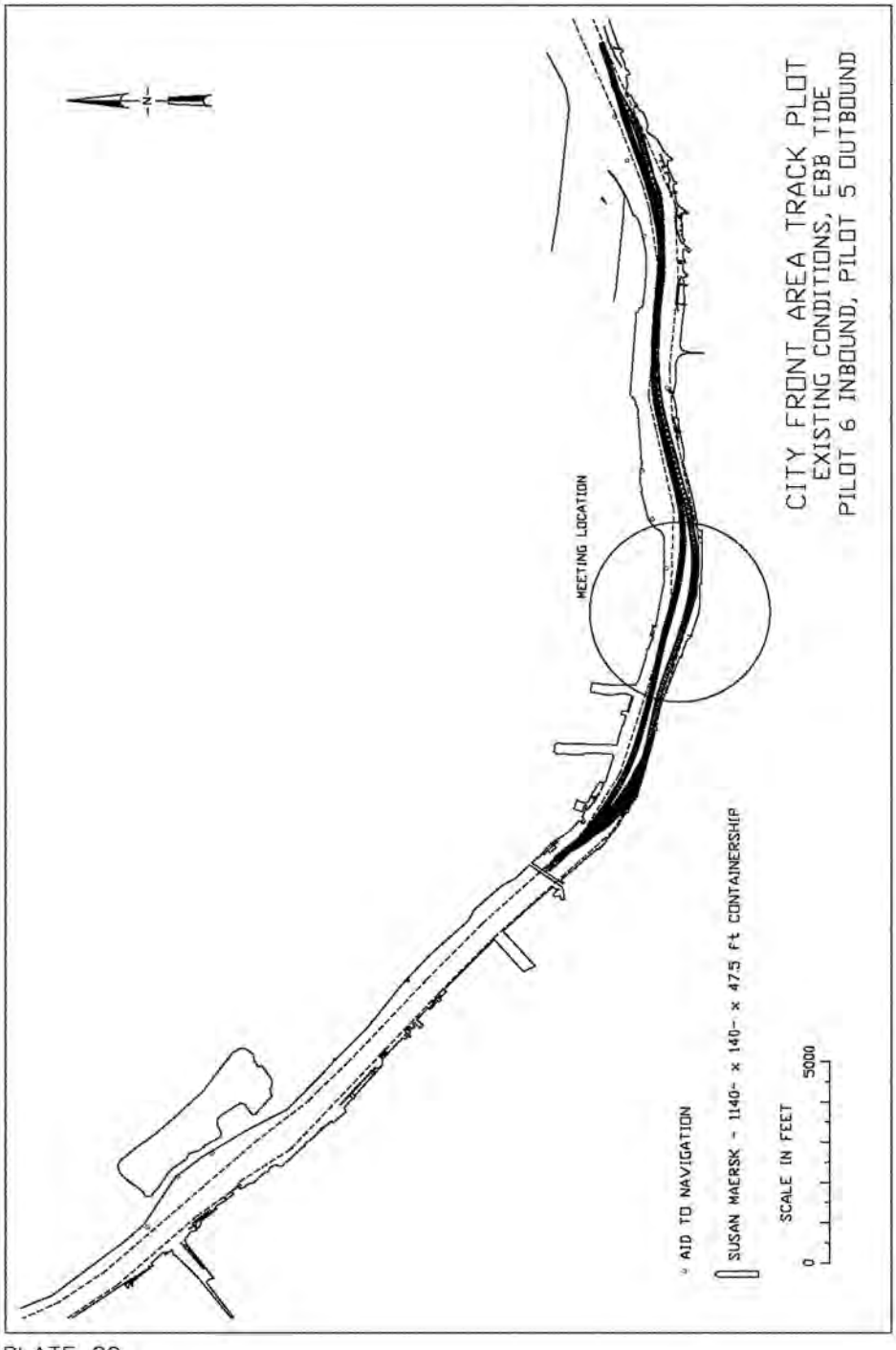

CITY FRONT AREA TRACK PLOT
EXISTING CONDITIONS, EBB TIDE
PILOT 6 INBOUND, PILOT 5 OUTBOUND
MEETING LOCATION
AID TO NAVIGATION
SUSAN MAERSK - 1140' x 140' x 47.5 ft CONTAINERSHIP
SCALE IN FEET
0
5000

PLATE 98

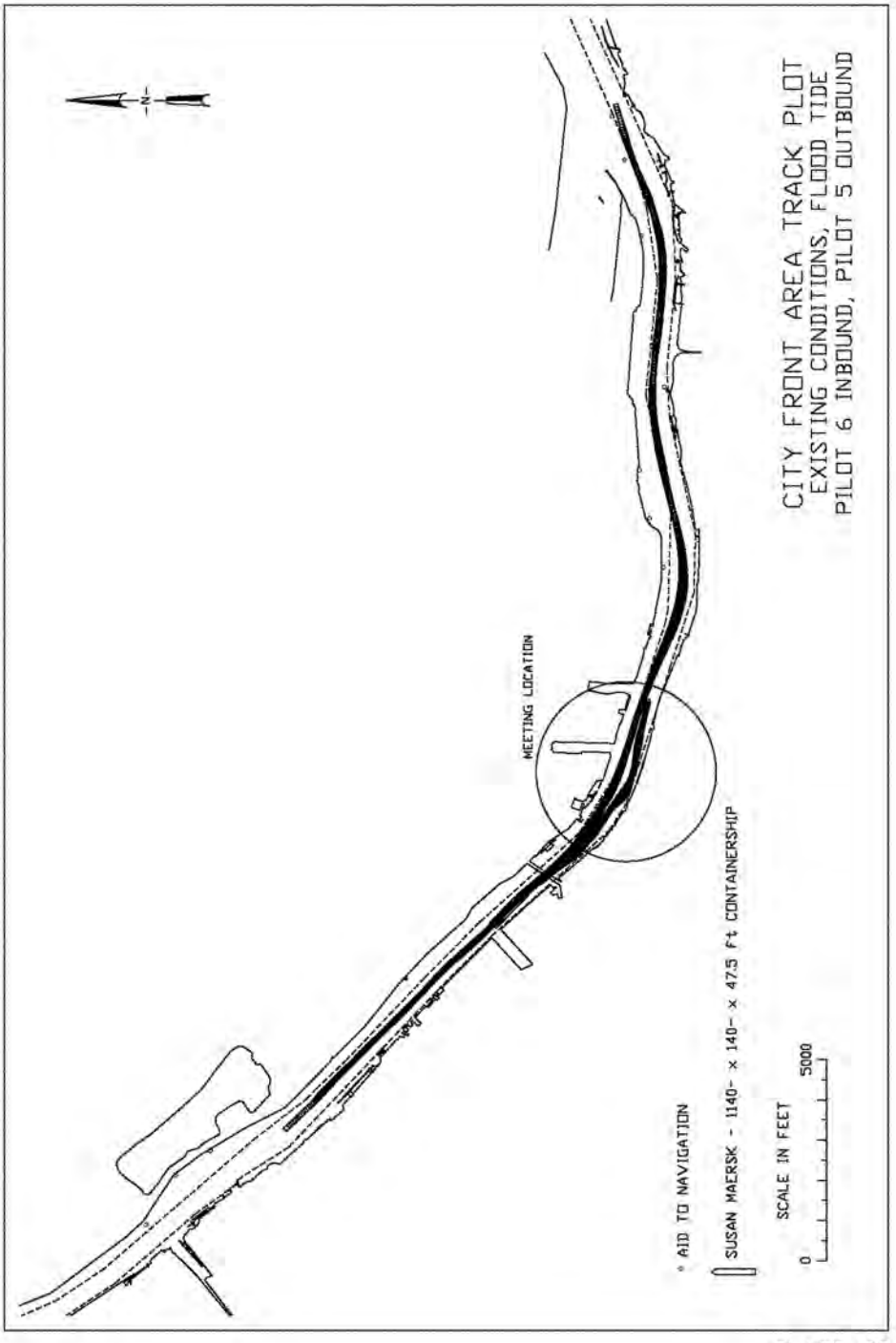

CITY FRONT AREA TRACK PLOT
EXISTING CONDITIONS, FLOOD TIDE
PILOT 6 INBOUND, PILOT 5 OUTBOUND
MEETING LOCATION
* AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
SCALE IN FEET
0
5000

PLATE 99

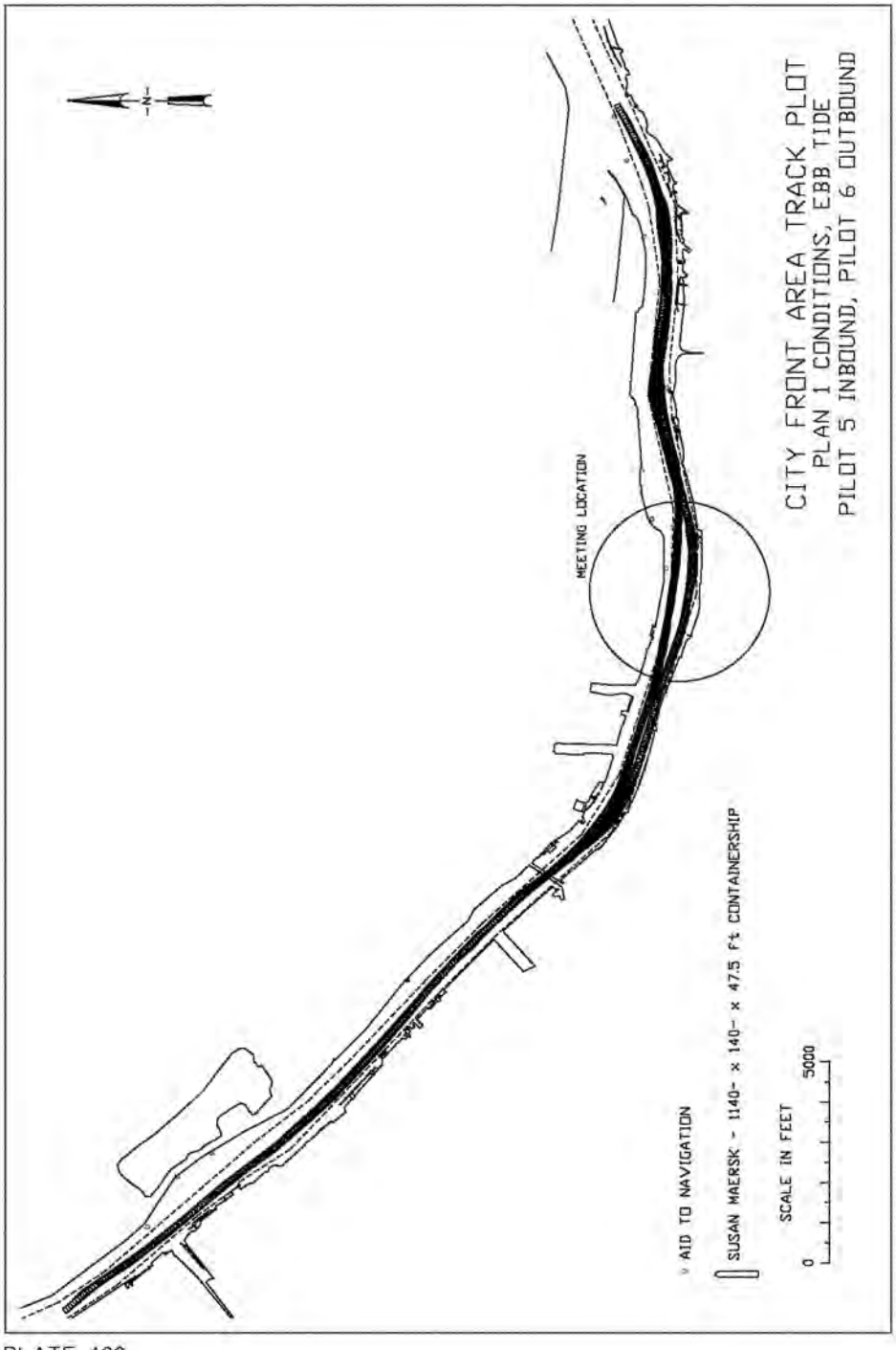

CITY FRONT AREA TRACK PLOT
PLAN 1 CONDITIONS, EBB TIDE
PILOT 5 INBOUND, PILOT 6 OUTBOUND
MEETING LOCATION
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 Ft CONTAINERSHIP
SCALE IN FEET
0
5000

PLATE 100

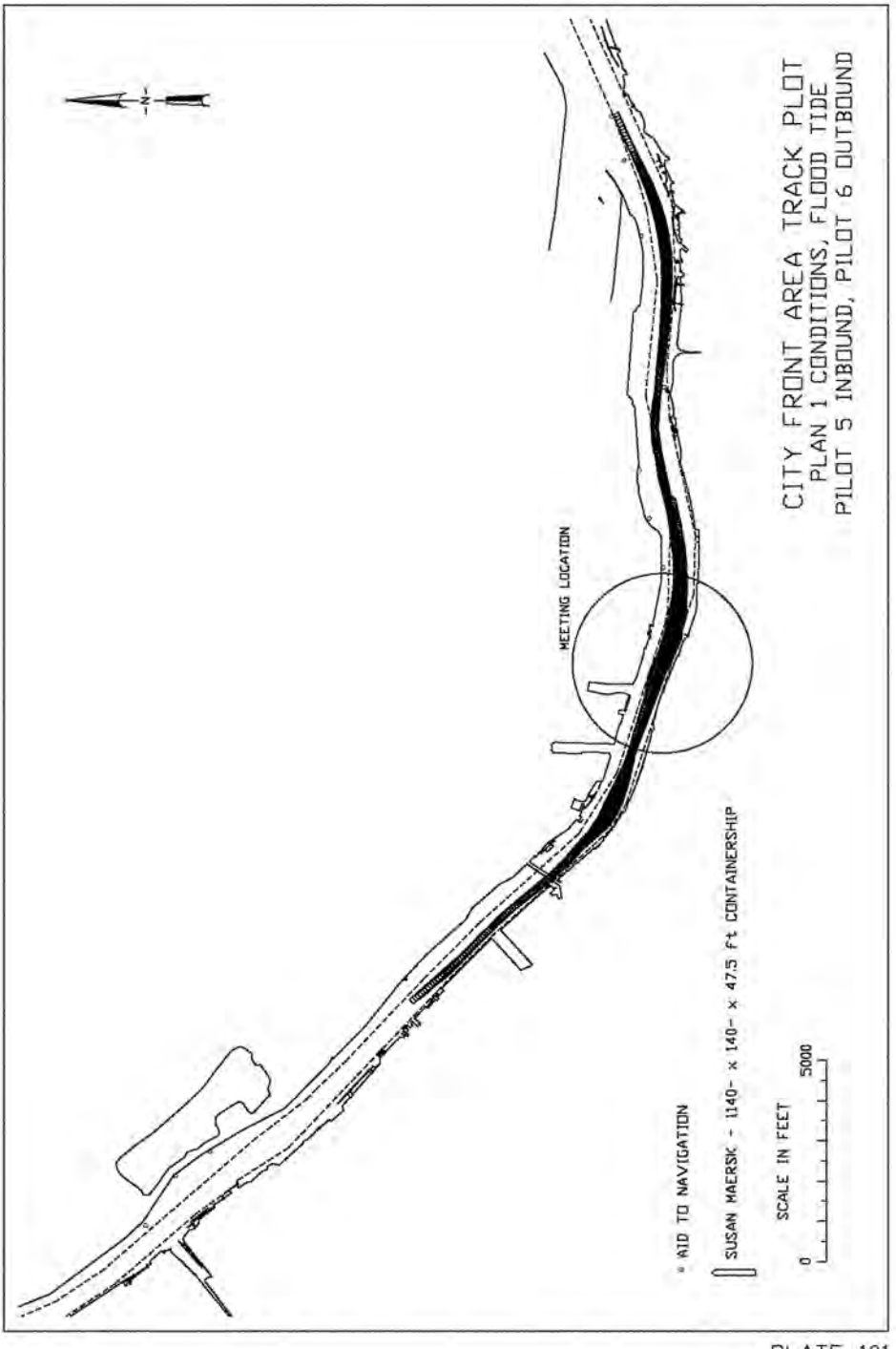

CITY FRONT AREA TRACK PLOT
PLAN 1 CONDITIONS, FLOOD TIDE
PILOT 5 INBOUND, PILOT 6 OUTBOUND
MEETING LOCATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
= AID TO NAVIGATION
SCALE IN FEET
0
5000

PLATE 101

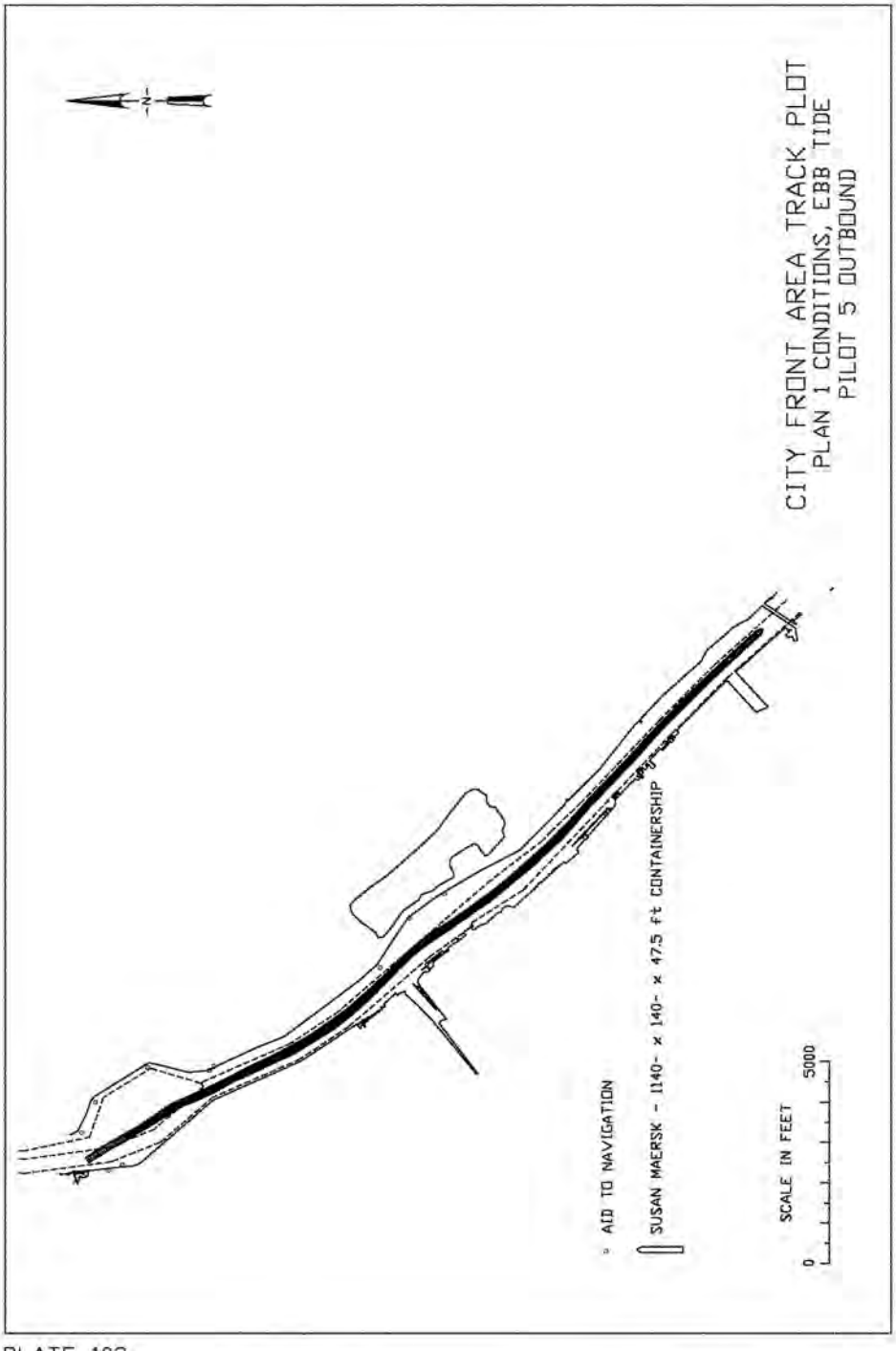

CITY FRONT AREA TRACK PLOT
PLAN 1 CONDITIONS, EBB TIDE
PILOT 5 OUTBOUND
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
SCALE IN FEET
0
5000

PLATE 102

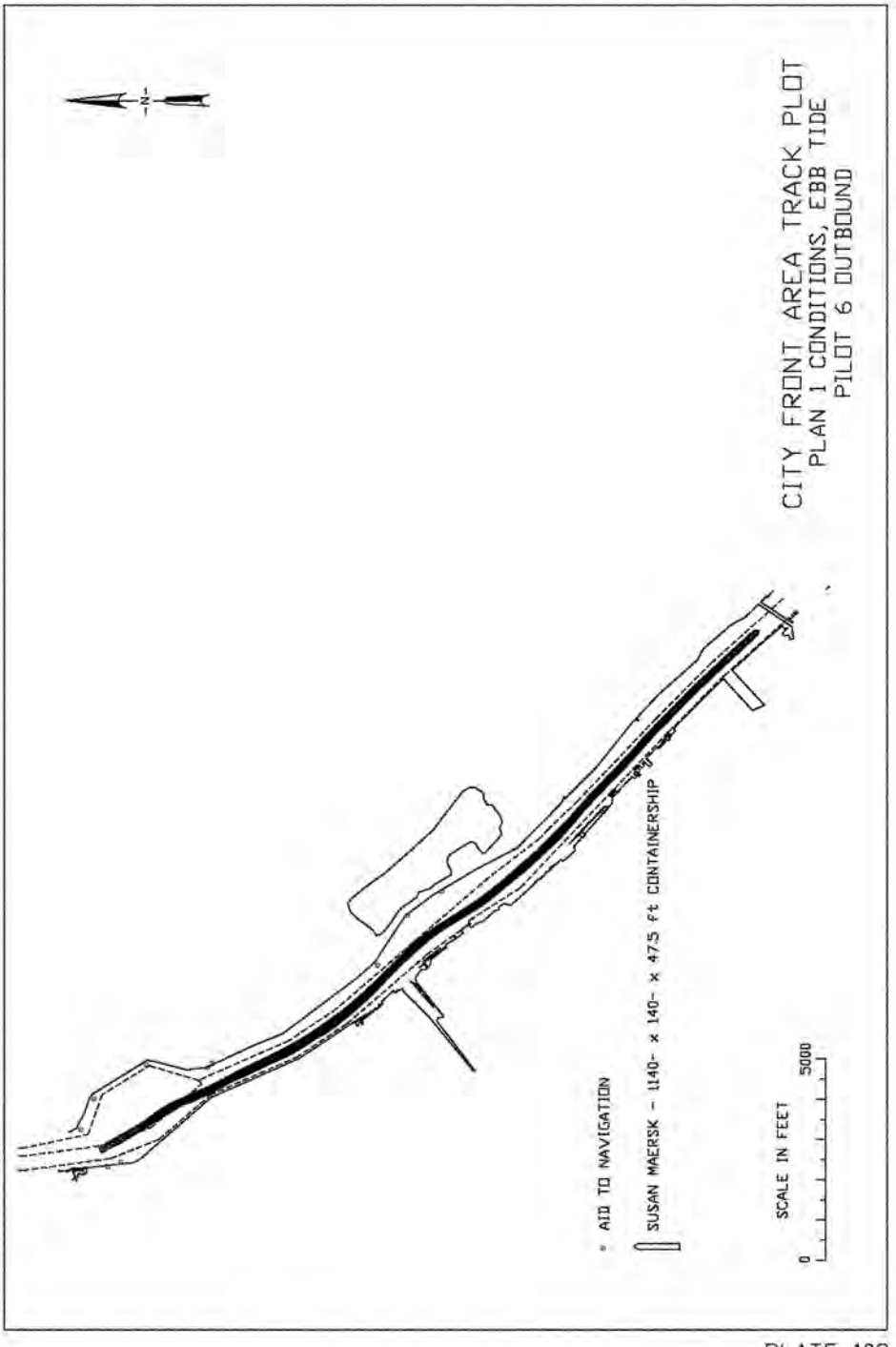

CITY FRONT AREA TRACK PLOT
PLAN 1 CONDITIONS, EBB TIDE
PILOT 6 OUTBOUND
N
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
SCALE IN FEET
0
5000

PLATE 103

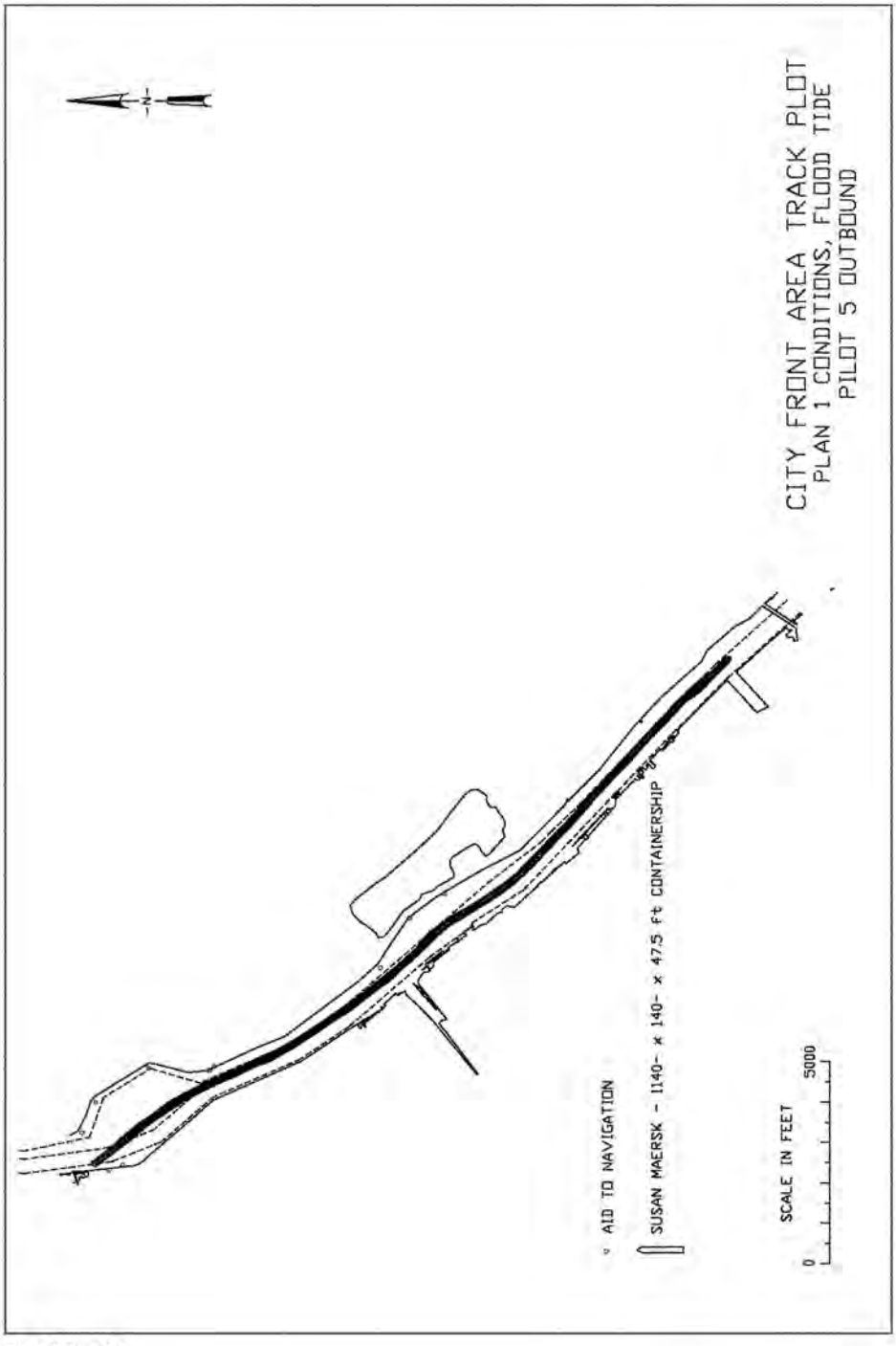

CITY FRONT AREA TRACK PLOT
PLAN 1 CONDITIONS, FLOOD TIDE
PILOT 5 OUTBOUND
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
SCALE IN FEET
0
5000

PLATE 104

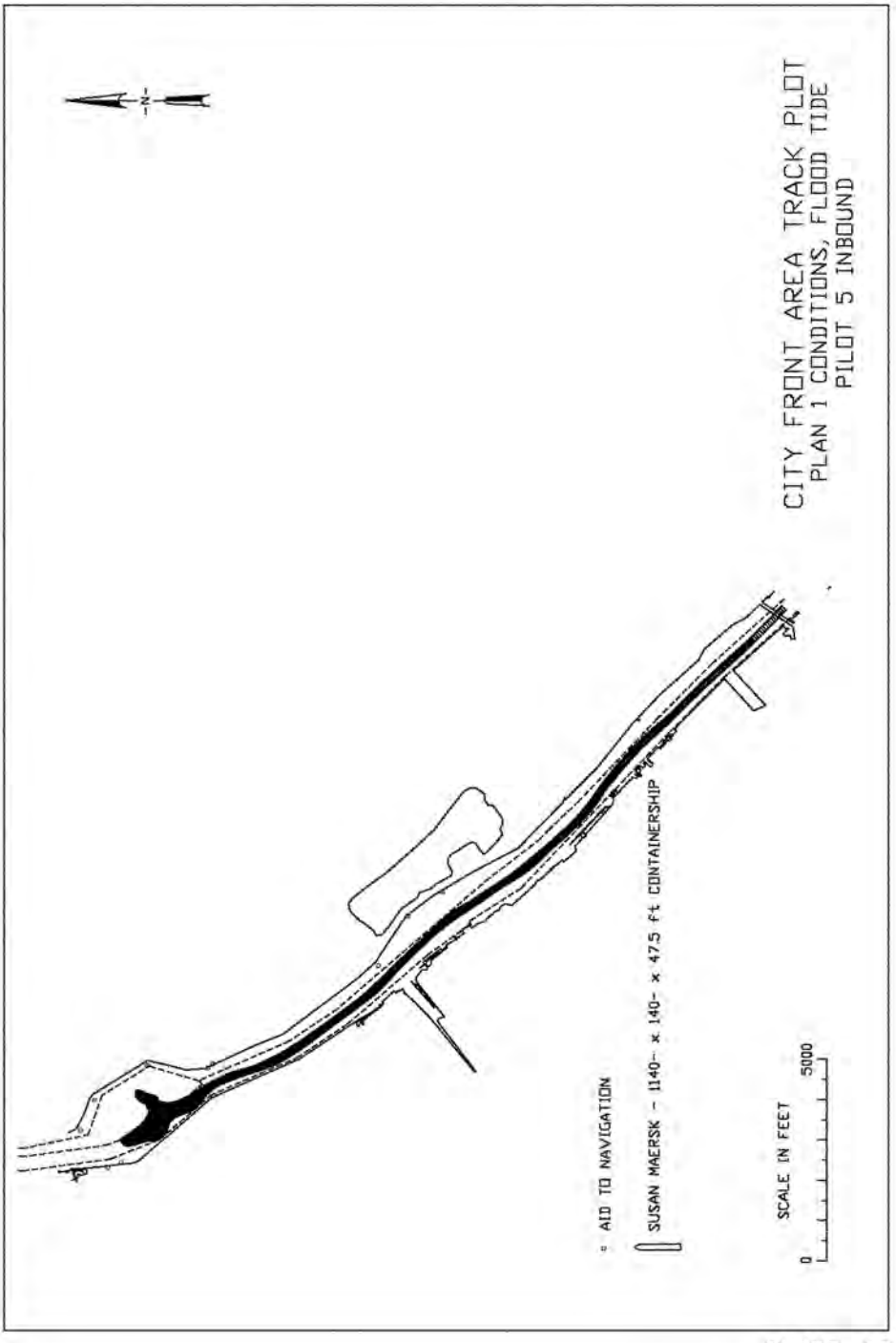

CITY FRONT AREA TRACK PLOT
PLAN 1 CONDITIONS, FLOOD TIDE
PILOT 5 INBOUND
N
AID TO NAVIGATION
SUSAN MAERSK - 1140- x 140- x 47.5 ft CONTAINERSHIP
SCALE IN FEET
0
5000

PLATE 105

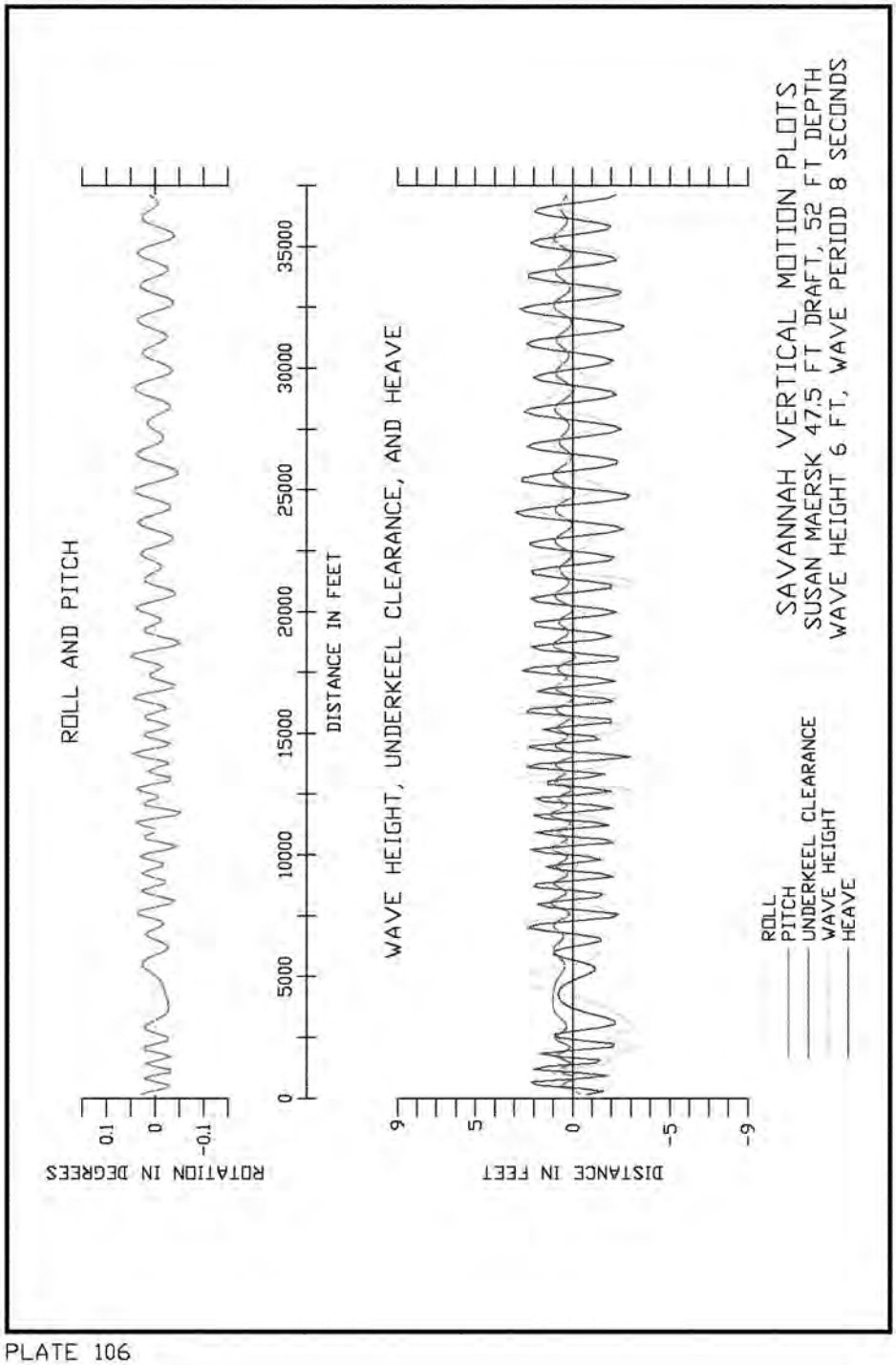

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 47.5 FT DRAFT, 52 FT DEPTH
WAVE HEIGHT 6 FT, WAVE PERIOD 8 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
0
5000
10000
15000
20000
25000
30000
35000
DISTANCE IN FEET

PLATE 106

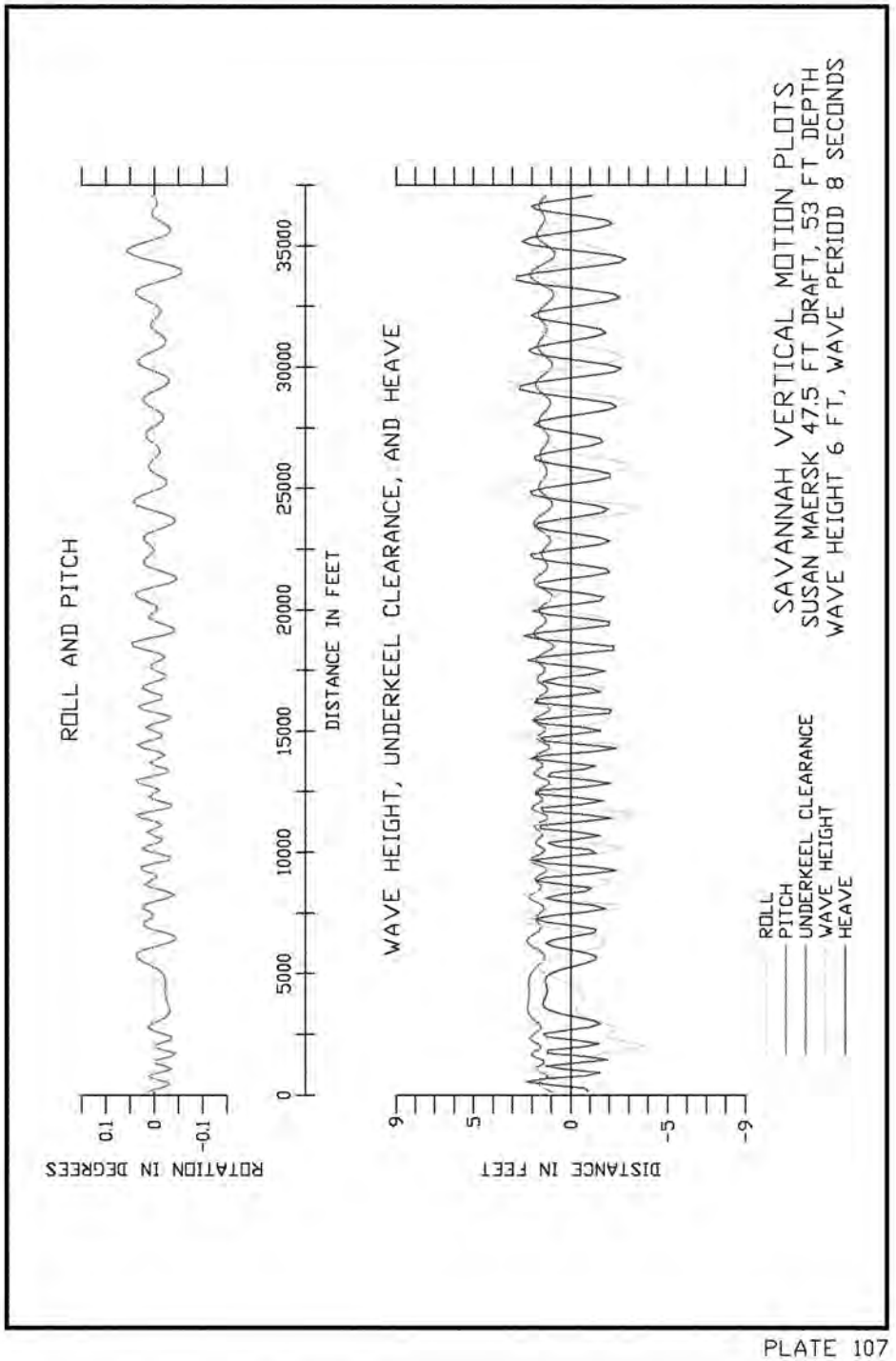

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 47.5 FT DRAFT, 53 FT DEPTH
WAVE HEIGHT 6 FT, WAVE PERIOD 8 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
DISTANCE IN FEET
0
5000
10000
15000
20000
25000
30000
35000

PLATE 107

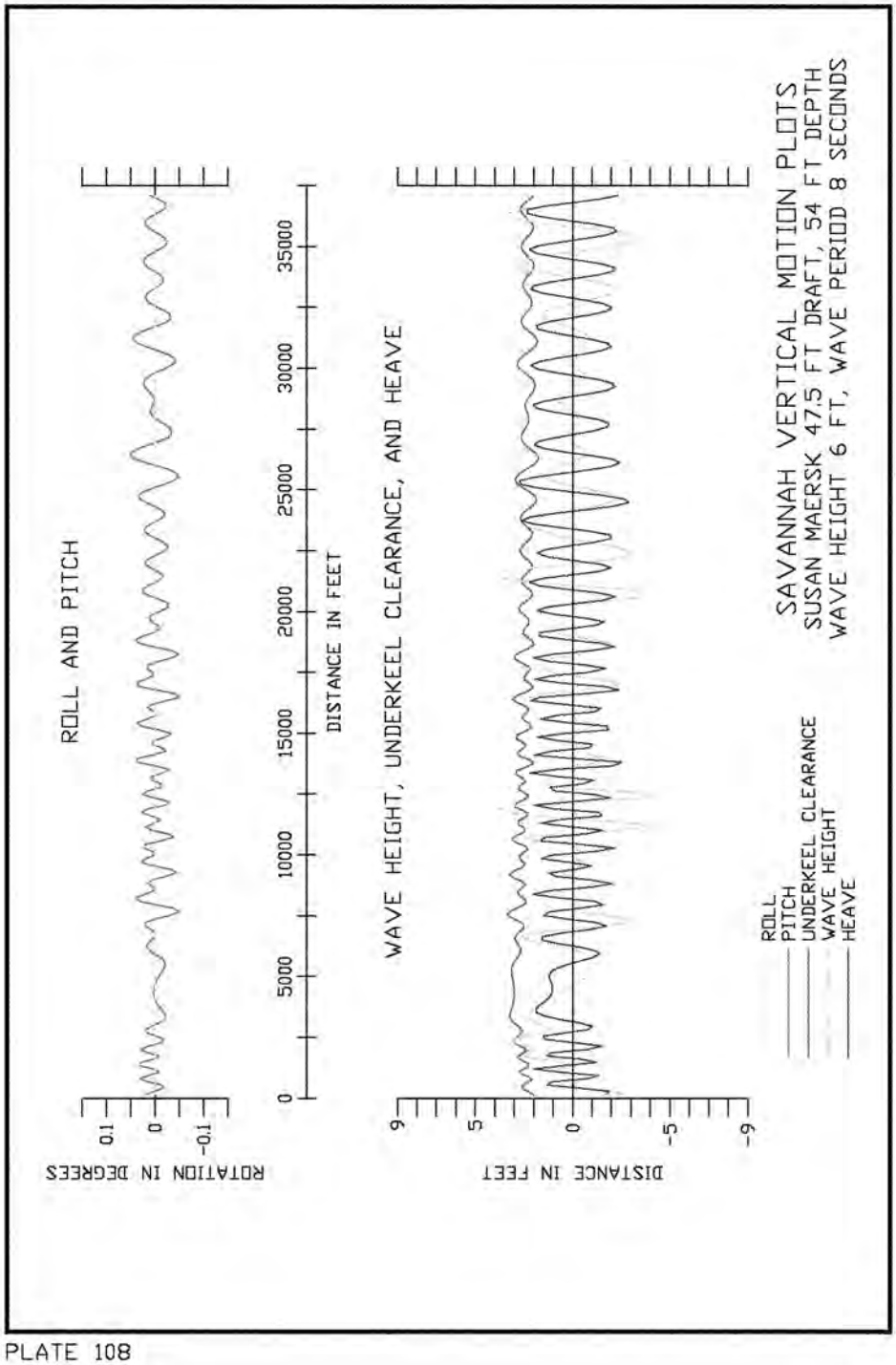

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 47.5 FT DRAFT, 54 FT DEPTH
WAVE HEIGHT 6 FT, WAVE PERIOD 8 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
DISTANCE IN FEET
0
5000
10000
15000
20000
25000
30000
35000

PLATE 108

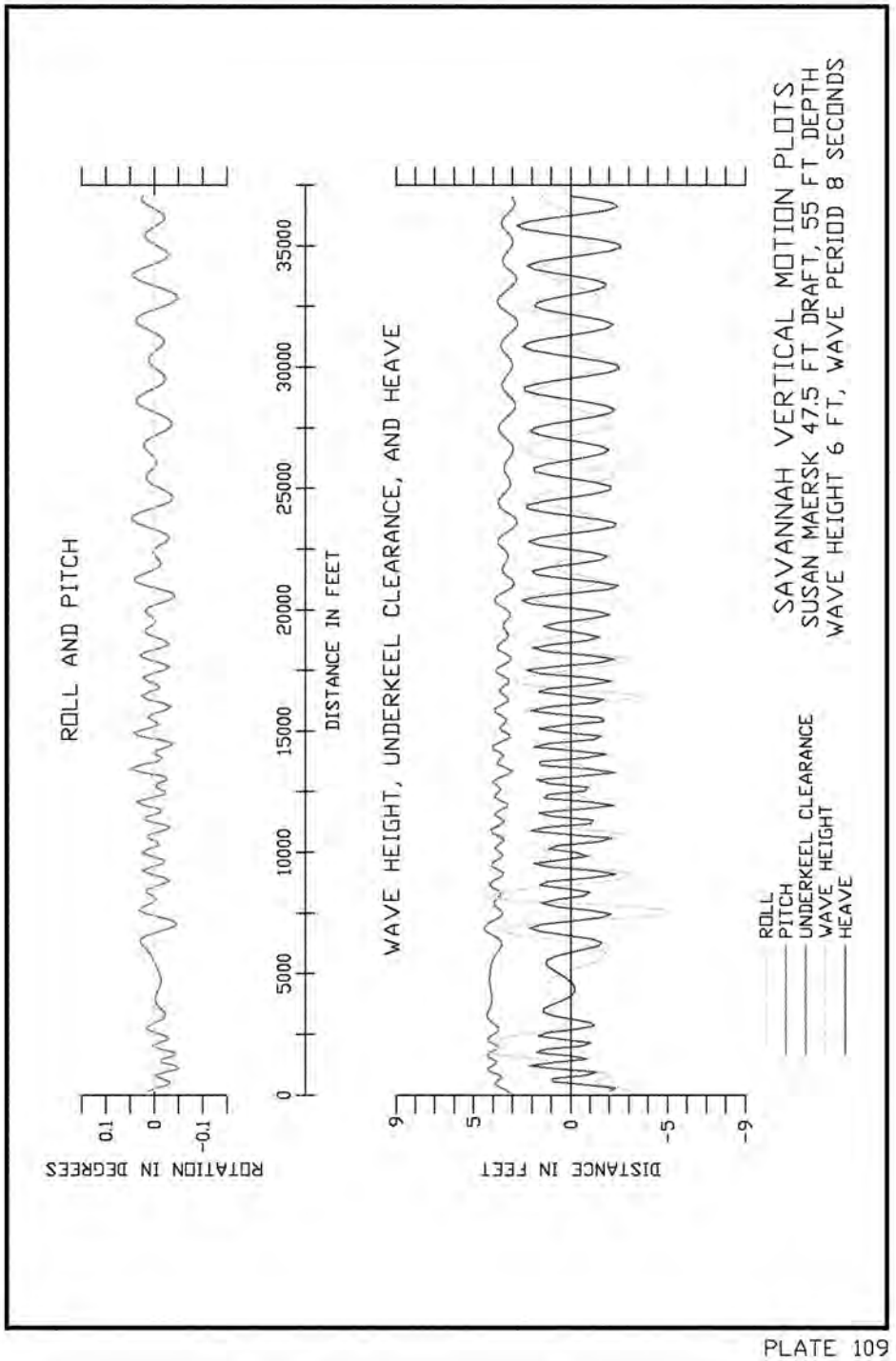

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 47.5 FT DRAFT, 55 FT DEPTH
WAVE HEIGHT 6 FT, WAVE PERIOD 8 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
0
5000
10000
15000
20000
25000
30000
35000
DISTANCE IN FEET

PLATE 109

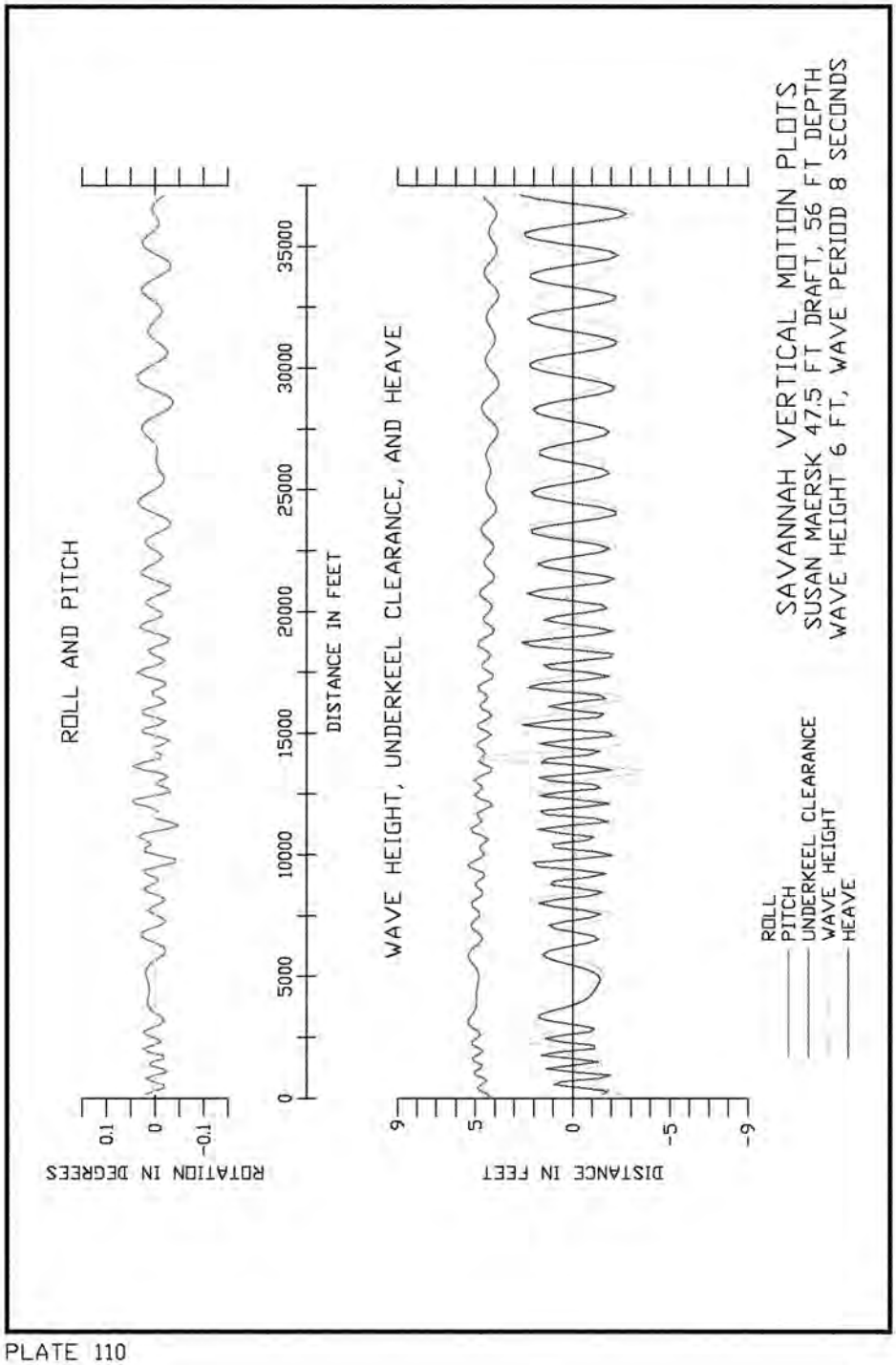

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 47.5 FT DRAFT, 56 FT DEPTH
WAVE HEIGHT 6 FT, WAVE PERIOD 8 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
0
5000
10000
15000
20000
25000
30000
35000
DISTANCE IN FEET

PLATE 110

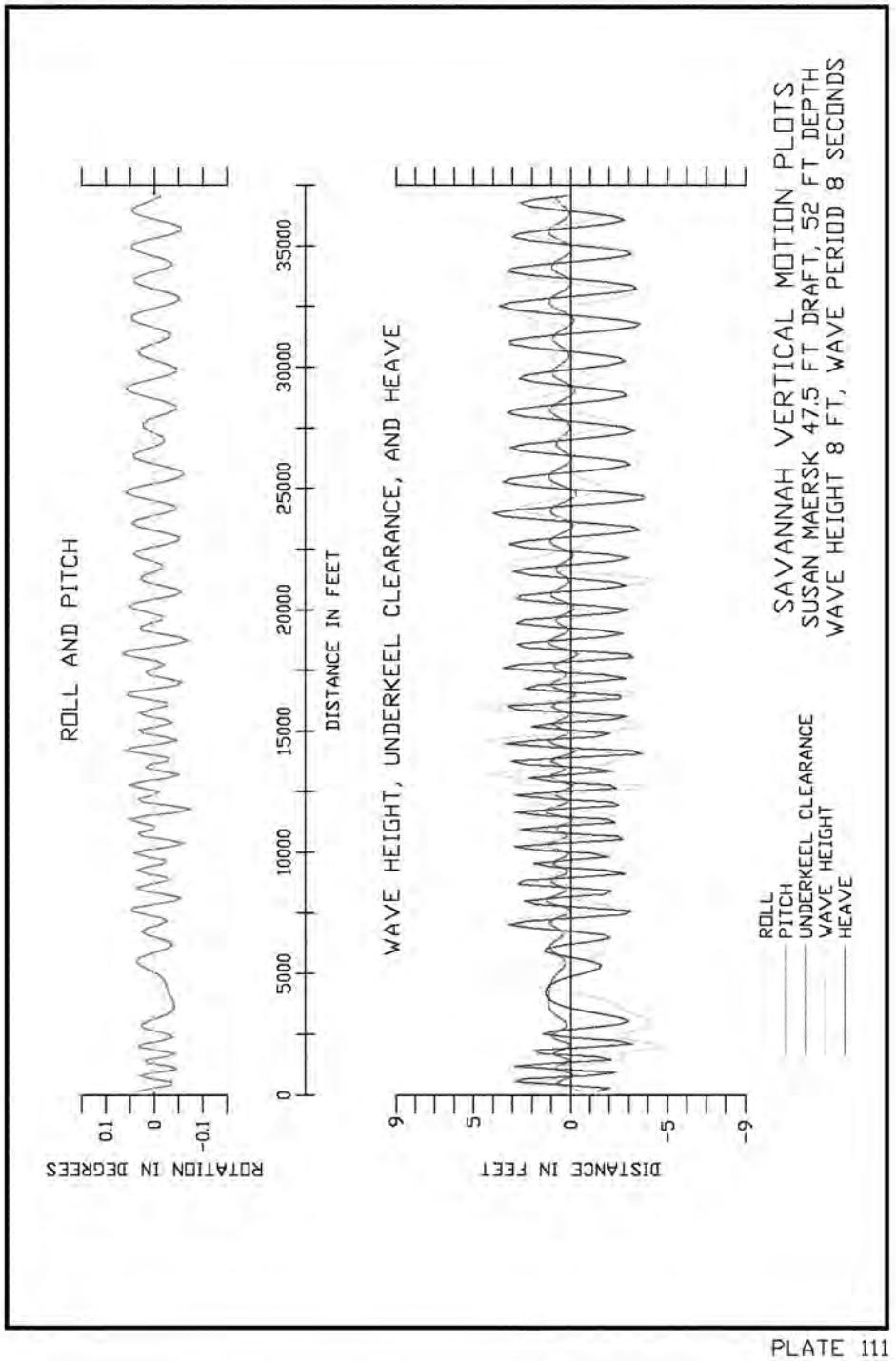

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 47.5 FT DRAFT, 52 FT DEPTH
WAVE HEIGHT 8 FT, WAVE PERIOD 8 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
0
5000
10000
15000
20000
25000
30000
35000
DISTANCE IN FEET

PLATE 111

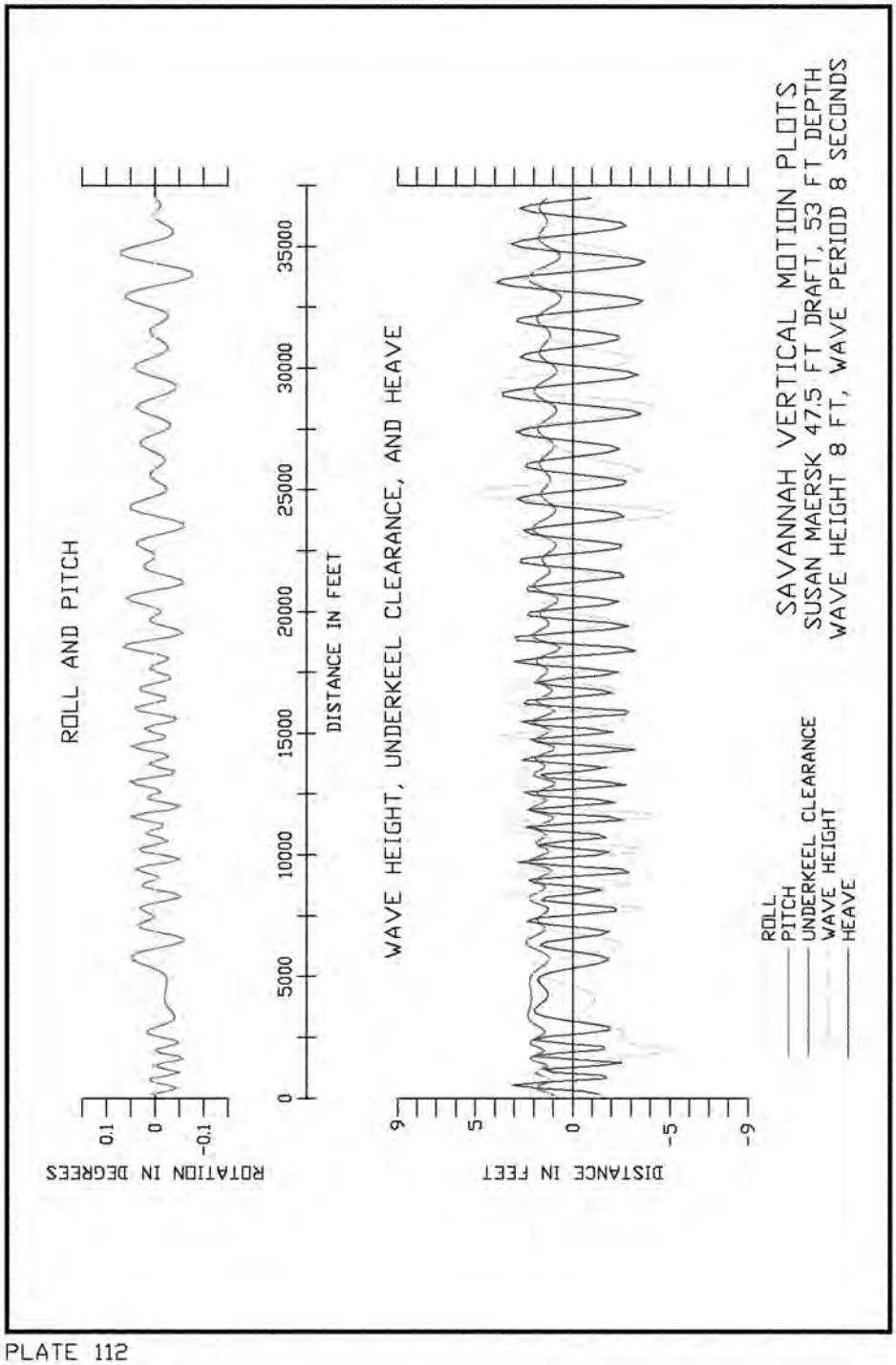

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 47.5 FT DRAFT, 53 FT DEPTH
WAVE HEIGHT 8 FT, WAVE PERIOD 8 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
0
5000
10000
15000
20000
25000
30000
35000
DISTANCE IN FEET

PLATE 112

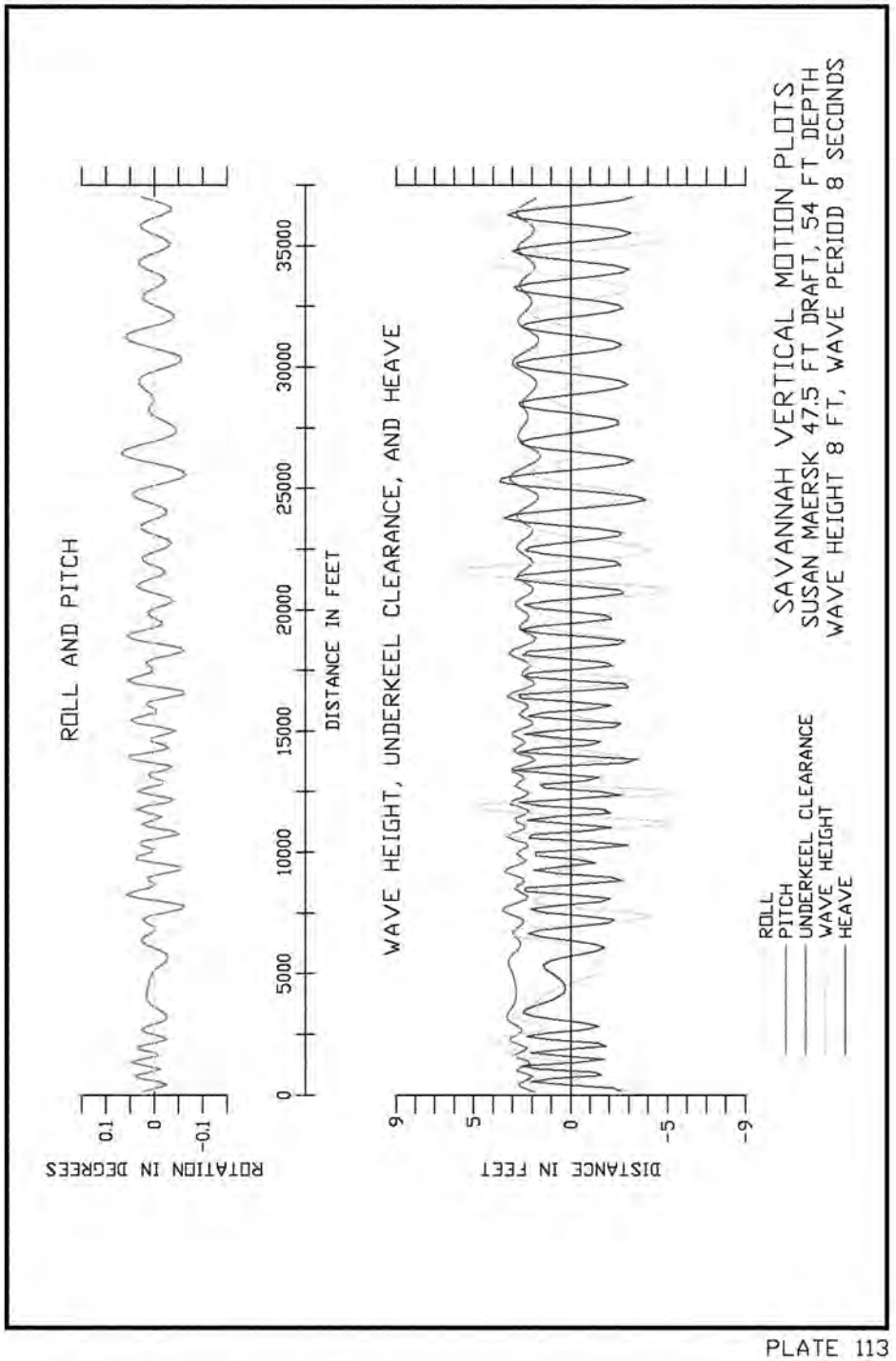

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 47.5 FT DRAFT, 54 FT DEPTH
WAVE HEIGHT 8 FT, WAVE PERIOD 8 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
DISTANCE IN FEET
0
5000
10000
15000
20000
25000
30000
35000

PLATE 113

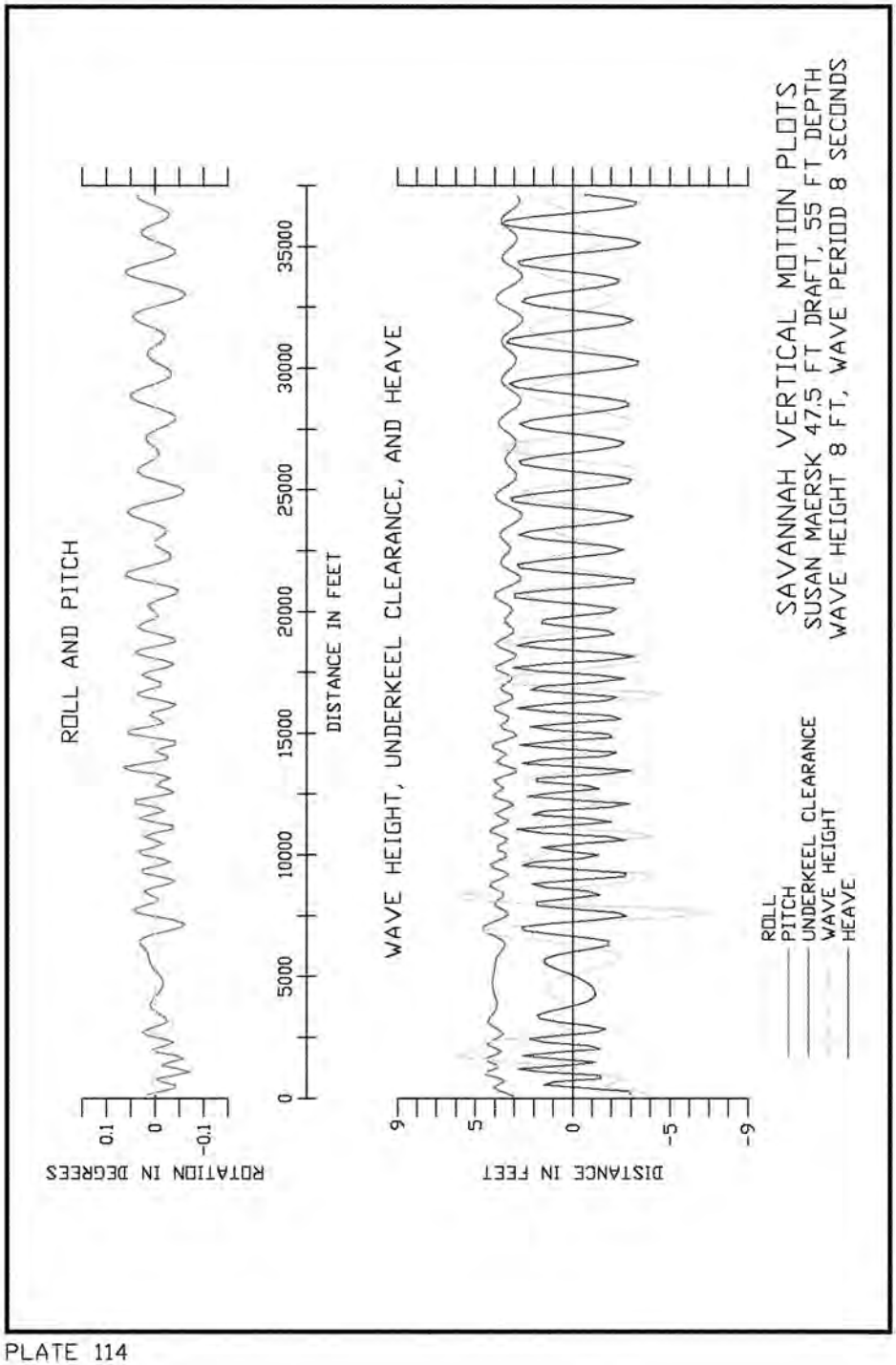

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 47.5 FT DRAFT, 55 FT DEPTH
WAVE HEIGHT 8 FT, WAVE PERIOD 8 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
0
5000
10000
15000
20000
25000
30000
35000
DISTANCE IN FEET

PLATE 114

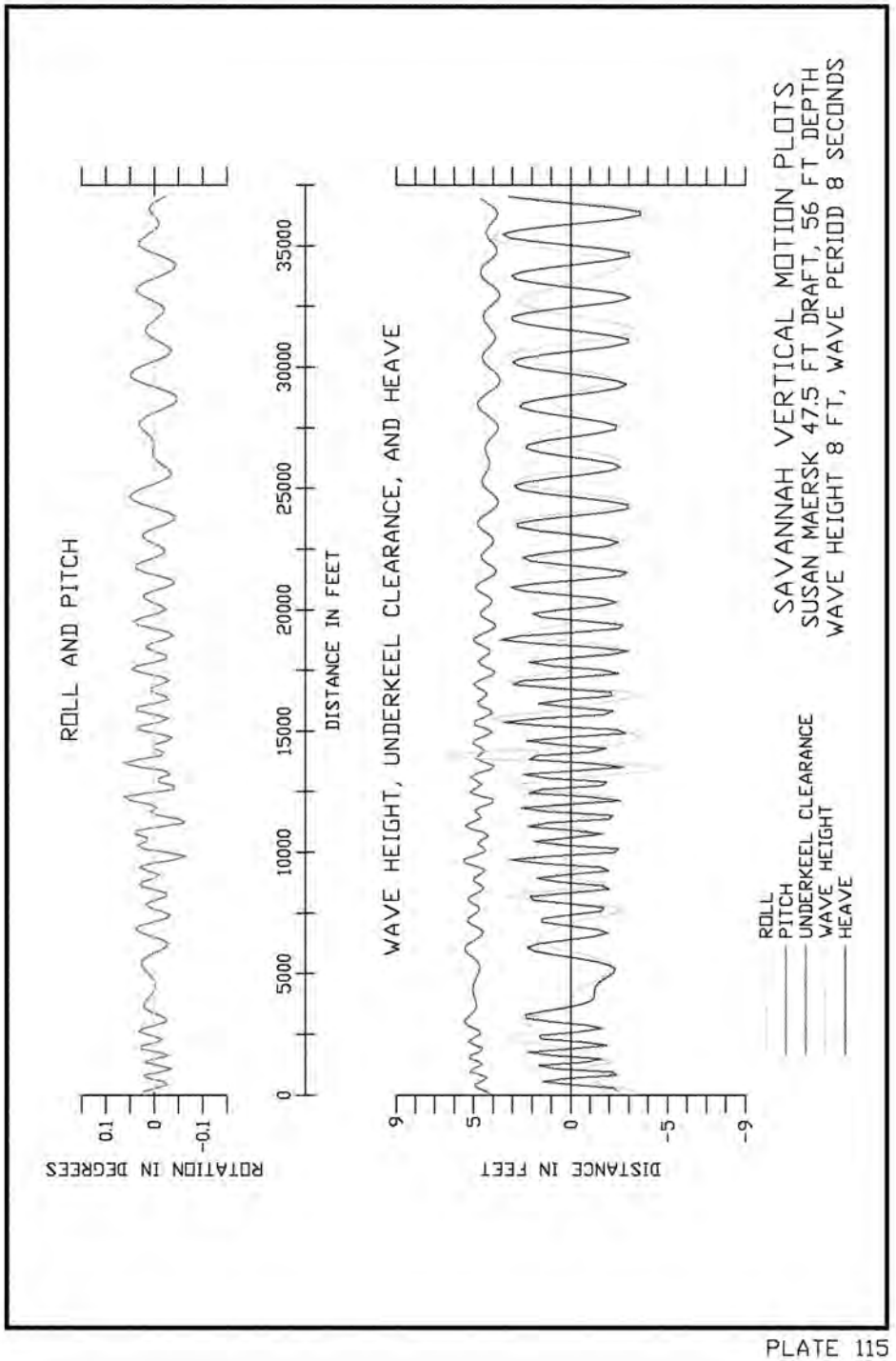

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 47.5 FT DRAFT, 56 FT DEPTH
WAVE HEIGHT 8 FT, WAVE PERIOD 8 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
0
5000
10000
15000
20000
25000
30000
35000
DISTANCE IN FEET

PLATE 115

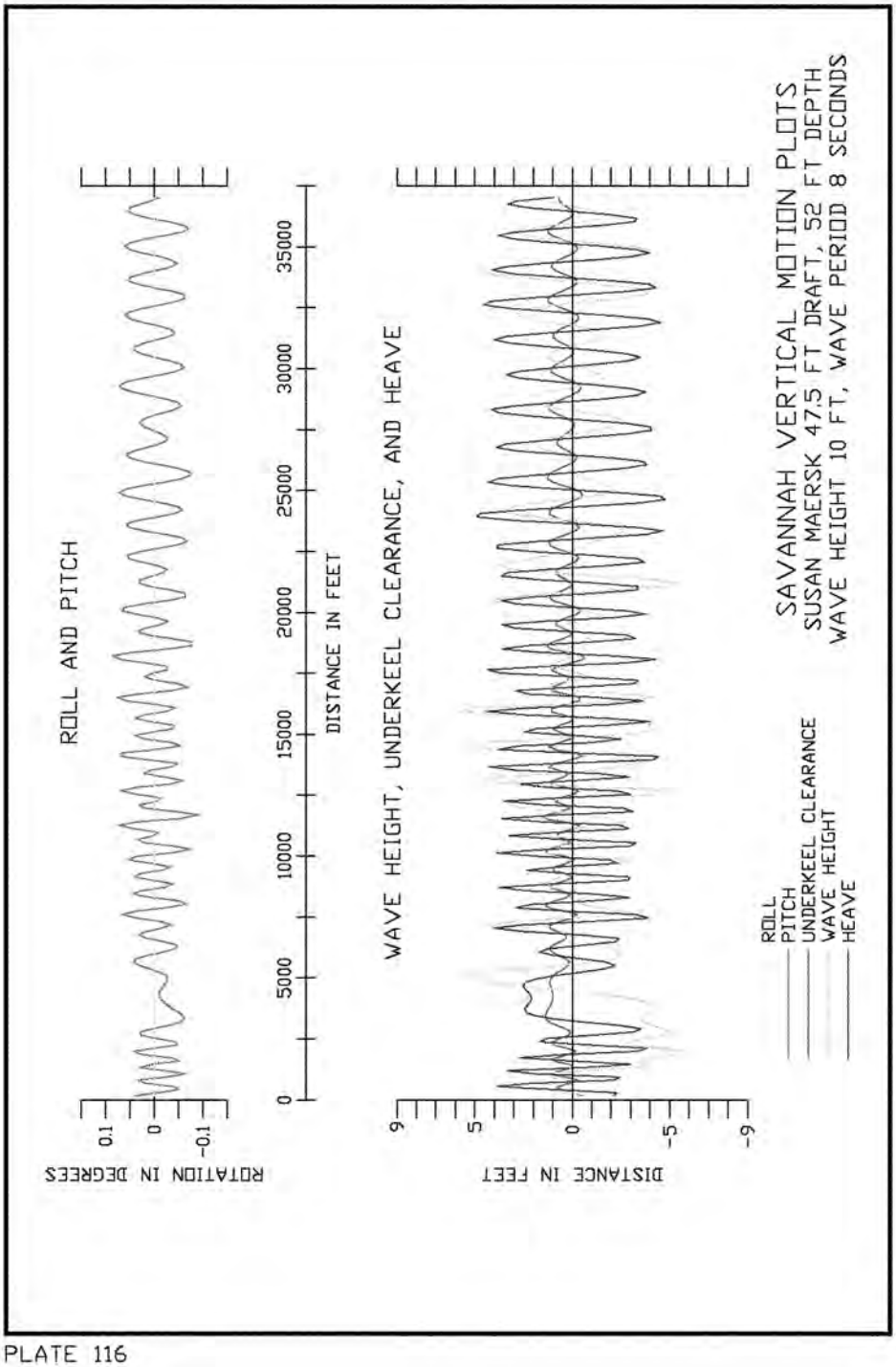

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 47.5 FT DRAFT, 52 FT DEPTH
WAVE HEIGHT 10 FT, WAVE PERIOD 8 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
0
5000
10000
15000
20000
25000
30000
35000
DISTANCE IN FEET

PLATE 116

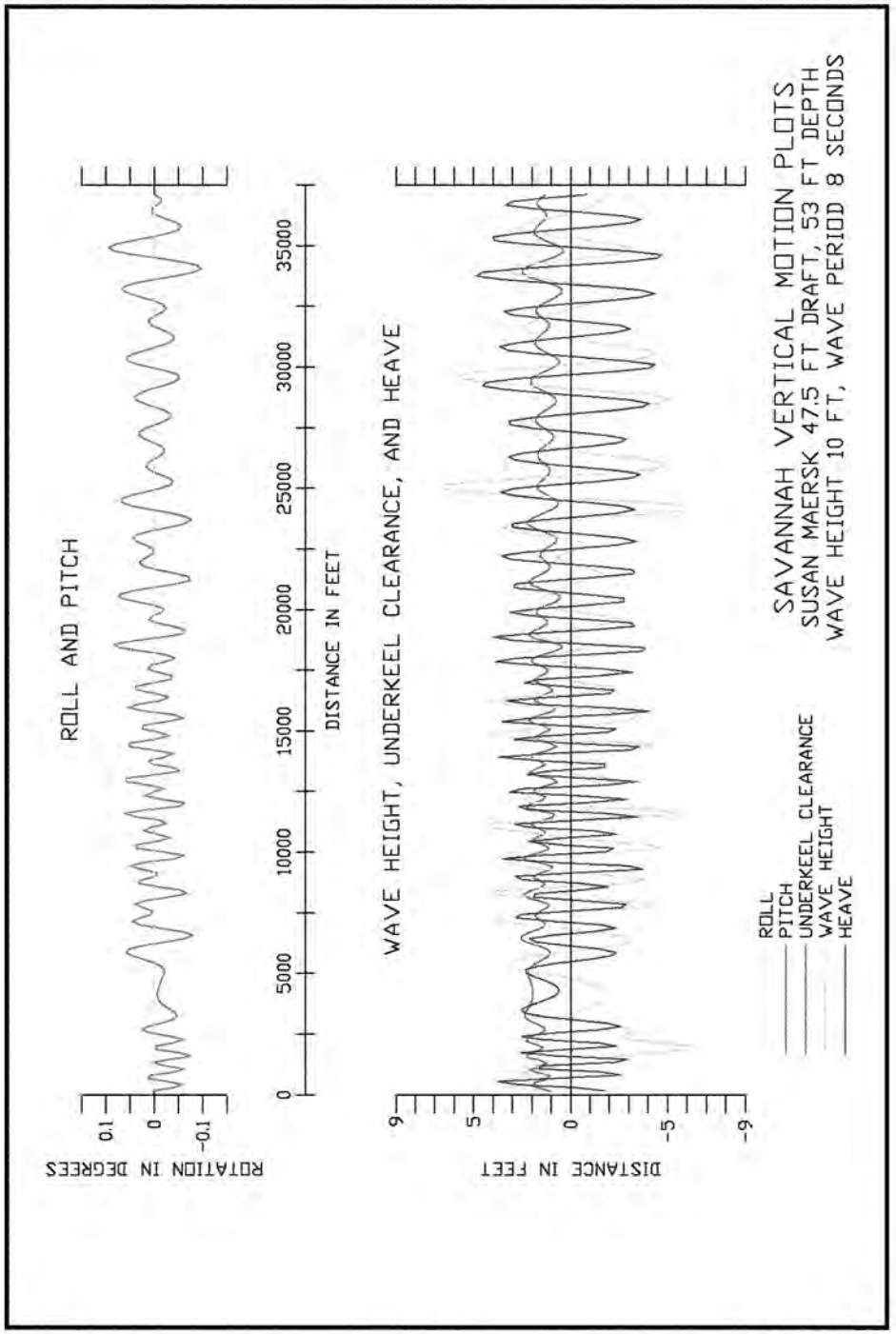

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 47.5 FT DRAFT, 53 FT DEPTH
WAVE HEIGHT 10 FT, WAVE PERIOD 8 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
0
5000
10000
15000
20000
25000
30000
35000
DISTANCE IN FEET

PLATE 117

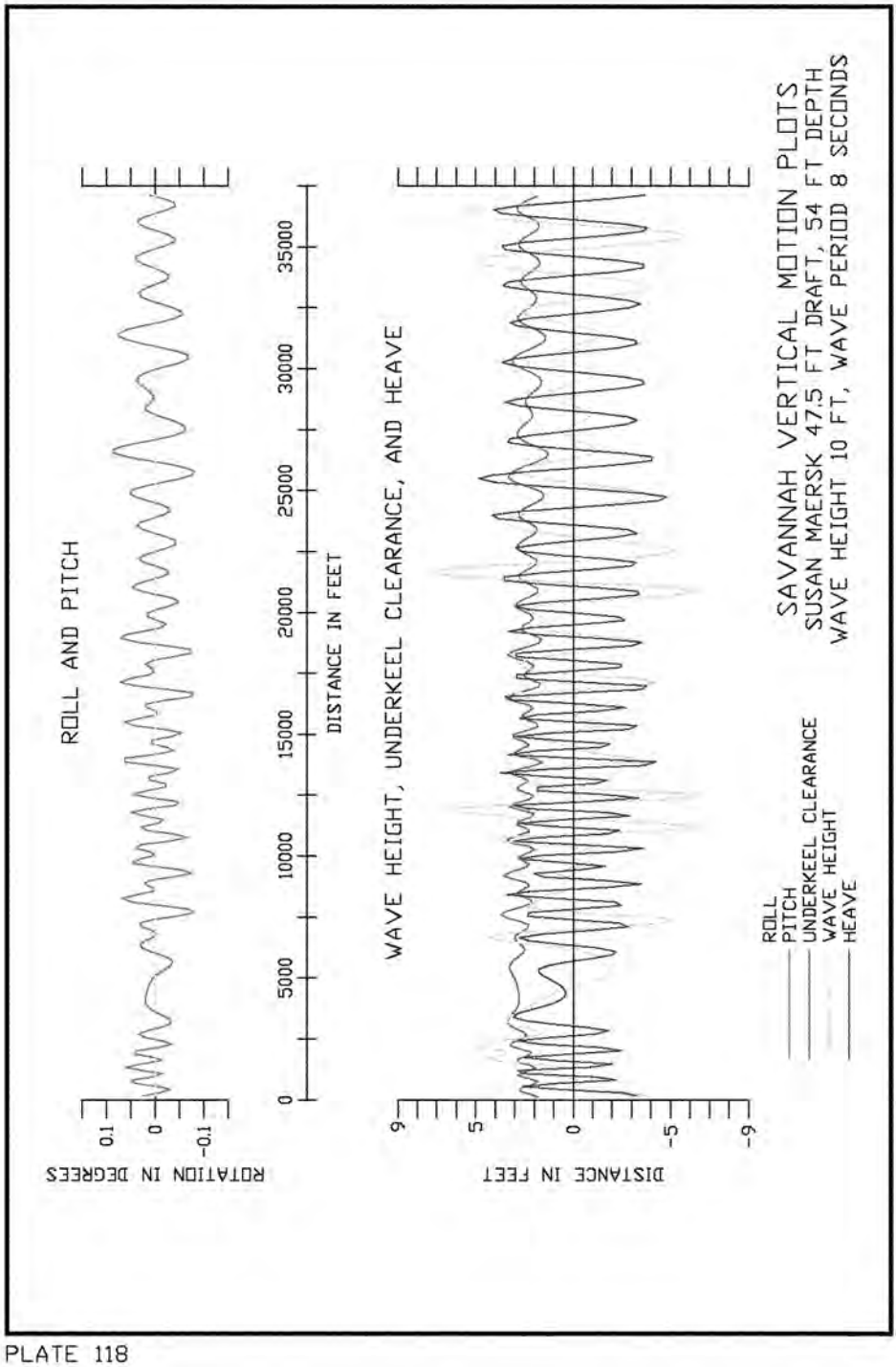

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 47.5 FT DRAFT, 54 FT DEPTH
WAVE HEIGHT 10 FT, WAVE PERIOD 8 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
0
5000
10000
15000
20000
25000
30000
35000
DISTANCE IN FEET

PLATE 118

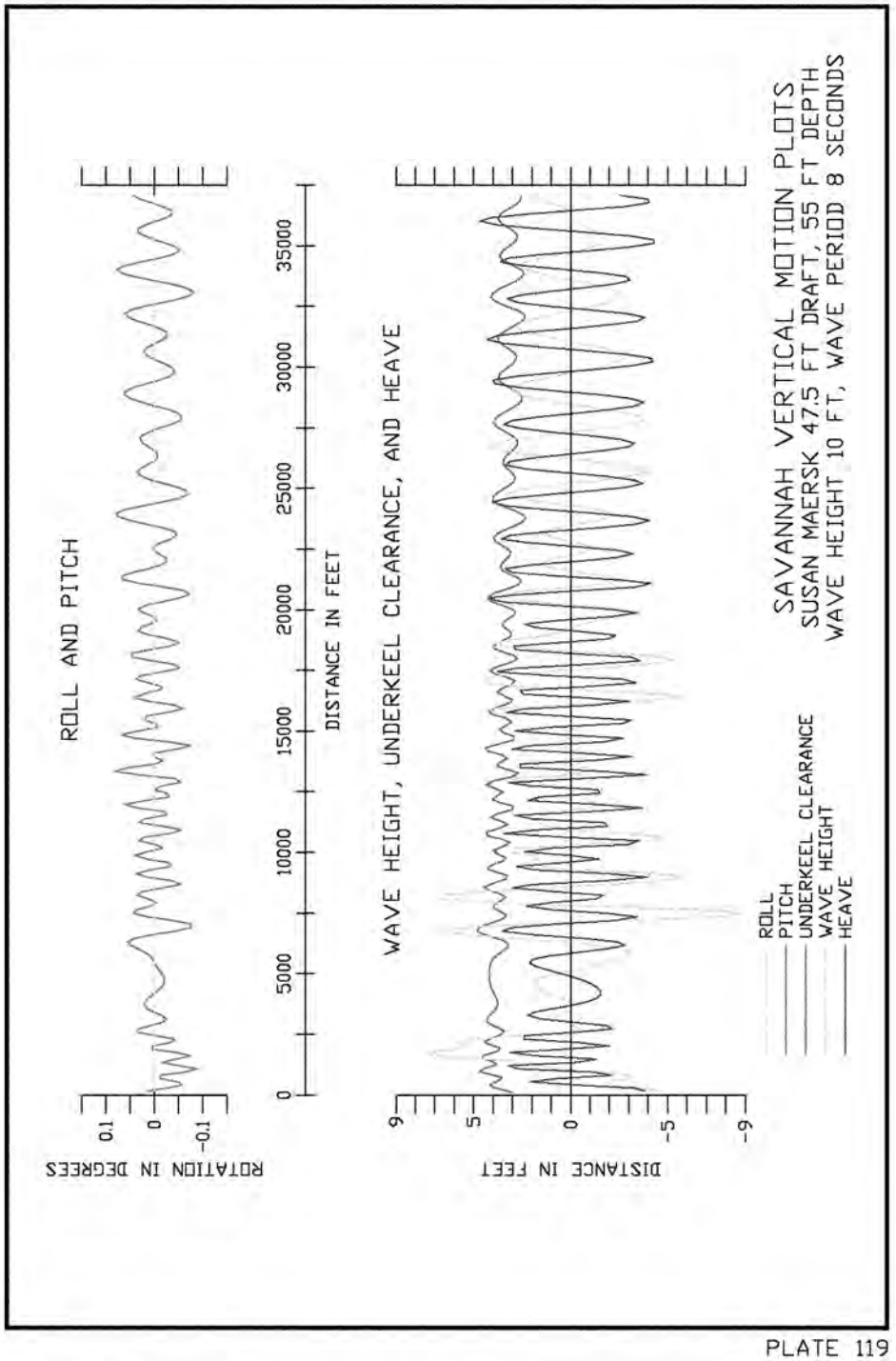

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 47.5 FT DRAFT, 55 FT DEPTH
WAVE HEIGHT 10 FT, WAVE PERIOD 8 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
0
5000
10000
15000
20000
25000
30000
35000
DISTANCE IN FEET

PLATE 119

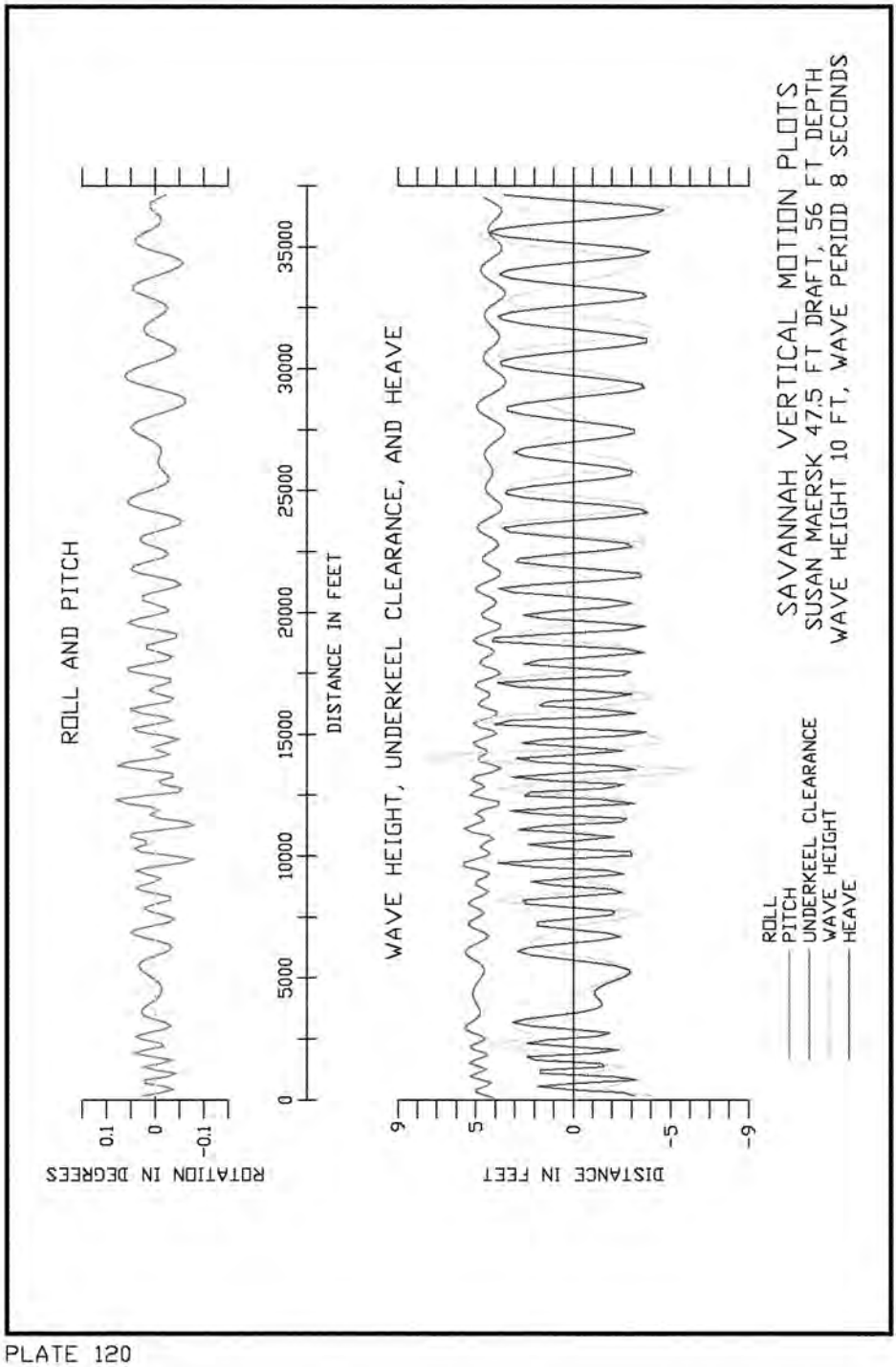

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 47.5 FT DRAFT, 56 FT DEPTH
WAVE HEIGHT 10 FT, WAVE PERIOD 8 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
0
5000
10000
15000
20000
25000
30000
35000
DISTANCE IN FEET

PLATE 120

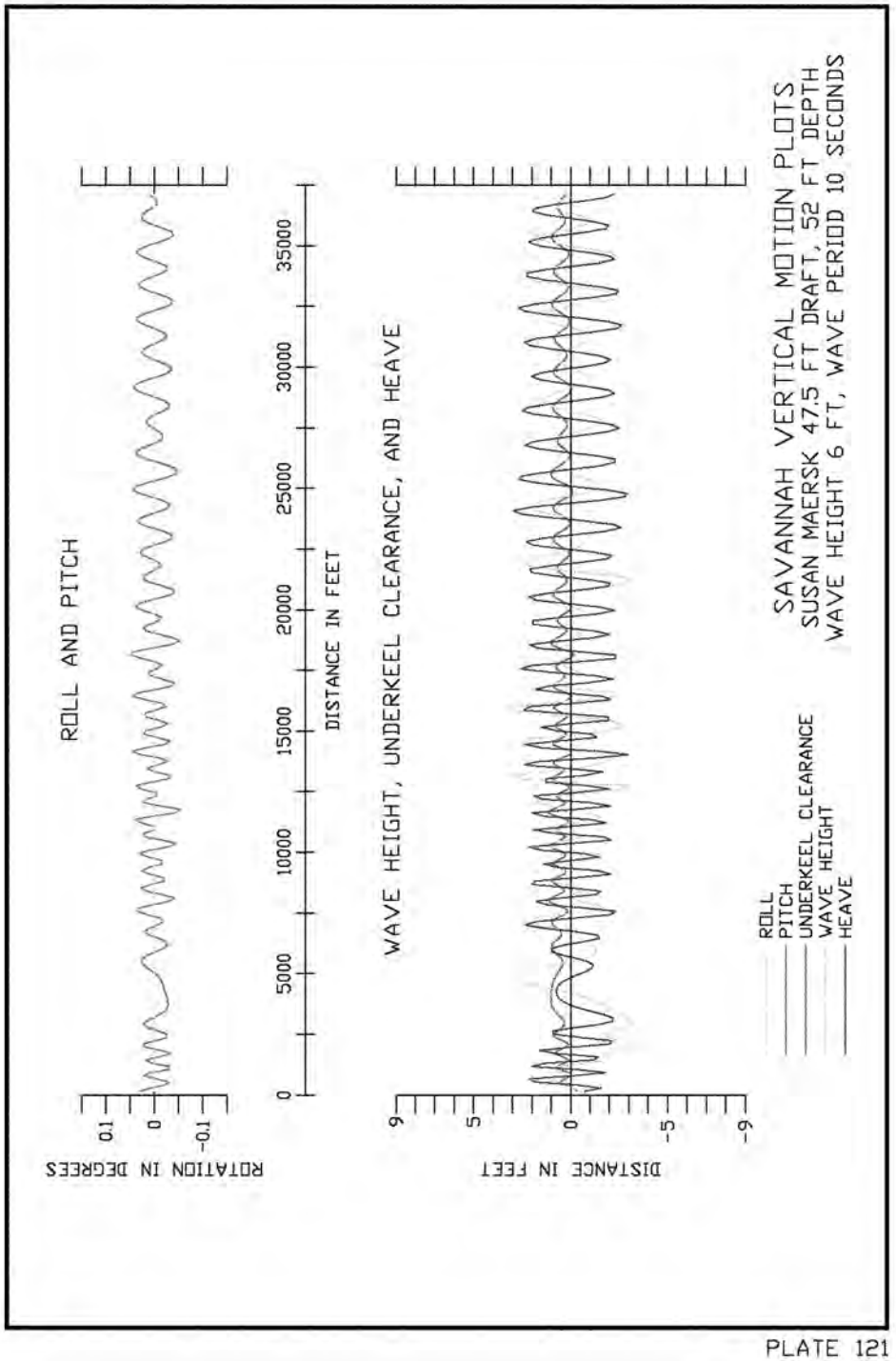

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 47.5 FT DRAFT, 52 FT DEPTH
WAVE HEIGHT 6 FT, WAVE PERIOD 10 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
DISTANCE IN FEET
0
5000
10000
15000
20000
25000
30000
35000

PLATE 121

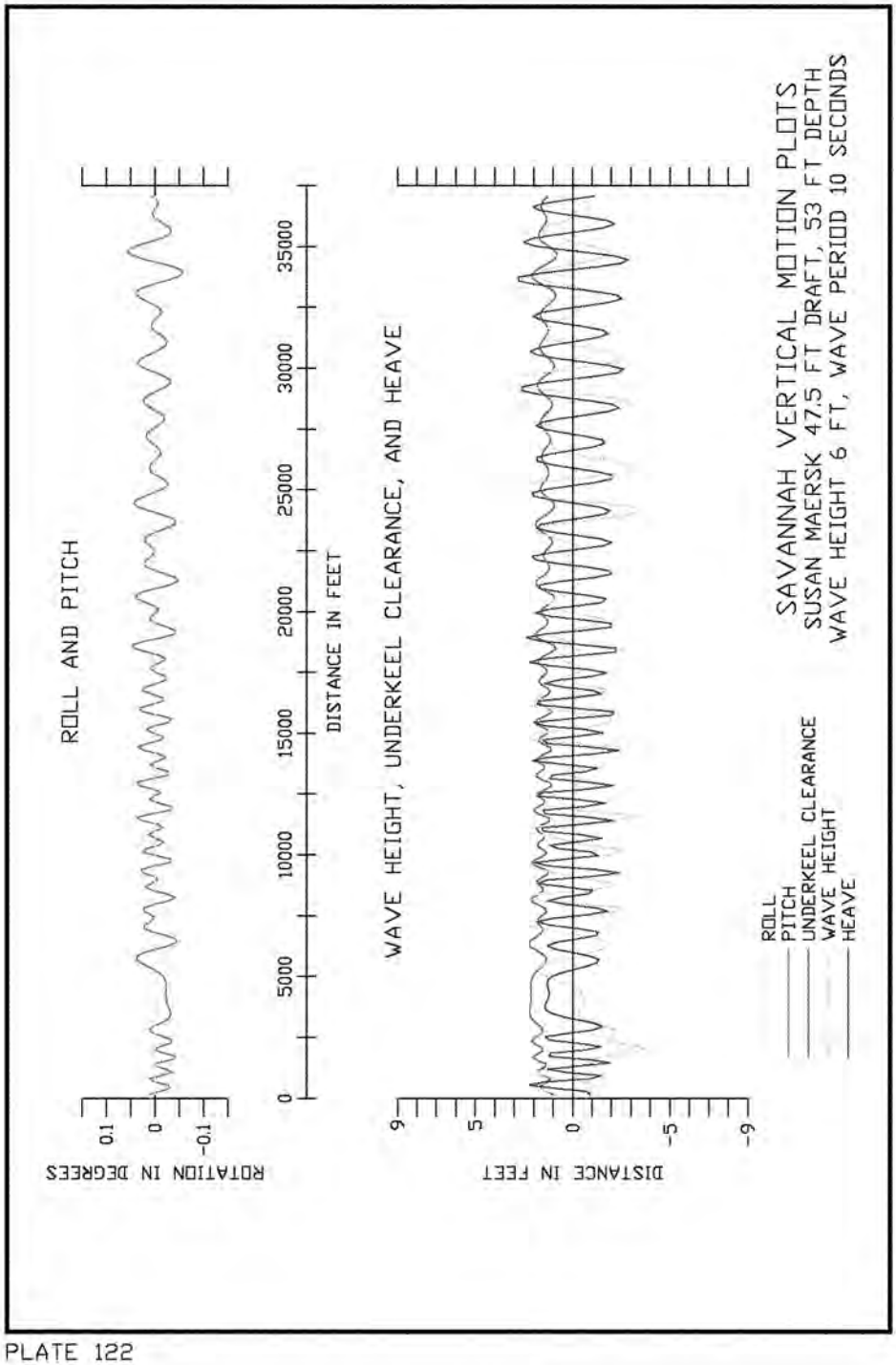

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 47.5 FT DRAFT, 53 FT DEPTH
WAVE HEIGHT 6 FT, WAVE PERIOD 10 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
DISTANCE IN FEET
0
5000
10000
15000
20000
25000
30000
35000

PLATE 122

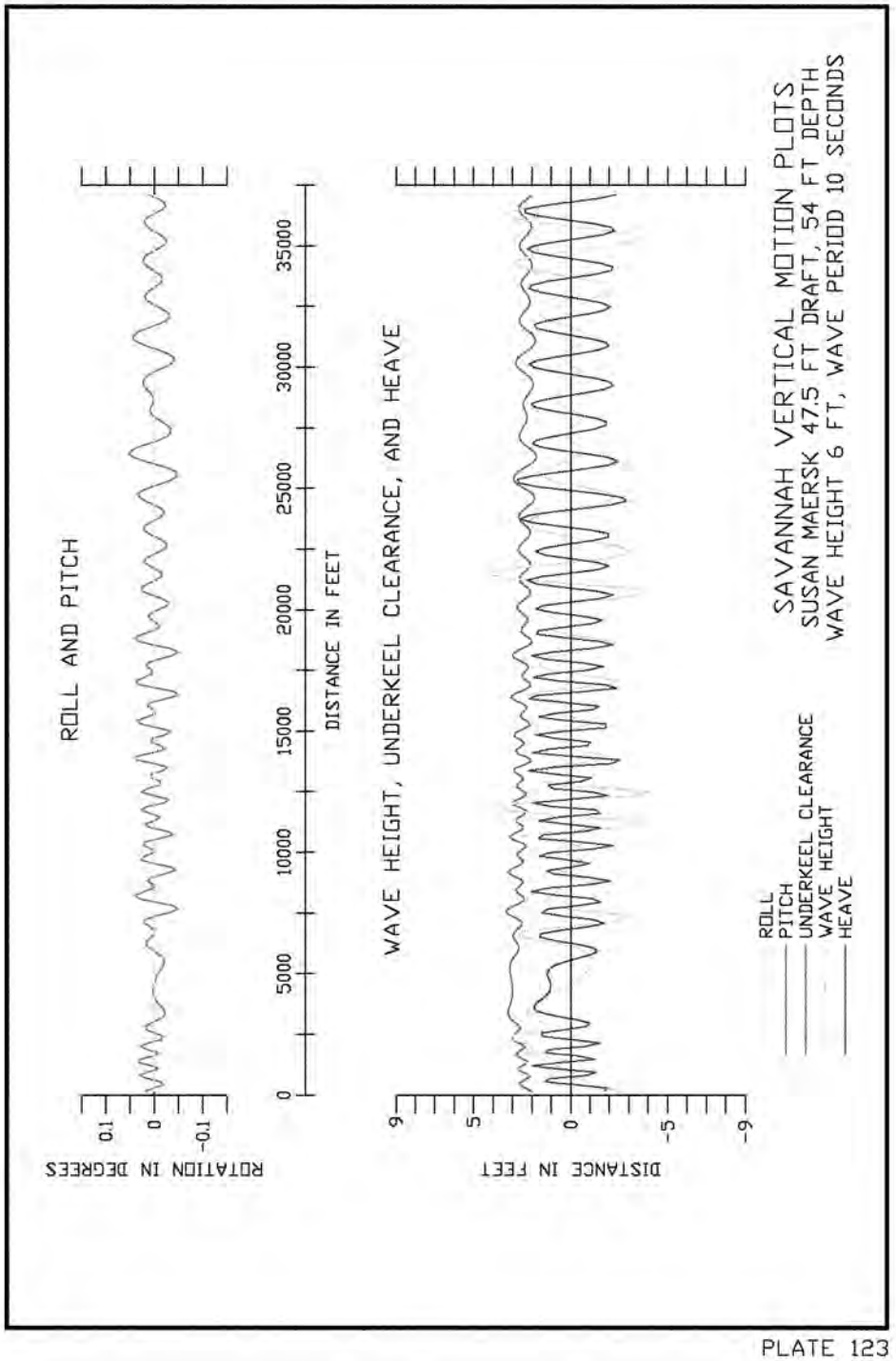

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 47.5 FT DRAFT, 54 FT DEPTH
WAVE HEIGHT 6 FT, WAVE PERIOD 10 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
DISTANCE IN FEET
0
5000
10000
15000
20000
25000
30000
35000

PLATE 123

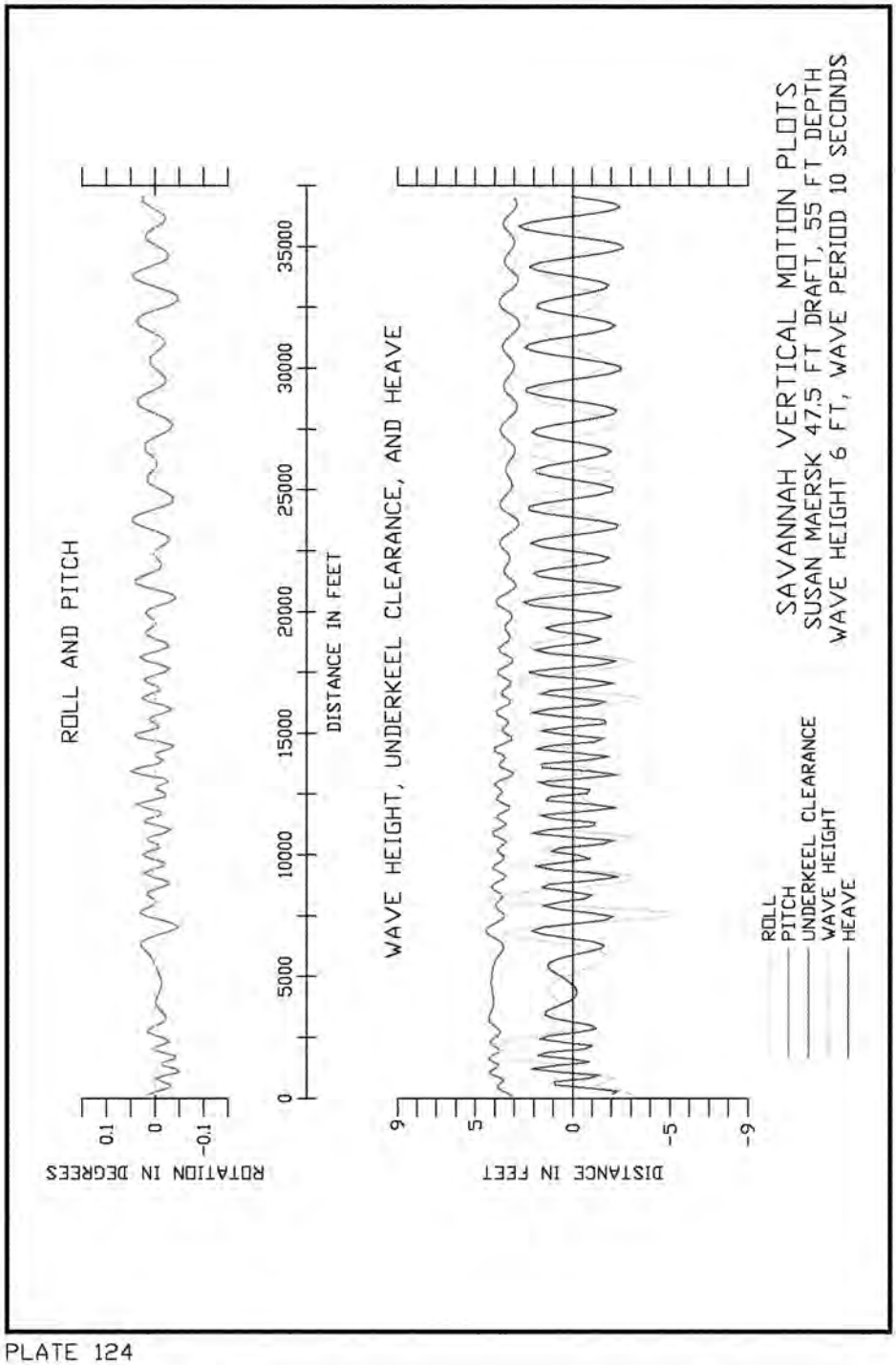

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 47.5 FT DRAFT, 55 FT DEPTH
WAVE HEIGHT 6 FT, WAVE PERIOD 10 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
0
5000
10000
15000
20000
25000
30000
35000
DISTANCE IN FEET

PLATE 124

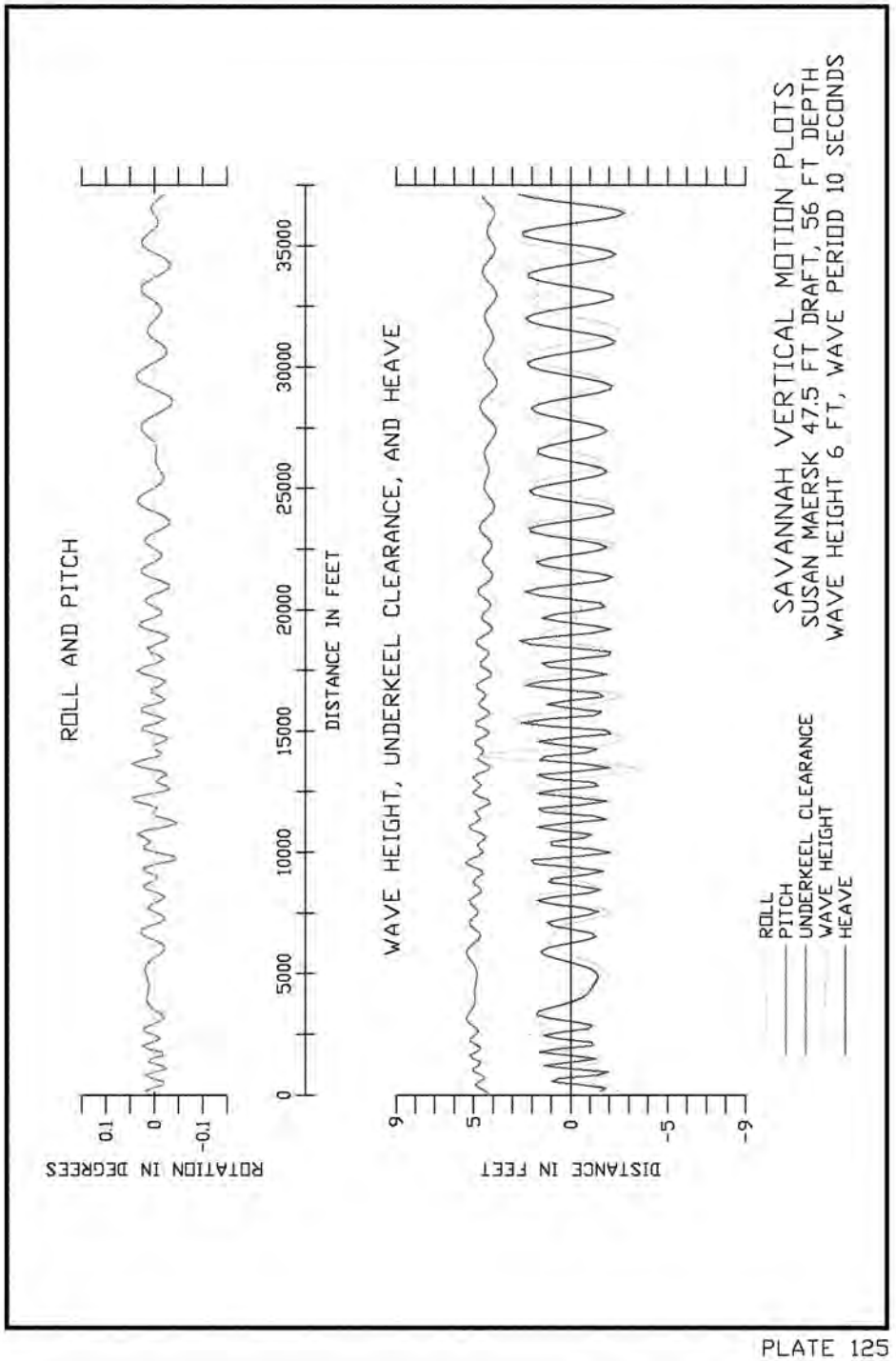

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 47.5 FT DRAFT, 56 FT DEPTH
WAVE HEIGHT 6 FT, WAVE PERIOD 10 SECONDS
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
0
5000
10000
15000
20000
25000
30000
35000
DISTANCE IN FEET
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE

PLATE 125

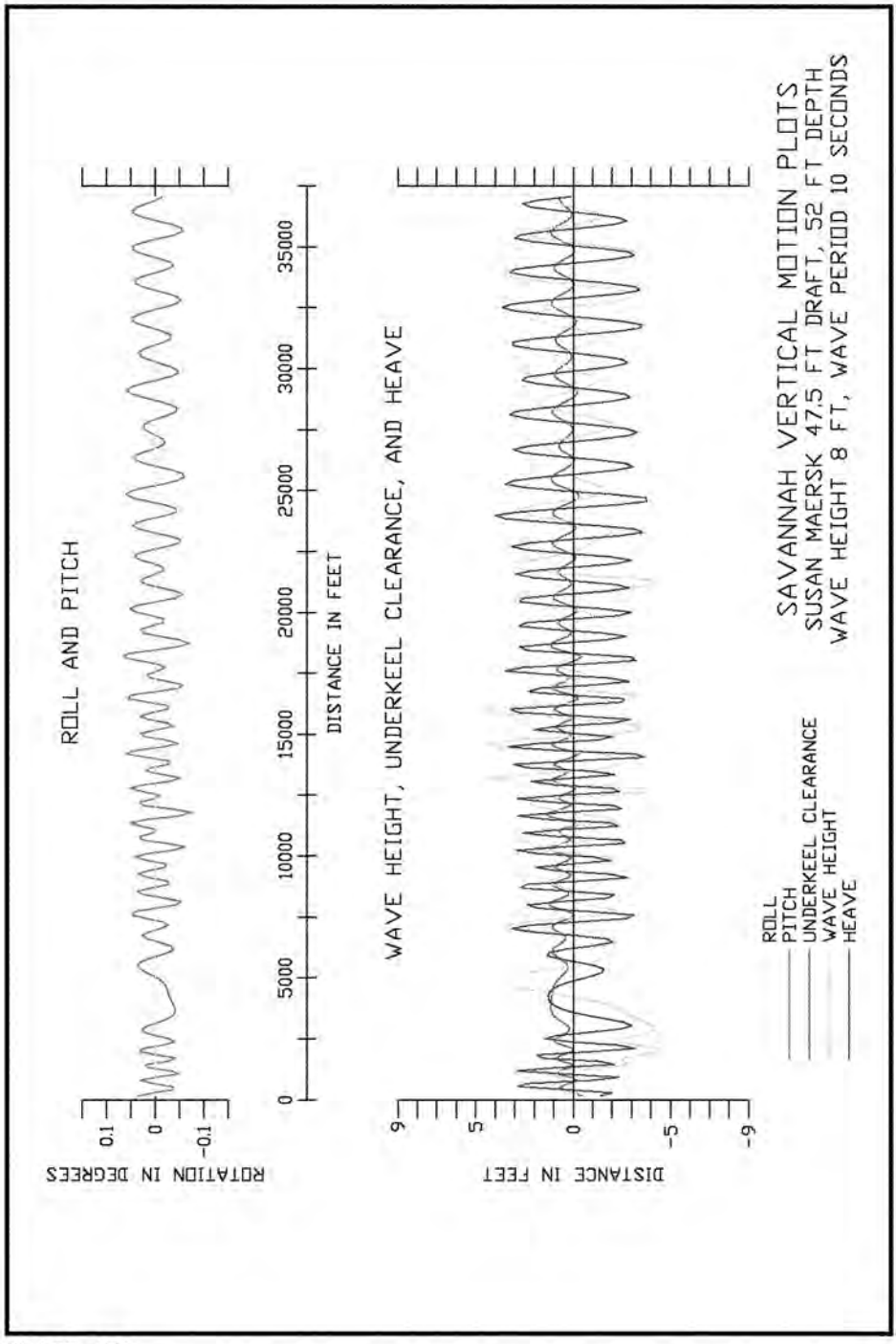

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 47.5 FT DRAFT, 52 FT DEPTH
WAVE HEIGHT 8 FT, WAVE PERIOD 10 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
0
5000
10000
15000
20000
25000
30000
35000
DISTANCE IN FEET

PLATE 126

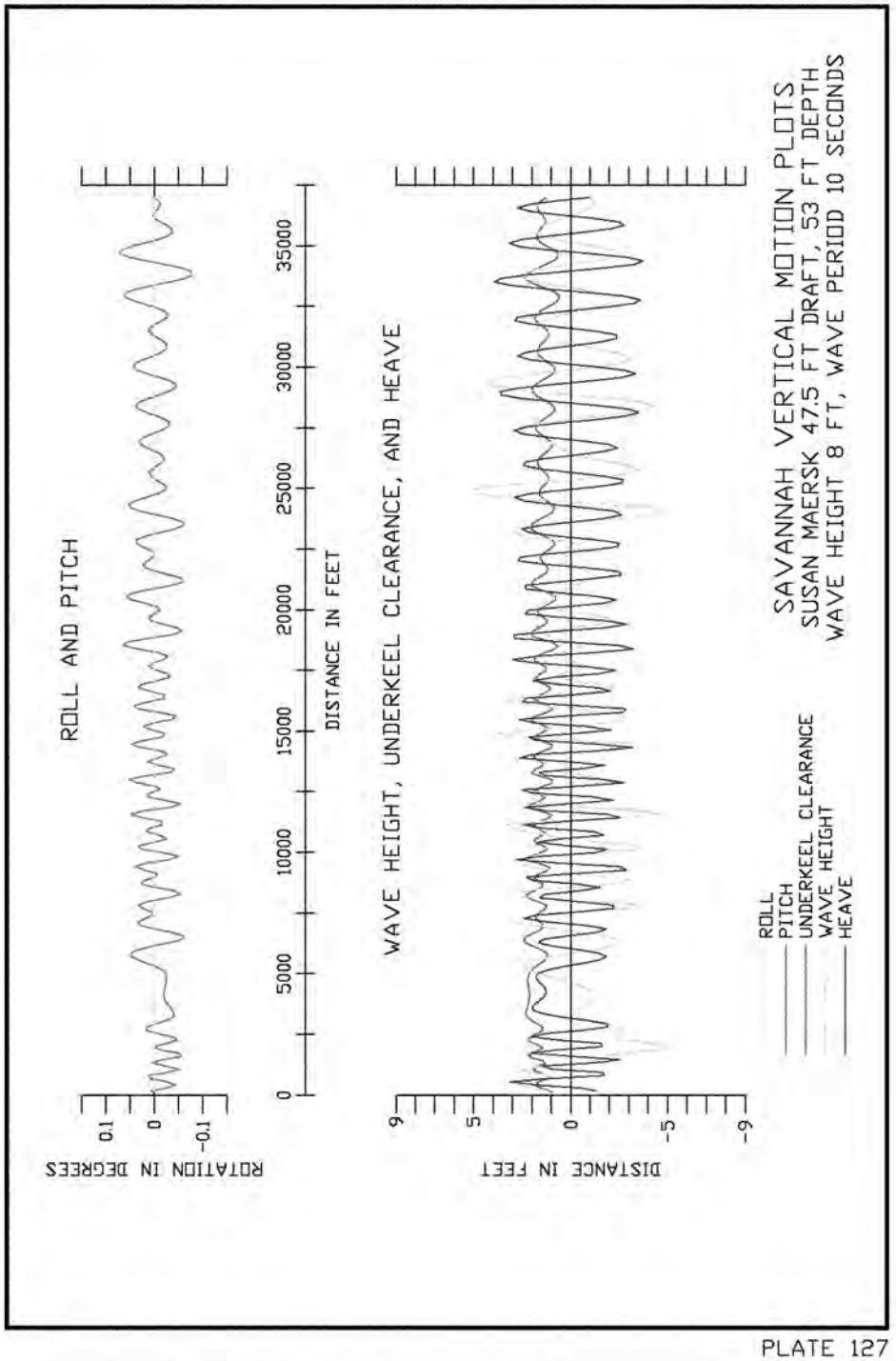

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 47.5 FT DRAFT, 53 FT DEPTH
WAVE HEIGHT 8 FT, WAVE PERIOD 10 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
0
5000
10000
15000
20000
25000
30000
35000
DISTANCE IN FEET

PLATE 127

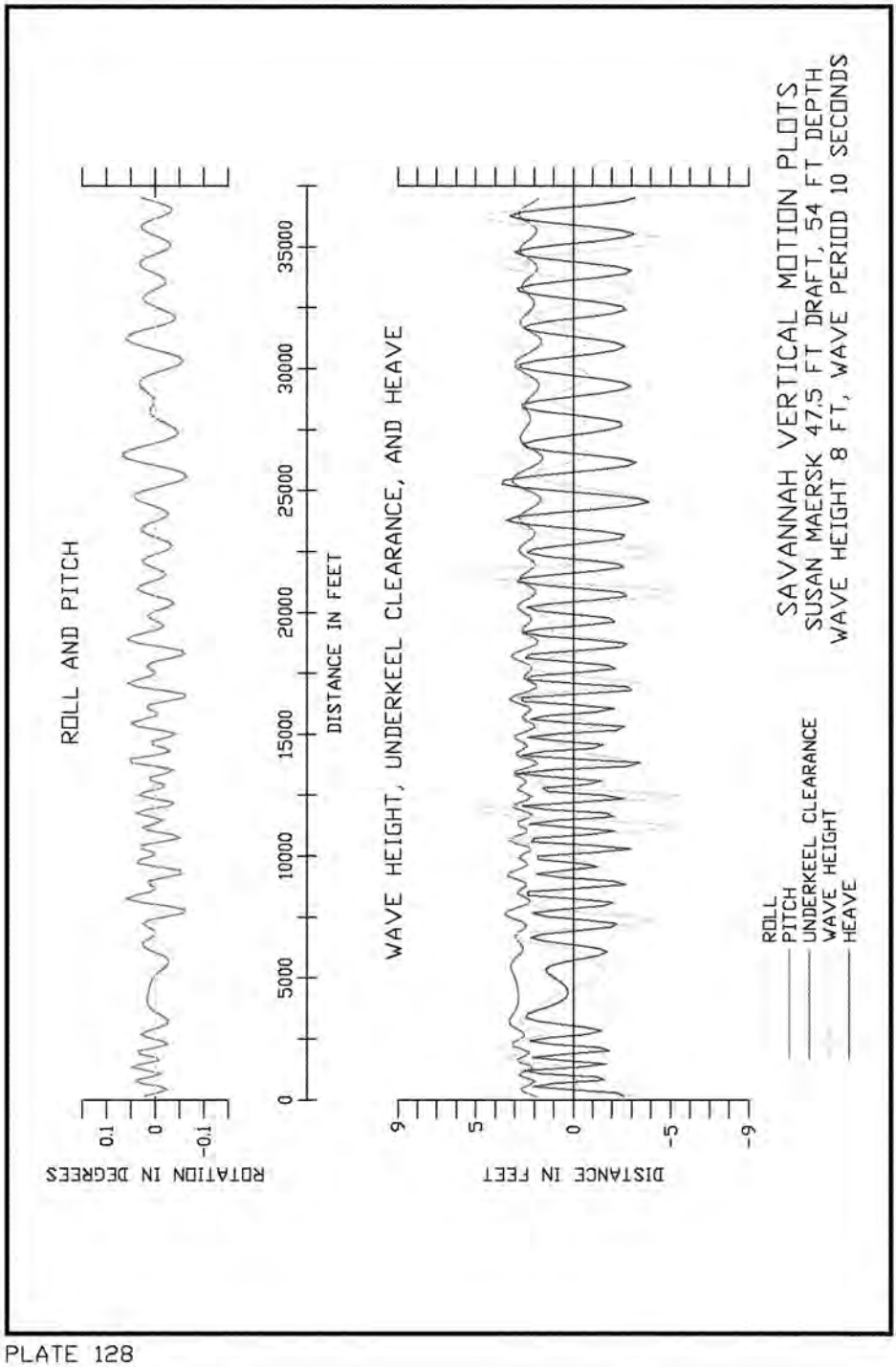

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 47.5 FT DRAFT, 54 FT DEPTH
WAVE HEIGHT 8 FT, WAVE PERIOD 10 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
DISTANCE IN FEET
0
5000
10000
15000
20000
25000
30000
35000
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1

PLATE 128

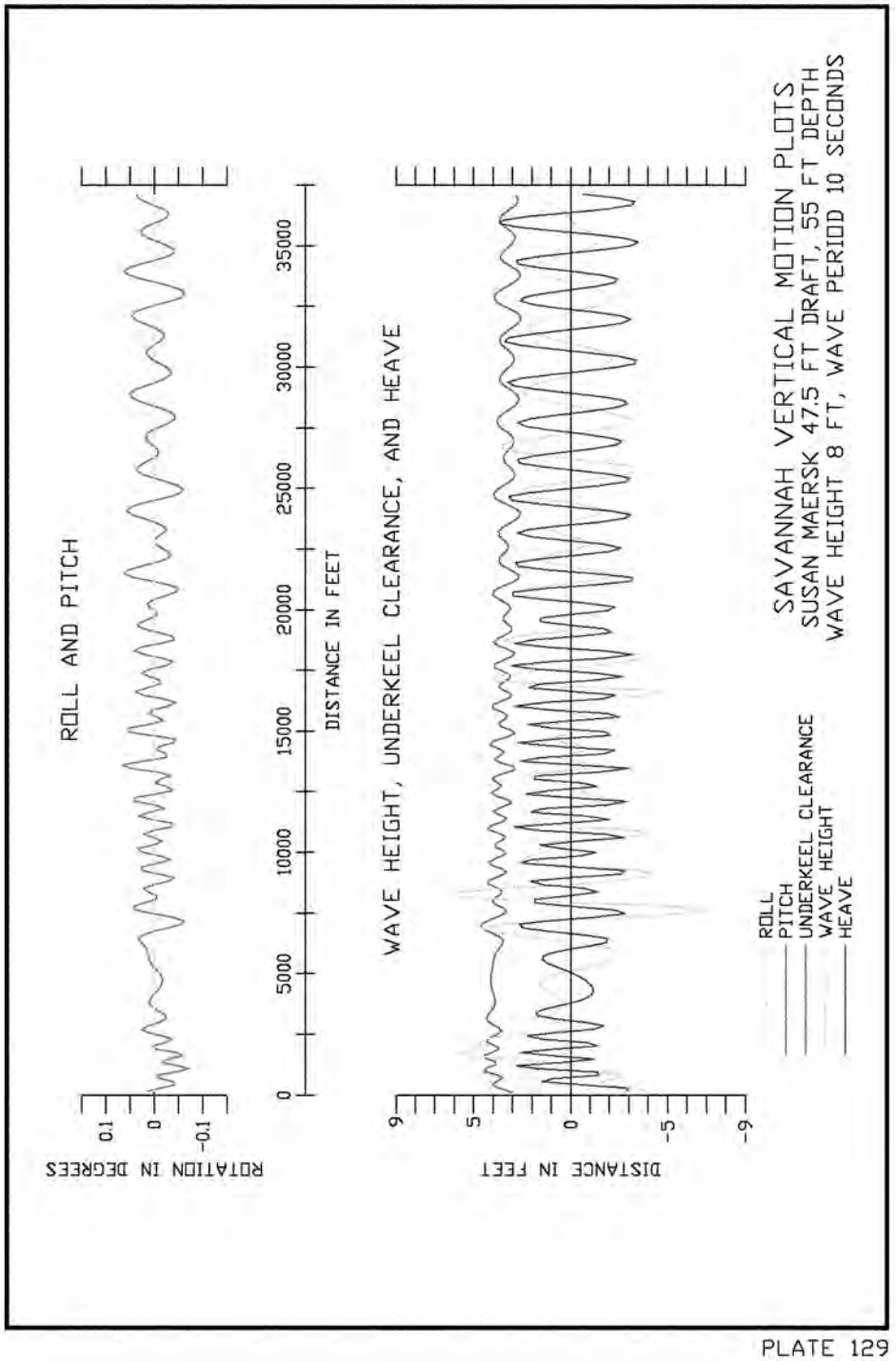

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 47.5 FT DRAFT, 55 FT DEPTH
WAVE HEIGHT 8 FT, WAVE PERIOD 10 SECONDS
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
0
5000
10000
15000
20000
25000
30000
35000
DISTANCE IN FEET
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE

PLATE 129

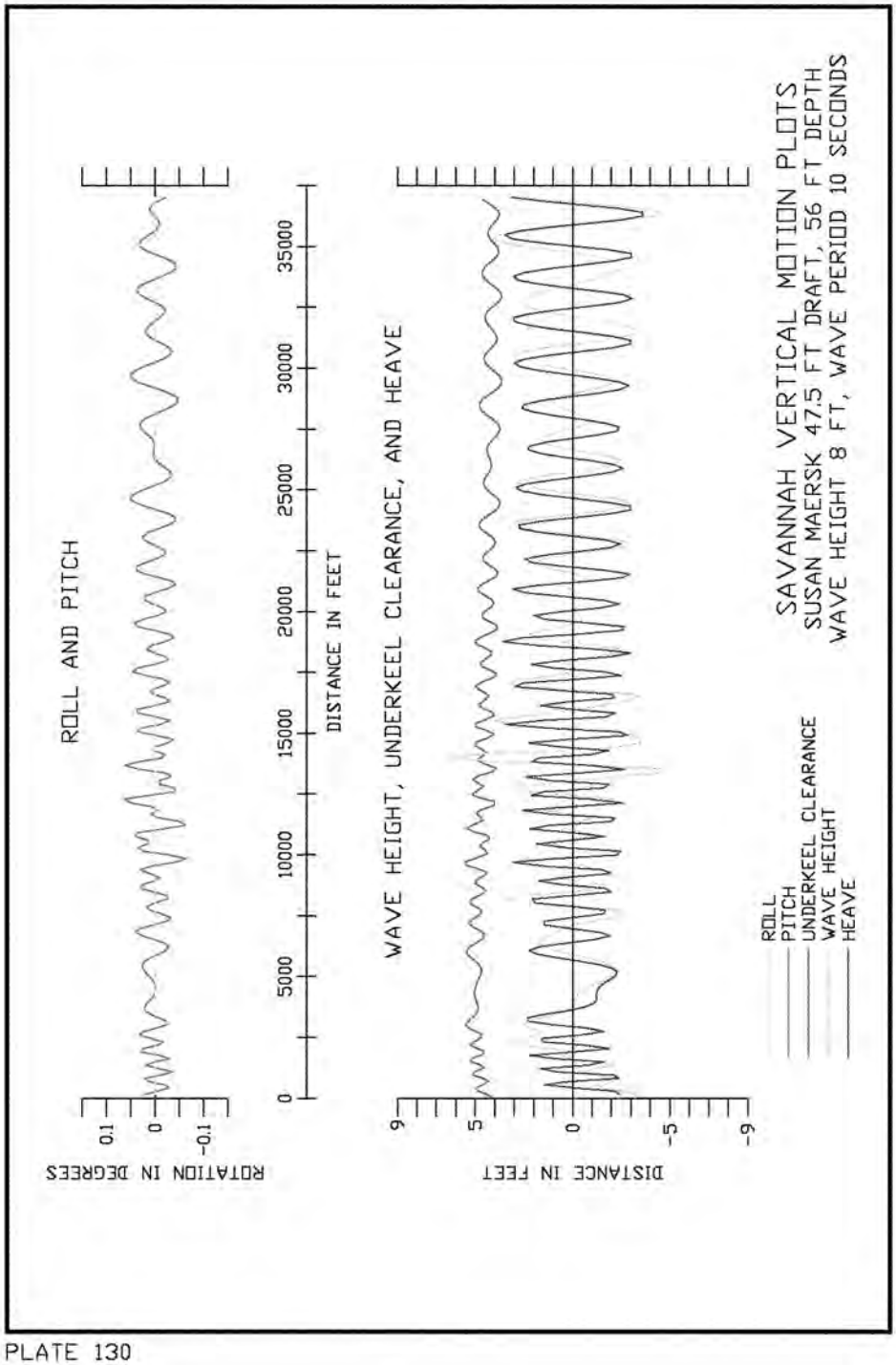

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 47.5 FT DRAFT, 56 FT DEPTH
WAVE HEIGHT 8 FT, WAVE PERIOD 10 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
0
5000
10000
15000
20000
25000
30000
35000
DISTANCE IN FEET

PLATE 130

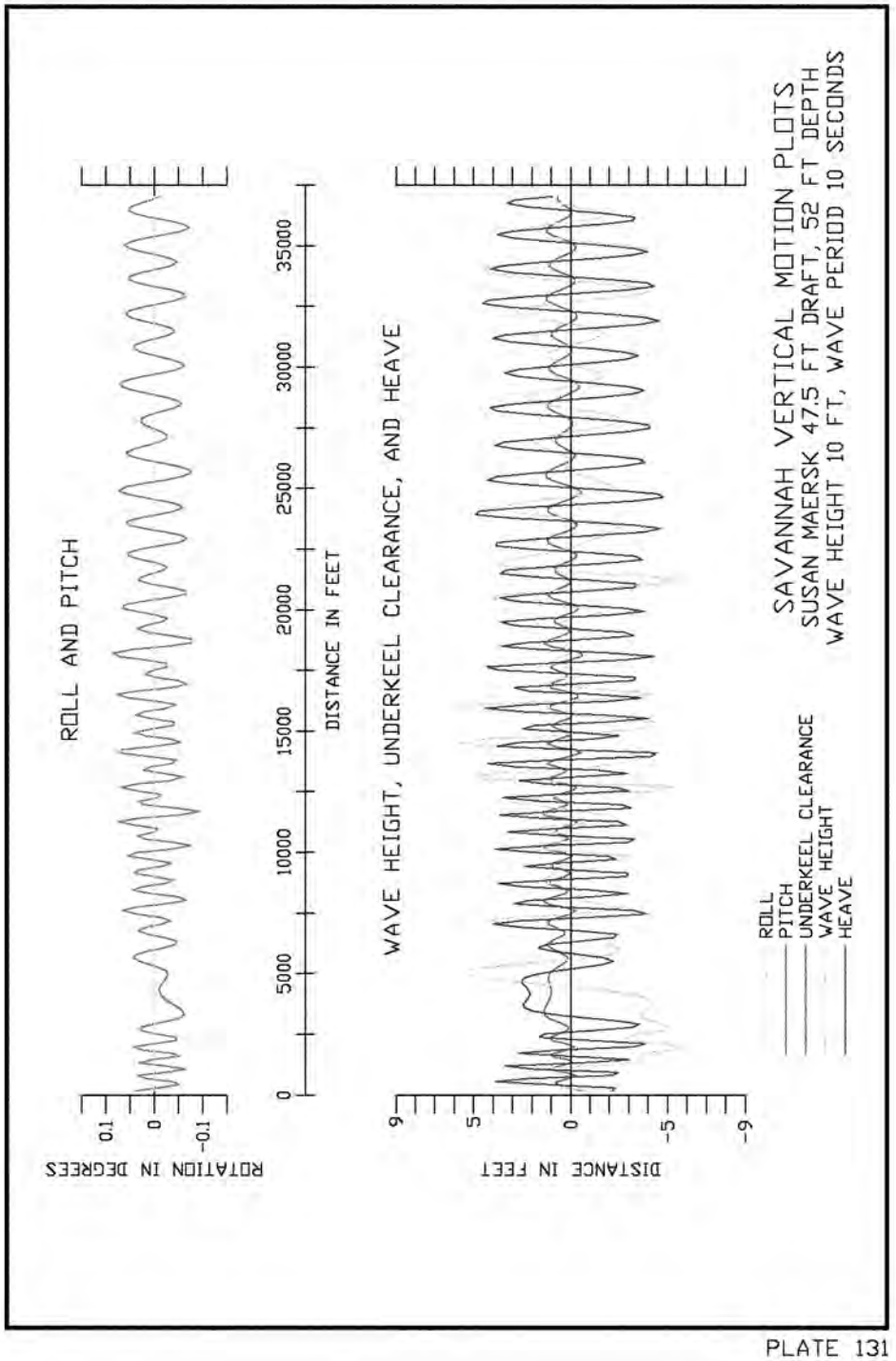

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 47.5 FT DRAFT, 52 FT DEPTH
WAVE HEIGHT 10 FT, WAVE PERIOD 10 SECONDS
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
0
5000
10000
15000
20000
25000
30000
35000
DISTANCE IN FEET
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE

PLATE 131

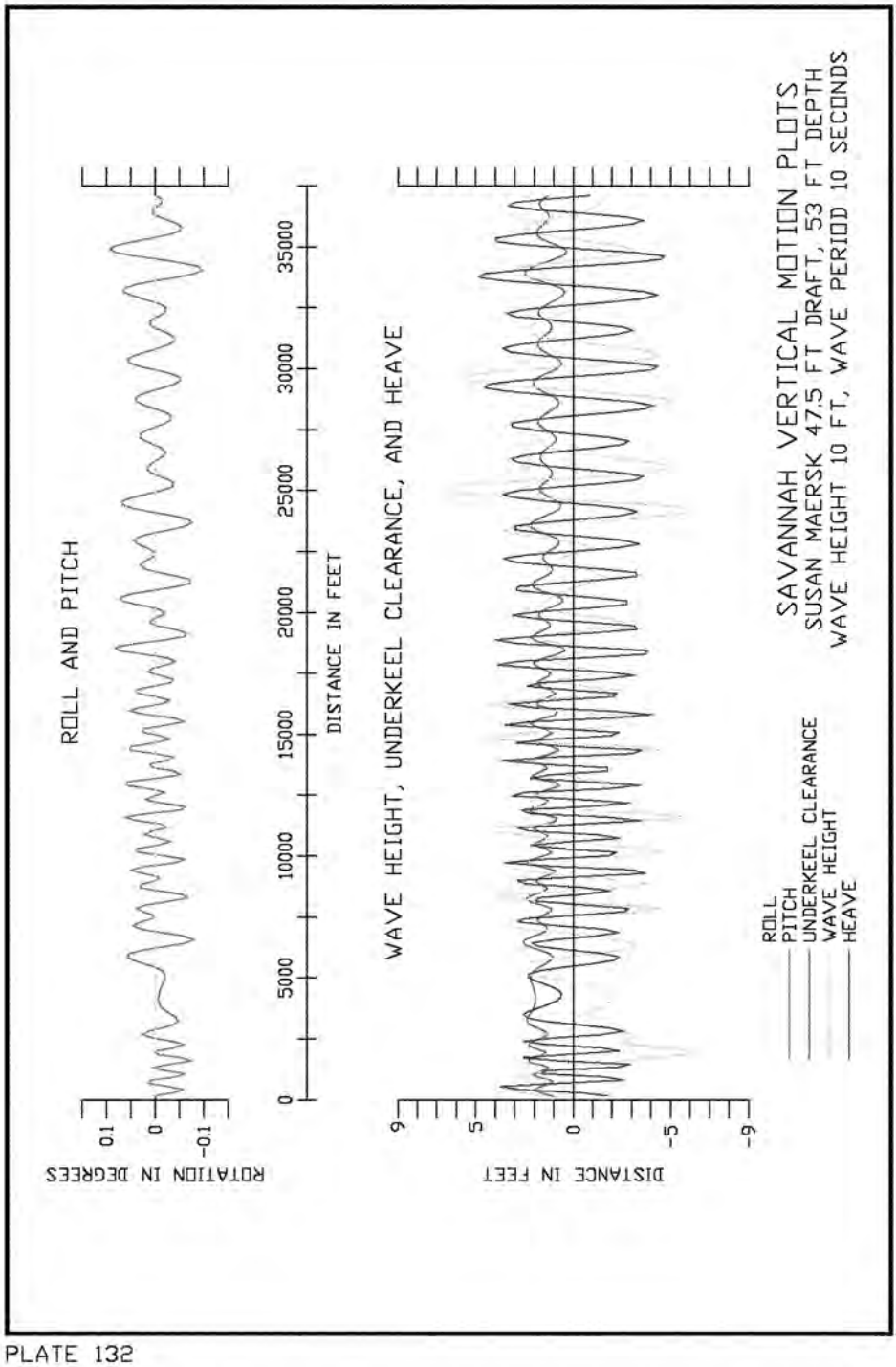

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 47.5 FT DRAFT, 53 FT DEPTH
WAVE HEIGHT 10 FT, WAVE PERIOD 10 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
0
5000
10000
15000
20000
25000
30000
35000
DISTANCE IN FEET

PLATE 132

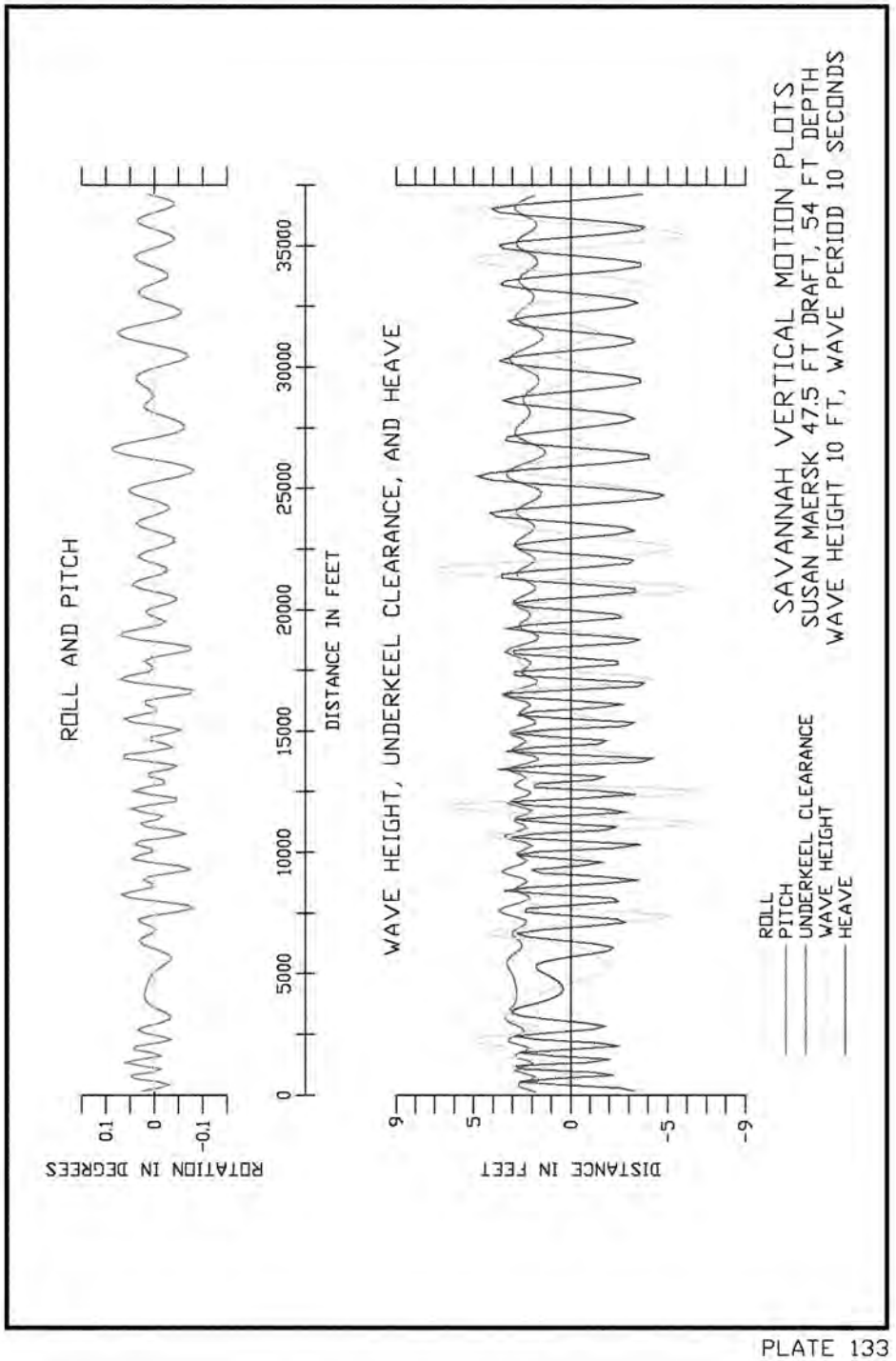

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 47.5 FT DRAFT, 54 FT DEPTH
WAVE HEIGHT 10 FT, WAVE PERIOD 10 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
DISTANCE IN FEET
0
5000
10000
15000
20000
25000
30000
35000

PLATE 133

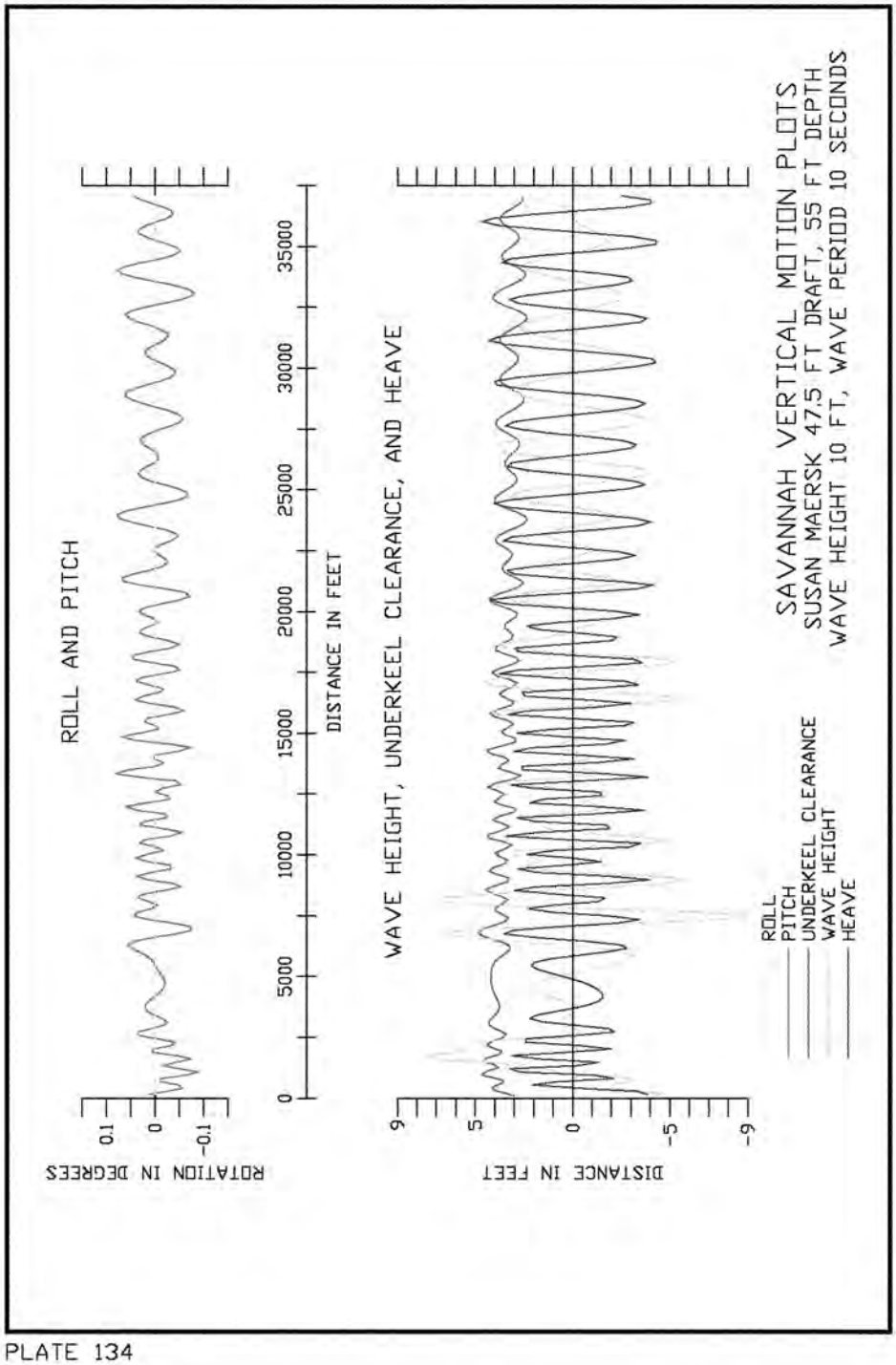

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 47.5 FT DRAFT, 55 FT DEPTH
WAVE HEIGHT 10 FT, WAVE PERIOD 10 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
DISTANCE IN FEET
0
5000
10000
15000
20000
25000
30000
35000

PLATE 134

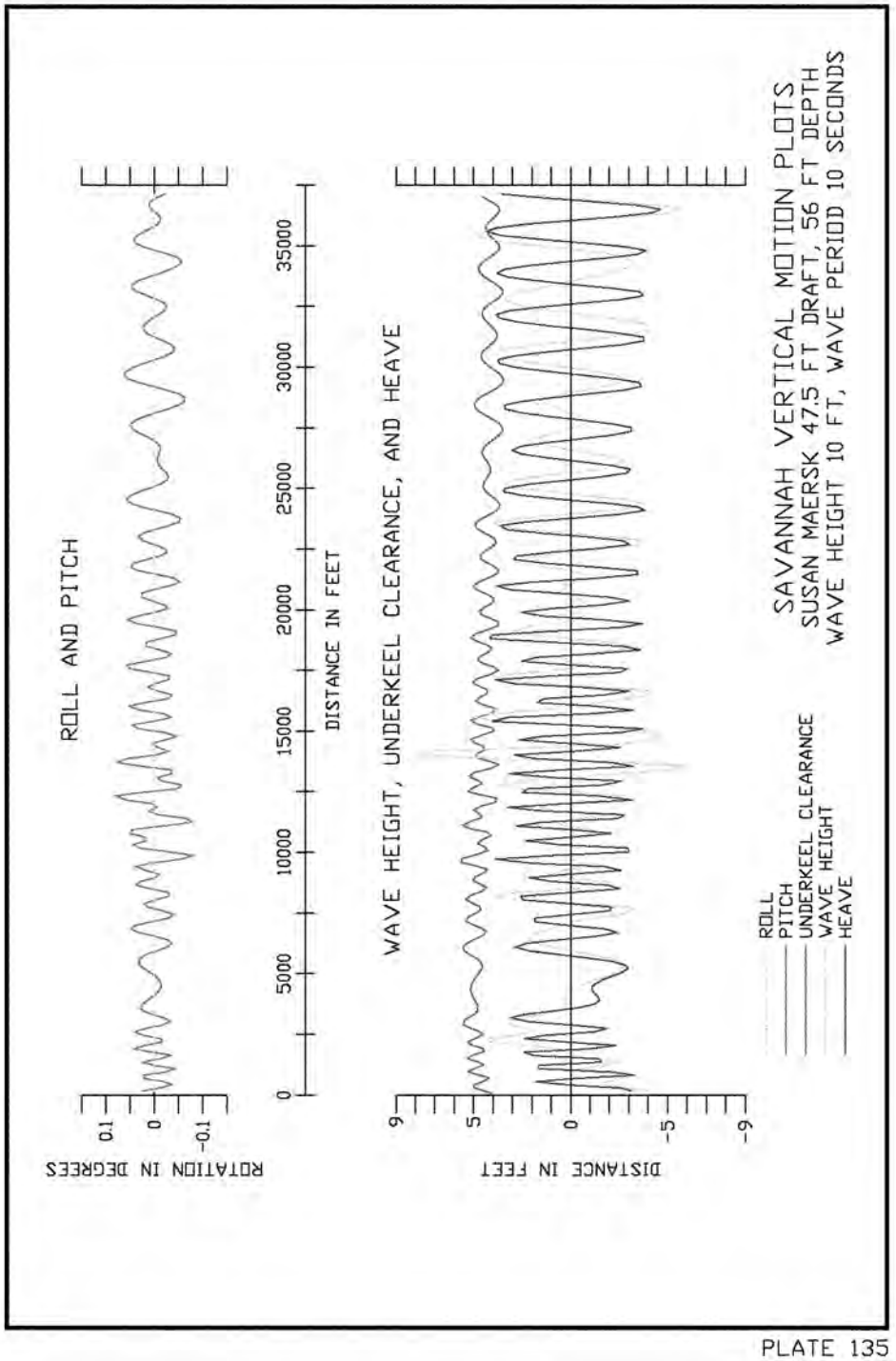

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 47.5 FT DRAFT, 56 FT DEPTH
WAVE HEIGHT 10 FT, WAVE PERIOD 10 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
0
5000
10000
15000
20000
25000
30000
35000
DISTANCE IN FEET

PLATE 135

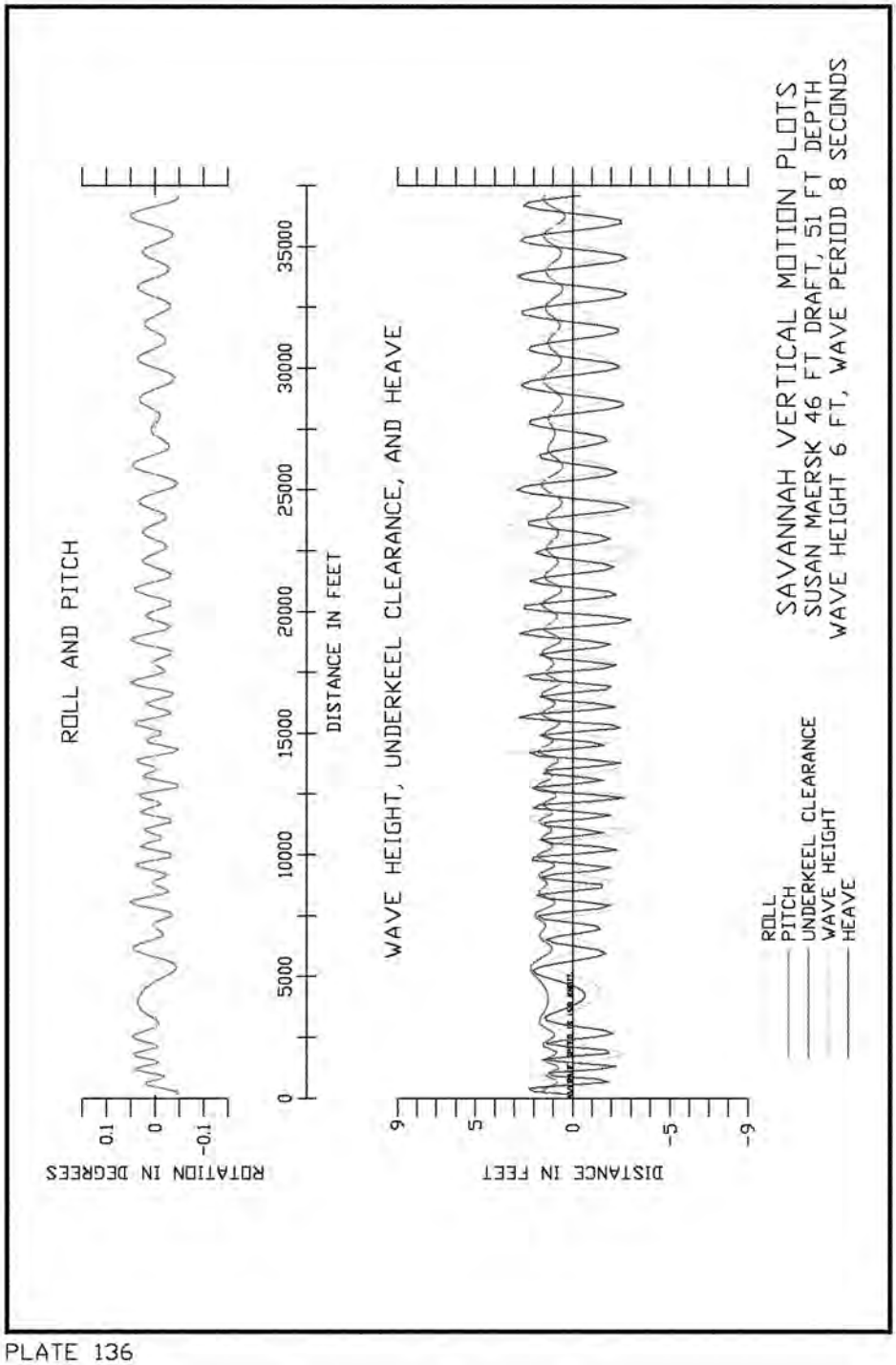

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 46 FT DRAFT, 51 FT DEPTH
WAVE HEIGHT 6 FT, WAVE PERIOD 8 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
0
5000
10000
15000
20000
25000
30000
35000
DISTANCE IN FEET

PLATE 136

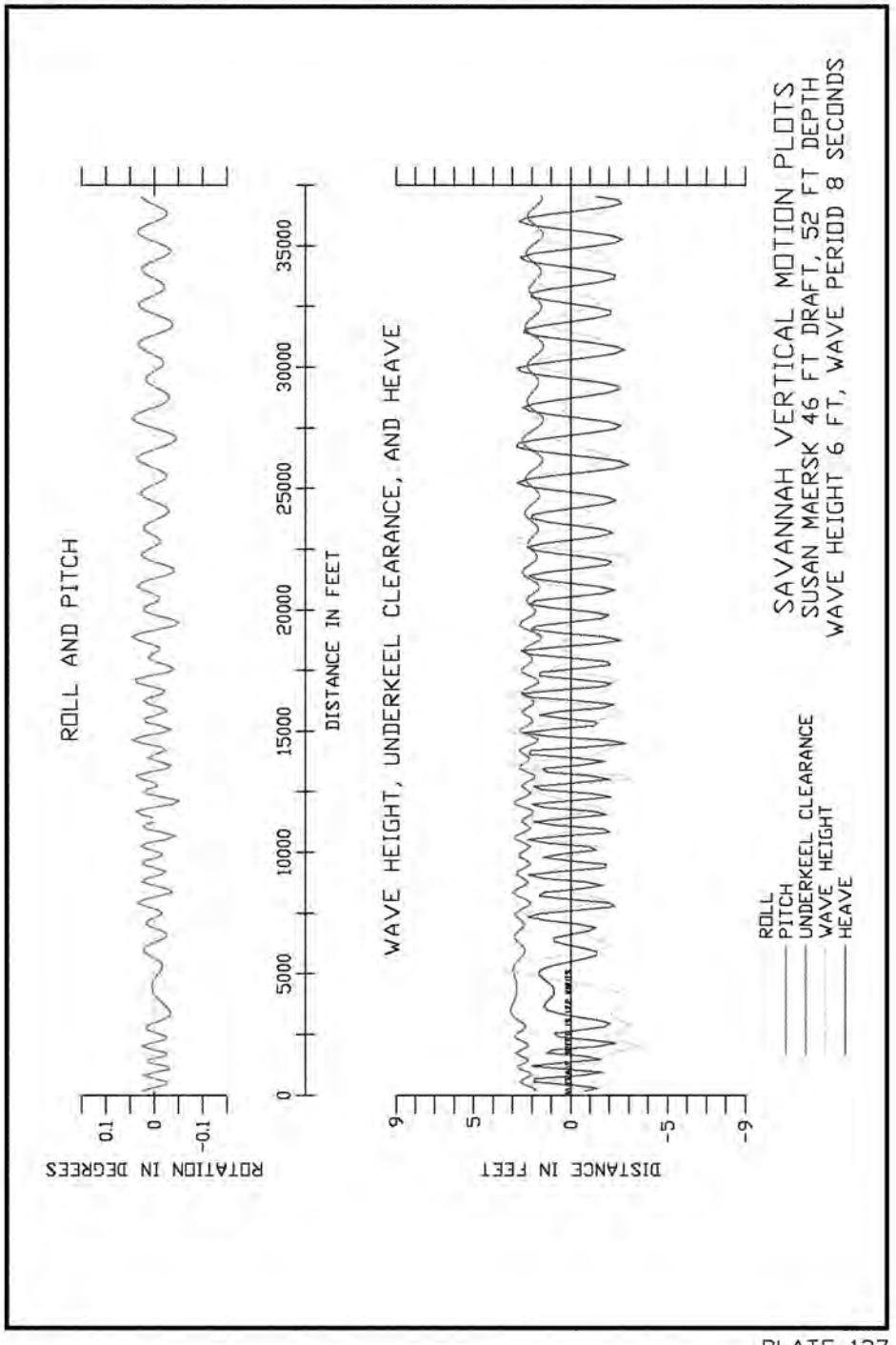

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 46 FT DRAFT, 52 FT DEPTH
WAVE HEIGHT 6 FT, WAVE PERIOD 8 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
DISTANCE IN FEET
0
5000
10000
15000
20000
25000
30000
35000

PLATE 137

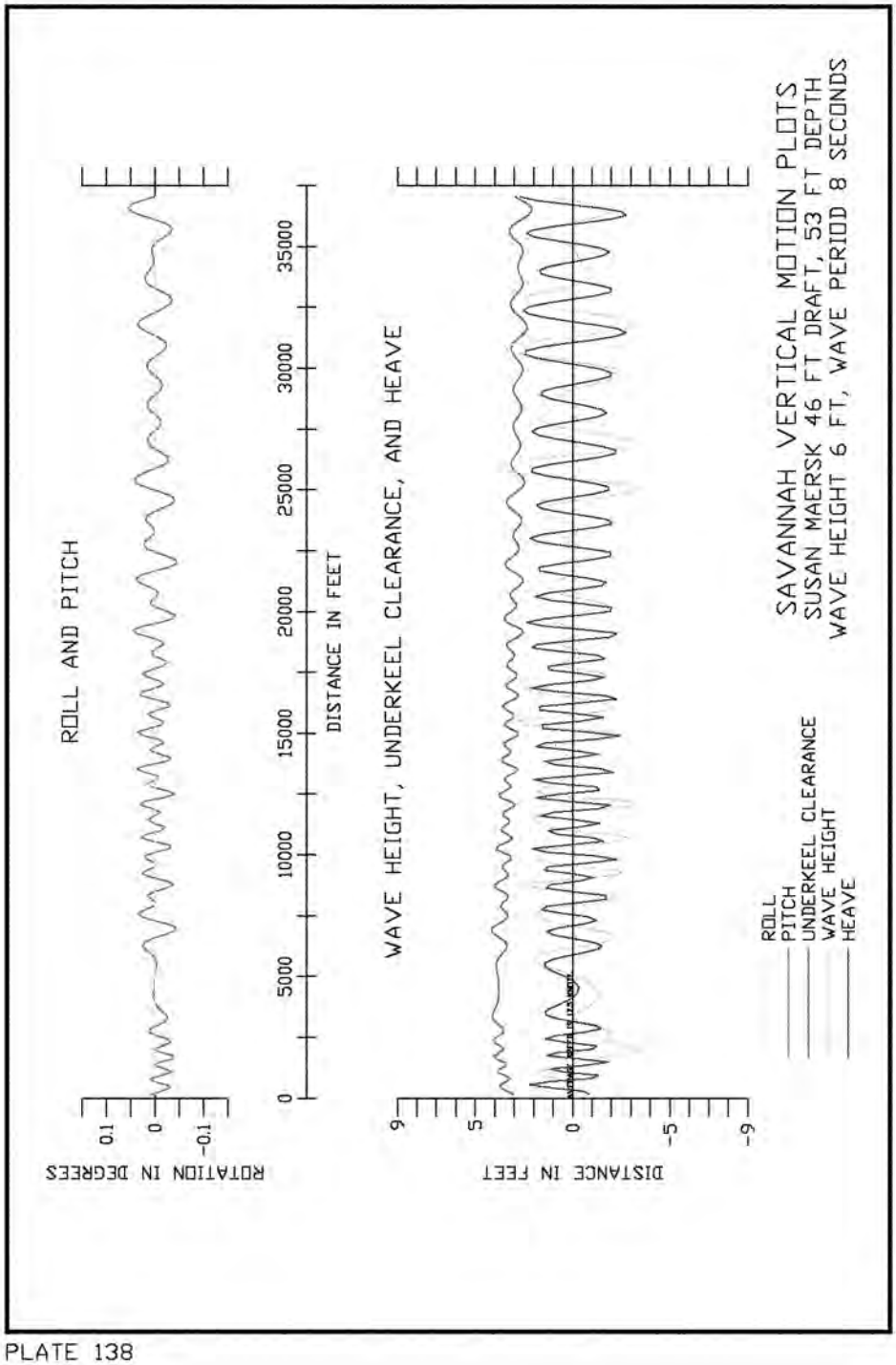

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 46 FT DRAFT, 53 FT DEPTH
WAVE HEIGHT 6 FT, WAVE PERIOD 8 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
DISTANCE IN FEET
0
5000
10000
15000
20000
25000
30000
35000

PLATE 138

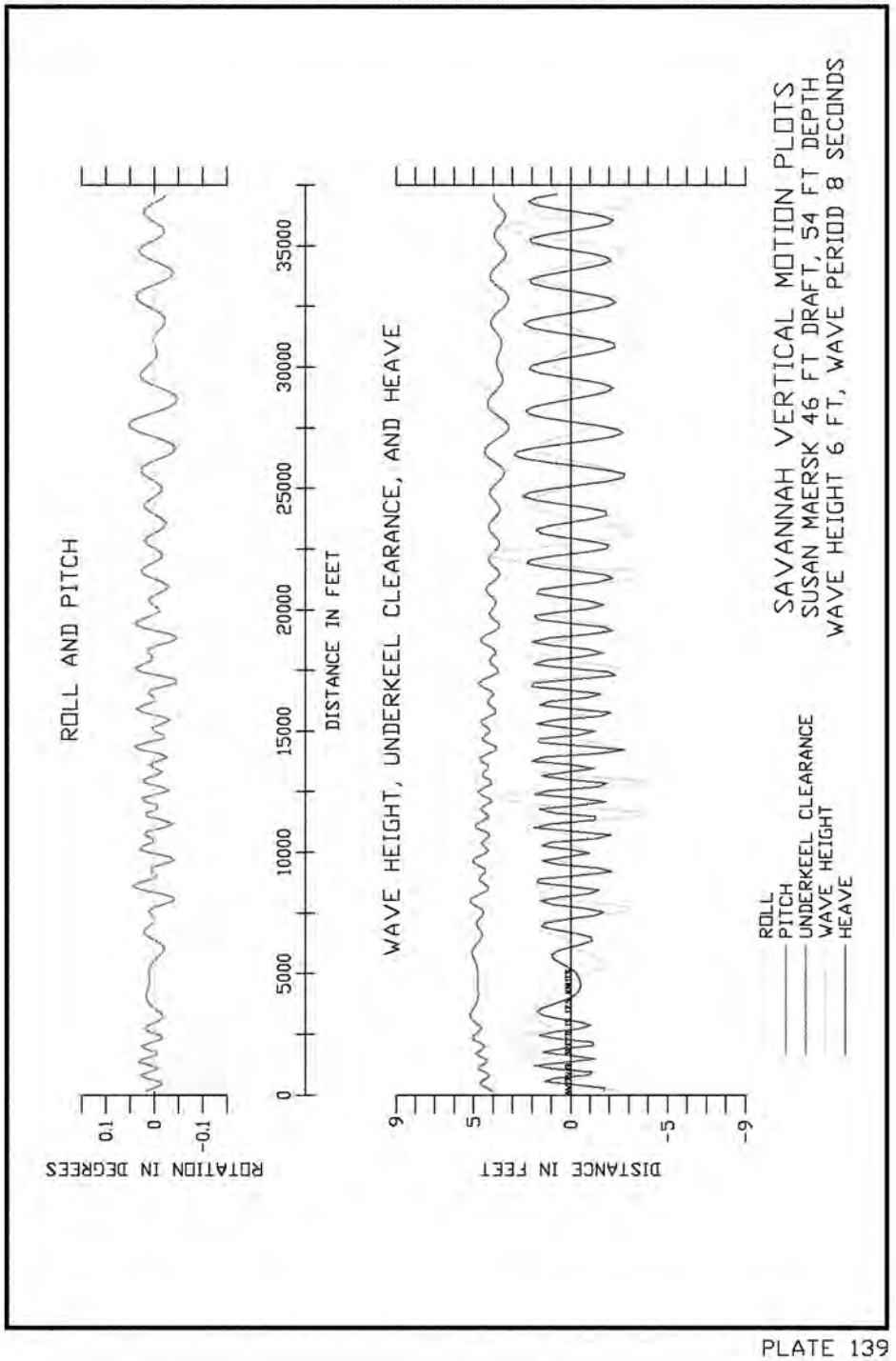

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 46 FT DRAFT, 54 FT DEPTH
WAVE HEIGHT 6 FT, WAVE PERIOD 8 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
0
5000
10000
15000
20000
25000
30000
35000
DISTANCE IN FEET

PLATE 139

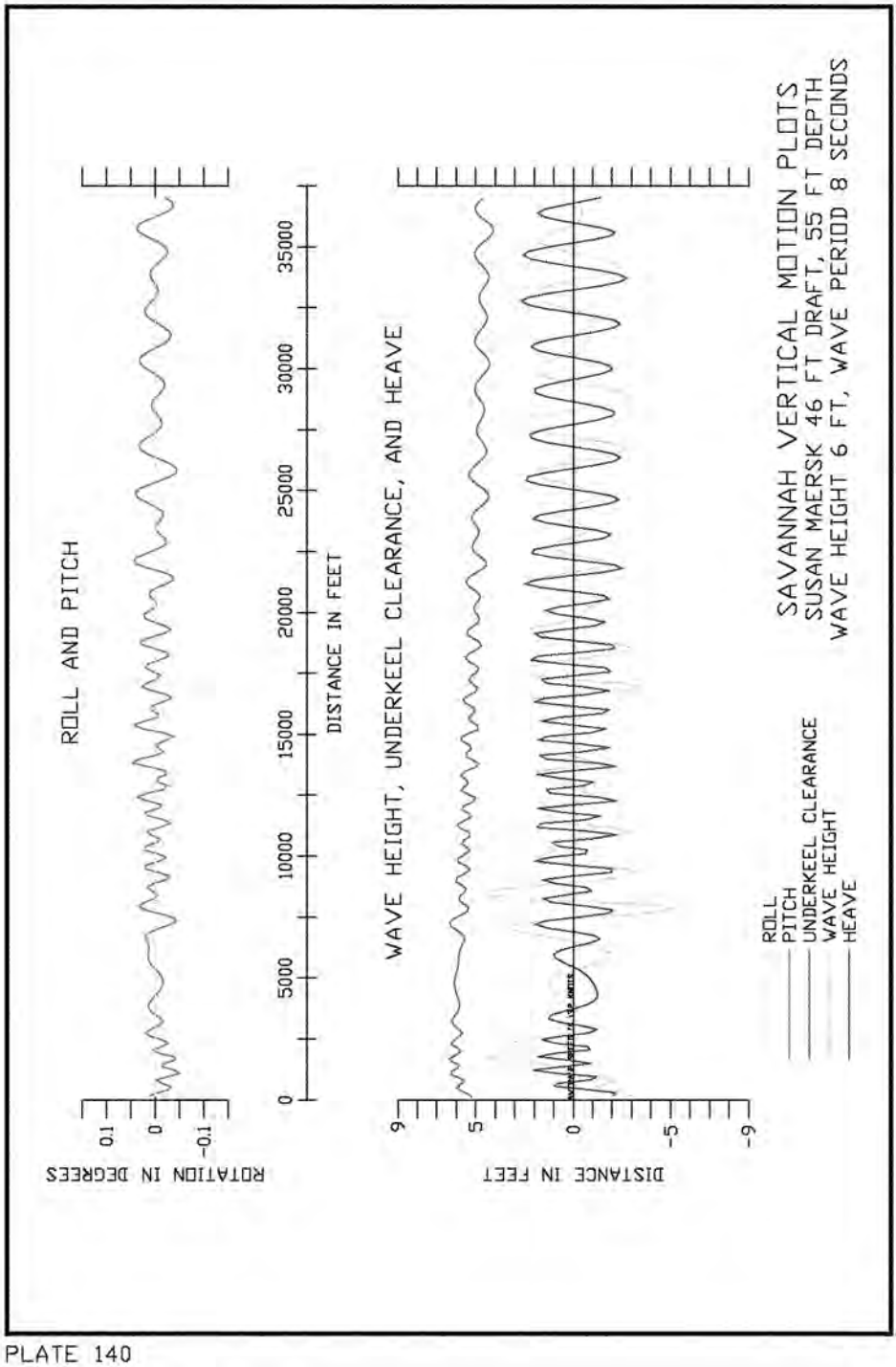

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 46 FT DRAFT, 55 FT DEPTH
WAVE HEIGHT 6 FT, WAVE PERIOD 8 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
DISTANCE IN FEET
0
5000
10000
15000
20000
25000
30000
35000

PLATE 140

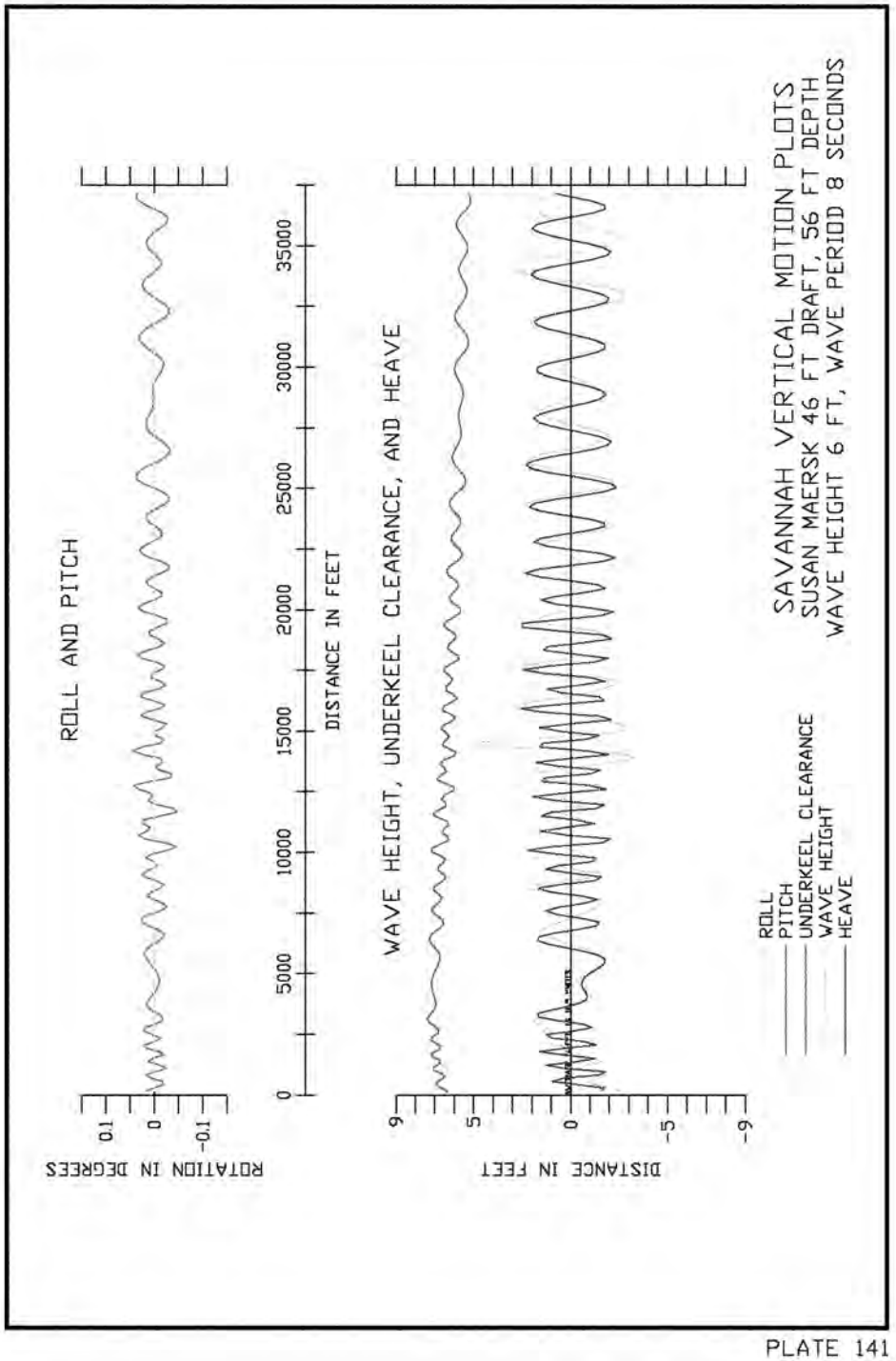

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 46 FT DRAFT, 56 FT DEPTH
WAVE HEIGHT 6 FT, WAVE PERIOD 8 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
0
5000
10000
15000
20000
25000
30000
35000
DISTANCE IN FEET

PLATE 141

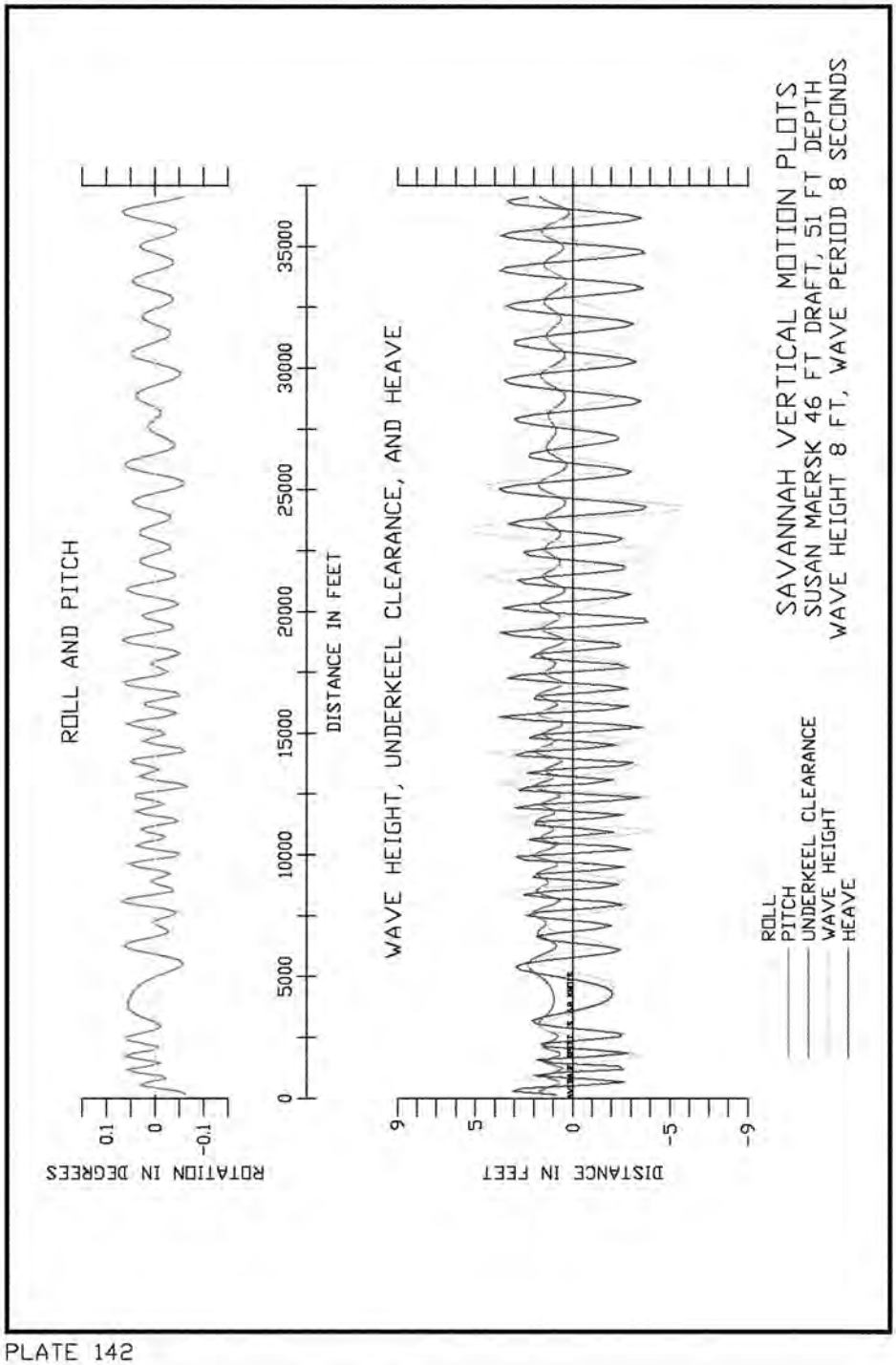

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 46 FT DRAFT, 51 FT DEPTH
WAVE HEIGHT 8 FT, WAVE PERIOD 8 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
DISTANCE IN FEET
0
5000
10000
15000
20000
25000
30000
35000
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1

PLATE 142

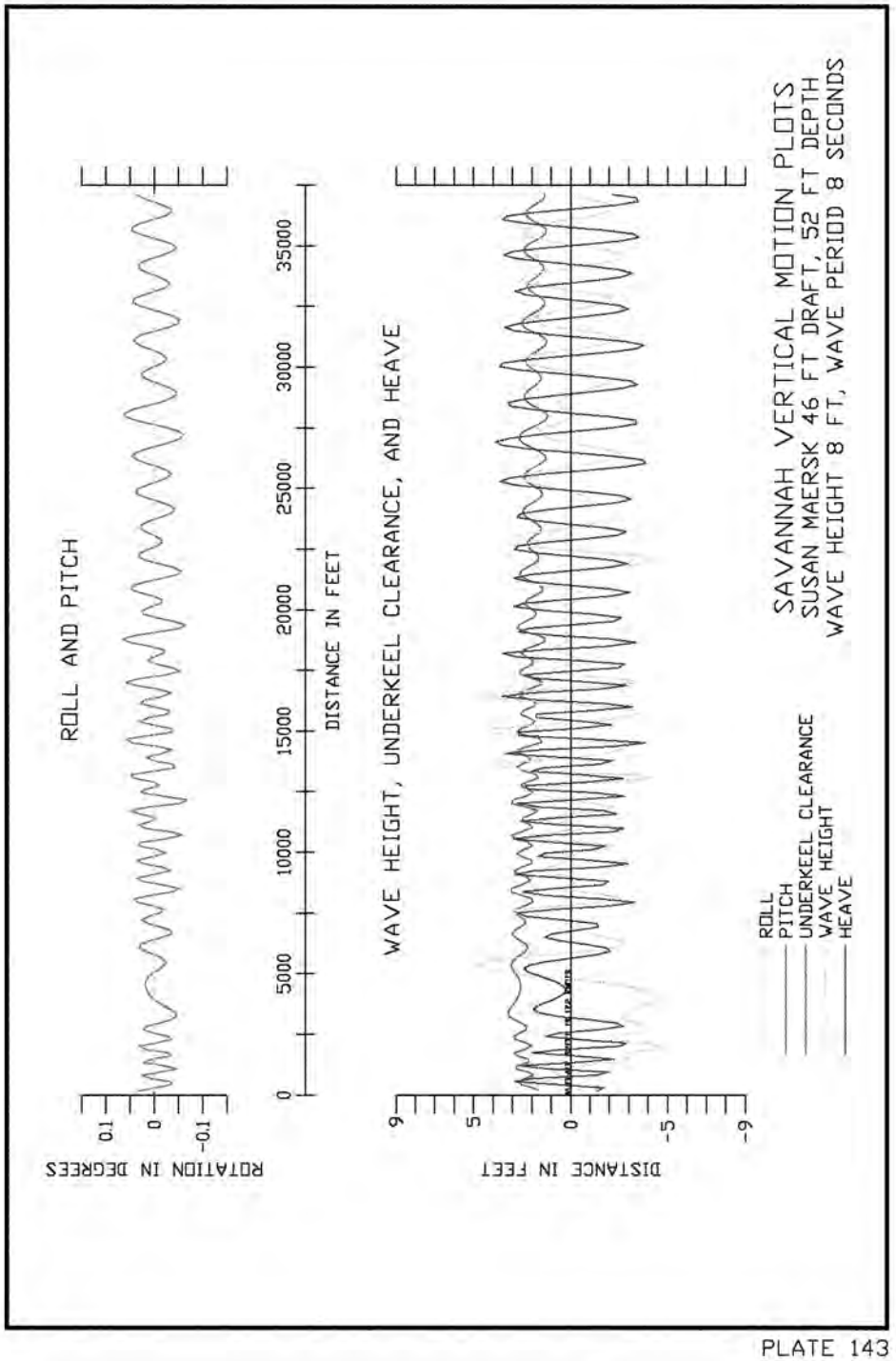

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 46 FT DRAFT, 52 FT DEPTH
WAVE HEIGHT 8 FT, WAVE PERIOD 8 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
DISTANCE IN FEET
0
5000
10000
15000
20000
25000
30000
35000

PLATE 143

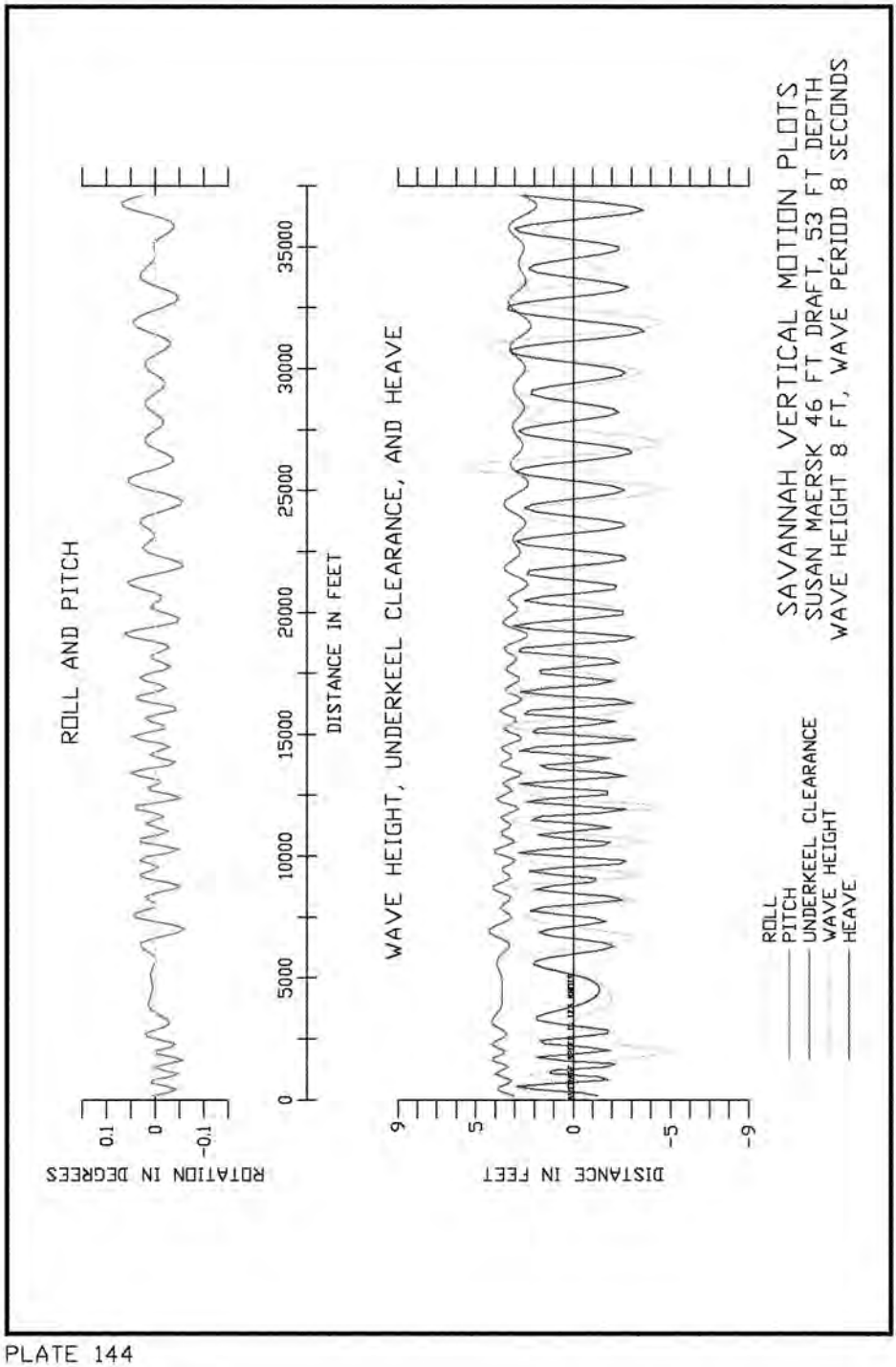

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 46 FT DRAFT, 53 FT DEPTH
WAVE HEIGHT 8 FT, WAVE PERIOD 8 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
0
5000
10000
15000
20000
25000
30000
35000
DISTANCE IN FEET

PLATE 144

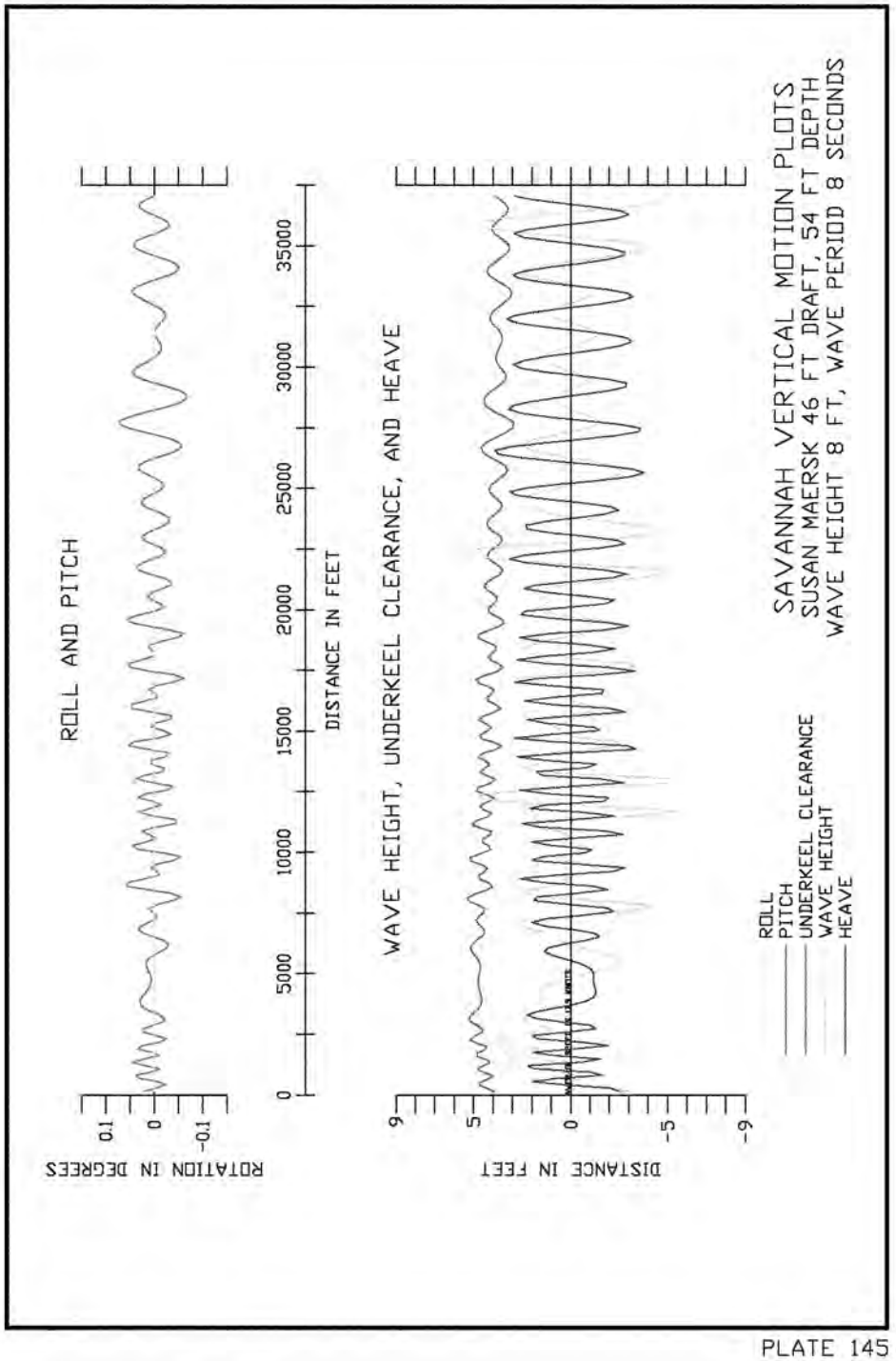

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 46 FT DRAFT, 54 FT DEPTH
WAVE HEIGHT 8 FT, WAVE PERIOD 8 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
DISTANCE IN FEET
0
5000
10000
15000
20000
25000
30000
35000

PLATE 145

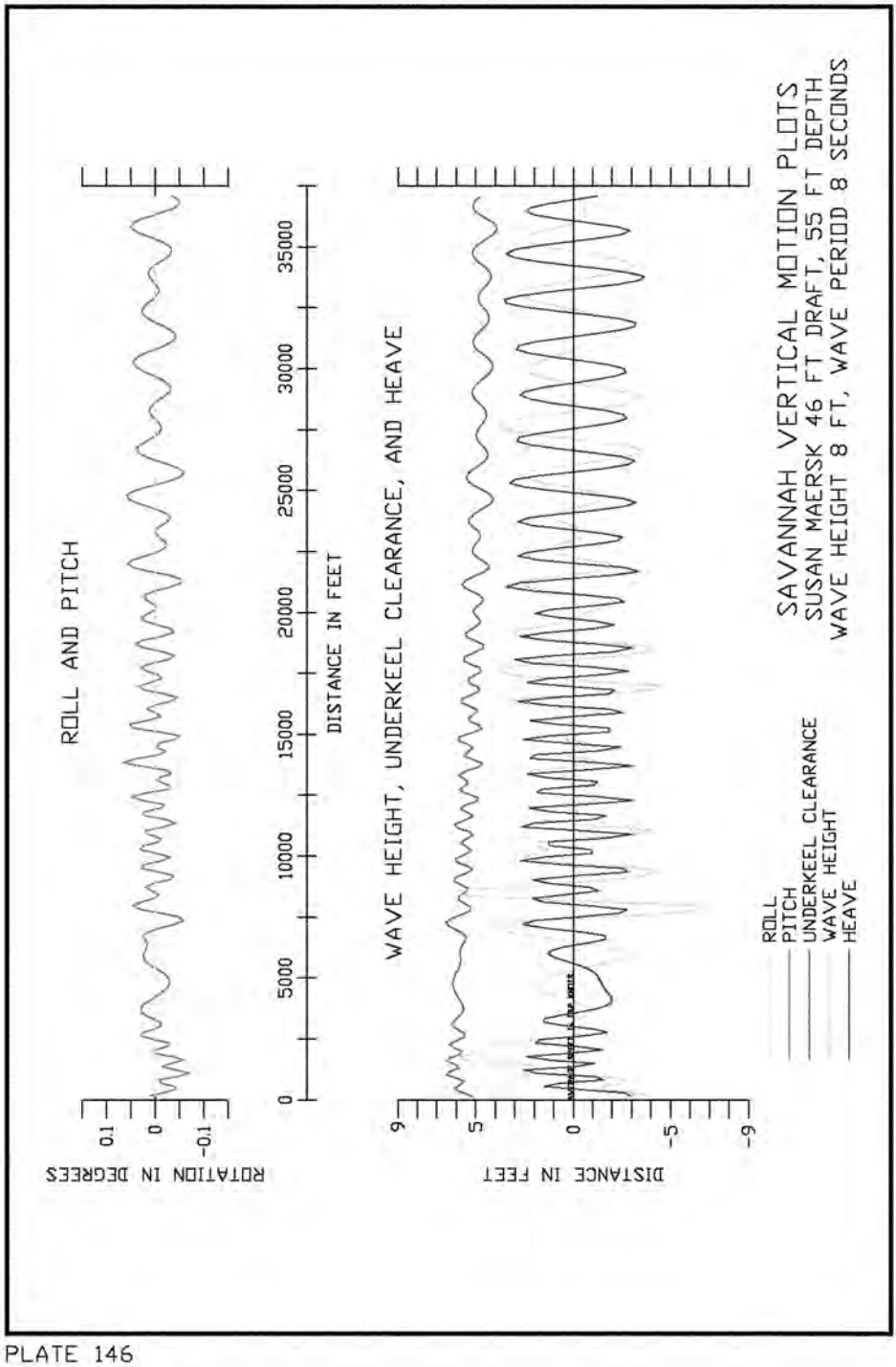

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 46 FT DRAFT, 55 FT DEPTH
WAVE HEIGHT 8 FT, WAVE PERIOD 8 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
DISTANCE IN FEET
0
5000
10000
15000
20000
25000
30000
35000

PLATE 146

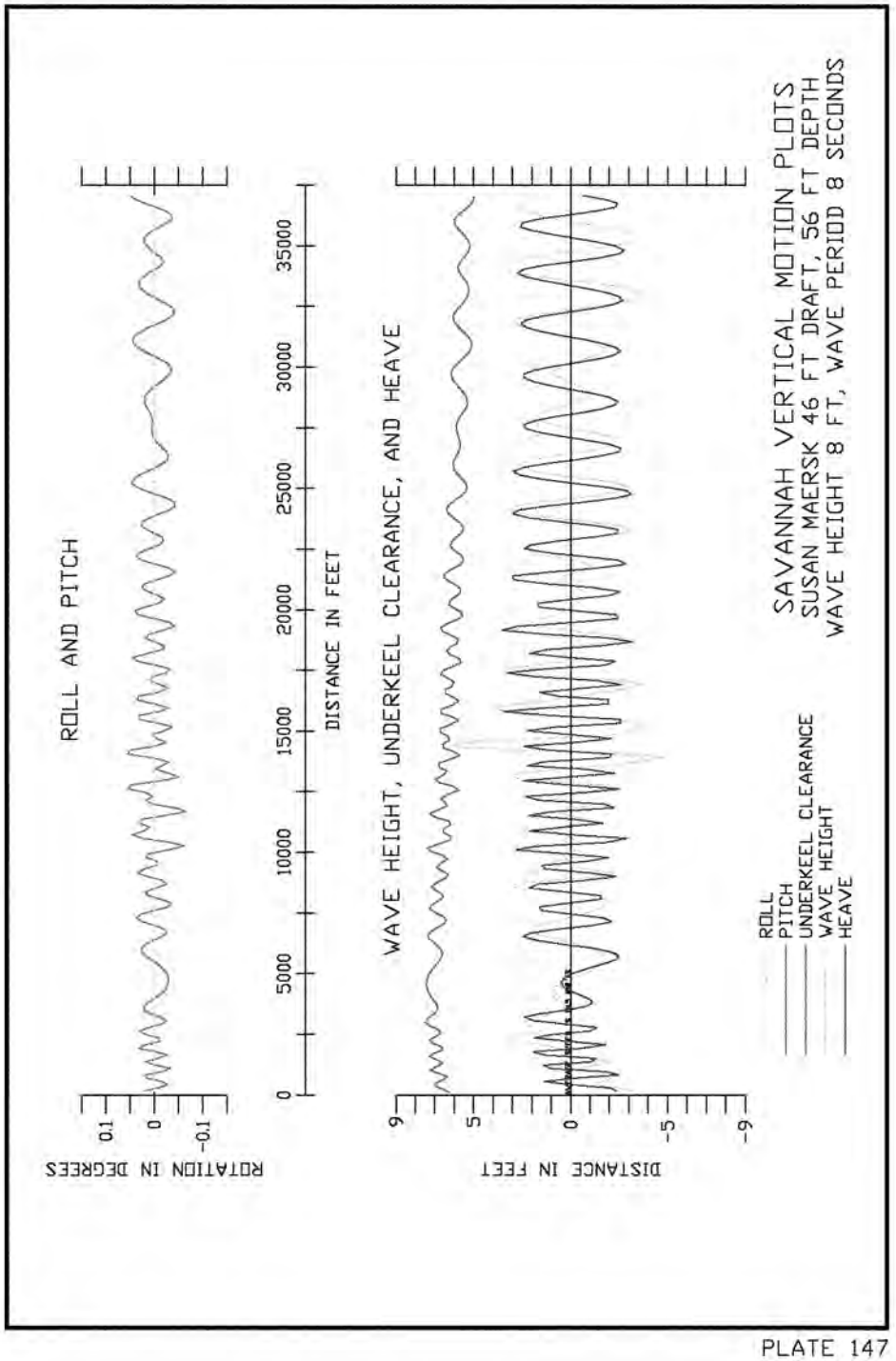

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 46 FT DRAFT, 56 FT DEPTH
WAVE HEIGHT 8 FT, WAVE PERIOD 8 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
DISTANCE IN FEET
0
5000
10000
15000
20000
25000
30000
35000

PLATE 147

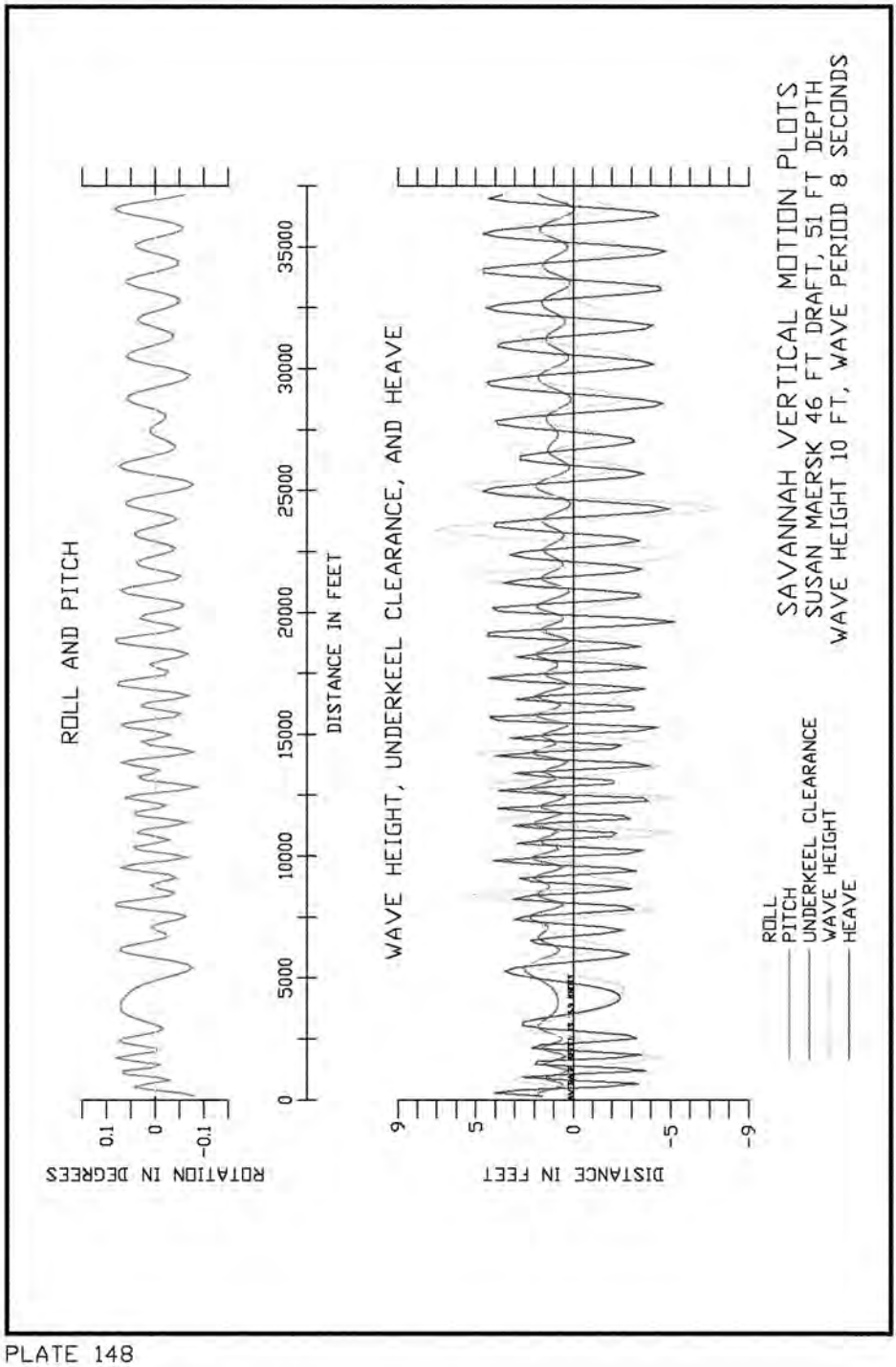

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 46 FT DRAFT, 51 FT DEPTH
WAVE HEIGHT 10 FT, WAVE PERIOD 8 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
0
5000
10000
15000
20000
25000
30000
35000
DISTANCE IN FEET

PLATE 148

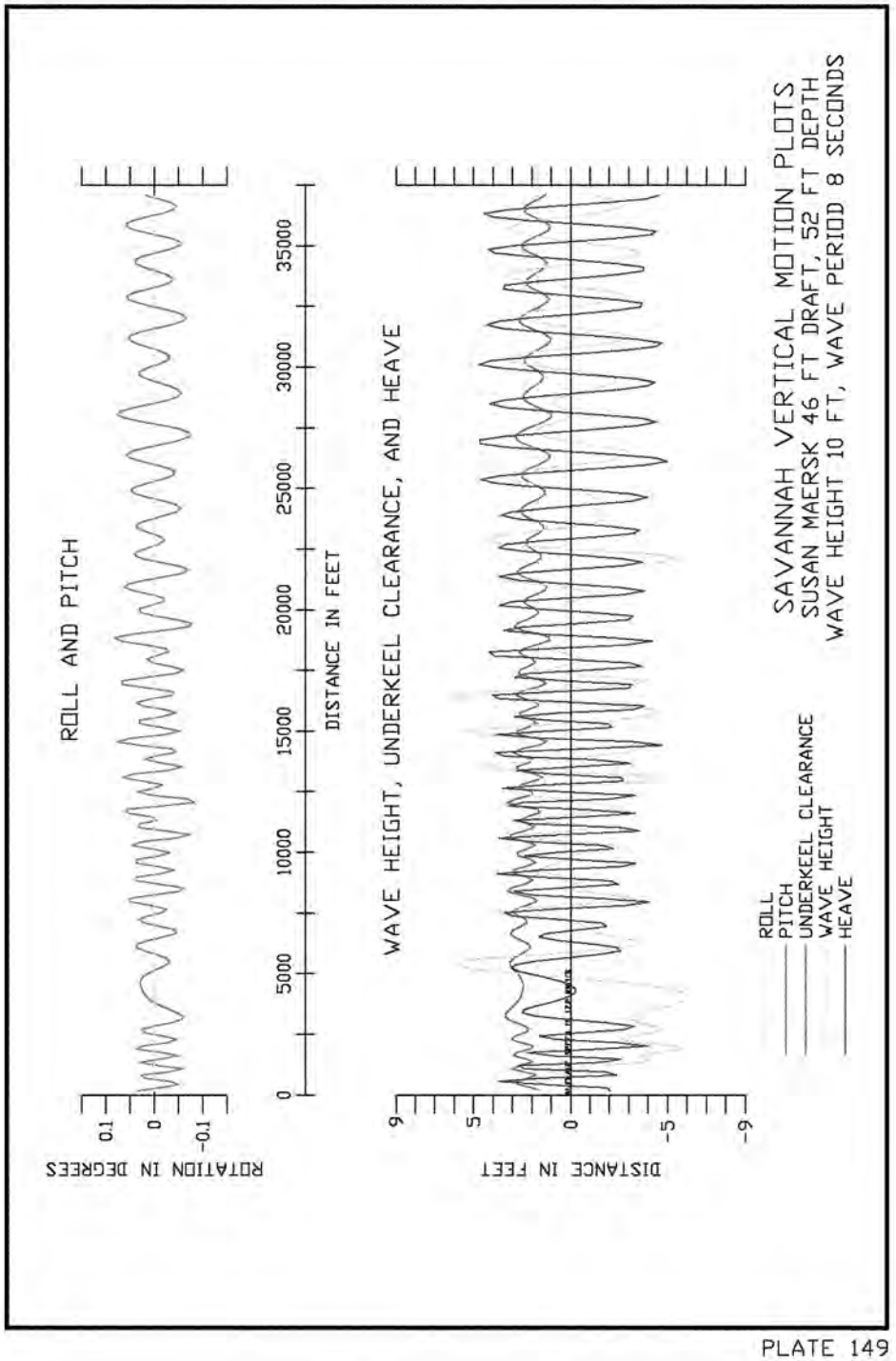

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 46 FT DRAFT, 52 FT DEPTH
WAVE HEIGHT 10 FT, WAVE PERIOD 8 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
0
5000
10000
15000
20000
25000
30000
35000
DISTANCE IN FEET

PLATE 149

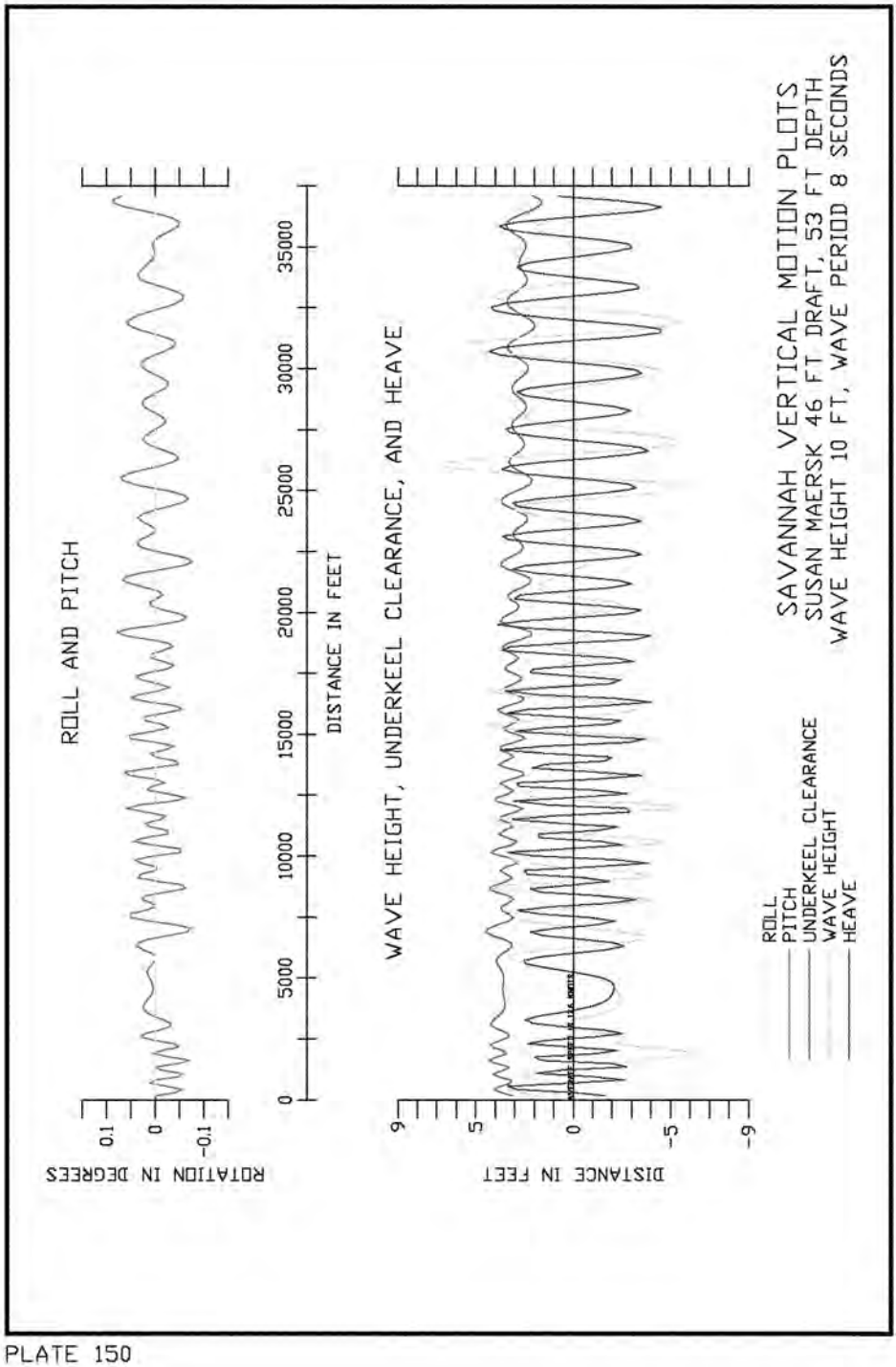

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 46 FT DRAFT, 53 FT DEPTH
WAVE HEIGHT 10 FT, WAVE PERIOD 8 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
0
5000
10000
15000
20000
25000
30000
35000
DISTANCE IN FEET

PLATE 150

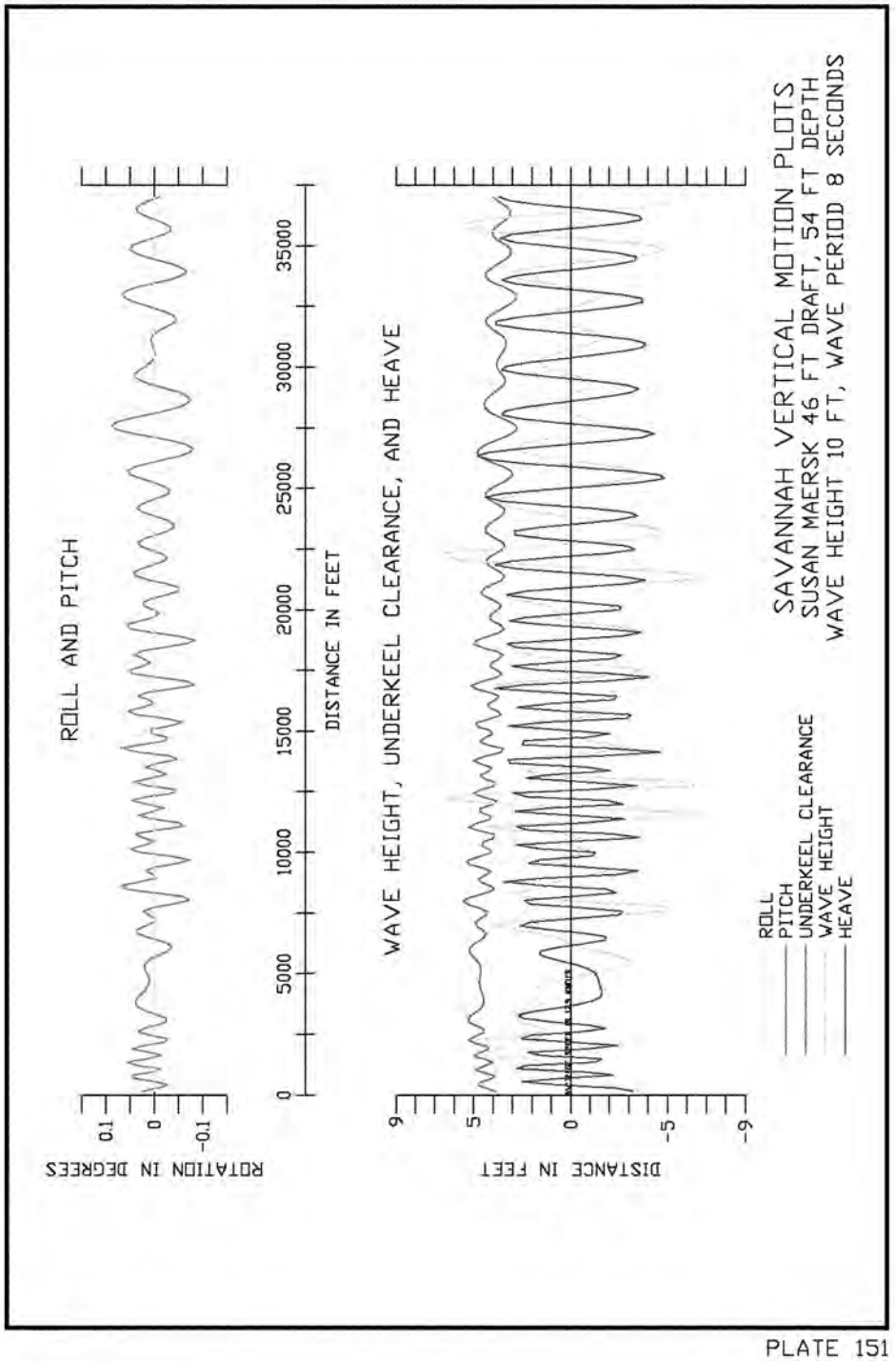

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 46 FT DRAFT, 54 FT DEPTH
WAVE HEIGHT 10 FT, WAVE PERIOD 8 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
DISTANCE IN FEET
0
5000
10000
15000
20000
25000
30000
35000

PLATE 151

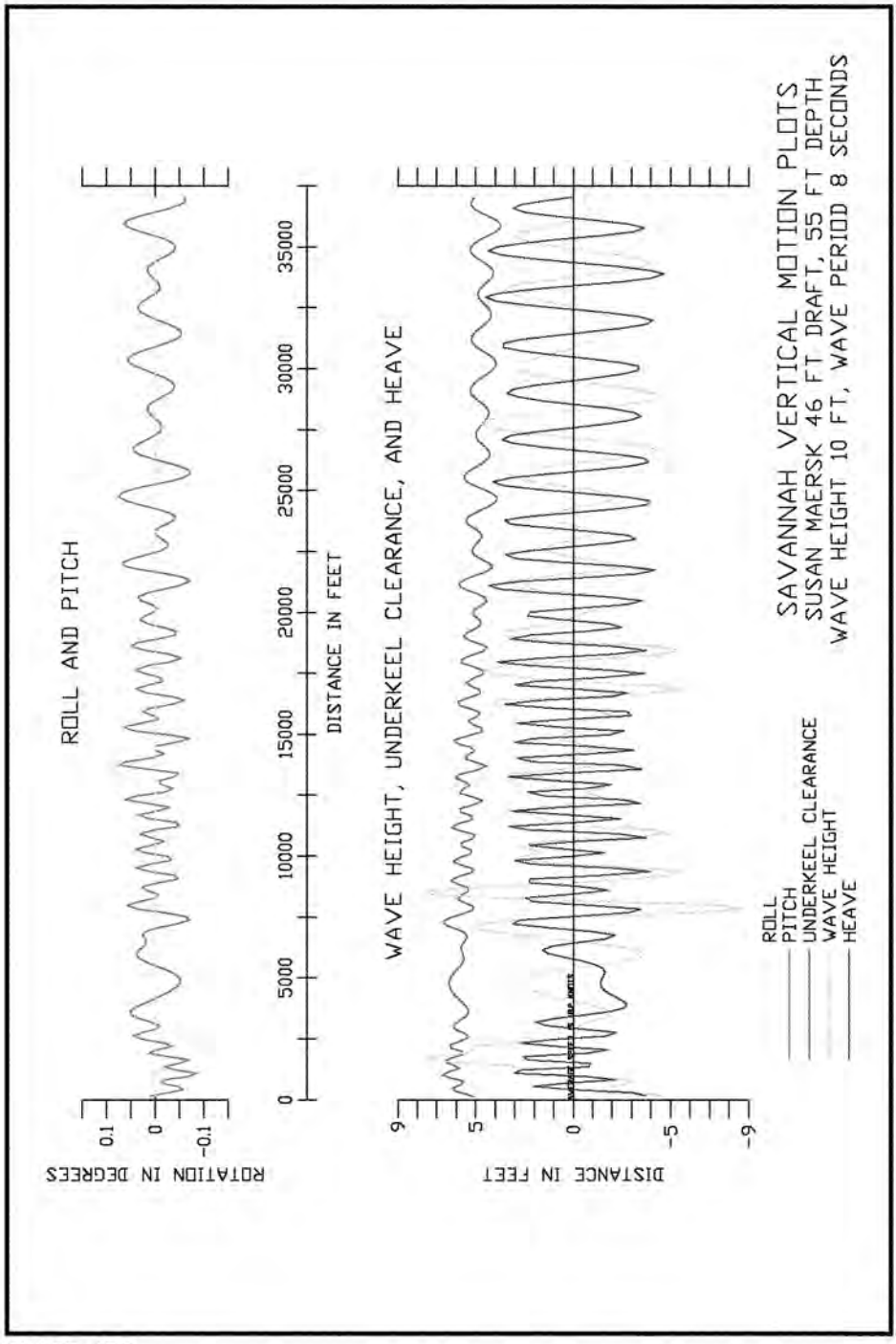

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 46 FT DRAFT, 55 FT DEPTH
WAVE HEIGHT 10 FT, WAVE PERIOD 8 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
DISTANCE IN FEET
0
5000
10000
15000
20000
25000
30000
35000

PLATE 152

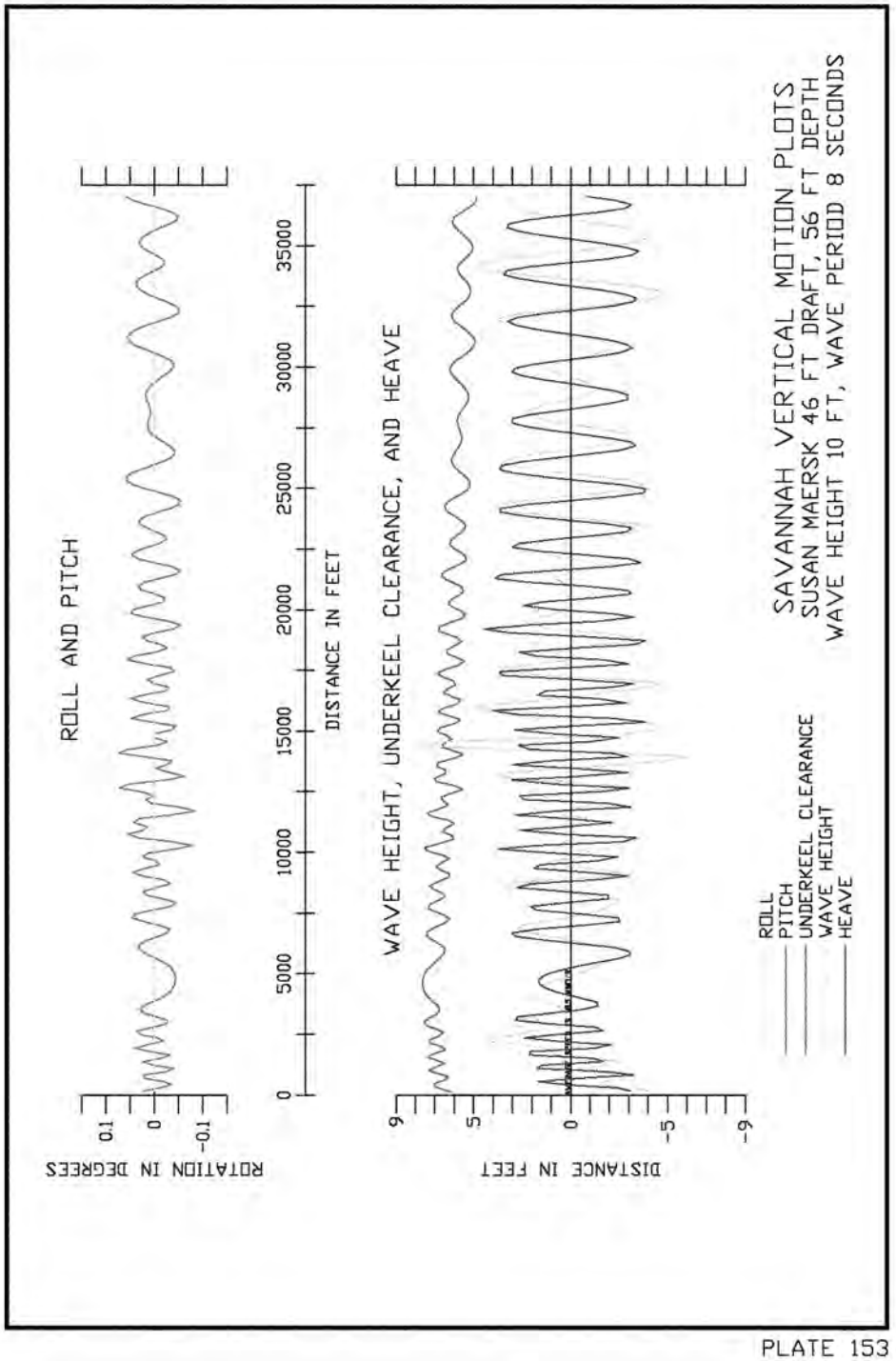

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 46 FT DRAFT, 56 FT DEPTH
WAVE HEIGHT 10 FT, WAVE PERIOD 8 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
0
5000
10000
15000
20000
25000
30000
35000
DISTANCE IN FEET

PLATE 153

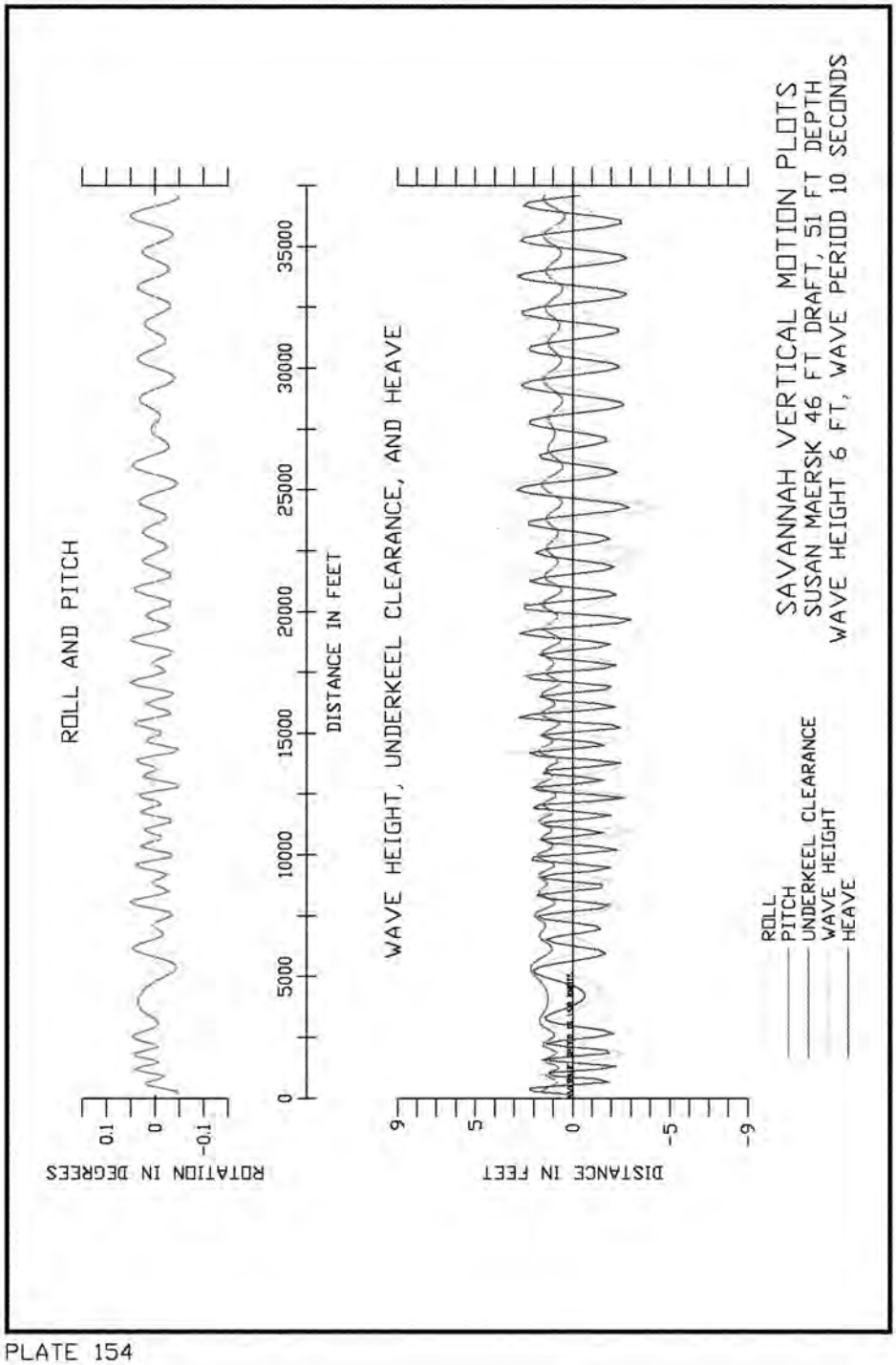

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 46 FT DRAFT, 51 FT DEPTH
WAVE HEIGHT 6 FT, WAVE PERIOD 10 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
DISTANCE IN FEET
0
5000
10000
15000
20000
25000
30000
35000

PLATE 154

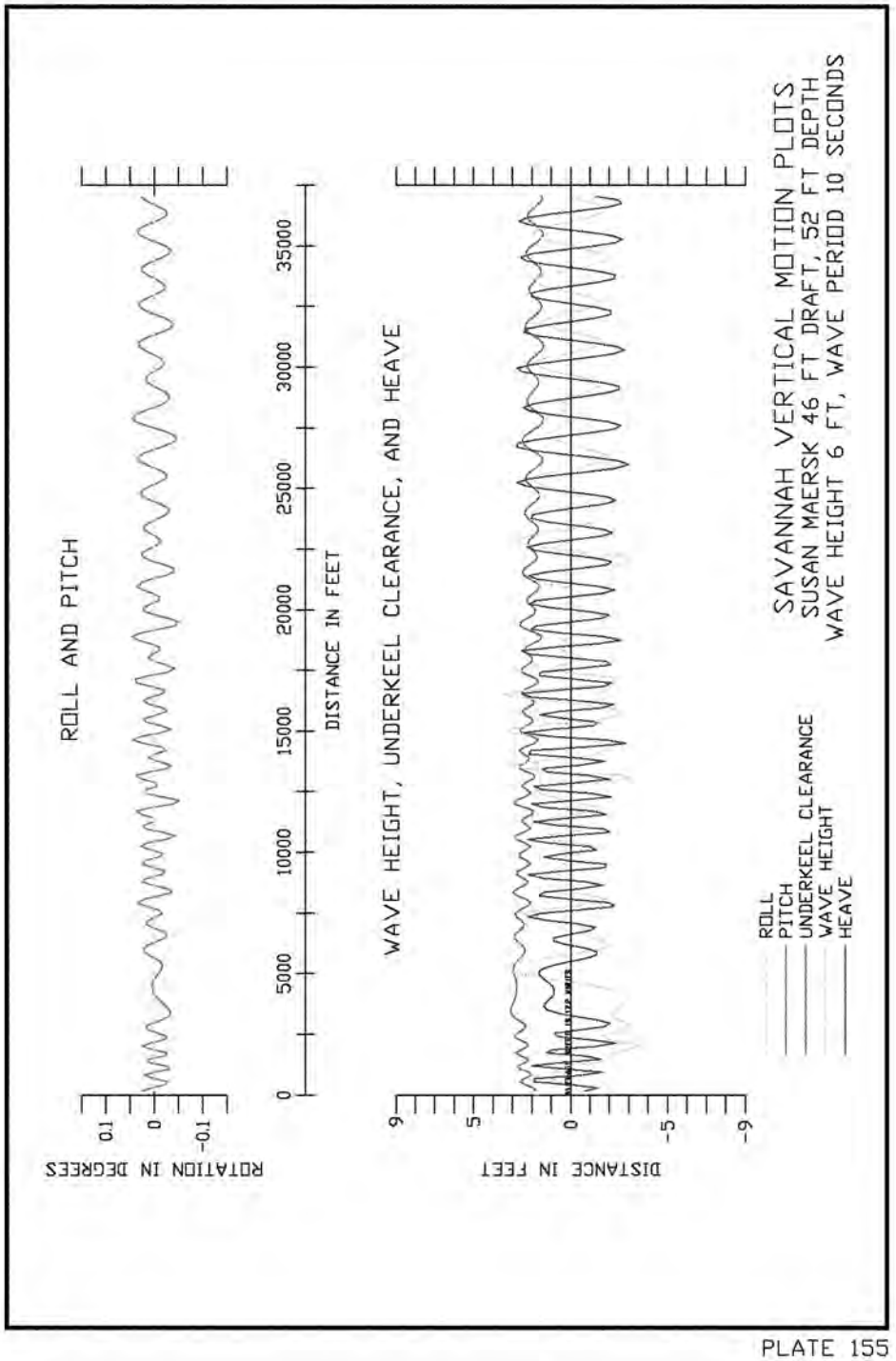

ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
0
5000
10000
15000
20000
25000
30000
35000
DISTANCE IN FEET
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 46 FT DRAFT, 52 FT DEPTH
WAVE HEIGHT 6 FT, WAVE PERIOD 10 SECONDS

PLATE 155

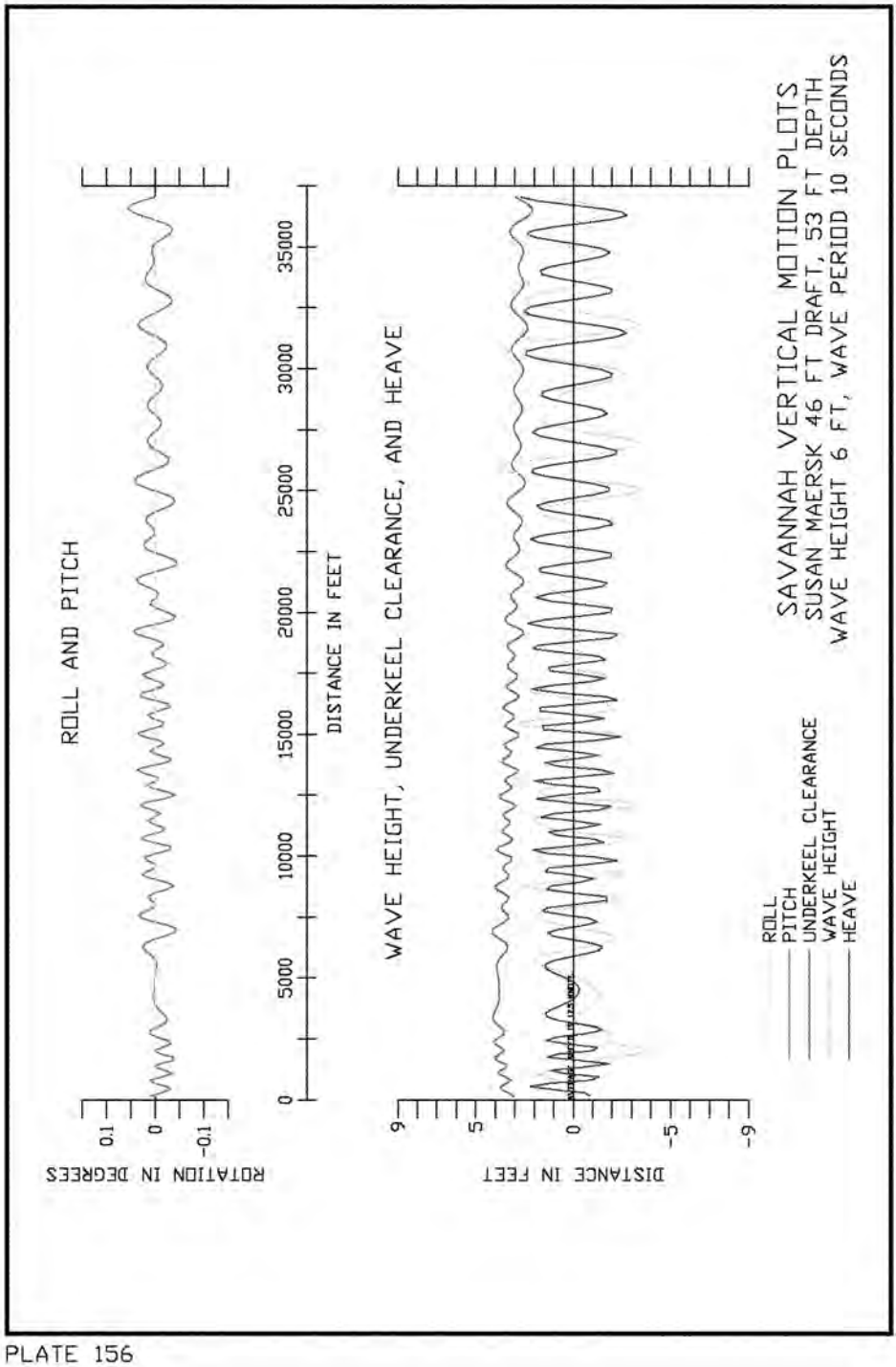

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 46 FT DRAFT, 53 FT DEPTH
WAVE HEIGHT 6 FT, WAVE PERIOD 10 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
DISTANCE IN FEET
0
5000
10000
15000
20000
25000
30000
35000

PLATE 156

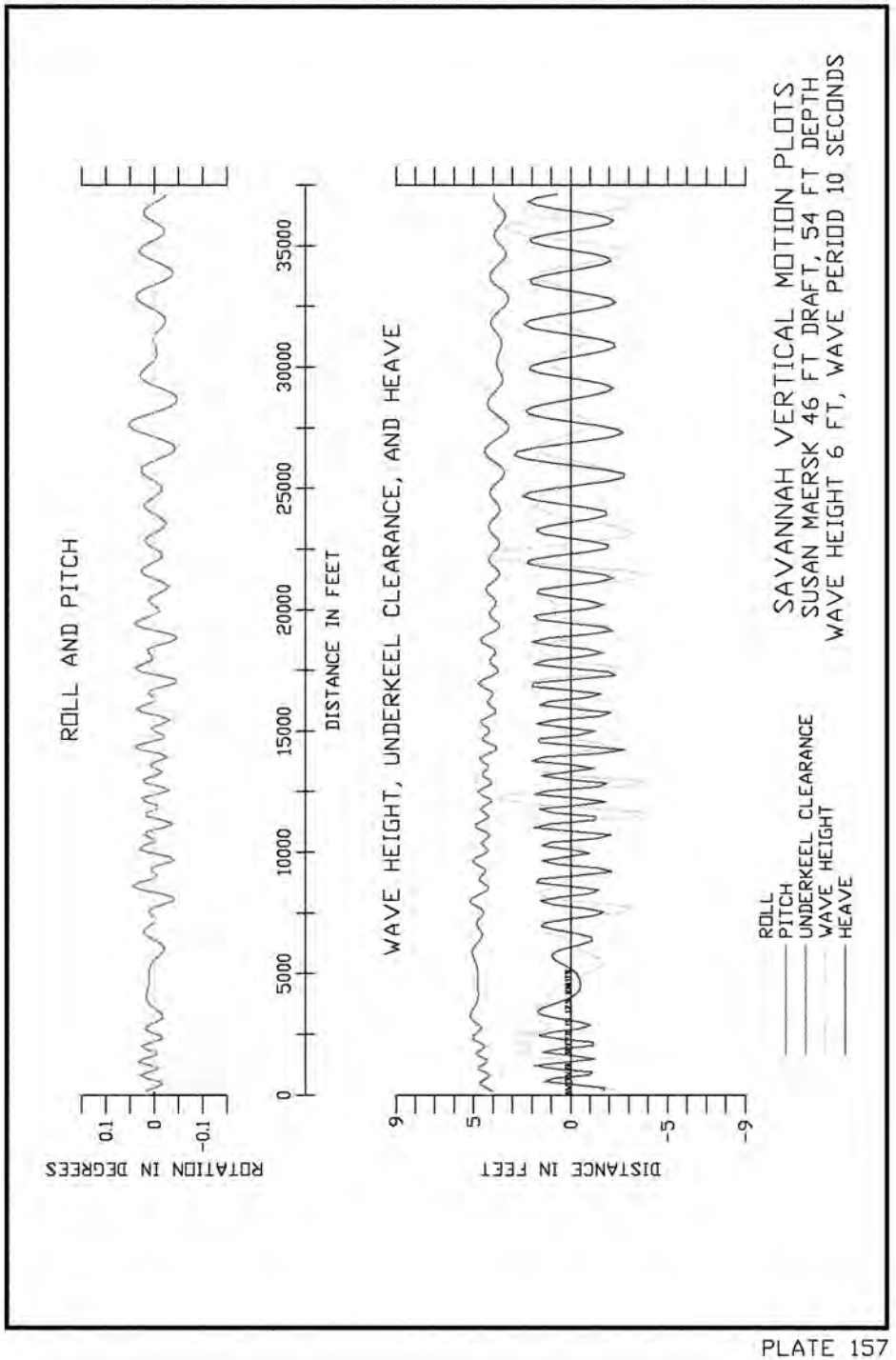

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 46 FT DRAFT, 54 FT DEPTH
WAVE HEIGHT 6 FT, WAVE PERIOD 10 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
DISTANCE IN FEET
0
5000
10000
15000
20000
25000
30000
35000

PLATE 157

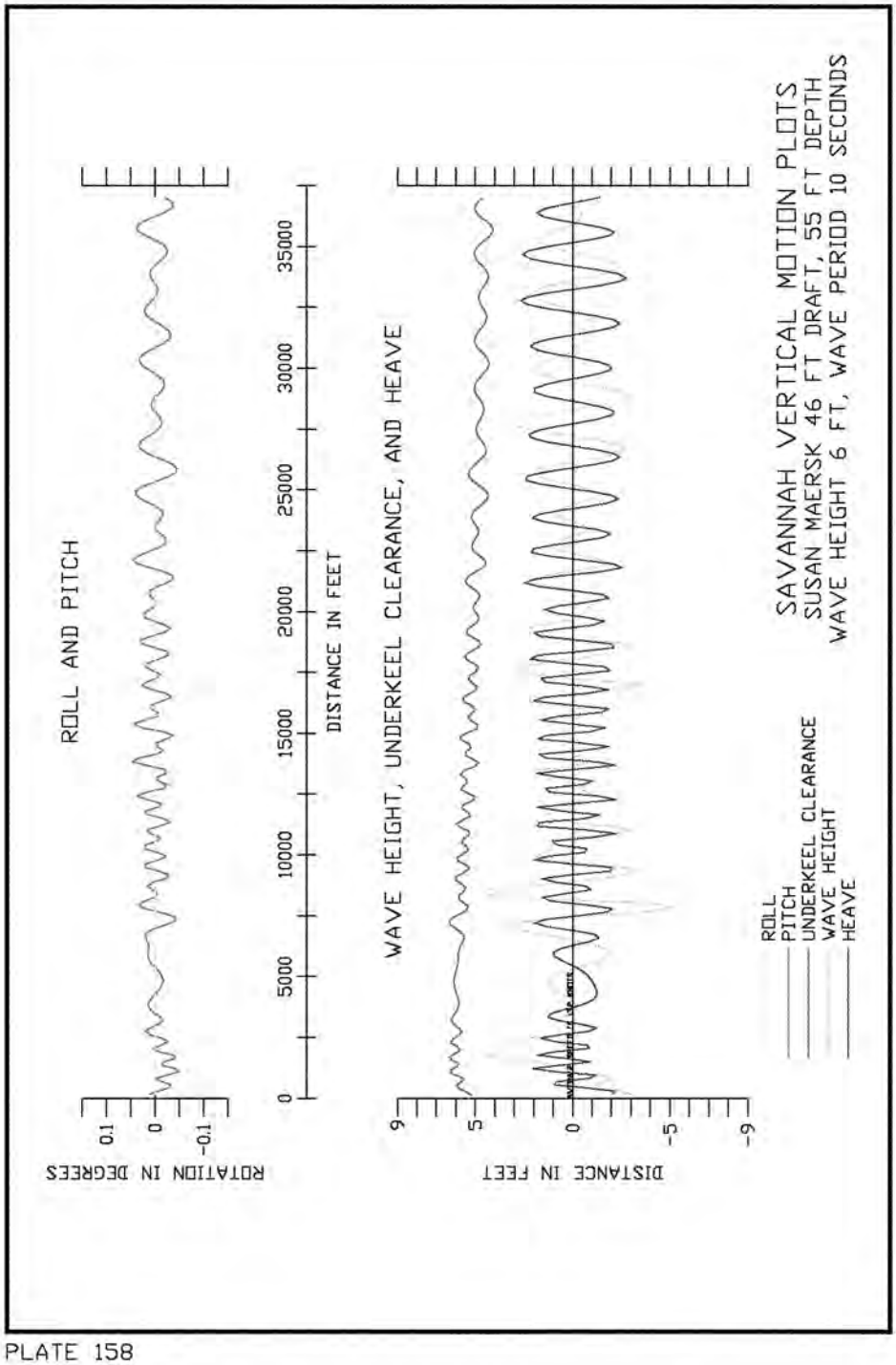

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 46 FT DRAFT, 55 FT DEPTH
WAVE HEIGHT 6 FT, WAVE PERIOD 10 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
0
5000
10000
15000
20000
25000
30000
35000
DISTANCE IN FEET

PLATE 158

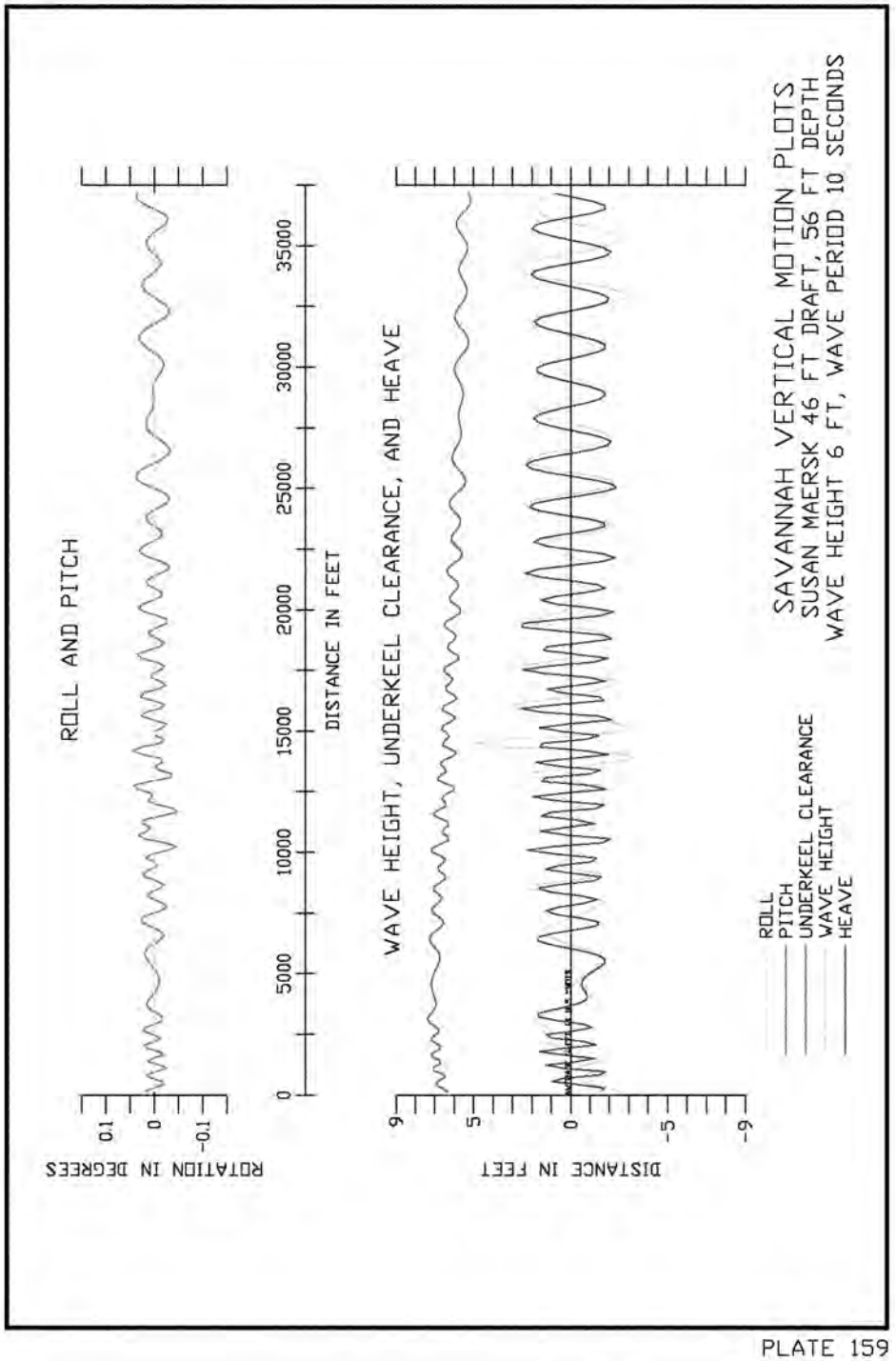

ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
0
5000
10000
15000
20000
25000
30000
35000
DISTANCE IN FEET
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 46 FT DRAFT, 56 FT DEPTH
WAVE HEIGHT 6 FT, WAVE PERIOD 10 SECONDS

PLATE 159

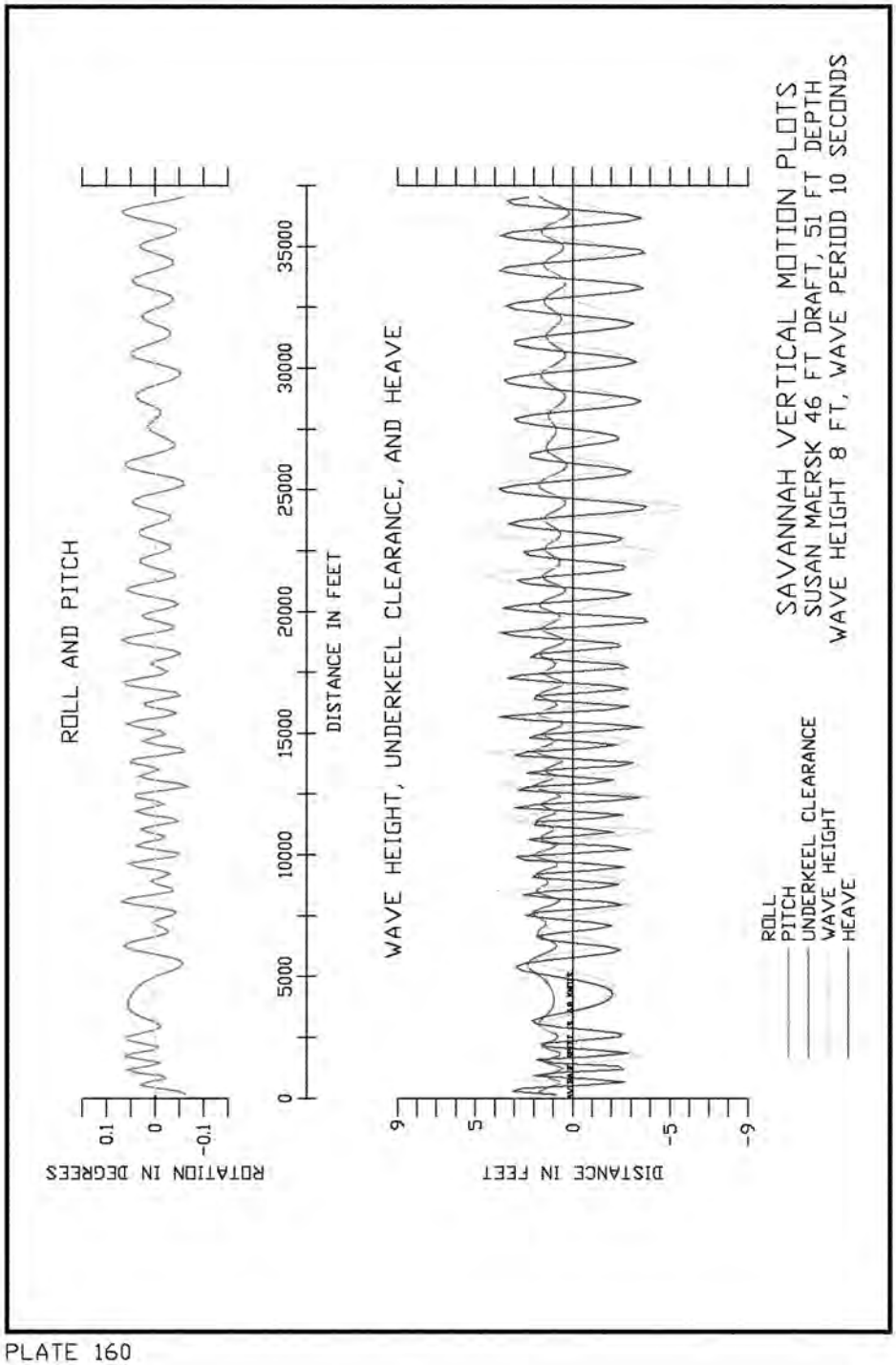

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 46 FT DRAFT, 51 FT DEPTH
WAVE HEIGHT 8 FT, WAVE PERIOD 10 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
DISTANCE IN FEET
0
5000
10000
15000
20000
25000
30000
35000
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1

PLATE 160

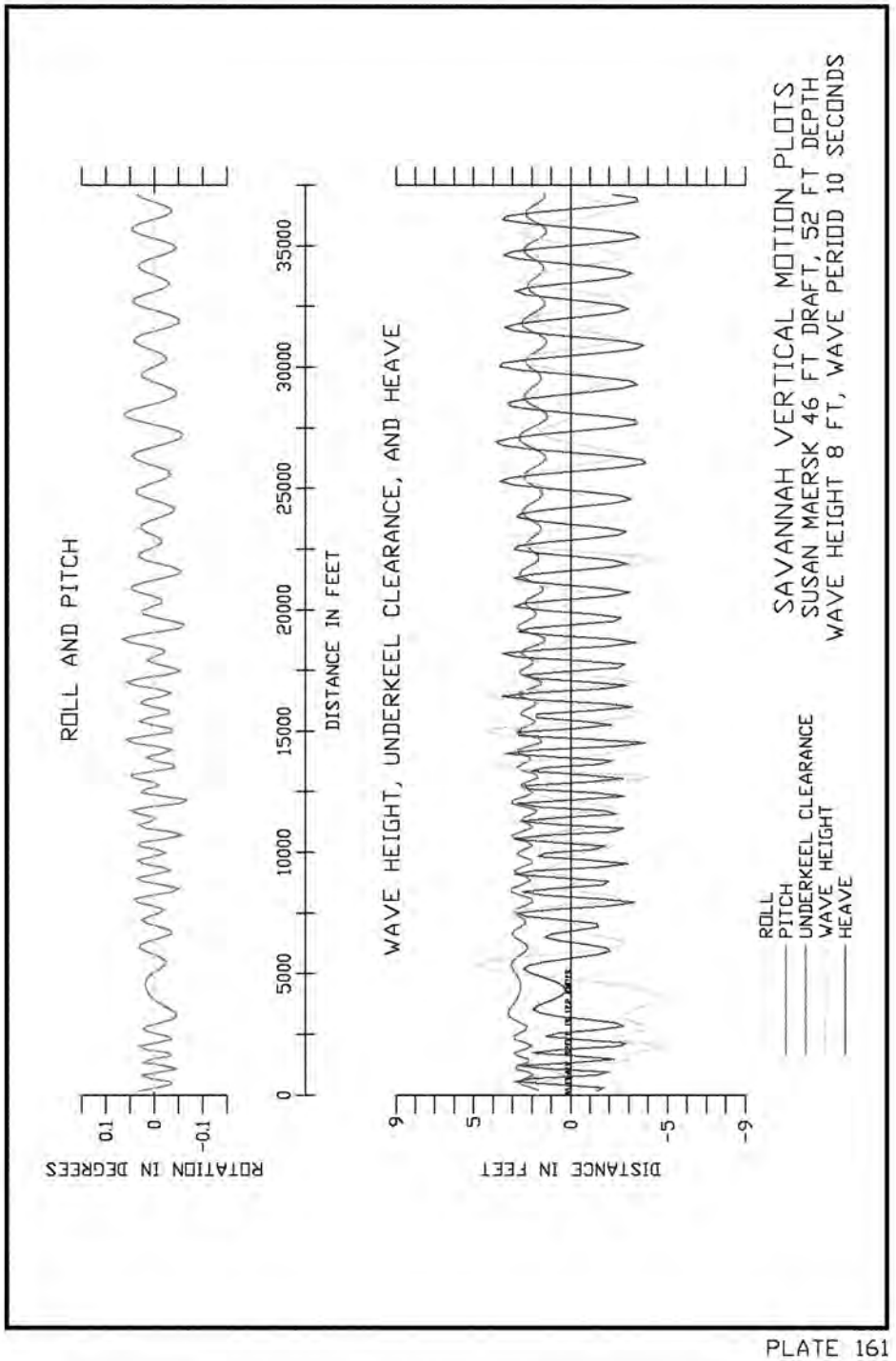

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 46 FT DRAFT, 52 FT DEPTH
WAVE HEIGHT 8 FT, WAVE PERIOD 10 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
0
5000
10000
15000
20000
25000
30000
35000
DISTANCE IN FEET

PLATE 161

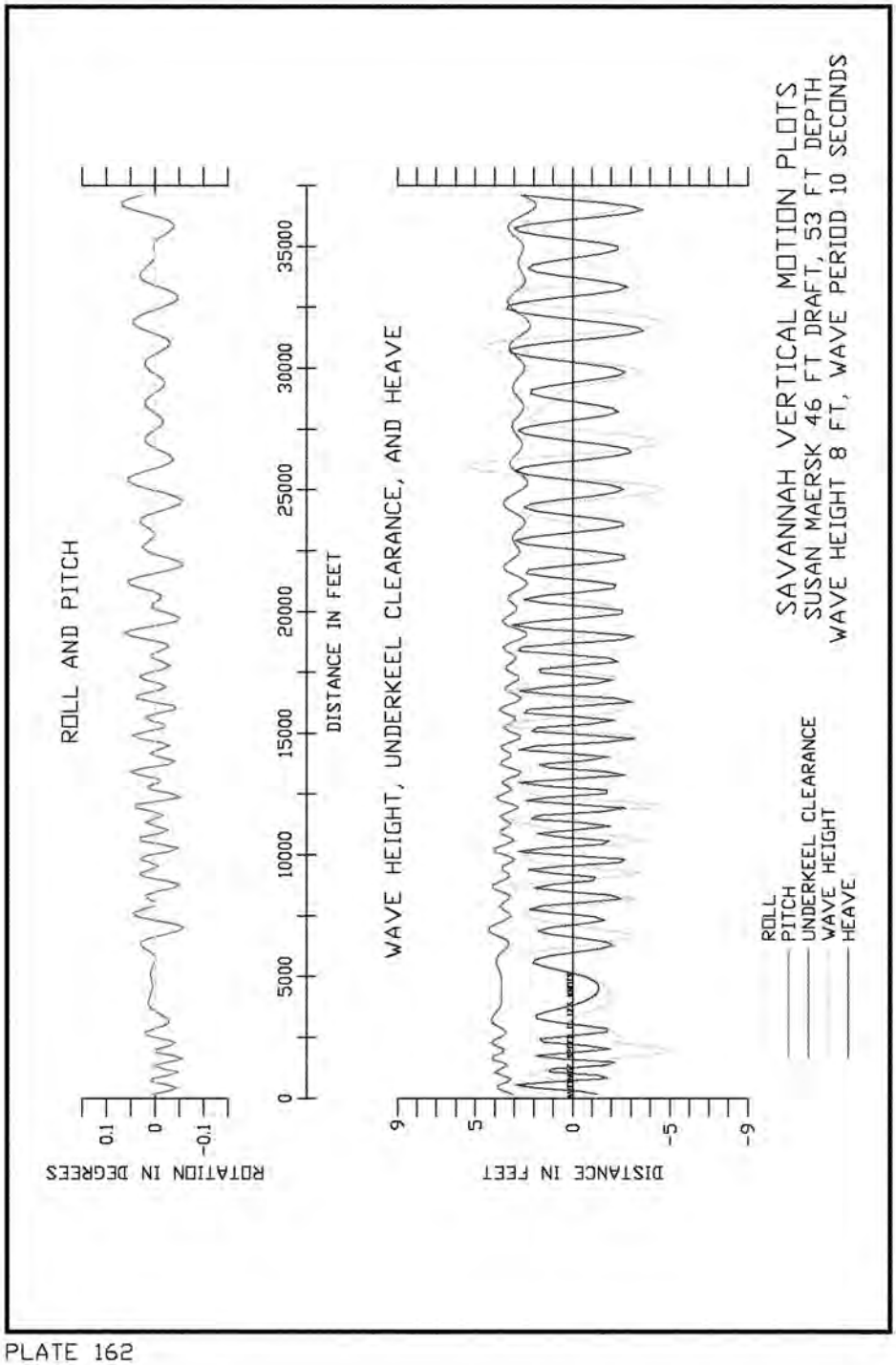

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 46 FT DRAFT, 53 FT DEPTH
WAVE HEIGHT 8 FT, WAVE PERIOD 10 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
0
5000
10000
15000
20000
25000
30000
35000
DISTANCE IN FEET

PLATE 162

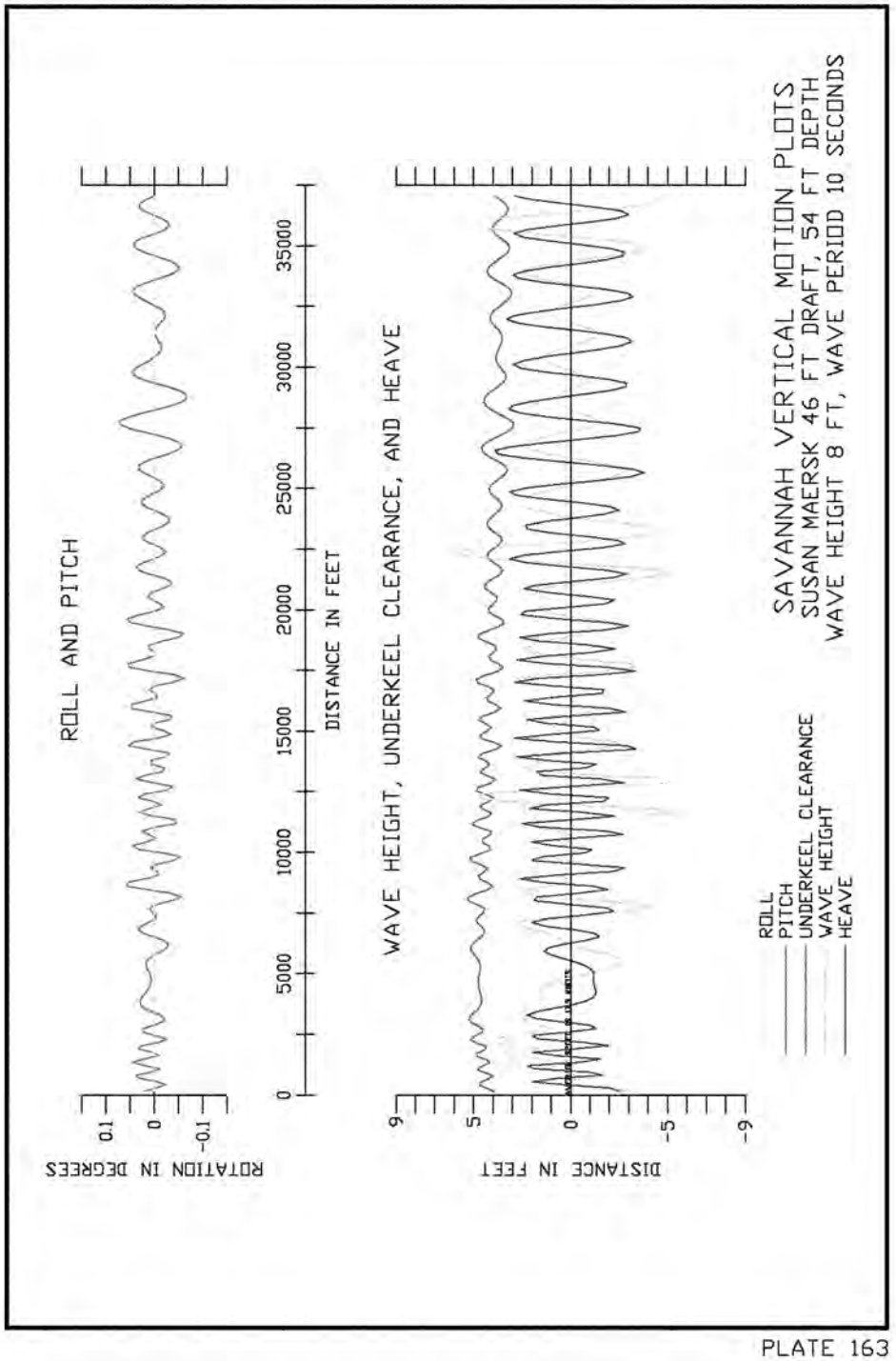

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 46 FT DRAFT, 54 FT DEPTH
WAVE HEIGHT 8 FT, WAVE PERIOD 10 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
0
5000
10000
15000
20000
25000
30000
35000
DISTANCE IN FEET

PLATE 163

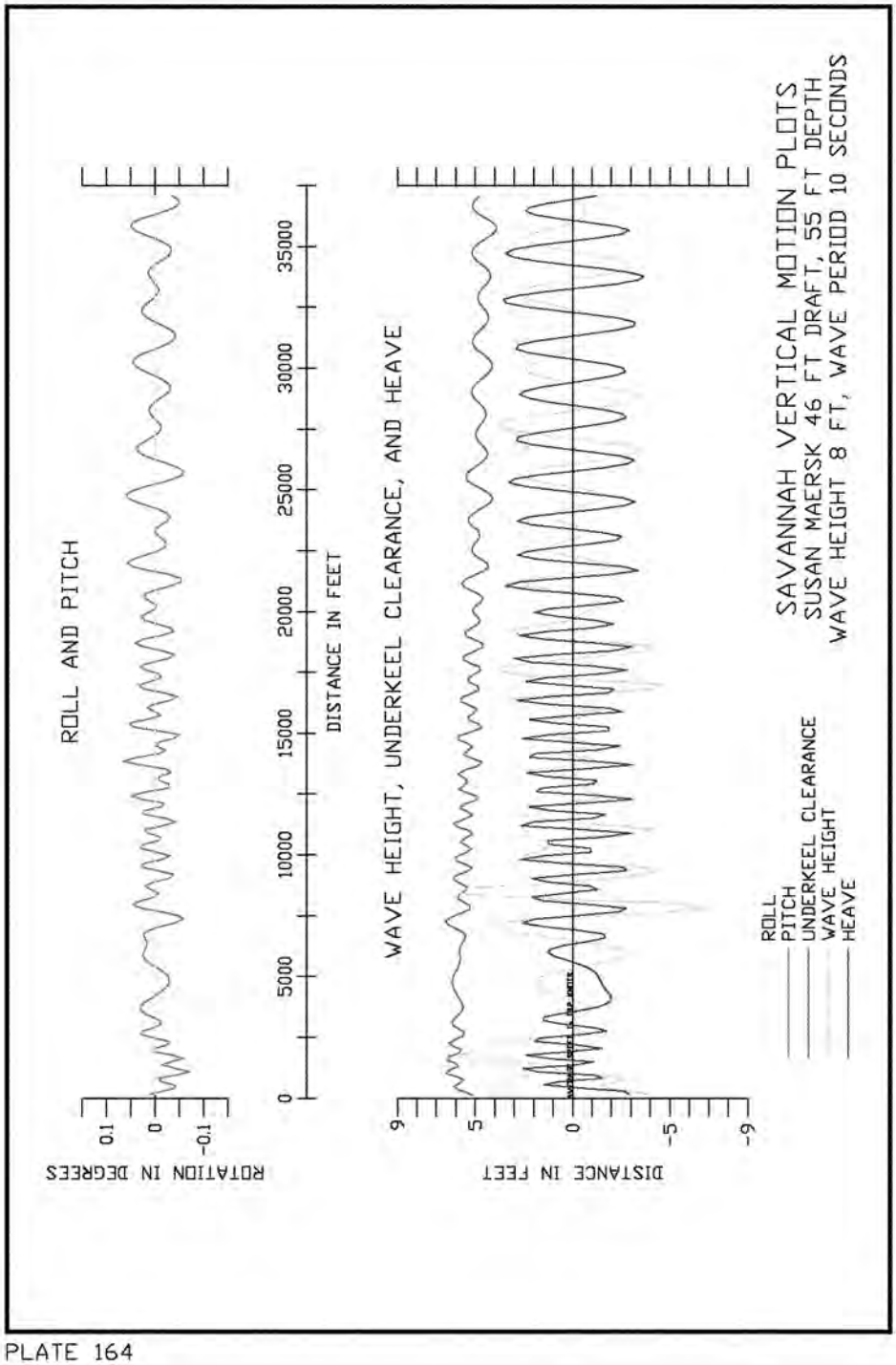

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 46 FT DRAFT, 55 FT DEPTH
WAVE HEIGHT 8 FT, WAVE PERIOD 10 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
0
5000
10000
15000
20000
25000
30000
35000
DISTANCE IN FEET

PLATE 164

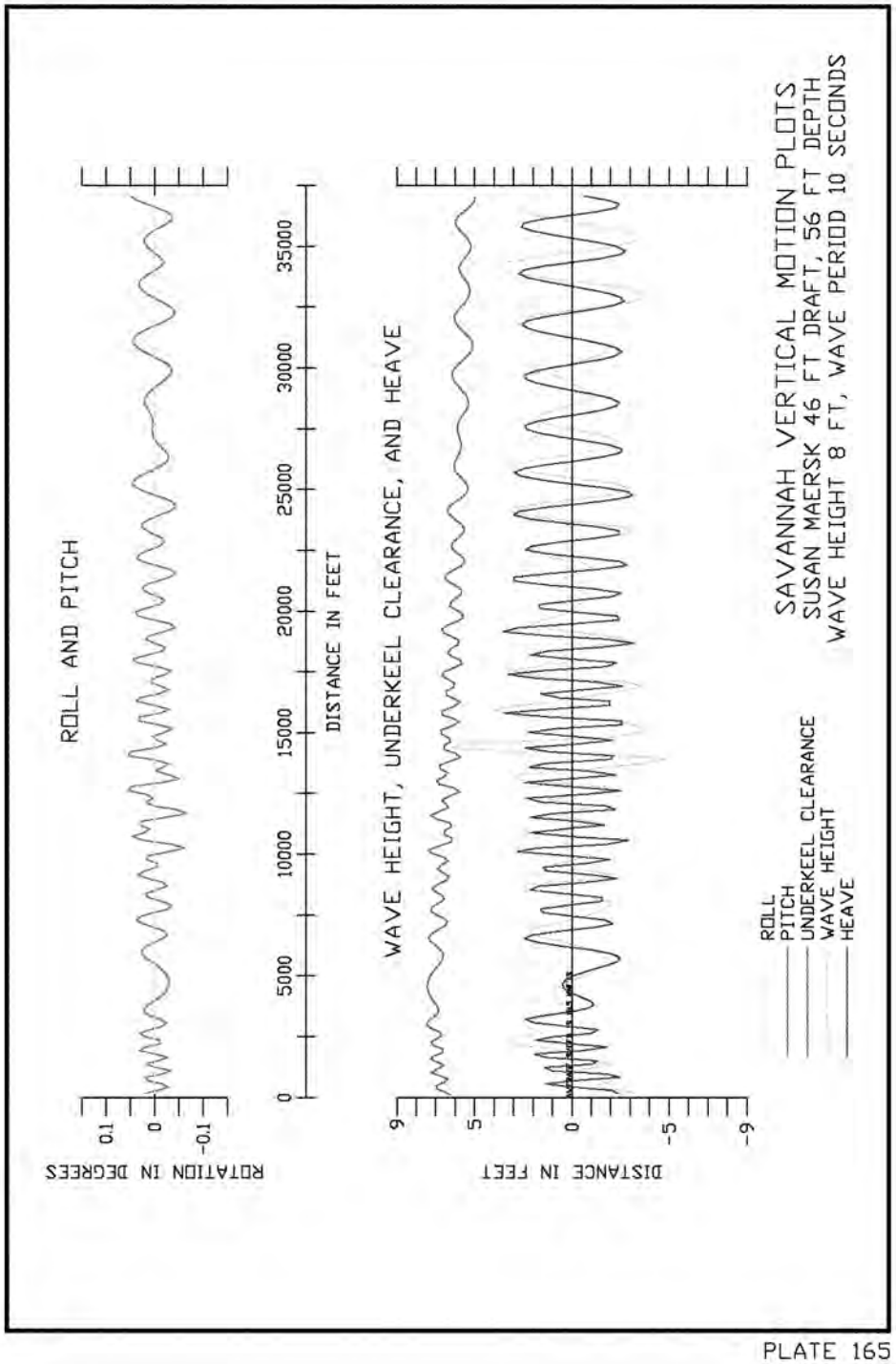

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 46 FT DRAFT, 56 FT DEPTH
WAVE HEIGHT 8 FT, WAVE PERIOD 10 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
DISTANCE IN FEET
0
5000
10000
15000
20000
25000
30000
35000

PLATE 165

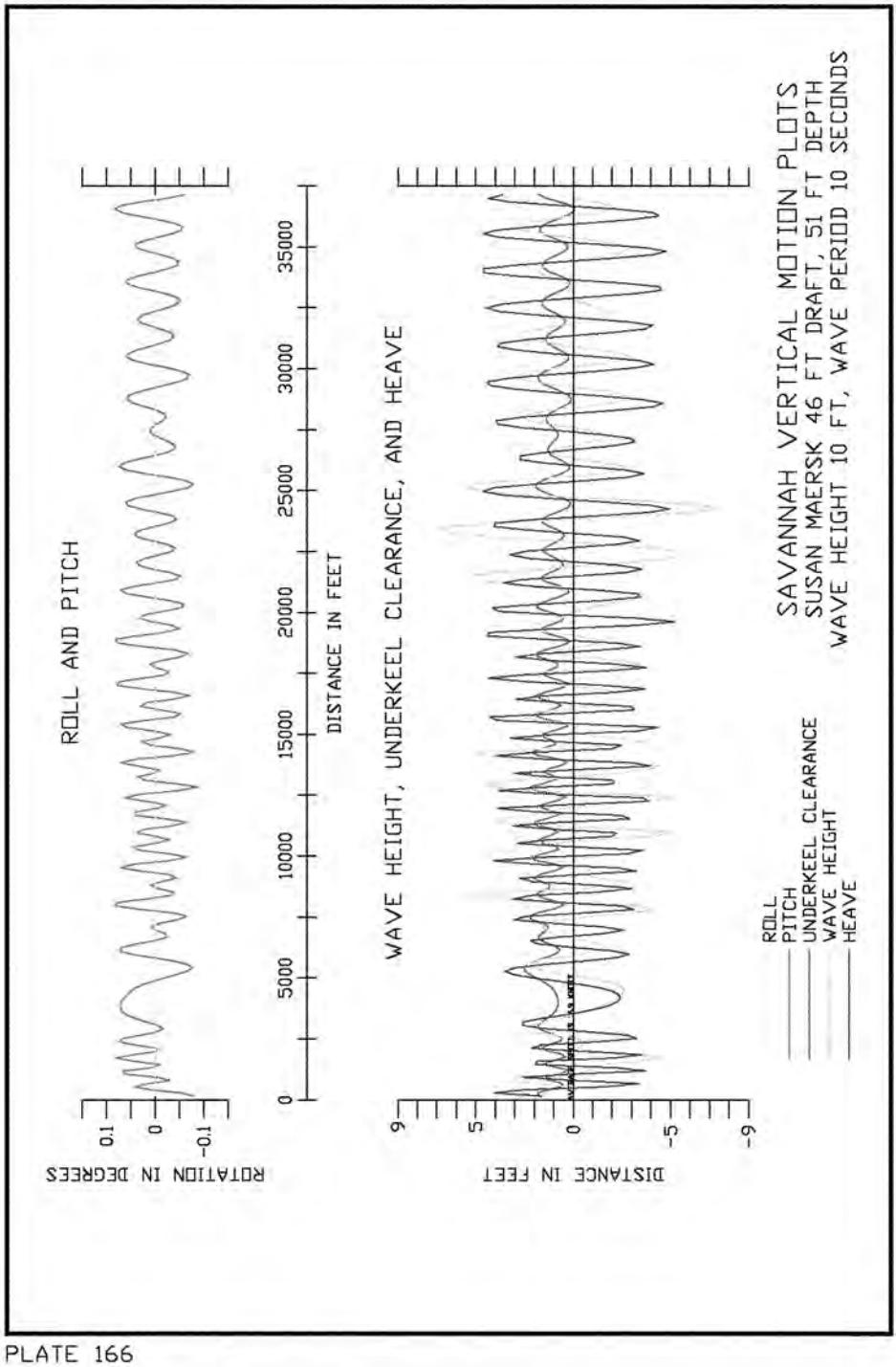

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 46 FT DRAFT, 51 FT DEPTH
WAVE HEIGHT 10 FT, WAVE PERIOD 10 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
DISTANCE IN FEET
0
5000
10000
15000
20000
25000
30000
35000

PLATE 166

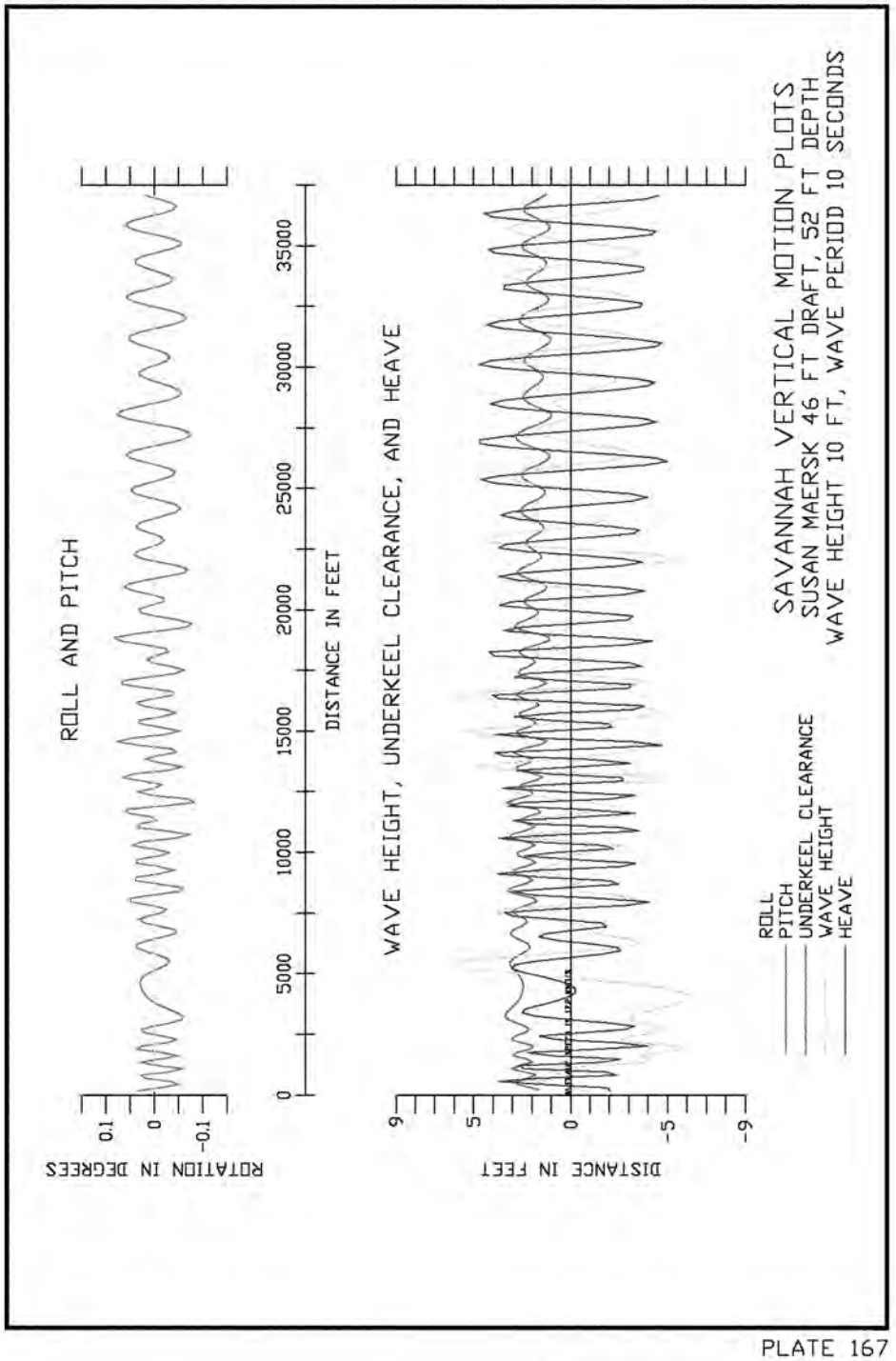

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 46 FT DRAFT, 52 FT DEPTH
WAVE HEIGHT 10 FT, WAVE PERIOD 10 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
0
5000
10000
15000
20000
25000
30000
35000
DISTANCE IN FEET

PLATE 167

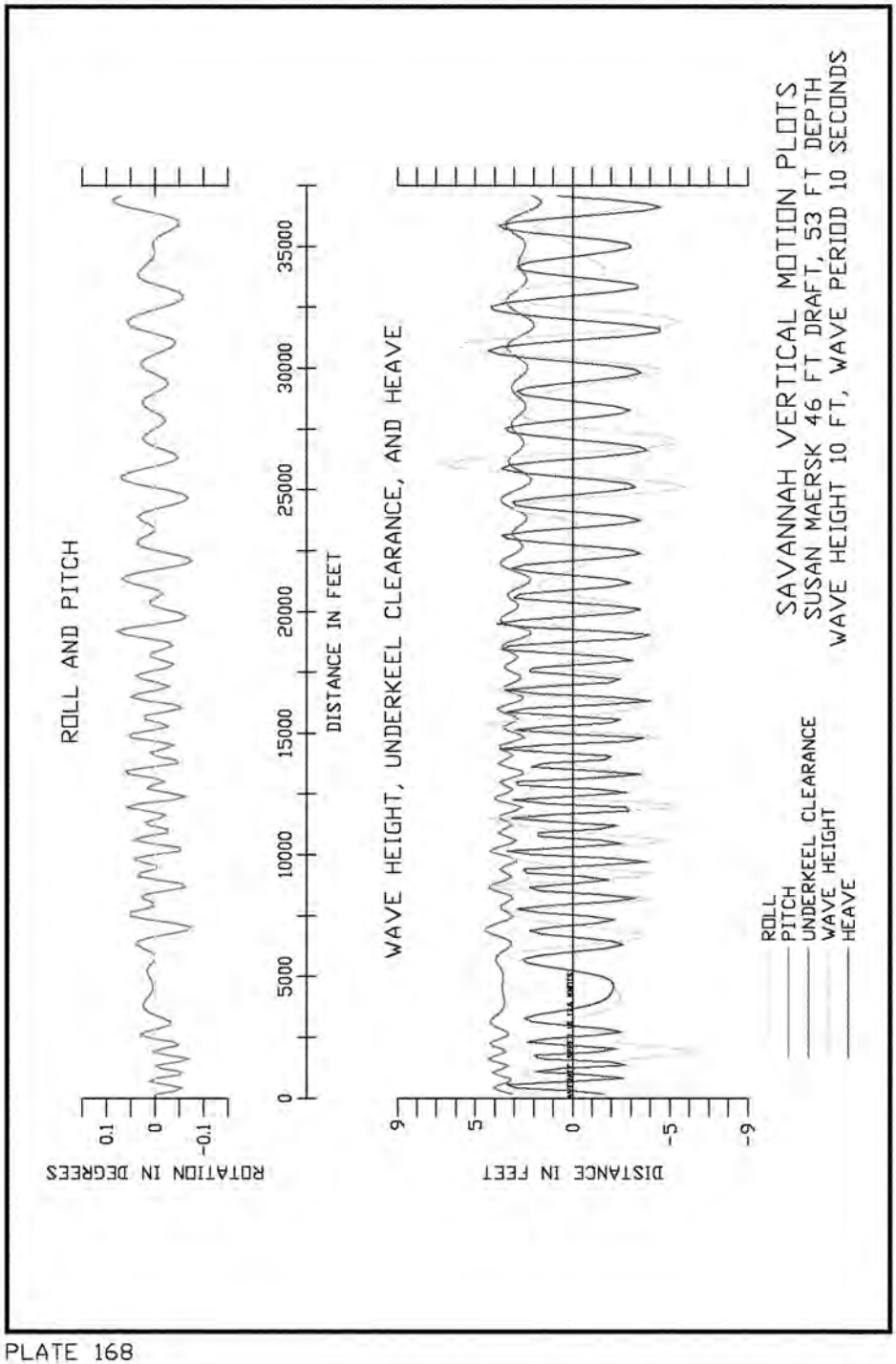

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 46 FT DRAFT, 53 FT DEPTH
WAVE HEIGHT 10 FT, WAVE PERIOD 10 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
0
5000
10000
15000
20000
25000
30000
35000
DISTANCE IN FEET

PLATE 168

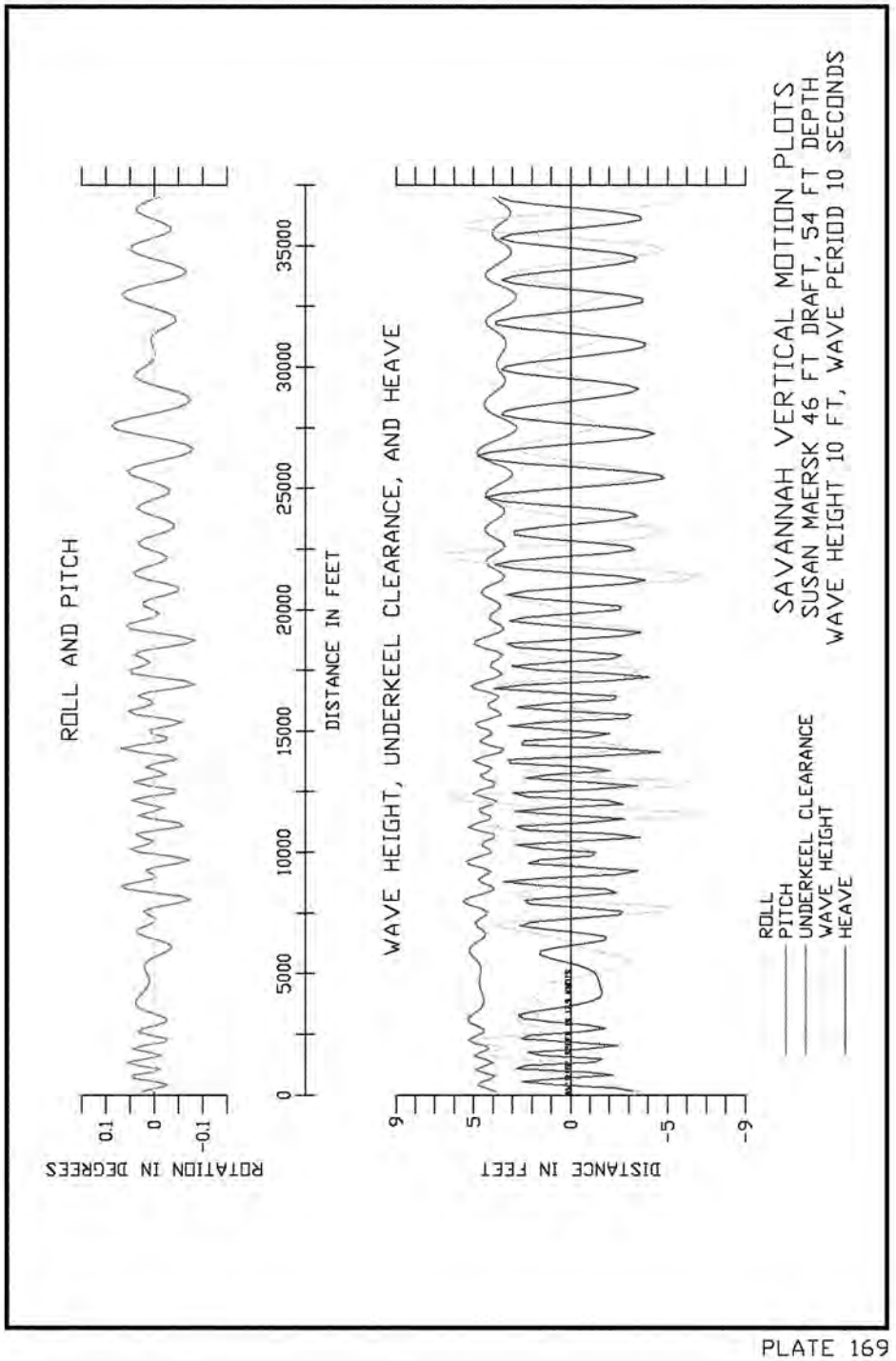

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 46 FT DRAFT, 54 FT DEPTH
WAVE HEIGHT 10 FT, WAVE PERIOD 10 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
0
5000
10000
15000
20000
25000
30000
35000
DISTANCE IN FEET

PLATE 169

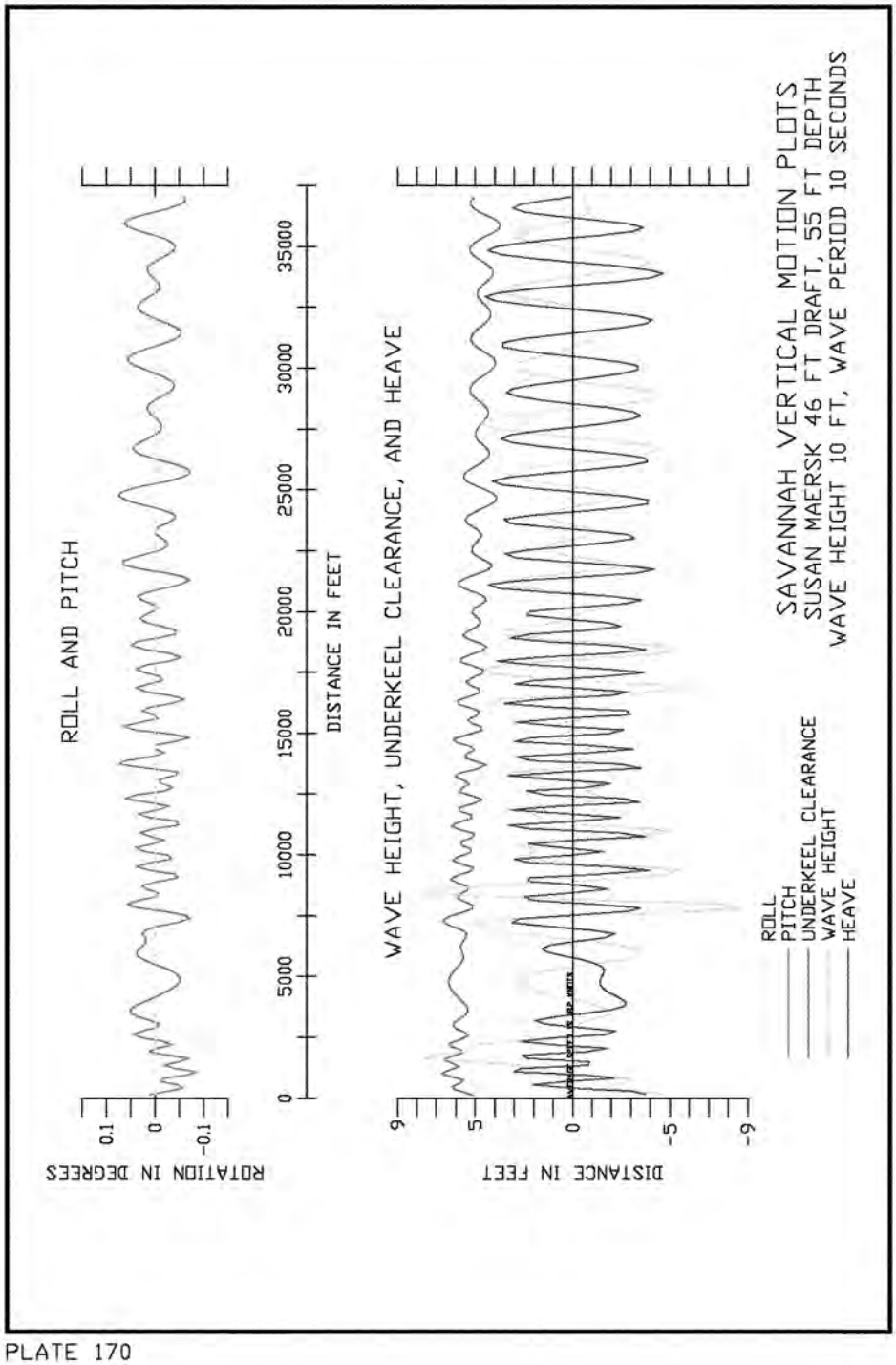

SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 46 FT DRAFT, 55 FT DEPTH
WAVE HEIGHT 10 FT, WAVE PERIOD 10 SECONDS
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
DISTANCE IN FEET
0
5000
10000
15000
20000
25000
30000
35000

PLATE 170

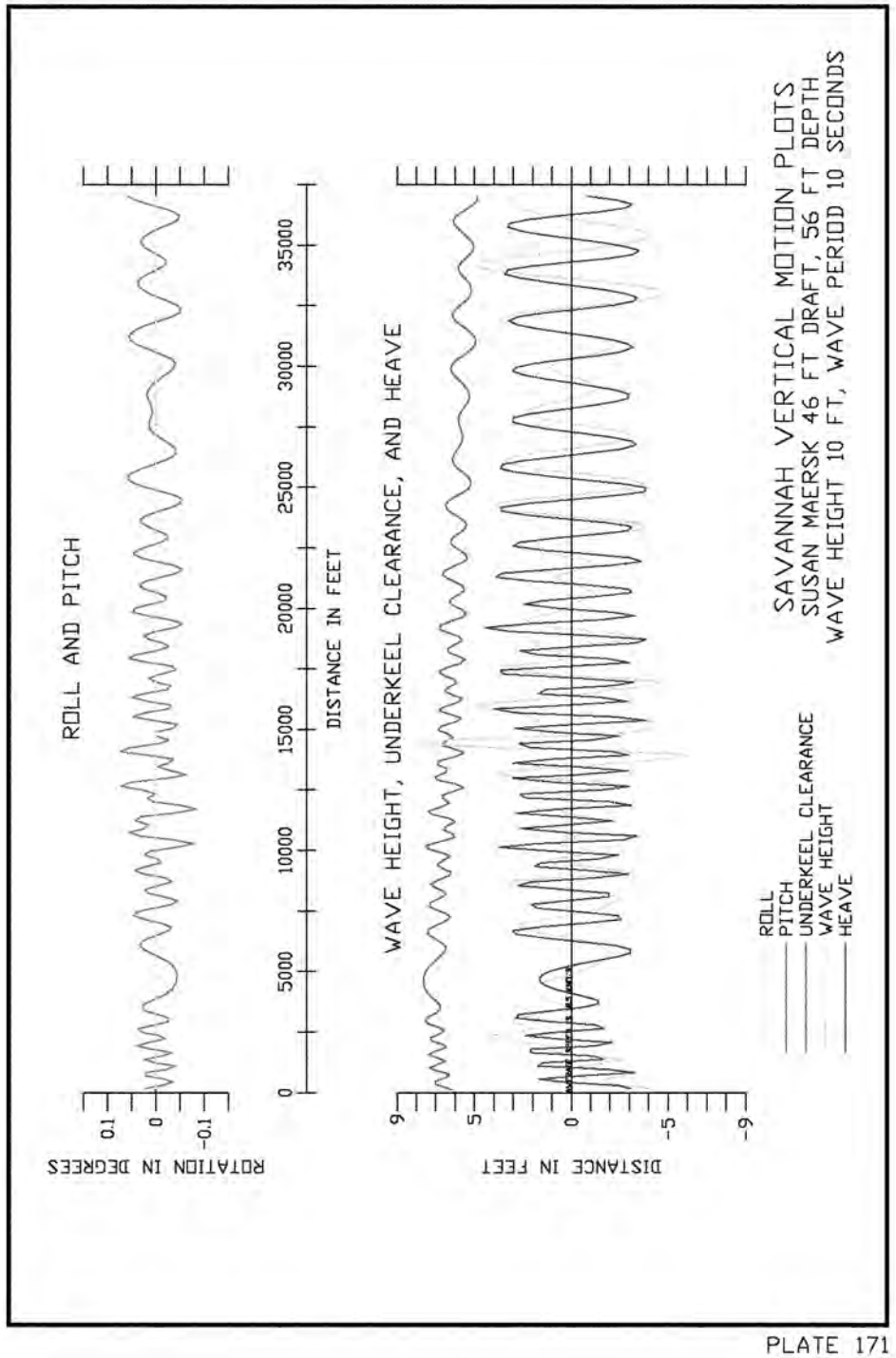

ROLL AND PITCH
ROTATION IN DEGREES
0.1
0
-0.1
0
5000
10000
15000
20000
25000
30000
35000
DISTANCE IN FEET
WAVE HEIGHT, UNDERKEEL CLEARANCE, AND HEAVE
DISTANCE IN FEET
9
5
0
-5
-9
ROLL
PITCH
UNDERKEEL CLEARANCE
WAVE HEIGHT
HEAVE
SAVANNAH VERTICAL MOTION PLOTS
SUSAN MAERSK 46 FT DRAFT, 56 FT DEPTH
WAVE HEIGHT 10 FT, WAVE PERIOD 10 SECONDS

PLATE 171

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. **PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.**

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
September 2004	Final report	

4. TITLE AND SUBTITLE

Navigation Study for Savannah Harbor Channel Improvements

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

Dennis Webb

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

U.S. Army Engineer Research and Development Center
Coastal and Hydraulics Laboratory
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

8. PERFORMING ORGANIZATION REPORT NUMBER

ERDC/CHL TR-04-13

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

U.S. Army Engineer District, Savannah
PO Box 889
Savannah, GA 31402-088

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT

Savannah Harbor is located on the eastern shore of the state of Georgia. The harbor is being evaluated for deepening and widening. The purpose of the proposed improvements is to accommodate larger, deep-draft containerships to use the port. The widening is being considered to provide additional room for two-way traffic. To evaluate these improvements a real-time ship simulation study was undertaken. Simulation models were developed for both Savannah's present and future conditions. Pilots from Savannah Harbor operated the simulator as they would in real-life. Based upon these simulations, a final improved channel was developed.

15. SUBJECT TERMS

Savannah
HARBORS
Containership
Navigation study
Simulation

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			19b. TELEPHONE NUMBER *(include area code)*
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED		222	

ERDC/LAB TR-0X-X

US Army Corps
of Engineers®
Engineer Research and
Development Center

DRAFT

Impacts of Savannah Harbor Expansion Project

Jane McKee Smith, Donald K. Stauble, Brian P. Williams,
Raymond Chapman

October 2006

Coastal and Hydraulics Laboratory

ERDC/CHL TR-0X-X
October 2006

Impacts of Savannah Harbor Expansion Project

Jane McKee Smith and Donald K. Stauble

Coastal and Hydraulics Laboratory
U.S. Army Engineer Research and Development Center
3909 Halls Ferry Road
Vicksburg, MS 39180-3999

Brian P. Williams

Charleston District

Raymond Chapman

Coastal and Hydraulics Laboratory

Draft report

Prepared for U.S. Army Corps of Engineers, Savannah District

1 Introduction

Savannah Harbor is a deep-draft harbor on the South Atlantic at Savannah, Georgia. The harbor and deep-draft navigation channel comprise the lower 21.3 miles of the Savannah River and 11.4 miles of channel across the bar to the Atlantic Ocean. This study evaluates the impact of deepening the Savannah navigation channel from the present -44 ft MLW to -50 ft MLW. This report documents the results of the numerical circulation, wave, and sediment transport modeling and the updated sediment budget analysis performed by Wilmington and Charleston District and the Engineer Research and Development Center.

This study was conducted under two tasks. The first task was analysis of shoreline and sediment volume. This task is documented in Chapter 2. The second task involved numerical modeling of circulation, waves, and potential sediment transport for the existing bathymetry and the deepened channel bathymetry. The models were run for four month-long simulations (November 1979, January 1992, July 1999, and December 1999) and for Hurricane Hugo (September 1989) re-tracked to directly hit Savannah. The circulation, wave, and sediment transport modeling is documented in Chapter 3, 4, and 5, respectively. A summary and conclusions is provided in Chapter 6.

2 Shoreline and Volume Change Analysis

Introduction

Congress authorized construction of the Federal navigation project at Savannah Harbor, and it was initially constructed in 1874. The Savannah River empties into the Atlantic Ocean on the border between Georgia and South Carolina. The shoreline is composed of several shore barrier islands known as the Sea Islands along the Georgia Bight, an embayment in the north-south orientation of the coast (Figure 2-1). The barrier islands to the north of the Savannah River entrance are Hilton Head, Daufuskie and Turtle. Calibogue Sound is a north/south oriented inlet separating Hilton Head Island from the embayed Daufuskie Island. The New River Entrance bisects Daufuskie and Turtle Islands. The Wright River Entrance separates Turtle Island from Oyster Bed Island. The main navigation channel of the Savannah River is south of Oyster Bed Island. Cockspur Island separates the main navigation channel from the South Channel of the Savannah River. Two jetties were constructed at the mouth of the Savannah River entrance, completed in 1896, and a submerged offshore breakwater, completed in 1897 to stabilize the inlet and provide a shelter for shipping entering Tybee Roads. Tybee Island is located on the south side of the entrance channel to the Savannah River. Tybee Creek separates Tybee Island from Little Tybee Island on the south.

The navigation channel of the Savannah River was deepened from 21.5 ft mlw to a depth of 26 ft mlw in 1912 to accommodate larger ships. Depth increases were later made in 1936 to 30 ft mlw and 1945 to 36 ft mlw. The channel was widened and deepened in 1972 to a depth of 40 ft mlw. In 1994, the authorized depth of the channel was increased to 44 ft mlw. At present, approximately 31 miles of navigation channel exist, extending from Savannah Harbor across Tybee Roads into the Atlantic Ocean. Construction and maintenance of the Federal navigation channel at Savannah Harbor has resulted in disruption of sediment transport pathways across Tybee Roads. Sediment shoaling in the navigation channel has necessitated annual dredging in order to maintain navigability (Figure 2-2). The magnitude and frequency of channel dredging confirms intersection of sediment pathways in this complex coastal setting of high tidal ranges and short barrier islands bisected by numerous tidal inlets.

Northern Tybee Island, located directly downdrift of the Savannah Harbor navigation channel has experienced shoreline recession, particularly along the north-south oriented oceanfront between 1st St and 6th St. To mitigate for this erosion, a beach nourishment project placed sand on the beach at four separate times from 1986 to 2000. An 800-ft-long north terminal groin was constructed in 1975 to trap sand from moving north along the shoreline. A 600-ft-long South Terminal Groin was constructed in 1986/87 to trap and hold fill sand on the southern end of Tybee Island. Erosion south of this groin required construction of two additional T-head Groins

and an L-head terminal groin further to the south in 1994 to retain sand at the very southern end of the island.

The purpose of this report is to evaluate the impact of deepening the Federal navigation project at Savannah Harbor. This chapter investigates the long-term trends at Savannah to place the deepening in perspective. The goals of this study are to assess the impact of the Savannah Harbor navigation project on the regional morphology and to quantify the influence of the navigation project on increased shoreline recession rates along Tybee Island. These will be evaluated through a combination of quantitative shoreline change analysis, volume change calculations, and hydro/sediment modeling. A review of aspects of the ATM (2001) report is included in this effort based on critical comments of the review of that document.

For the Savannah Harbor Channel, data available prior to the date of construction (1874) based on early National Oceanic and Atmospheric Administration (NOAA) National Ocean Survey (NOS) topographic (known as T sheets) and hydrographic surveys (known as H sheets) are likely to have a higher degree of error, inherent with early survey data. Therefore, the determination of regional shoreline change trends over the lifetime of the project was done to minimize errors in the volume change analyses. Regional trends will allow comparison of shoreline change over contemporary time periods during which coastal processes are similar.

Shoreline Change Analysis

Shorelines were acquired from various sources to evaluate the shoreline change history of both Tybee Island on the Georgia side of Savannah River Entrance and the three islands on the South Carolina side of the entrance. Table 2-1 summarizes the mean high water (MHW) shorelines that were used in this study and the sources of the data. All of the early data were digitized field surveys from NOAA T sheets. The USACE Savannah District (SAS) supplied some of the data from their digital files from the NOAA T sheets. Some of the shorelines were digitized by Coastal Carolina University from paper maps from a joint NOAA/CERC (Coastal Engineering Research Center) shoreline movement study covering Tybee Island Georgia to Cape Fear, North Carolina (Anders et al. 1990). These shorelines were compiled by NOAA from field survey T sheets and the 1982 shoreline was from aerial photography and is archived at the USACE Coastal and Hydraulics Laboratory (CHL). The US Geological Survey (USGS) has completed a study on long-term shoreline change along the Southeast Atlantic coast using four shoreline periods to calculate change rates (Miller, Morton and Sallinger 2005). This analysis used the NOAA/CERC shorelines from 1863, 1920 (South Carolina beaches only) and 1963 shorelines, and NOAA T-sheets from 1925 for Georgia beaches (Tybee Island). The 1999 Georgia and 2000 South Carolina shorelines were derived from LIDAR surveys conducted by the USGS. The Savannah District supplied a set of beach profiles surveyed in February 2005. The MHW shoreline was derived from the MHW elevation (3.07 ft above NAVD88) on each profile based on the NOAA tide station 8670870 at Ft Pulaski, located on Cockspur Island at the mouth of the Savannah River and contoured using ArcView GIS software. A digital aerial photograph flown in October 2005, with a resolution of 1 ft, was supplied by Wilber Wiggins of SAS. A visual shoreline was digitized off the high-resolution air photo in the GIS using the local high water mark visible on the air photo.

Table 2-1. Historic Shorelines used in report				
Date	Georgia	Source	South Carolina	Source
1854	x	SAS	x	SAS
1863	x	USGS NOAA/CERC	x	USGS NOAA/CERC
1900	x	SAS		
1920	x	SAS	x	SAS/USGS
1925	x	USGS		
1964	x	NOAA/CERC	x	USGS NOAA/CERC
1970			x	NOAA/CERC
1971	x	USGS		
1982/84			x	NOAA
1992		NOAA		
1993	x	SAS	x	SAS
1997	x	SAS	x	SAS
1999	x	USGS LIDAR		
2000			x	USGS LIDAR
2005	Profiles-Feb Air Photo Oct	SAS		

The historical shoreline positions generated for this study for Tybee Island are shown in Figure 2-3. A distinct change in shoreline orientation can be seen between the 1863 shoreline and the 1900 shoreline. A bulge in the northern Tybee shoreline present in the 1854 and 1863 shoreline was removed by the 1900 shoreline. This bulge was also present on an 1867 NOAA nautical chart. The loss of this large volume of sand was most likely due to the jetty construction (1886-1896, Sargent 1988). The island grew southward at its southern tip and accreted seaward south of the budge at the same time as the ocean shoreline was reorienting itself. The northern end of the island also expanded to the north and west. A more detailed look at the shoreline change over time is illustrated in Figure 2-4 which shows the historical shoreline position change at the north end of the island. The general trend is for the north tip of Tybee Island to migrate northward into the southern channel of the Savannah River and also to progressively move westward over time.

The central portion of Tybee Island has shown erosion of the bulge between 1867 and 1900 with a movement of sand both north and south and accretion to the north and south of the area formerly occupying the bulge. A hot spot is located between 1st and 6th Streets where the shoreline has rotated around a nodal point in the vicinity of 2nd Street (Figure 2-5). South of the nodal point the shoreline has moved seaward over time. The southern part of the island has grown to the south and seaward over the historic period with the most change taking place between 1863 and 1900 (Figure 2-6).

Shore protection efforts that affected the shoreline position are summarized in Table 2-2. Numerous seawall and groin structures were constructed from 1912 to 1941 to protect the upland from erosion. Figure 4-5 in the ATM report identifies the locations of these historic seawall and groins along the Tybee Island shoreline. In 1976 the North Terminal Groin was constructed and a 2.2 mil cy beach fill was placed on the beachfront from the groin south to 18th Street (Figure 2-7). The South Terminal Groin was constructed in 1986-87 and the North Terminal Groin was rehabilitated. A second 1.2 mil cy fill was placed on the beach between the two terminal groins at that time as well as placement of 0.157 mil cy of fill to the south of the South Terminal Groin. Fill material was placed between the North Terminal Groin and 3rd Street in 1993 to mitigate for the hot spot erosion. Erosion persisted at the south end of the island so two T-Head Groins and a

L-Head groin were constructed in 1994 south of the South Terminal Groin to help retain sand. In 1995, 285,000 cy of fill was placed on the southern end of the island between 13th Street and the South Terminal Groin and 50,000 cy of fill was placed between that Groin and the L-Head groin. Another 1.5 mil cy of fill was placed between the two Terminal Groins in 2000, with an additional 0.2 mil cy of fill placed between the South Terminal Groin and the L-Head Groin on the south end.

Table 2-2. Navigation and Shoreline Erosion Control Efforts, Tybee Island Vicinity

Date	Construction
1874	Initial dredging of navigation channel to 21.5 ft mlw
1886-1896	Construction of North and South Jetties at entrance to Savannah R.
1897	Construction of submerged offshore Breakwater at Tybee Roads
1912	Construction of steel pile old seawall 1st St vicinity
1915	Navigation channel deepened to 26 ft mlw
1928	Construction of wood groins along beach
1930	Construction of 2 groins along Ft Screven beachfront
1931	Construction of 3 additional groins along Ft Screven beachfront
1936	Construction of wood groins by WPA along beachfront
	Navigation channel deepened to 30 ft mlw
1937	Construction of wood groins by WPA along beachfront
1938	Construction of wood groins by WPA along beachfront
1939	Construction of wood groins by WPA along beachfront
1940	Construction of wood groins by WPA along beachfront
	Construction of concrete bulkhead (seawall) along ocean front.
1941	Construction of wood groins by WPA along beachfront
1945	Navigation channel deepened to 36 ft mlw
1964	Placed riprap in front of seawall
1972	Navigation channel deepened to 40 ft mlw
1975-1976	Construction of 800 ft long North Terminal Groin
	2.2 mil cy beach fill placed between North Terminal Groin and 18th St.
1986-1987	600 ft South Terminal Groin constructed
	North Terminal Groin rehabilitated
	1.2 mil cy fill placed between groins
	0.157 mil cy fill placed south of South Terminal Groin
1993-1994	1.5 mil cy Fill placed North Terminal Groin to 3rd St.
	Navigation channel deepened to 44 ft mlw
	South Beach 2 T-Head Groins and 1 L-Head Groin constructed
1995	0.282 mil cy fill placed between 13th St. and South Terminal Groin
	0.05 mil cy fill placed between South Terminal Groin and L-Head Groin
2000	1.5 mil cy fill placed between Terminal groins
	0.2 mil cy fill placed between South Terminal Groin and L-Head Groin

Source: Oertel et al. 1985, Savannah District

The historical shoreline positions for the three islands in South Carolina are shown in Figure 2-8. The general trend is for erosion of Turtle Island marsh-like open coast shoreline with steady landward retreat of the shoreline. The shoreline has moved to the south into Wright River entrance. Turtle Island is composed of mostly fine grained material typical of a marsh shoreline with little sandy open beach material. Early charts show that this has been the case since the

1850's. Daufuskie Island has also exhibited landward retreat over time, but this island has a narrow sandy beachfront more typical of an open coast barrier island shore. A private beach nourishment project placed 1.4 mil cy of sand along the island in 1998 (ATM 2001). Across Calibogue Sound entrance, the southern end of Hilton Head Island has shown accretion of the shoreline over the study period. Erosion of the northern end of Hilton Head Island required beach fills in 1980 of 550,000 cy, 1982 of 800,000 cy of fill and 1990 of 2 mil cy (Valverde et al. 1999). Drift is to the south along this island as indicated by the growth of the south end of the island to the south.

Bathymetry Change Analysis

Historic bathymetry was collected from several sources. ATM supplied bathymetry used in their report which already contained corrections for sea level rise and a correction for each data set to the NGVD 29 vertical datum. Additional historic bathymetric data sets were collected from NOAA's GEODAS database of NOS hydrographic surveys of coastal waters in the study area and were referenced either to mlw or mllw depending on date of collection. The Savannah District supplied before and after dredging surveys, as well as examination surveys of the navigation channel and a February 2005 beach and nearshore survey. Table 2-3 summarizes the historic bathymetric data sets used in this study. All data was converted to a common datum of NAVD88 meters vertical datum and latitude/longitude NAD83 horizontal datum to allow comparisons and change analysis.

The first bathymetric data set available was collected in 1854. Figure 2-9 shows the orientation of the pre-project nearshore bathymetry and natural channel orientations of the Calibogue Sound, New River, Wright River and Savannah River entrances. The Calibogue Sound bisects into two channels with a small marginal flood channel next to Hilton Head Island. The New River channel is oriented to the south. The Wright River and the Savannah River and South Channel all converge on one main channel in the vicinity of Tybee Roads. Figure 2-10 shows the 1897 bathymetry just after completion of jetty construction in 1896 at the entrance to the Savannah River and the 1897 submerged breakwater. The breakwater was constructed at the landward edge of the southern limit of Barrett Shoals (Figure 2-1). Due to the short time frame after construction, these structures may not have had time to fully affect the bathymetry. The survey is limited in area but shows the South Channel and hints at the fact that the bulge still exists on the north end of Tybee Island and that the three channels of the Wright and Savannah Rivers still converge in Tybee Roads. The 1920 bathymetry is shown in Figure 2-11 and is also limited in area coverage. Calibogue Sound channel has migrated to the south and has its distal limits controlled by the submerged breakwater which deflects the channel to the east. The jetties at the Savannah River Entrance have caused the main navigation channel to be the main channel with the South Channel shoaling in as the north end of Tybee Island eroded back and to the north and south along the shoreline. The 1920 shoreline shows a spit growing into the area formally occupied by the South Channel. The 1920 bathymetry shows deflation of the north Tybee Shelf region along the south edge of the channel and accumulation in the North Tybee Shoal. These trends are consistent with the sediment modeling in Chapter 5. The 1930/31 data set was limited just to the mouth of the Savannah River and was not used in this report due to its small area of coverage. The 1970/83 bathymetry is shown in Figure 2-12 and is a combination of several early 1970's NOAA NOS surveys that has a wide area of coverage. A 1980/83 survey was used to increase the coverage area to the south. This survey best represents the post construction area bathymetry. The dredged channel is seen as well established at this time and extends from the jetty out to the nearshore shelf. The channel is maintained to 12 m (40 ft) mlw at this time. The New River entrance channel has migrated northward and the Calibogue Sound Channel has migrated back to the north, leaving behind a cut off channel just north of the submerged breakwater. The North Tybee Shoal continues to grow, with accumulation north of the South

Table 2-3. Historic Bathymetry Data Sets

Date	Source	Original Data	Vertical Conversion	Horizontal Conversion	Remarks
Hydrographic Survey					
1854	ATM	NOAA - H439	convert from NGVD29 to NAVD88	Ga State Plane East to Lat/Lon NAD83	ATM applied original conversions
1897	ATM	NOAA - H2296	convert from NAVD29 to NGVD88	Ga State Plane East to Lat/Lon NAD83	
1920	ATM	NOAA - H4154	convert from NAVD29 to NGVD88	Ga State Plane East to Lat/Lon NAD83	
1931-34	NOAA-GEODAS	H05134 – 03601015 1931	convert from mlw to NAVD88		Covers Savannah River Entrance area only not used
		H05549 - 03F11077 1934	convert from mlw to NAVD88		
		H05592 - 03F11085 1934	convert from mlw to NAVD88		
		H05599 - 03F11088 1934	convert from mlw to NAVD88		
		H05571 - 03F11218 1934	convert from mlw to NAVD88		
		H09197 - 03F12061 1971-73	convert from mlw to NAVD88		
1970-83	NOAA-GEODAS	H09314 - 03081138 1973	convert from mlw to NAVD88		
		H09144 - 03081139 1973	convert from mlw to NAVD88		
		H09459 - 03F12085 1974	convert from mlw to NAVD88		
		H09865 - 03141047 1980	convert from mllw to NAVD88		
		H10577 - 03081184	convert from mllw to NAVD88		
		H10582 - 03081186	convert from mllw to NAVD88		
1994-95	NOAA-GEODAS	H10591 - 03081187	convert from mllw to NAVD88		
		H10629 - 03081195	convert from mllw to NAVD88		
		H10631 - 03081197	convert from mllw to NAVD88		
Channel Surveys only					
17-18 Dec 1998	SAS	bd_99.xyz	convert from mlw to NAVD88	Ga State Plane East to Lat/Lon NAD83	Before Dredge
Jan, Feb, Apr 1999		ad-99.xyz	convert from mlw to NAVD88	Ga State Plane East to Lat/Lon NAD83	After Dredge
Jan, Feb 2000		bd_00.xyz	convert from mlw to NAVD88	Ga State Plane East to Lat/Lon NAD83	Before Dredge
Sep-05		exam-savhbar-sept2005.xyz	convert from mllw to NAVD88	Ga State Plane East to Lat/Lon NAD83	Exam survey
Profile Surveys					
Feb-05	SAS	tybee-feb2005land.xyz profiles	convert from mllw to NAVD88	Ga State Plane East to Lat/Lon NAD83	Land survey
		tybee-feb2005-1 xyz profiles	convert from mllw to NAVD88	Ga State Plane East to Lat/Lon NAD83	Boat survey

Channel. Figure 2-13 shows more recent bathymetric surveys from the 1993/94 time frame, but is limited in coverage to the southern portion of the study area. The material dredged from the channel and deposited in the Offshore Dredge Material Disposal Site (ODMDS) can be seen in shoals in that area. The channel is maintained at 13 m (44 ft) mlw at this time.

The only recent surveys available for this study consist of before and after dredge and examination surveys of the navigation channel itself. Figures 2-14 to 2-16 are a series of surveys of just the channel from 1989 (before dredge), 1999 (after dredge) and 2000 (before dredge) that show that the dredging requires removal of a small area on the south side of the channel just off Tybee island and to the east side of the channel on the southern end of the channel as it passes the lower end of Barrett Shoals. A survey consisting of beach and nearshore boat surveys along designated profiles was conducted in February 2005 along Tybee Island. That survey is limited to the nearshore area but shows the condition of the beach and nearshore at 5 years after the most recent beach nourishment placement (Figure 2-17). An exam survey was conducted in September of 2005 of the navigation channel again showing the tip of the North Tybee Shoal encroaching on the channel just off the jetties and the encroachment of the southern tip of Barrett Shoals on the southern area of the channel. These appear to be the dominant areas where sediment enters the channel.

Sediment Budget and Volume Changes

This analysis was limited to the 1854 pre-project bathymetry coverage, the 1920 survey, and a composite of 1970 to 1974 and 1980 to 1983 bathymetry. The early data were collected by NOAA NOS's predecessor the U.S. Coast and Geodetic Service (USC&GS) using lead line. The accuracy of the surveys is the best of that day. No standard datums were available at that time. The data were transformed by ATM (2001) to the standard vertical datum of NGVD 1929 and a horizontal datum of Georgia State Plane East Zone. This transformation also included sea level corrections. The data was further transformed to the present NAVD 1988 datum by CHL using ArcView software. The 1970 data was collected at a datum of mlw. NOAA switched to a vertical datum of mllw around 1980. The data were converted to a common datum of NAVD88 using the ArcView software. Table 2-4 shows the correction factors used based on the NOAA tidal gauge elevation information. The conversion from NGVD 29 to NAVD88 was 0.29 m (0.96 ft). Each of these conversions has the potential to add uncertainty to the analysis, but care was taken to bring all of the data into a common horizontal and vertical datum for analysis.

Table 2-4. Elevatioin Information for NOAA Tide Gauge Station 8670870 Referenced to 1983-2001 tidal Epoch

Tidal Datum	mllw	NGVD29	NAVD88
Mean Higher High Water - MHHW	2.29 m (7.50 ft)	1.34 m (4.4 ft)	1.05 m (3.44 ft)
Mean High Water - MHW	2.17 m (7.13 ft)	1.23 m (4.03 ft)	0.94 m (3.07 ft)
North American Vertical Datum - NAVD88	1.24 m (4.06 ft)	0.29 m (0.96 ft)	0
Mean tide Level - MTL	1.12 m (3.67 ft)	0.17 m (0.57 ft)	-0.12 m (-0.39 ft)
National Geodetic Vertical Datum - NGVD29	0.95 m (3.1 ft)	0	-0.29 m (-0.96 ft)
Mean Low Water - MLW	0.07 m (0.22 ft)	-0.88 m (-2.88 ft)	-1.17 m (-3.48 ft)
Mean Lower Low Water - MLLW	0	-0.95 m (-3.10 ft)	-1.24 m (-4.06 ft)

In order to understand the impact of the Federal navigation channel has had on the Savannah River Entrance, area a comparison was made between the conditions that existed before any channel improvements were done to conditions that exist after dredging to deepen and widen the channel and construction of navigation improvement structures. The project was initiated with

dredging of the channel in 1874 and had been deepened five times from 3.8 m (21.5 ft) to the present 13.4 m (44 ft) mlw (Table 2-5). Each time the channel was deepened or widened new dredging was initiated and required removal of larger quantities of sediment from the channel (Figure 2-2). Almost annual maintenance has been required to keep the channel at the design depth (Figure 2-2). Most of the sediment was placed on the ODMDS, except for a beach fill in 1993/94 where the dredged channel material was placed on the beach.

The study has been hampered by lack of good coverage both spatially and temporally of historic shoreline position, bathymetry, multiple dredging records and storm climatology. There is only one good bathymetric survey in 1854 before the project was initiated. This data set was surveyed before a standard national vertical datum was established. ATM (2001) has done the calculations to correct to the NGVD 1929 datum and this present study has adjusted to the new NAVD 1988 datum. They also have corrected for sea level rise.

Difference maps were constructed using the ArcView GIS software to assess the changes in bathymetry between surveys. Figure 2-18 shows the change between the pre-project 1854 and the immediate post construction of the two navigation jetties and the offshore submerged breakwater surveyed in 1897. The 1897 survey was limited in coverage so the difference map was limited to the smallest common area between the two surveys. Areas of loss of bed elevation are shown in red and gain in bottom elevations are shown in green. The channel centerlines show the change in orientation of the several channels over the time period. The main change was the reorientation of the channels at the entrance of Savannah River, Wright River, and New River from four channels that merged into one to two channels due to the construction of the two jetties at the mouth of the main channel of the Savannah River in 1896. The channel complex exiting Calibogue Sound has four distinct channel branches trending off the main channel to the east in 1854. The limited coverage of the 1897 data does not cover all of the channels but the general trend is for movement to the south. Loss of sediment was measured in Calibogue Sound entrance channel and in most of the channels in the vicinity of Tybee Roads. Gain of sediment was measured at the submerged breakwater at the southern end of Barrett Shoals and on the north tip of Tybee Island where the channel exiting the South Channel was moved further north. Further deflation is seen on the north portion of the Tybee Island Shelf and accumulation on the North Tybee Shoal. Both the digital 1854 and 1863 shorelines show the bulge on the north end of Tybee Island. No shorelines exist between a chart of 1873 and 1900 to pinpoint when the bulge began to erode away.

From 1897 to 1920 the four channels of the Calibogue Sound entrance remain but move further southward (Figure 2-19). Accretion of the bed is found in the lee of the submerged breakwater on the north end of Tybee Roads. The shoreline bulge of north Tybee Island has eroded and the shoreline spit has formed on the north end of the island. Accretion is also present in the north part of the North Tybee Shoal area. The growth of the shoal and spit along the shoreline has deflected the South Channel to the north to merge with the main navigation channel of the Savannah River. The north portion of the Tybee Island Shelf continues to deflate, and it appears the sediment is moving to the northwest, toward the North Tybee Shoal (which is consistent with the sediment transport modeling presented in Chapter 5). The New River Channel also meets with the main channel just seaward of the jetty tips. There is general loss of sediment on the bed on the rest of the shelf area. From 1920 to 1970/83 there is a general southward shift in the individual east-west channels coming off the Calibogue Sound entrance (Figure 2-20). The 1920 channel locations have filled in and a new channel has eroded sediment south of each for the four channels. The southernmost channel has moved south and is now deflected to the east by the submerged breakwater. The southern tip of Barrett Shoals is now accreting (consistent with sediment transport modeling results). The New River entrance channel has migrated to the north and is now detached from the main Savannah River navigation Channel.

Table 2-5. Bar Channel Dredging

Year	Channel Depth (ft-MLW)	New Dredging Vol. (cy)	Maint Dredging Vol (cy) Multiple Source
1910	21.50		1,640,000
1915	26.00		667,000
1921	26.00		565,000
1922	26.00		156,690
1923	26.00		270,200
1924	26.00		1,142,197
1925	26.00		322,794
1926	26.00		502,244
1927	26.00		217,000
1928	26.00		716,727
1930	26.00	2,470,490	
1931	26.00	NO	NO
1944	30.00	DATA	DATA
1945	36.00	BETWEEN 1931-1945	BETWEEN 1931-1945
1946	36.00		2,380,977
1947	36.00		695,709
1948	36.00	671,350	
1950	36.00	2,830,694	
1951	36.00		2,864,450
1953	36.00		916,454
1954	36.00		667,330
1956	36.00		450,636
1957	36.00		1,826,336
1958	36.00		202,234
1959	36.00		66,752
1961	36.00		1,368,231
1962	36.00		1,414,182
1963	36.00		1,339,289
1964	36.00		903,051
1965	36.00		655,513
1966	36.00		879,518
1968	36.00		458,430
1969	36.00		401,814
1970	36.00		877,949
1971	36.00		582,442
1972	40.00	3,469,633	499,687
1973	40.00	2,151,664	771,923
1974	40.00	1,146,262	1,415,731
1975	40.00	1,146,262	96,503
1976	40.00	979,235	1,066,024
1977	40.00	1,806,359	2,811,201
1978	40.00	988,500	2,763,715
1980	40.00		471,084
1981	40.00		865,736
1982	40.00		188,266
1983	40.00		644,940
1984	40.00		789,754

Table 2-5. (*continued*) Bar Channel Dredging			
1985	40.00		1,212,478
1986	40.00		1,166,528
1989	40.00		442,414
1990	40.00		600,000
1991	40.00		1,104,991
1993	40.00		554,707
1994	44.00	2,454,441	
1995	44.00		1,993,061
1996	44.00		486,108
1997	44.00		544,508
1998	44.00		548,044
1999	44.00		508,885
2000	44.00		1,217,300
2001	44.00		1,117,856
2002	44.00		186,537
2003	44.00		635,163
2004	44.00		620,642
2005	44.00		888,101

Notes: Maintenance Dredging data sources are:
Annual Reports data in black, Dredging Records data in green, and [illegible] Data in blue

There is a gain in sediment in the old 1920 New River channel and erosion of the bed in the new orientation, as well as a gain in sediment deposition at the mouth of that new channel. The spit on north Tybee Island has eroded and the South Channel is now next to the island. The main navigation channel has migrated northward out from between the jetties and the old channel has filled in due to the northwest movement of sediment and accumulation in the North Tybee Shoal. The pattern of deflation continues on the Tybee Island Shelf and the southern portion of the North Tybee Shoal. There is general loss of sediment on the Tybee Island shelf platform in front of the island.

The long-term change in the bathymetry from the 1854 pre-project bathymetry to the more modern 1970/83 bathymetry shows a trend of southward channel migration of the four channels of the Calibogue Sound entrance channel with erosion in the present location of the centerlines and a filling in of the older channel locations (Figure 2-21). All of the channels from Calibogue Sound are now north of the submerged breakwater. The New River entrance channel has migrated northward and filled in the old channel orientation. The south end of Barrett Shoals has gained sediment on its southern tip just north of the navigation channel. This is the area where dredging is the greatest. The dredging of the main navigation channel has removed sediment from that area. The green areas in Figure 2-21 adjacent to the channel are areas where the dredging requirement is greatest at present. The large change in the Tybee Island shoreline and removal of the bulge has resulted in gain of sediment on the North Tybee Shoal as the South Channel and main navigation channel of the Savannah River have moved slightly to the north. The remainder of the Tybee Island Shelf has lost sediment.

An update to the change in bathymetry was added to this report by adding the change in the bathymetry reflected by the 1994 NOAA bathymetry. Unfortunately the coverage is limited to the southern portion of the study area (Figure 2-22). The seaward end of the navigation channel shows the effects of dredging with a loss of sediment in the channel. The gain in sediment in the

ODMDS area can be seen where most of the dredge material was placed. The rest of the shelf platform area shows little change to slight loss of elevation.

The available newer bathymetry is limited to surveys of the navigation channel. A comparison of the before- to after-dredge surveys of 1998 and 1999 are shown in Figure 2-23, where there is a slight gain in sand on the northern end of the Tybee Knoll Bar Channel and at the western end of the Tybee Roads Bar Channel. A loss of sediment was found in the central part of the Tybee Roads Bar Channel, which is most likely due to the dredging. Between the after 1999 dredging and the before 2000 dredging the difference plot shows a gain of sediment in the Tybee Roads Bar Channel where the southern tip of Barrett Shoals abuts the channel (Figure 2-24). A gain in sediment along the southern side of Tybee Knoll Bar Channel indicated that sediment is moving into the channel from the south along the North Tybee Shoal platform. Erosion of the north side of the channel is evident, probably in response to North Tybee Shoal accumulation. A longer term change between 2000 and 2005 indicate that the channel has been dredged for the most part except for the lower end of the Tybee Roads Bar Channel which has shown accretion (Figure 2-25). This accretion indicates that the southern tip of Barrett Shoals is a source of sediment to fill in the channel as sand moves southward and westward across the shoal. Accretion in the channel is also evident due to encroachment of the North Tybee Shoal. A comparison of the beach and nearshore survey in February 2005 with the 1970/83 survey along the Tybee Island beachfront shows accretion of the nearshore reflecting the four beach nourishment placements since 1975. The nearshore on the north end of the island shows accretion indicating northward transport of fill from the hot spot around 2nd Street. That area shows a net loss of sediment in the nearshore. A slight gain in sand is found on the shelf along the central part of the island where the shoreline orientation changes from north/south to more northeast/southwest. Accretion is also shown at the southern end of the island where sediment is transported southward onto the ebb shoal of Tybee Creek Inlet.

Storms are an important force in transport of sediment and the formation/evolution of coastal morphology. Table 2-6 (see end of chapter) lists all tropical storms that have come within 200 miles of Tybee Island since 1851. This data was downloaded from the NOAA Coastal Services Center and contained a GIS database of all tropical storms from 1851 to 2002. Data for 2003 to 2005 was downloaded from the National Weather Service and transformed into GIS compatible data. Figure 2-26 shows the occurrence of these tropical storms by year. There were several active tropical storm seasons with more than three storms per season. This analysis does not include extratropical storms so there may be more storms than listed that could have affected the Tybee Island area. The period between 1872 and 1916 was active with several years having multiple occurrences of storms. There may be some correlation between the change in the bulge in the north Tybee Island shoreline and the number of storms that occurred during this time period.

The USGS has recently completed a study of the long-term change in shoreline position along the southeastern US East Coast from North Carolina to Florida (Miller et al. 2005). Long-term rates of shoreline change, in units of m/yr, were calculated at 50-m transect spacing using linear regression applied to shoreline positions from the earliest (1863) to the most recent (1999/2000). Linear regression was selected because it has been shown to be the most statistically robust quantitative method when a limited number of shorelines are available and it is the most commonly applied statistical technique for expressing shoreline movement and estimating rates of change. Uncertainties for the long-term rates are also reported in units of m/yr and represent a 90 percent confidence interval for the slope of the regression line. This means with 90 percent statistical confidence that the true rate of shoreline change falls within the range of ±0.01 to 5.5 m/yr depending on location (Miller et al. 2005). One of their calculations was to measure the rate of change in shoreline movement from their first shoreline data set to their most recent LIDAR

derived shoreline. In the case of the Tybee Island area, the shorelines were the 1863 to 1999 in Georgia and 2000 in South Carolina which include the effects of the beach fills. Figure 2-27 shows a graphic of the rate of change in m/yr for the barrier islands in the study area over this 162-163 year period. These long-term rates are similar to rates measured on a few points between the 1854 and 1971 shorelines in this study to provide consistent dates between the bathymetric data and shoreline data. The USGS rate of change data are representative of the study period and will be used even though the dates are different from the bathymetry change period of 1854 to 1970/83.

Data for Hilton Head Island shows that the center portion of the island is either stable (± 0.5 m/yr in yellow bands, Figure 2-27) or eroding at a rate of -0.5 to -2 m/yr (light red bands). The south end of the island is growing around +0.5 to +2 m/yr (light green) and +2 to +4 m/yr (dark green) as the island shoreline progresses southward. The maximum seaward movement was +4.2 m/yr at the tip of the island. In spite of the beach fill on Daufuskie Island in 1998, the long-term trend is for erosion along the entire length of the island. Rates range from either -0.5 to -2 m/yr (light red) or -2m to 4 m/yr (dark red) with a maximum landward retreat of -2.1 m/yr. Turtle Island is eroding up to -3 m/yr except for the southern end that has migrated into the Wright River inlet at a rate of up to +3.8 m/yr. The long-term shoreline change rate for Tybee Island reflects the erosion of the bulge on the north end with erosion of the shoreline from the North Terminal Groin southward in this area. The USGS analysis does not extend to the north of the North Terminal Groin due to the truncated position of the 1863 shoreline. The later shorelines visually show a gain as the spit and later shorelines extend to the north. The erosion rate in the area of the hot spot between 1st and 6th Streets is up to -3.6 m /yr. The nodal point around 2nd Street remains stable as the shoreline erodes to the north and accretes to the south of that area. The area south of the nodal point has shown accretion of up to +1.6 m/yr from 1863 to 1999, which included all but the last beach fill period. The USGS data stops at the South Terminal Groin since the 1863 shoreline terminates at that point. The later shorelines have migrated to the south and the southern part of the island has grown to the south. The South Terminal Groin and the two T-Head groins and terminal L-Head groin as well as the beach fills have stabilized this southern portion of the island. The construction of the jetties at the mouth of the Savannah River Entrance and initial dredging corresponds with the loss of the bulge on Tybee Island. Possible new flow patterns as a result of the jetties would confine the flow between the jetties and have higher velocities that would move the channel further seaward. The Tybee island shoreline responded by moving north and south of the nodal point. This may be an indication that the tidal flow patterns changed at the entrance and the shoreline responded to these flow pattern changes. A summary of the changes to the channels from the river entrances show that the channel centerlines have migrated south over the study period (except New River, which has migrated north). Figure 2-28 shows the positions of the channel centerlines mapped from the pre-project 1854 bathymetry. The location of the seaward end of all of the channels have migrated to the south in all cases by the 1920 time period after the initial dredging and construction of the jetties and breakwater. By the 1970's the Savannah River entrance navigation channel was dredged and fixed in its present location. All of the other channels have continued to migrate southward except for the New River entrance channel which has migrated northward. There are four identified channels trending to the east from the Calibogue Sound entrance through most of its history. These channels migrate to the south consistent with net movement of sediment to the south along Barrett Shoals. By the1970's an additional channel had formed. Beginning in the north, the marginal flood channel that is adjacent to the southern shoreline of Hilton Head Island has moved to the south as the island has migrated in that direction. The southern most channel of that group has been controlled by the location of the submerged breakwater, limiting the southern movement. The main navigation channel of the Savannah River entrance has moved north in the Tybee Knoll range as the jetties have controlled this part of the channel location. The channel

from the South Channel has also migrated northward as sand has accumulated in the Tybee Shoal and Tybee Island has migrated northward, consistent with northward movement of sand at north Tybee due to changing tidal flow patterns reshaping the nearshore in front of Tybee Island.

The general trends in morphologic change in the nearshore can be illustrated with the change in the -5 m (-16.4 ft) depth contour. The general trends in shoreline evolution can be illustrated by the change in the shoreline position of the 1854 and 1971 shorelines (represented by the brown arrows in Figure 2-29). The black arrows show the trends in bathymetric change from the pre-project 1854 bathymetry and present day configuration illustrated by the 1970/83. The shelf in front of Hilton Head Island shows a landward movement. The channels trending eastward from the main Calibogue Sound channel have also migrated south. The New River Channel has migrated northward on the Daufuskie/Turtle Island platform area but otherwise that platform has had little change. The -5 m contour on the shelf platform in front of Tybee Island has migrated toward the shore and southwest, while the North Tybee Shoal has grown to the north. Of interest is the fact that the -10 m (-32.8 ft) contour has remained relatively stable over this same time period. The shoreline of the southern end of Hilton Head has grown to the south. The shorelines of Daufuskie and Turtle Islands have retreated landward and in the case of Turtle Island have also moved to the south. The shoreline of Cockspur Island has also retreated landward. The ends of Tybee Island have migrated both north and south of the hot spot nodal point as the bulge has retreated landward somewhere between the 1870's and 1900.

Based on bathymetric change patterns and distinct morphologic characteristics, eight morphologic areas have been identified to calculate volume changes for the study area. Figure 2-30 shows the boundaries of each of these areas. The largest of these areas is Barrett Shoals, which is composed of several channels trending eastward with adjacent shoals that are related with the Calibogue Sound entrance channel. The main thalweg of the Sound is also identified as a separate area. The shallow platform in front of Daufuskie and Turtle Islands is also identified as an area of shoals and the thalweg of the New River entrance channel. The main navigation channel of the Savannah River is divided into the more east/west Tybee Knolls Bar Channel and the more northwest/southeast trending Tybee Roads Bar Channel. The area on the north side of these bar channels has been called the Breakwater Lee Shoal area in the lee of the submerged breakwater area of Tybee Roads and is composed of shoals outside of the dredged channel. The shallow shelf platform in front of Tybee Island has been divided into two sections: the North Tybee Shoal and the Tybee Island shelf based on the change in shoal configuration and depth contours over the study period.

An analysis of the difference in depths between the 1854 bathymetry and the 1970/83 bathymetry was done using ArcView Spatial Analysis. The differences at specific grid points spaced 7.6 m (25 ft) apart were summed for each area shown in Figure 2-30 and divided by the number of years between the surveys to produce an average rate of change for each morphologic area. Figure 2-31 shows the results of this analysis. The Barrett Shoals area has lost only 4,200 m^3/yr (essentially zero volume loss) as the southward shifting channels fill in the old channel locations. The Calibogue Sound channel has a net loss rate of 40,000 m^3/yr as the channel has deepened and elongated to the south. The Daufuskie/Turtle Islands shelf platform has gained +5,200 m^3/yr (essentially zero volume) as sediment is eroded off the beaches of the two islands and the shift in New River entrance channel orientation to the north has filled in the old channel as the newer channel is cut. The Breakwater Lee Shoal area has gained around 11,500 m^3/yr of sediment as sediment has possibly been added from all adjacent areas. Both the Tybee Knoll Bar Channel and the Tybee Roads Bar channel have been dredged on a near annual basis and from the period of 1854 to 1970/83 a net loss of sediment was measured in both areas (-119,800 m^3/yr for Tybee Knoll Bar Channel and -100,000 m^3/yr for Tybee Roads Bar Channel for a total of 219,800 m^3/yr). That material was for the most part disposed of in the ODMDS during the dates of this

analysis. The ODMDS was outside the limits of the 1854 bathymetry so no measurement of change could be made from the difference analysis. Dredging records indicate some 40 million m^3 was removed from both bar channels between 1910 and 1979 (note that dredging records in Table 2-5 is in cubic yards). The difference between the net volume changes in the channels and the dredging volume is an indication of the sediment input from the North Tybee Shoal and Barrett Shoals, but the dredging records are incomplete over the full time period. The North Tybee shoal area has gained 99,800 m^3/yr of sediment with the erosion of the bulge on Tybee Island and the reorientation of the South Channel. Tidal flows also indicate that material is carried into that area on flood tide. The shoal platform in front of Tybee Island has a net loss rate of 219,000 m^3/yr. This net loss corresponds to the -5 m depth contour migration inland and to the south. Table 2-7 provides a summary of the volume changes for 1854 to 1970/83 and rates calculated for 1920 to 1970/83. The 1920 to 1970/83 rates provide some idea of change in rates over time following initial construction of the navigation project. The deflation on the Tybee Island Shelf appears to be slowing, while Barrett Shoals is growing at an increased rate. The Breakwater Lee Shoal area remains relatively stable.

The accuracy of the early surveys was less that present day results and were taken with lead line, but the data represents the best available data. The more recent bathymetric surveys were taken by digital echosounder to a class three hydrographic survey standards. The shoreline change analysis done by the USGS (Miller et al. 2005) indicated that the 1863 shoreline was digitized from NOAA USC&GS T-Sheets and the shoreline was based on plain table survey techniques to identify the MHW shoreline. The recent 1999/2000LIDAR surveys were identified by MHW tidal elevations based on the Cockspur Island NOAA tidal gauge. Uncertainties were estimated to show the significance of the volume change rates. The uncertainties are very high due to accuracy of the early surveys, and they indicate that even moderate volume changes may not be meaningful. Uncertainties assigned to the survey depths were 1 m for 1854, 0.5 m for 1920, and 0.3 m for 1970/83. These values are probably optimistic (Gibbs and Gelfenbaum 1999, Byrnes et al. 2002, Mills 2006 personal communication). Survey errors can be systematic or random (random error will tend to average out over volume calculations). Potential contributors to errors include use of lead line in early surveys (particularly in areas with a soft bottom), vertical reference, tide correction, horizontal reference, sea conditions, sampling, and interpolation. The uncertainty in depth change is estimated as root-mean-square of the errors is depth (depth change uncertainty = $((error_1)^2 + (error_2)^2)^{1/2}$), or approximately 1 m for 1854 to 1970/83 and 0.6 m for 1920 to 1970/83. The uncertainty in volume change is estimated as the difference between the total volume change over a region and the volume change calculated exceeding the uncertainty in depth change (Byrnes et al. 2002). These volume change uncertainties have been converted to rates in Table 2-7.

Table 2-7. Volume Change Summary by Area (see Figures 2-30 to 2-32)		
Area	**Volume Change Rate (1854 -1970/83) m^3/yr**	**Volume Change Rate (1920-1970/83) m^3/yr**
Tybee Island Shelf 25 million m^3	-220,000 ± 26,000	-76,000 ± 3,000
North Tybee Shoal 7 mill m^3	+100,000 ± 6,000	+78,000 ± 2,000
Daufuskie/Turtle Island Shelf 29 mill m^3	+5,200 ± 12,000	+90,000 ± 7,000
Calibogue Sound Channel 5 mill m^3	-40,000 ± 3,000	+24,000 ± 4,000
Barrett Shoals 40 mill m^3	-4,200 ± 9,000	+150,000 ± 3,000
Breakwater Lee Shoal 5 mill m^3	+12,000 ± 1,000	-260 ± 1,000
Tybee Knoll Bar Channel 4 mill m^3	-120,000 ± 1,000	-74,000 ± 1,000
Tybee Roads Bar Channel 4 mill m^3	-100,000 ± 2,000	-91,000 ± 1,000
Uncertainty estimated using 1 m depth error for 1854 to 1970/86 and 0.6 m error for 1920 to 1970/86 (time = 122 or 56 yrs)		

The ATM (2001) study estimated the volume change of the Tybee subaqueous platform at -120,000 m^3/yr for the period 1920-1970/80 (their Table 8-5), slightly higher than the value in Table 2-7, but well within the range of confidence. The values in Table 2-7 are close to the ATM Tybee North Shoal rate of +58,000 m^3/yr and Barrett Shoals rate of +140,000 m^3/yr for the period 1920-1970/80.

While extending over a longer time period (1863 to 1999/2000), the USGS shoreline change analysis supports the bathymetric change patterns. The USGS data are shoreline position change rates in m/yr while the bathymetric analysis is measuring volume change in m^3/yr. Growth of the south end of Hilton Head Island indicated net longshore drift along the shoreline is to the south in this area. The long-term retreat of the MHW shoreline along Daufuskie and Turtle Islands and the gain in sediment in the Daufuskie/Turtle Island shelf platform indicates that the sediment (mostly fine sands and silts) are being eroded off the shoreline and deposited on the shelf in that area. Longshore transport rates were reported by ATM (2001). The Tybee Island shoreline change rates indicate that the nearshore net sediment transport is to the north from the nodal point north, which adds material into the North Tybee Island shoal area. South of the nodal point sediment is transported south along the beach and ending up on the ebb shoal of Tybee Creek Inlet.

A complete sediment budget was not produced due to lack of broad coverage for bathymetry, lack of multiple surveys pre-project to establish the baseline, and uncertainty in rates of some key pathways. A conceptual sediment pathway map was produced to indicate the probable movement of sediment between the areas within the study area (Figure 2-33). Details on the shoreline volume changes along the barrier islands were not part of the scope of this work. Southerly growth in Hilton Head Island provides input of sediment into the Barrett Shoals area due to the north east/southwest orientation of the island. Some sediment may be input into the Calibogue Sound Channel from the Sound itself. Little change in volume within the Barrett Shoal area indicates that sediment input is equal to output. Sediment flows into the Tybee Roads Bar Channel from this Shoal area based on bathymetric changes from before and

after dredging. The sediment dredged from the channel has mostly been placed on the ODMDS during the period of analysis. The north-south shoreline orientation of Tybee Island and the shoreline change patterns indicate that the sediment is being transported to the north and south of the nodal point in the very nearshore zone. The change in nearshore bathymetry from 1970/83 and 2005 indicate that this is the case. The North Tybee Shoal area is gaining sediment from the shoreline and some from the Tybee Island Shelf platform. Some of this material is likely to be transported into the Tybee Knoll Bar Channel. The Tybee Island Shelf is losing sediment to the northwest and southwest and is generally being deflated as little sediment is transported to the south over the Tybee Roads Bar Channel to replace material generally transported to the northwest and southwest the shelf.

Sediment Transport

The sediment grain size distributions shown in Figure 2-34 are from several sediment sampling efforts from 1981 to 1998 show that the typical sediment in this area is a fine sand with a mean grain size of 0.125 to 0.25 mm (2.0 to 3.0 phi). Very Fine sands (mean grain size of 0.0625 to 0.125 mm or 3.0 to 4.0 phi) were also common on the nearshore shelf and in the dredged Tybee Roads Bar Channel. Some coarse sediment (medium to coarse sands with mean grain sizes between 0.25 and 2 mm or 2.0 to -1.0 phi) was found in the Tybee Knolls Bar Channel and from the bed between the jetties. There areas have the highest tidal flows and would winnow out the finer grain sizes.

Impact Assessment

The sediment volume change analysis and modeling results were integrated to assess the impact of the Federal navigation channel to Savannah Harbor on sediment transport pathways in the Savannah Bight. Chapter 5 presents results of the GTRAN modeling. Limited shoreline position data and bathymetry from the time period of initial project construction in the years between 1874 and 1900 have limited the assessment of the most dramatic impact of the project dredging and jetty construction. Changes to the morphology on Tybee Island were compared with regional changes during a similar period of time beginning prior to construction (1854 to 1863) and ending with the present (1970/83 and additional partial surveys of the shoreline, shelf and channel up to 2005). The major change, the removal of the bulge on the north end of Tybee Island between 1863 and 1900, occurred as the channel was dredged and the jetties were placed. The jetties were constructed between 1886 and 1896 and the offshore submerged breakwater in 1897. It is suspected that the large change in measured shoreline position resulted from the modification of the entrance, but measurements are lacking between 1863 and 1900. This time period is also particularly active in terms of tropical storms (Table 2-5). From both morphologic and modeling data, the sediment lost from the oceanfront of North Tybee Island was transported northward into a spit that formed on the north end and on to the North Tybee Island Shoal. The deflection of the South Channel to the north into the main navigation channel of the Savannah River also allowed sediment to be deposited on the north shoal. The nodal point in longshore transport appears to be around 2nd Street. The material in the bulge was mainly north of that area and the transport is to the north of that point. South of that point the transport is to the south. The growth of the south end of Tybee Island and the growth of the ebb shoal of Tybee Creek Inlet support a southerly transport pattern south of the nodal point. The history of shore protection efforts (seawall and groin construction and placement of the four beach fills) indicated that it is difficult to maintain sand on the beach at the nodal point/hot spot. With the construction of the seawall and groins and the newer terminal groins and T-Head and L-Head groins on the south end of the island, the shoreline change has slowed in recent times. The beach fill has supplied additional sand to the northern and southern beach and nearshore area. Sand transport modeling

indicates that on the flood tide sediment transport across the Tybee platform is to the northwest on the northern portion and to the southwest/west on the southern portion of the platform. The shoreward movement of the -5 m contour on the shelf platform in front of Tybee Island is consistent with this sand transport pattern. The ebb directed net movement of sediment is generally confined to the navigation channel.

With the lack of data in both the spatial and temporal scale it is difficult to make a definitive assessment of how the dredging and construction of the jetties and breakwater have effected the Tybee Island shoreline changes. A hypothesis for this case/effect relationship is presented later in light of modeling results. The storm climate indicates that the turn of the century was an active time for tropical systems and they have most likely had an impact on the shoreline and shelf changes. It is difficult to discern any strong link between storm activity and the cause of what has taken place in the evolution of the Tybee Island area. The general sediment transport in the region is from north to south, so impacts of the project would be expected to the south. The volume change analyses support this, with little volume change on Barrett Shoals and the Daufuskie/Turtle Island Shelf and deflation of the Tybee Island Shelf. The initial construction of the jetties and dredging very likely contributed to the erosion of the bulge on the north end of Tybee Island and the increase in volume on the North Tybee Shoal (possibly resulting from collapse of a portion of the ebb shoal feature. It appears that dredging of the channel has cut off any bypassing that occurred from Barrett Shoals to the Tybee Island Shelf (dredge volumes have remained relatively constant in recent times, in spite of continued deepening of the channel. The volume of the Tybee Island Shelf area is deflating at a rate of 220,000 m^3/yr over the historic period. This rate appears to be decreasing with time, but more broad coverage survey data is required. Sediment transport patterns in the very nearshore are adjacent to Tybee Island are dictated by flood tidal flow directing sediment to the north on the northern end and to the south on the southern end, creating a hot spot due to flow divergence. Data are lacking to fully quantify the impact of the project on Tybee Island (primarily multiple full coverage surveys prior to the project to establish historic rate and recent surveys to establish present rates). The major impact is the cut off of bypassing from Barrett Shoals to the Tybee Island Shelf through dredging and deepening and changes induced in the shelf east of Tybee Island. A reasonable upper bound of this impact is the estimated 360,000-370,000 m^3/yr (ATM 2001, based on 1999-2000 dredging records and 1996-2005 dredging records assuming 80 percent of dredging volume is from Tybee Roads and 77 percent of material is sand) of sand bypassed from Barrett Shoals to the Tybee Roads Bar Channel (arguments to reduce this number could include that some of this volume originated in the Tybee Knoll Bar Channel or the Savannah River and that some portion of the bypassing from Barrett Shoals would have been transported offshore in the channel even if the project had not been constructed).

Acknowledgements

Mr. Matt Goodrich of Applied Technology and Management Inc., Charleston, SC supplied some of the historic bathymetry. Mr. Wilber Wiggins, USACE Savannah District, supplied several data sets and air photographs and information on dredging records, surveys and erosion control efforts on Tybee Island. Ms Mary Clair Allison, CHL provided assistance with GIS analysis.

Table 2-6. Tropical Systems within 200 miles of Tybee Island

Year	Dates	Name	Category	Pressure mb	Winds mph
1850					
1851	8/24/1851	Not Named	H1	n/a	80
1852	8/27-8/28		TS		45
	10/10/1852		TS		70
1853	10/21/1853		H2		105
1854	9/8-9/1854		H3	950	115
1855					
1856	8/31-9/1		TS		70
1857	9/12/2006		H1		90
1858	9/15/2006		TS		70
1959	10/26/2006		H1		90
1860	8/13-14/1860		TS		60
1861	11/1/2006		TS		60
1862					
1863	9/17/2018		TS		70
1864					
1865	8/20/2006		TS		60
1866					
1867	8/21-23/1867		H1		80
	10/6-8/1867		TS		70
1868	10/5/1868		TS		45
1869					
1870					
1871	8/18-23/1871		H1		80
	8/27-28/1871		TD		35
	9/6-7/1871		TS		70
	10/5-6/1871		TS		60
1872	10/23-24/1872		H1		80
1873	6/2/2006		TS		45
	9/19-20/1873		TS		70
	9/23/2006		TS		45
1874	9/28/1874		H1	981	90
1875					
1876	9/21/2006		H1		90
1877	9/20-21/1877		TS		45
	9/28/1877		TS		60
	10/3-4/1877		TS		60
	10/27/1877		TS		45
1878	9/11-12/1878		H1	985	90
	10/11/1878		TS		45
1879	8/18/1879		H3		115
	10/28/1879		TS		60
1880	9/8-9/1880		TS		70
	10/9/1880		TS		70
1881	8/27-28/1881		H2	970	105
1882	9/11/1882		TS		45

	9/22/1882	TS		45
	10/11-12/1882	TS		70
1883	9/10/2011	H?		105
1884	9/10-13/1884	TS		60
1885	8/24-25/1885	H3		115
	8/31/1885	TS		45
	9/21/1885	TS		45
	9/30-10/1	TS		60
	10/12/1885	TS		60
1886	6/21-22/1886	H1		75
	7/1/1886	TS		60
	7/19/1886	TS		65
1887	8/19/1887			115
	8/23-24/1887			125
	10/20/1887	TD		35
	10/30/1887	TS		45
1888	9/9-10/1888	TS		50
	10/11/1888	H1		80
1889	6/17-18/1889	TS		45
	9/24/1889	TS		50
1890				
1891	10/8/1891	TS		45
	10/10/1891	TS		50
1892				
1893	6/16/1893	TS		60
	8/28/1893	H3	954	115
	10/3-4/1893	TS		50
	10/13/1893	H3		120
1894	9/26-27/1894	H1		90
	10/9/1894	H1		80
1895				
1896	7/8/1896	TS		40
	9/29/1896	H3	963	115
1897	9/21-22/1897	TS		60
1898	8/30-9/1/1898	H1		85
	10/2/1898	H3	938	135
1899	8/14-15/1899			120
	10/5-6/1899	TS		45
	10/31/1899	H1		110
1900	10/12/1900	E		40
1901	7/3/1901	TS		40
	9/18/1901	TS		40
1902	6/15/1902	TS		40
1903	9/16/1903	TD		35
1904	9/14/1904	H1		80
	11/4/1904	TD		35
1905				
1906	9/17-18/1906	H1	977	80
	10/19-21/1906	H1		90
	10/17/1906	TS		40

1907	6/29/1907	TS		65
	9/29/1907	TS		40
1908	5/27-28/1908	H1		75
	7/30/1908	H1		80
	10/23/1908	E		45
1909	7/2-3/1909	TD		35
	8/31/1909	TS		40
1910	10/19/1910	TS		70
	8/27/1910	E		40
	10/20-21/1910	TS		70
1911	8/27-30/1911	H1	983	75
1912	6/14/1912	TS		40
	7/15/1912	TS		50
1913	10/8-10/1913	TS		50
1914	9/16-17/1914	TS		45
1915	8/1-3/1915	TS		50
1916	7/13-15/1916	H2	983	100
	9/5/1916	TS		40
	9/13/1916	TD		35
	10/4/1916	TS		45
1917				
1918				
1919				
1920	9/30/1920	TS		40
1921	10/26/1921	H1		90
1922				
1923				
1924	9/16/1924	TS		50
	9/30/1924	E		50
1925	12/1-2/1925	[illegible]		100
1926	7/28-29/1926	TS	975	70
1927	10/3/1927	TS		60
1928	9/9-11/1928	TS		45
	9/17-18/1928	H2	974	105
1929	10/1-2/1929	TS		45
1930	9/10-11/1930	TS		60
1931				
1932	9/15/1932	TS		50
1933	9/5-7/1933	TS		50
1934	5/28-31/1934	TS		60
	7/21-22/1934	TS		45
1935	9/5/1935	TS		70
1936	8/21-22/1936	TS		50
1937	7/30/1937	TS		45
	8/30/1937	TS		60
	9/21/1937	TD		35
1938				
1939	10/24/1938	TS		45
1940	8/2-3/1940	TS		45
	8/11-12/1940	H1	975	80

1941	10/8/1941		TS		65
	10/20-21/1941		TS		45
1942					
1943					
1944	8/1/1944		H1	990	90
	10/19-20/1944		TS	978	70
1945	6/24-25/1945		H1		80
	9/16-17/1945		H1	982	75
1946	5/6/1946		TS		45
	10/8-9/1946		TS		40
	11/2-3/1946		TD		30
1947	9/24/1947		TS	989	60
	10/7-8/1947		TS		45
	10/14-16/1947		H1	973	85
1948					
1949	8/27-28/1949		TS	982	65
1950	9/7/1950	EASY	TS		50
	10/19/1950	KING	TS		40
	10/21/1950	LOVE	TS		40
1951					
1952	8/30-31/1952	ABLE	H2		105
1953	8/31-9/1/1953		TS		60
	9/20/1953		TS		45
	9/27/1953	FLORENCE	E		60
1954	8/29-30/1945	CAROL	[illegible]		100
1955					
1956	9/25-26/1956	FLOSSY	E		40
1957	6/9/1957		TS		40
1958	9/27/1958	HELENE	[illegible]	934	125
1959	6/2/1959	ARLENE	TD		30
	7/5-9/1959	CINDY	H1		75
	9/29-30/1959	GRACIE	H4	950	140
1960	7/29/1960	BRENDA	TS		50
	9/11/1960	DONNA	H2	966	105
1961	9/13-14/1961		TD		35
1962	8/27/1962	ALMA	TS		50
1963	10/24-25/1963	GINNY	H2	976	105
1964	6/7-8/1964		TD		35
	8/28-30/1964	CLEO	TS	995	65
	9/9-13/1964	DORA	H3	964	115
1965	6/15/1965		TS		45
1966	6/10/1966	ALMA	TS		65
1967					
1968	6/6-12/1968	ABBY	TS		60
	6/19-20/1968	BRENDA	TD	1012	30
	8/11/1968	DOLLY	TD	1011	30
	10/19/1968	GLADYS	H1	966	85
1969	9/8/1969	GREDA	TS	1002	50
	10/3-4/1969	JENNY	TD		35
1970	7/25-26/1970	ALMA	TD	1005	30

	8/16-17/1970		TD	1013	35
1971					
1972	5/27-28/1972	ALPHA	SS	991	65
	6/20-21/1972	AGNES	TD	992	35
	9/13-14/1972	DAWN	TD		35
1973					
1974	6/25/1974	Subtropical #1	SS	1000	65
	10/7/1974	Subtropical #4	SS		45
1975	6/27-28/1975	AMY	TD	1012	30
	10/25-26/1975	HALLIE	SD	1005	35
1976	5/24/1976	subtropical #1	SS	998	45
	8/20/1976	DOTTIE	TS	999	45
	9/13-15/1976	subtropical #3	SS	1011	45
1977	9/6/1977	BABE	TD		30
	9/5/1977	CLARA	TD	1014	25
1978	9/12/1978	HOPE	TD	1010	30
1979	9/4-5/1979	DAVID	H2	970	100
1980					
1981	8/19/1981	DENNIS	TS	1002	45
1982	6/18/1982	subtropical #1	SS	992	70
1983					
1984	9/9-13/1984	DIANA	[redacted]	960	115
	9/29/1984	ISADORE	TS	1004	50
1985	7/24-25/1985	BOB	H1	1002	75
	8/9/1985	CLAUDETTE	SD	1013	30
	10/10-13/1985	ISABEL	TD	1011	35
	11/22/1985	KATE	H1	983	75
1986	6/6/1986	ANDREW	TS	1004	50
	8/13-16/1986	CHARLEY	TS	1002	45
1987					
1988	8/28/1988	CHRIS	TS	1005	50
1989	9/22/1989	HUGO	[redacted]	935	140
1990					
1991					
1992	9/29-30/1992	EARL	TS	1002	45
1993					
1994	11/21/1994	GORDON	TD	1013	25
1995	6/5-6/1995	ALLISON	TS	993	50
	8/25-27/1965	JERRY	TD	1004	30
1996	8/18-19/1996	ARTHUR	TS	1004	40
	7/12/19916	BERTHA	[redacted]	975	100
	9/5/1996	FRAN	[redacted]	952	115
	10/8/1996	JOSEPHINE	E	990	50
1997					
1998	8/26/1998	BONNIE	[redacted]	965	115
	9/3-4/1998	EARL	TS	990	50
1999	8/29-30/1999	DENNIS	[redacted]	964	105
	9/15-16/1999	FLOYD	[redacted]	943	115
	10/17/1999	IRENE	H1	984	75
2000	9/18/2000	GORDON	TD	1006	35

	9/23/2000	HELENE	TD	1011	30
	10/4-5/2000	LESLIE	SD	1010	35
2001	6/13/2001	ALLISON	SD	1004	30
	9/15/2001	GABRIELLE	TS	999	50
2002	9/2-5/2002	EDOUARD	TS	1002	65
	10/10-11/2002	KYLE	TS	1008	40
2003	9/6-7/2003	HENRI	TD	1006	35
2004	8/14/2004	CHARLIE	H1	994	75
	8/28-8/30	GASTON	TS	991	60
2005	9/13-9/14	OPHELIA	H1	980	75
	10/5-10/6	TAMMY	TS	1001	45

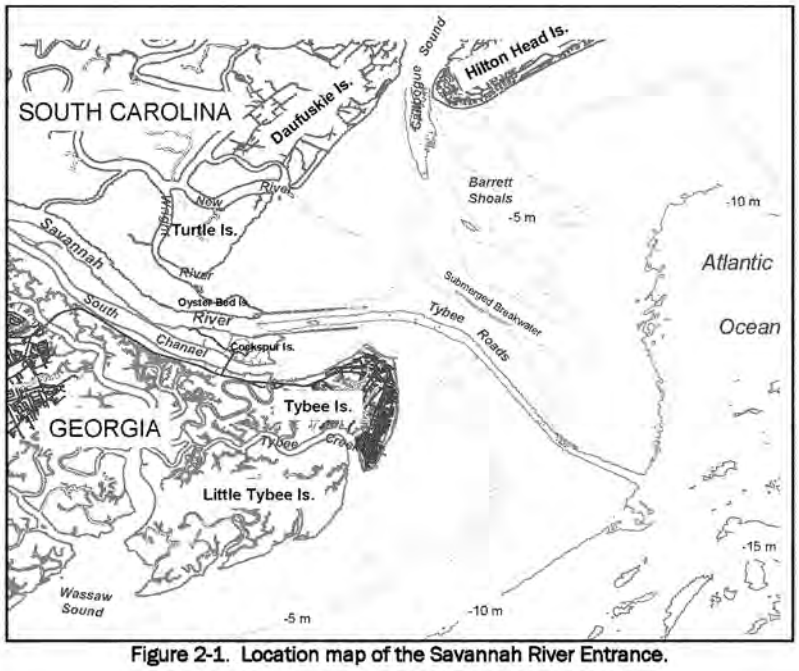


Figure 2-1. Location map of the Savannah River Entrance.

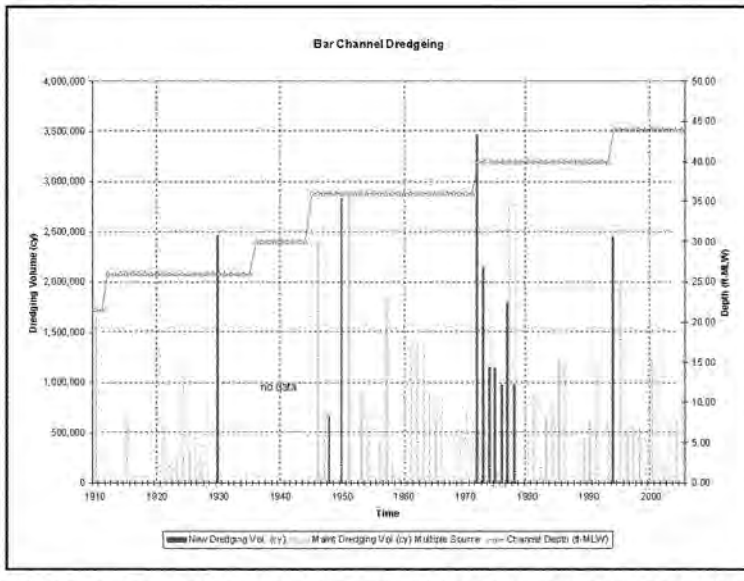


Figure 2-2. Plot of navigation channel depth and dredging volumes with time for the Savannah River Bar Channel.

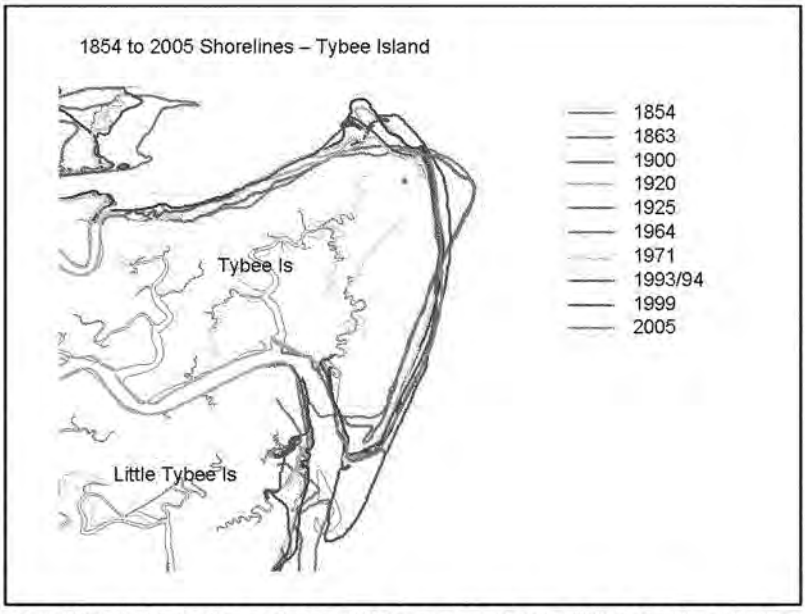


Figure 2-3. Historical shoreline positions of Tybee Island, GA from digital shoreline used in study.

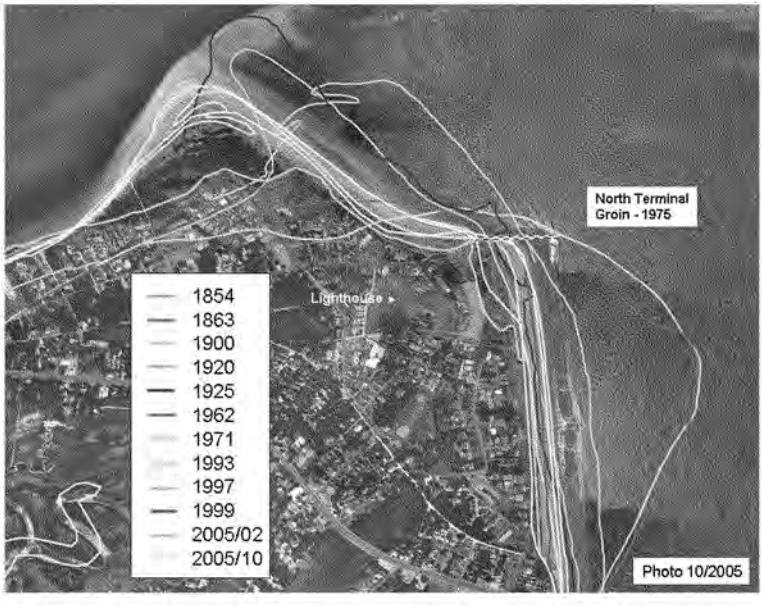


Figure 2-4. Historical shoreline positions along the North end of Tybee Island.

Figure 2-5. Historical shoreline positions along the central portion of Tybee Island in the vicinity of the hot spot.

Figure 2-6. Historical shoreline positions along the South end of Tybee Island.

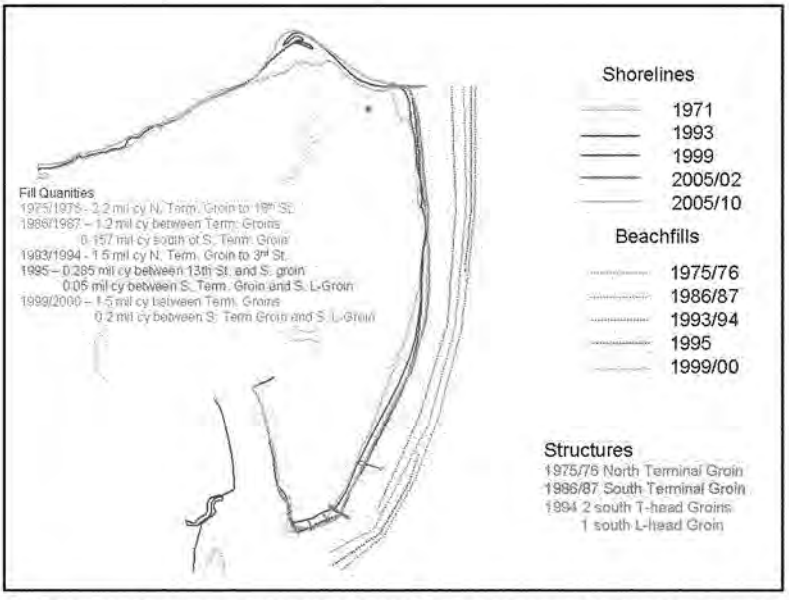


Figure 2-7. Shoreline change relative to recent beach fills and shore protection structure construction.

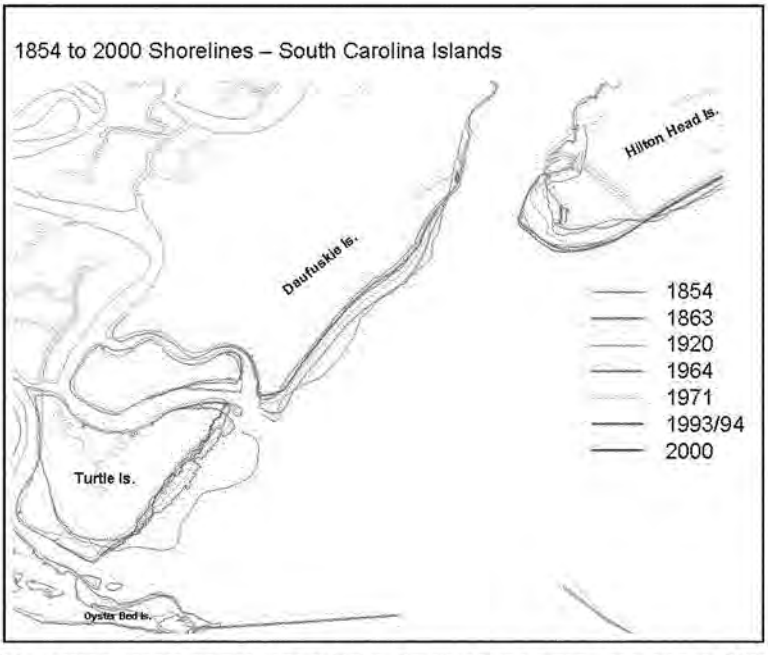


Figure 2-8. Historical shoreline positions of Turtle, Daufuskie and Hilton Head Islands, SC from digital shoreline used in study.

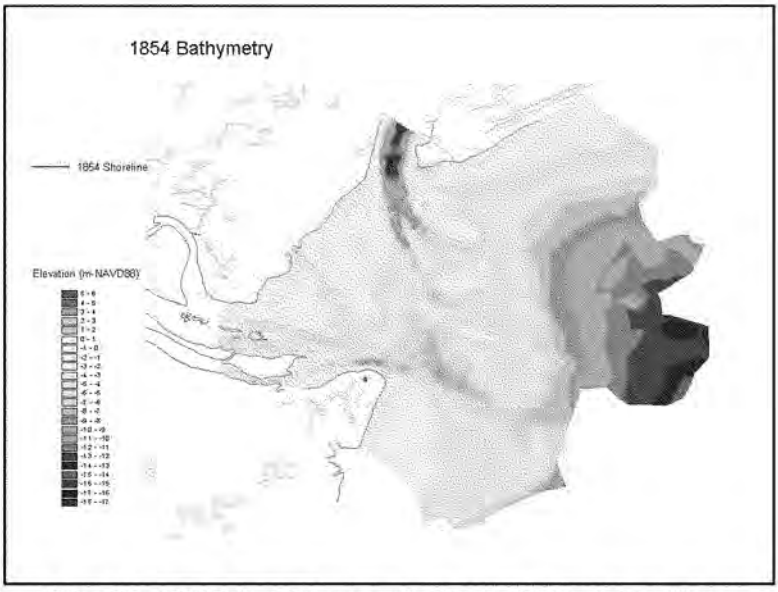


Figure 2-9. 1854 Bathymetry representing the pre 1871 project conditions.

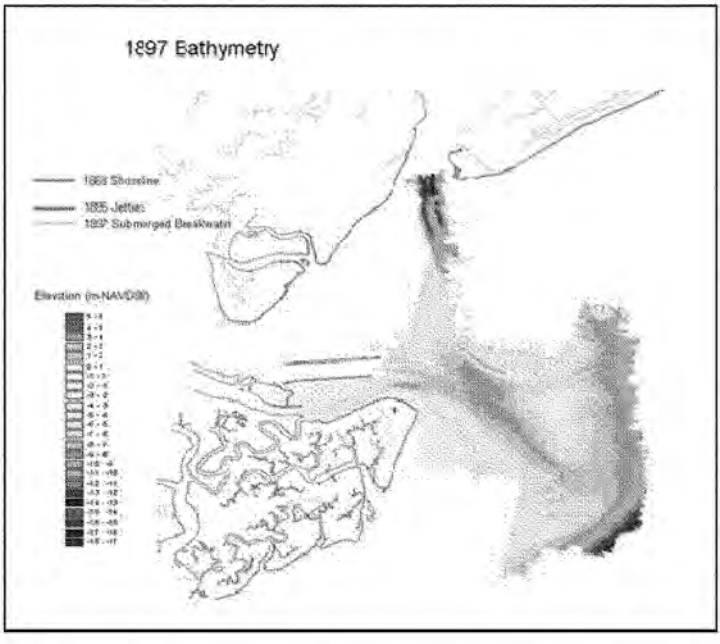


Figure 2-10. 1897 Bathymetry representing the immediate post-jetty and submerged breakwater construction conditions.

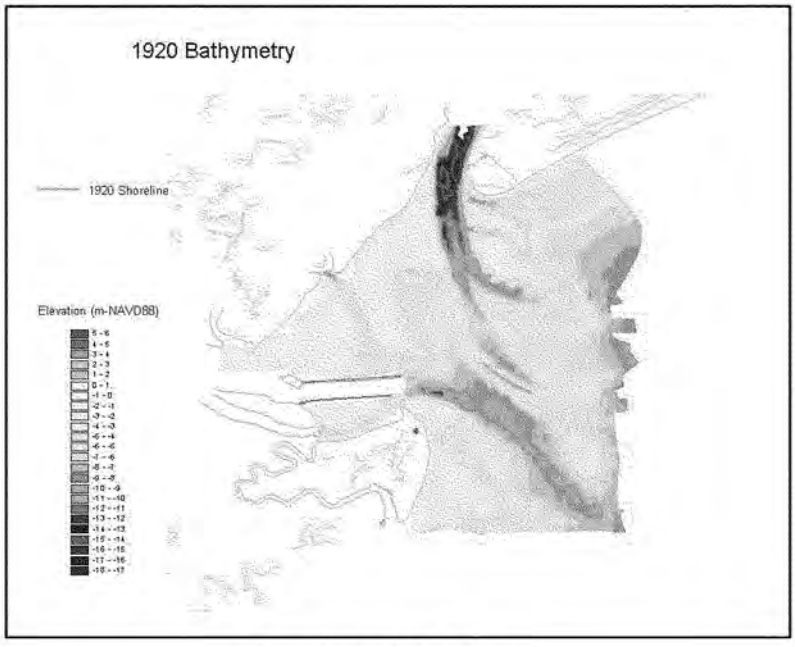


Figure 2-11. 1920 Bathymetry.

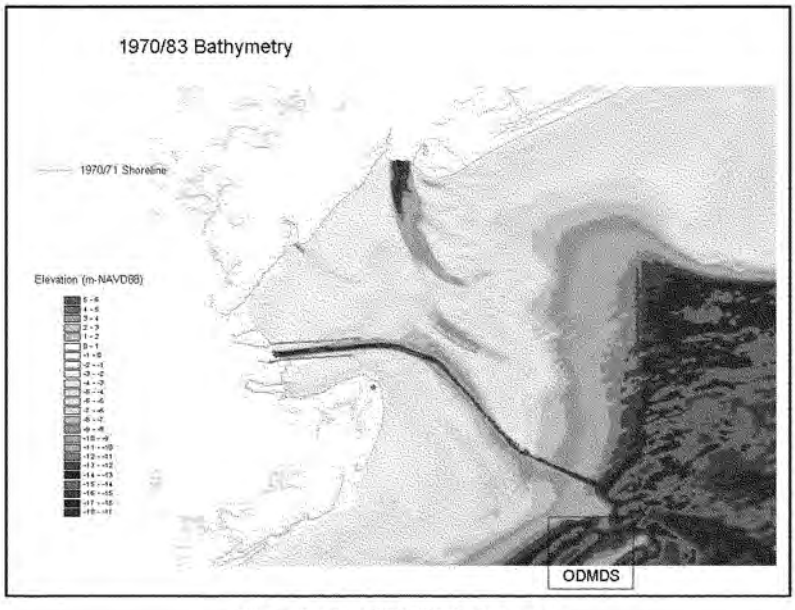


Figure 2-12. 1970/83 Bathymetry.

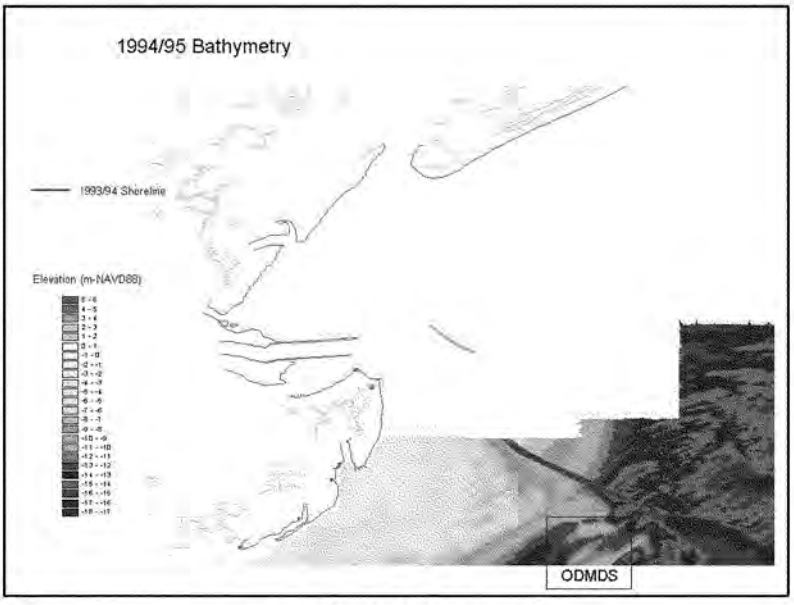


Figure 2-13. 1993/94 Bathymetry.

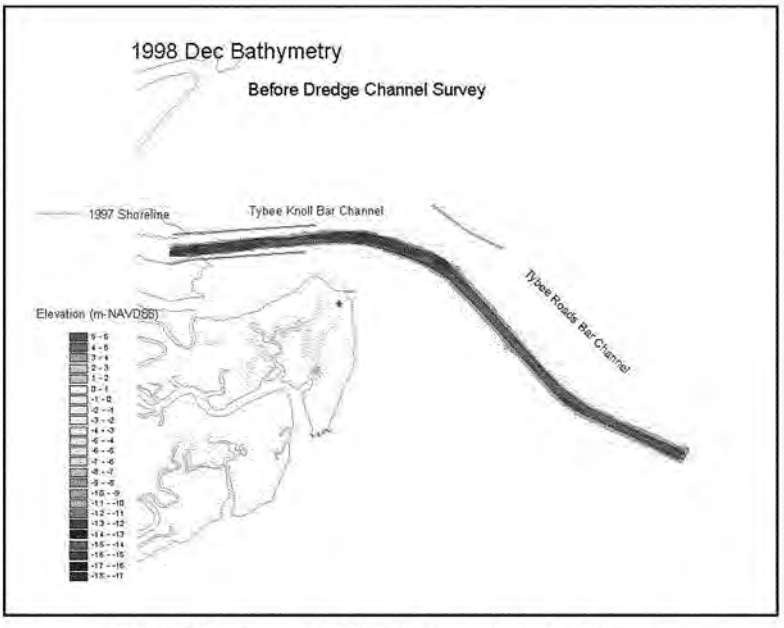


Figure 2-14. December 1998 Channel before dredge survey.

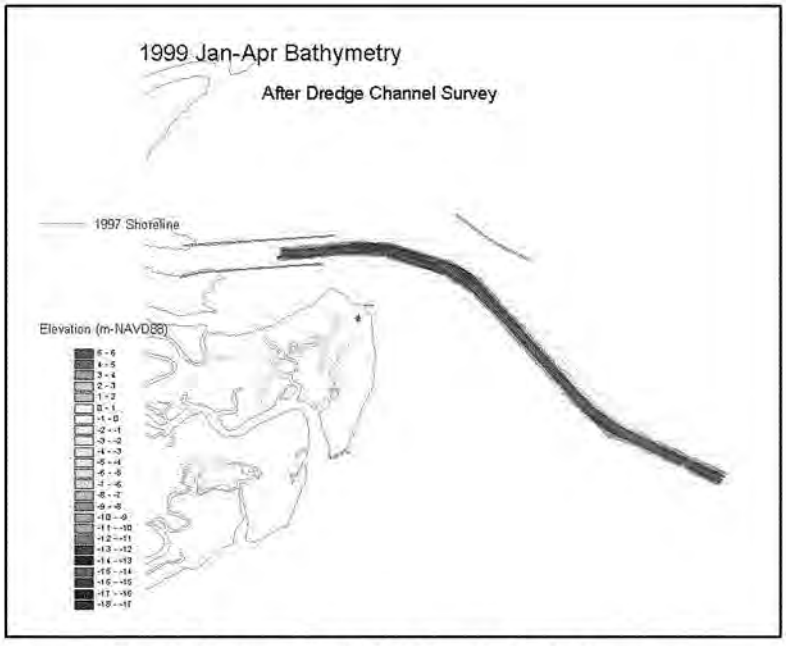


Figure 2-15. January/April 1999 Channel after dredge survey.

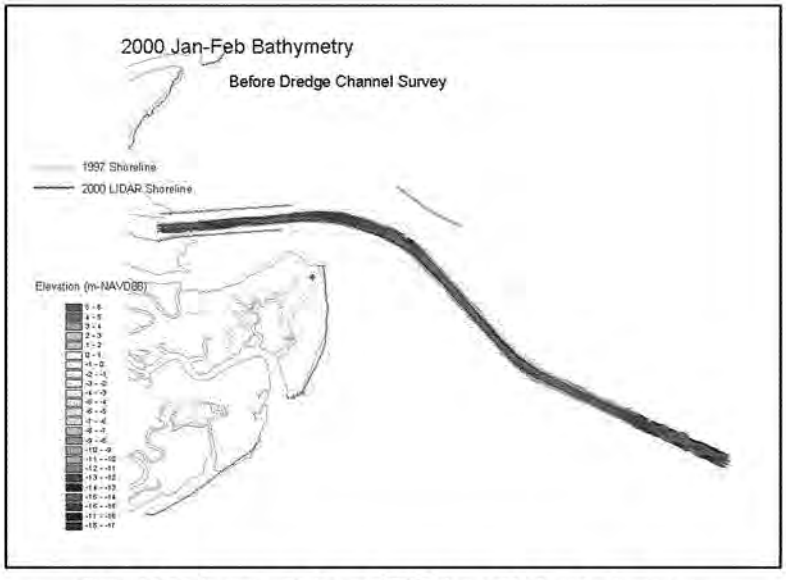


Figure 2-16. January – February 2000 Channel before dredge survey.

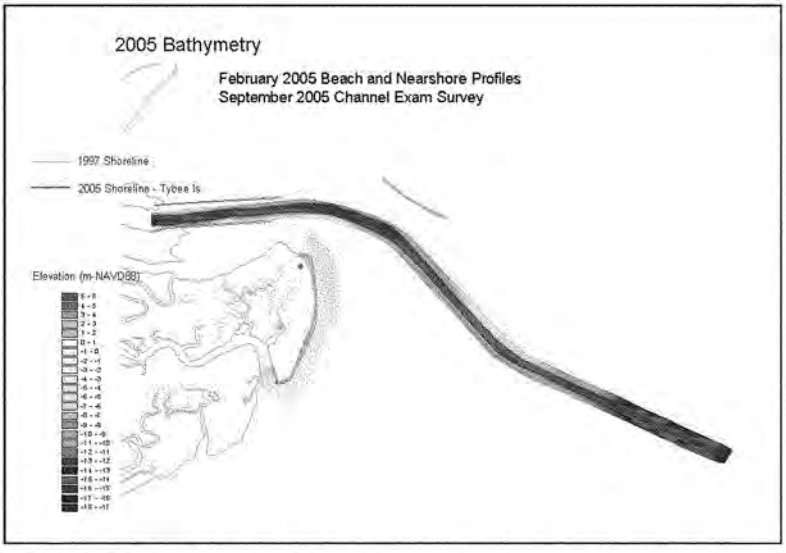


Figure 2-17. February 2005 Tybee Island profiles and September 2005 Channel exam survey.

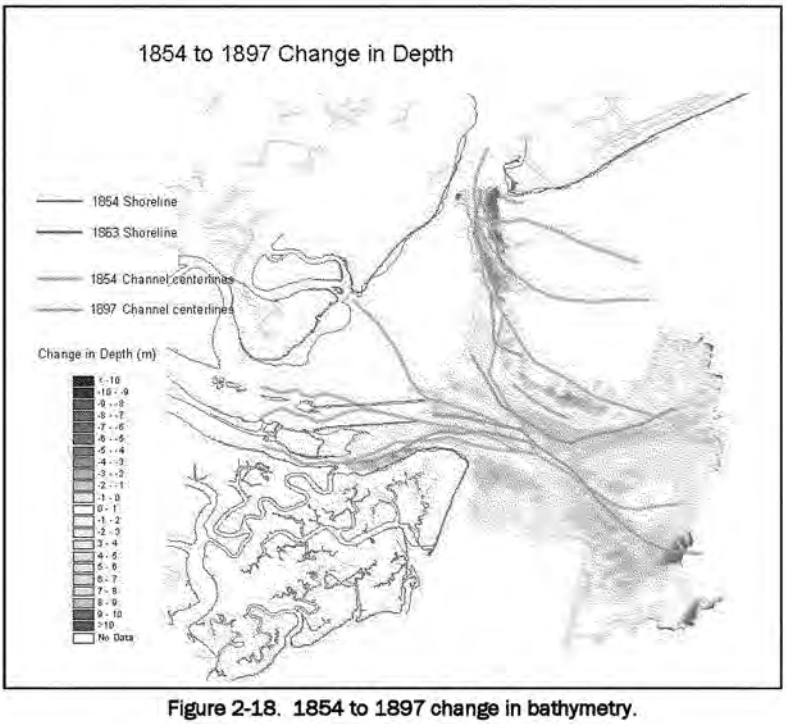


Figure 2-18. 1854 to 1897 change in bathymetry.

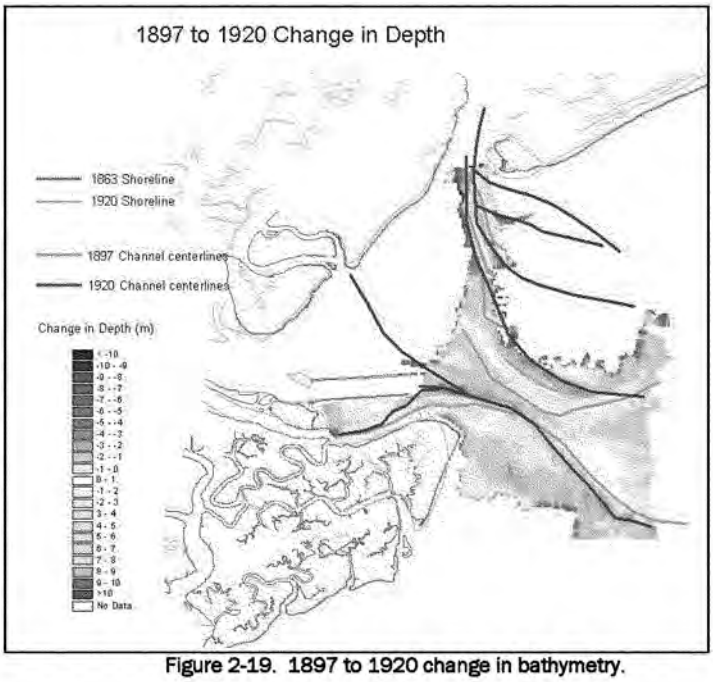


Figure 2-19. 1897 to 1920 change in bathymetry.

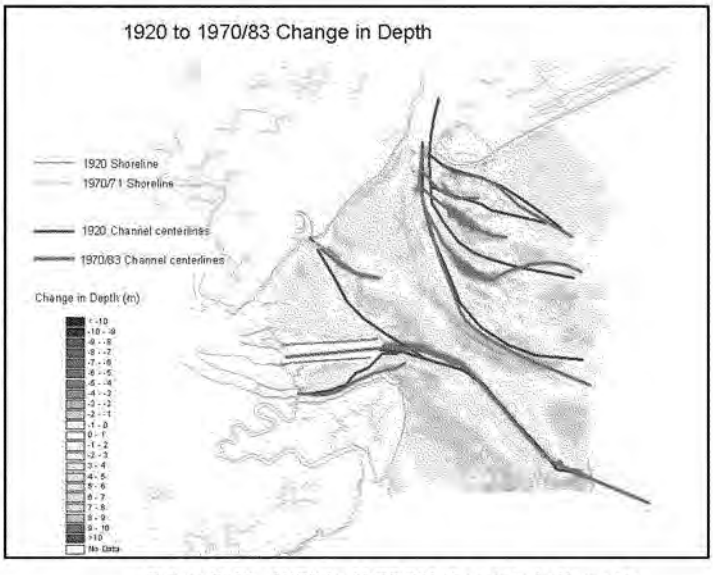


Figure 2-20. 1920 to 1970/83 change in bathymetry.

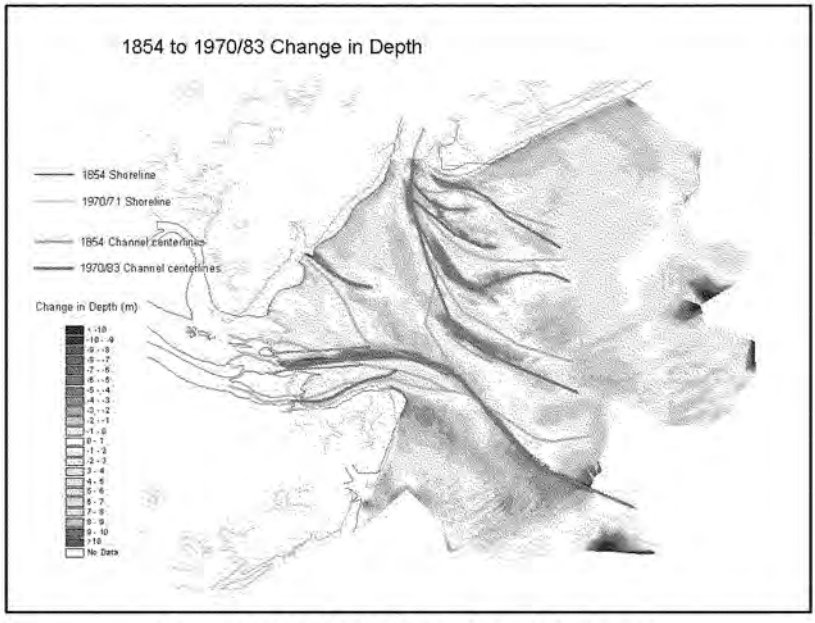


Figure 2-21. 1854 to 1970/83 change in bathymetry.

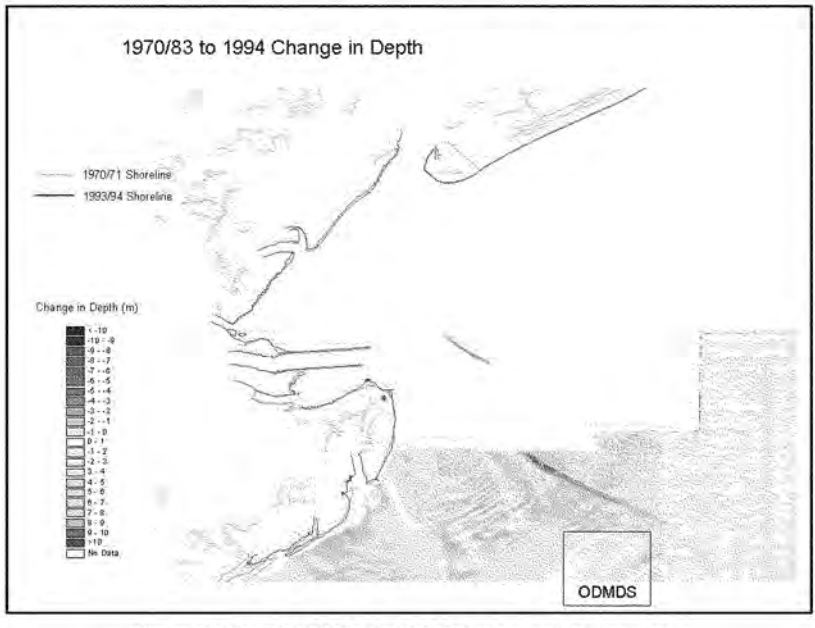


Figure 2-22. 1970/83 to 1993/94 change in bathymetry.

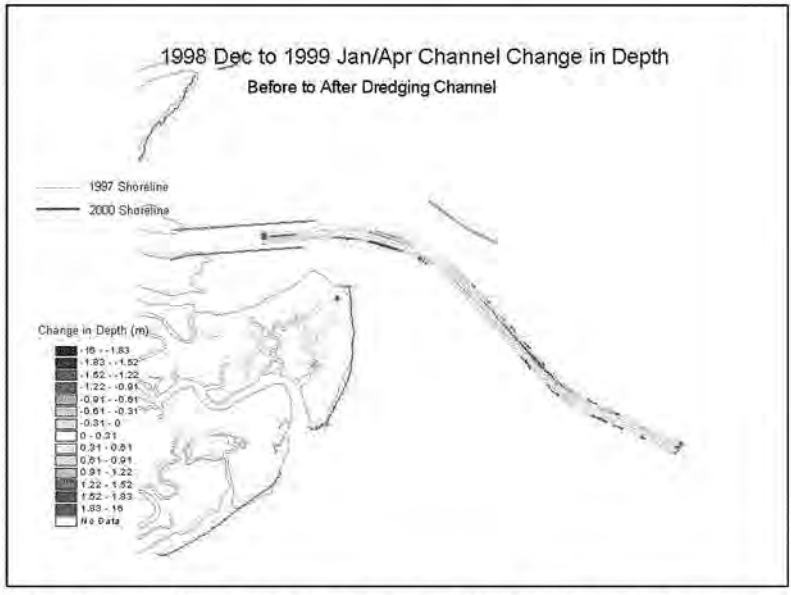


Figure 2-23. December 1998 before dredge to January/April 1999 after dredge survey change in channel bathymetry.

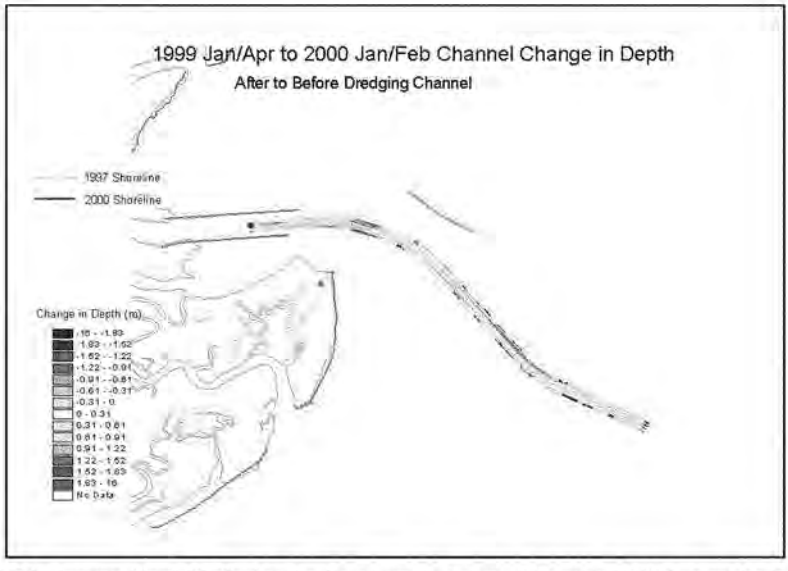


Figure 2-24. January/April 1999 after dredge survey to January/February 2000 before dredge survey change in channel bathymetry.

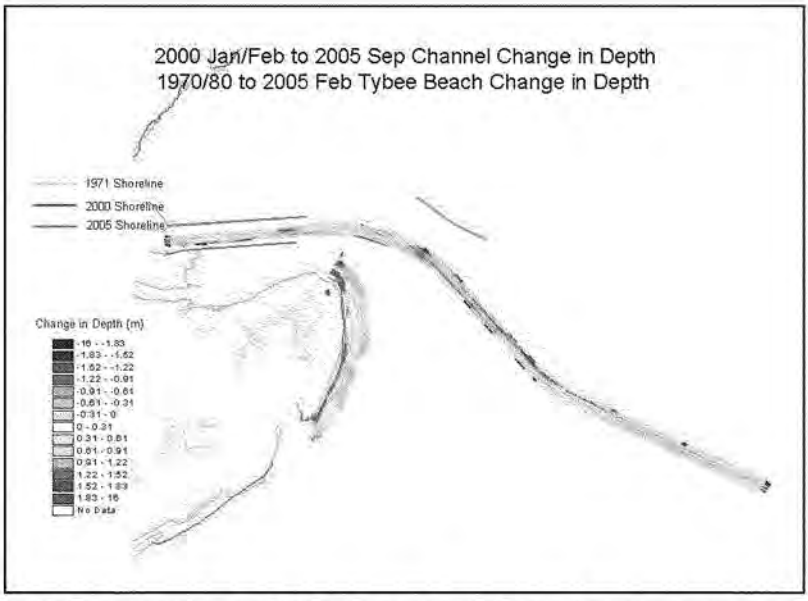


Figure 2-25. January/February 2000 to September 2005 change in channel bathymetry and 1970/83 to February 2005 change in nearshore bathymetry.

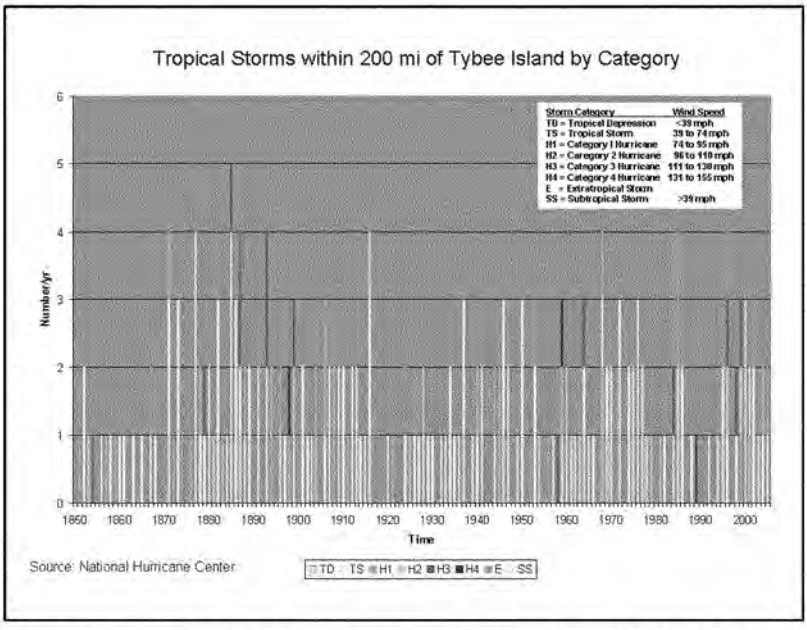


Figure 2-26. Tropical storm occurrence within 200 mi of Tybee Island 1850 to 2005.

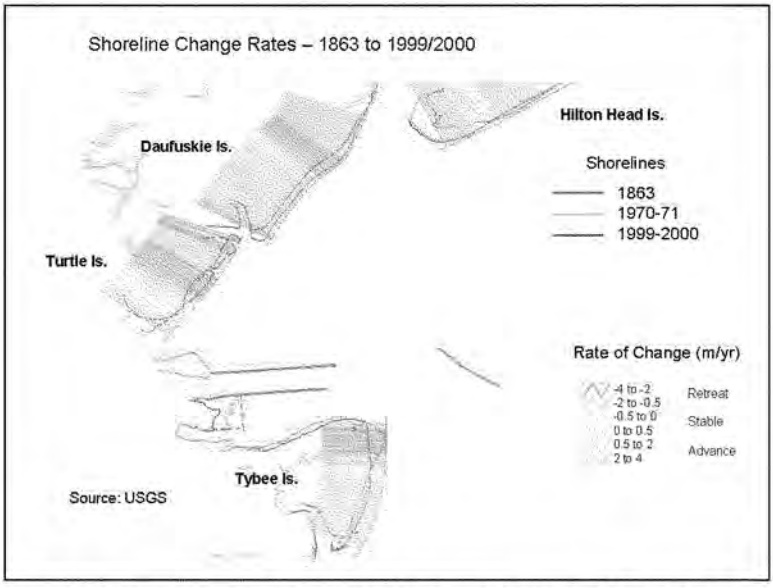


Figure 2-27. USGS shoreline change rate 1863-1999/2000 (after Miller et al 2005).

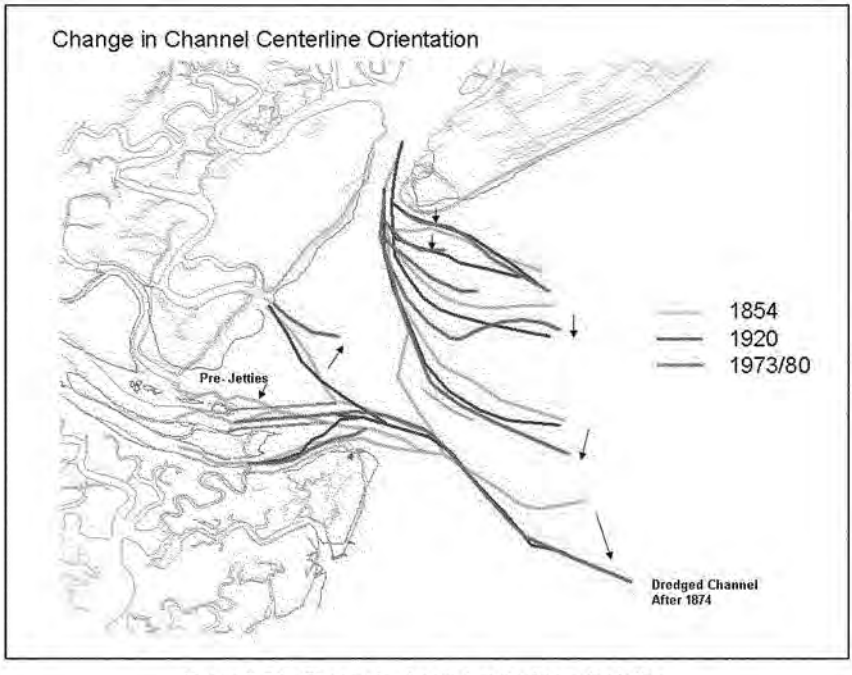


Figure 2-28. Change in channel centerline orientation.

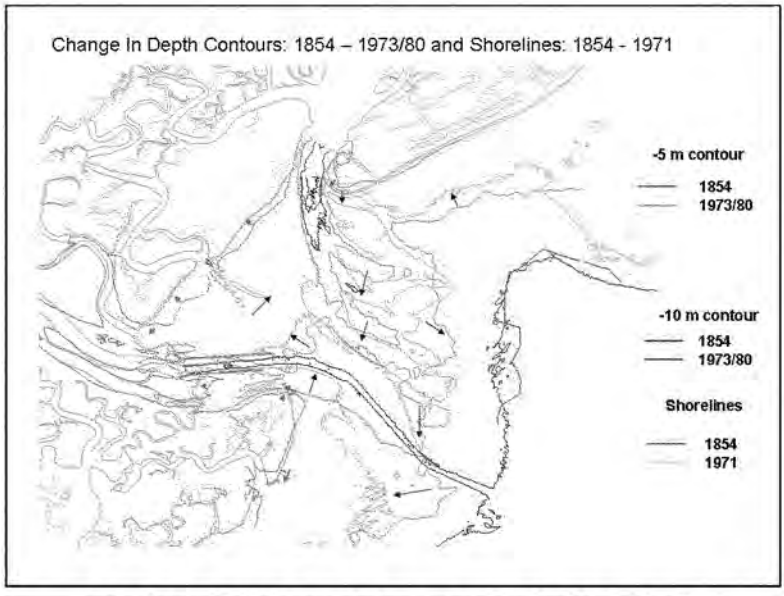


Figure 2-29. Change in 5m NAVD depth contour 1854 to 1970/83.

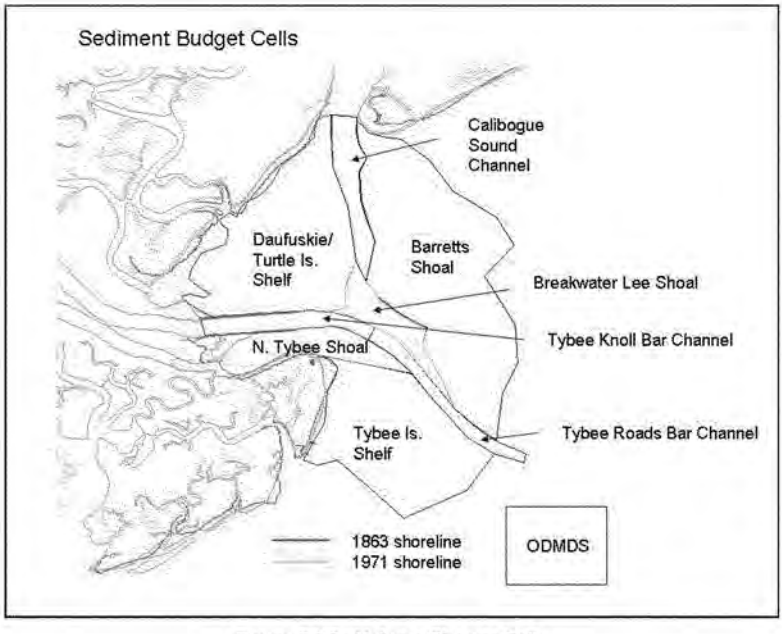


Figure 2-30. Volume Change Cells.

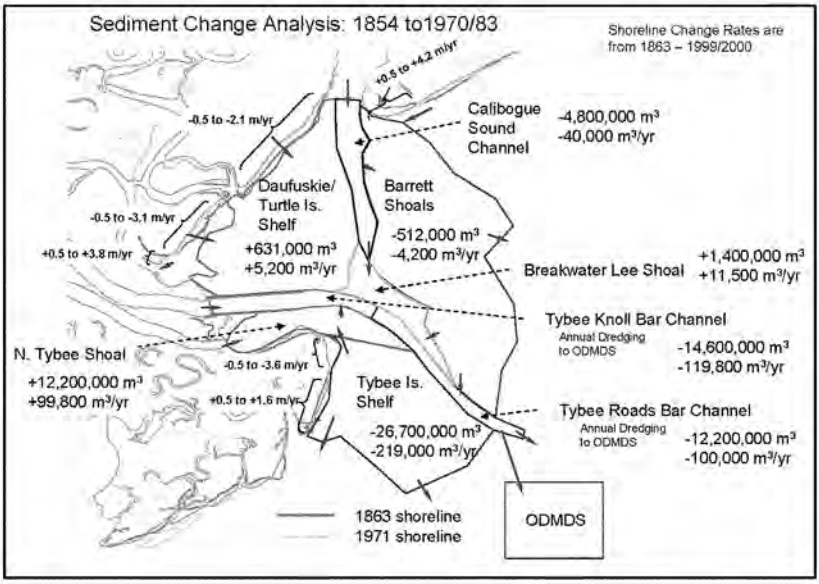


Figure 2-31. 1854 to 1970/83 Volume Change.

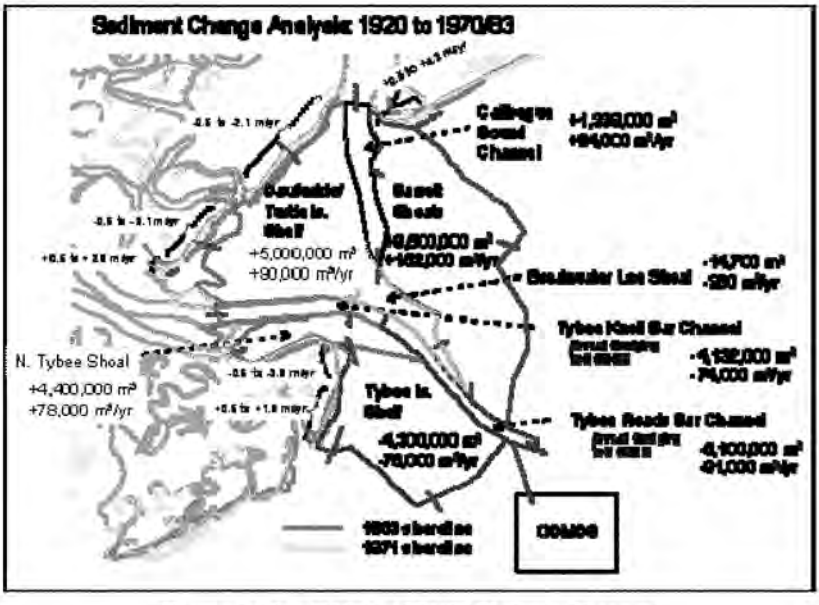


Figure 2-32. 1920 to 1970/83 Volume Changes

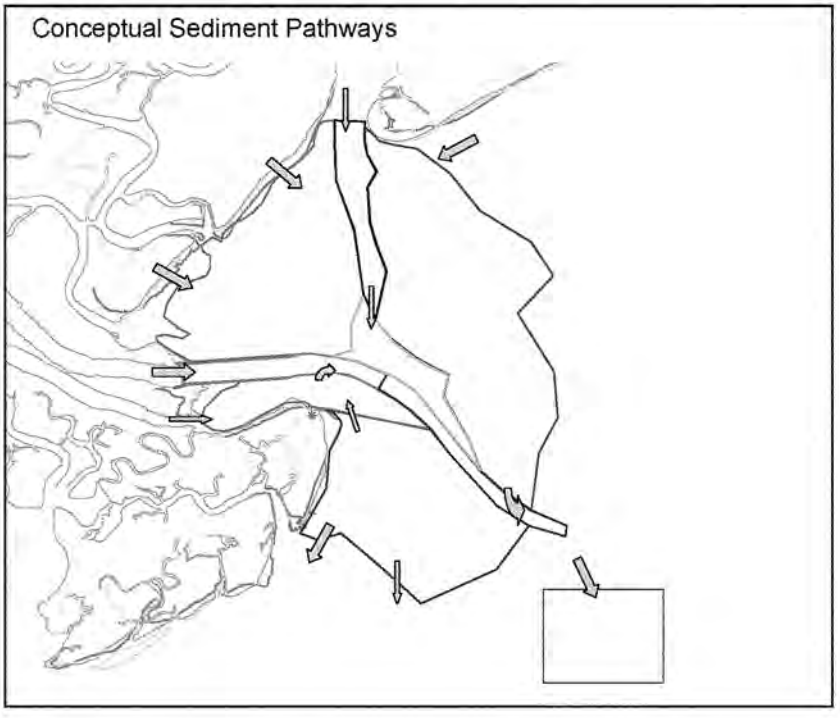


Figure 2-33. Conceptual Sediment Pathways.

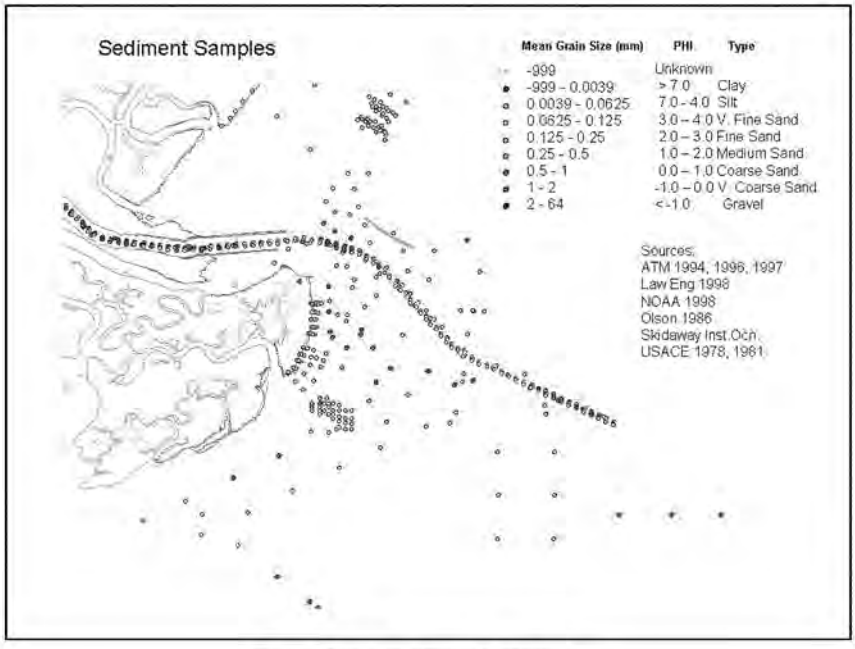


Figure 2-34. Sediment distribution.

3 Circulation Modeling

A major task completed during the Savannah Harbor Entrance Channel: Nearshore Placement of Dredged Material Study (Gailani et al. 2003) was the development, calibration, and application of a fine-grid hydrodynamic model of the Savannah River Entrance Channel and the surrounding ebb shoal and ocean-exposed coast. The ADvanced CIRCulation (ADCIRC) model (Luettich and Westerink 2004) was applied for generation of tidal currents, wind-driven currents and storm surges needed for the sediment transport and wave models. ADCIRC is a two-dimensional, depth-integrated, finite-element, ocean circulation model that has been proven to accurately simulate tidal and storm conditions in nearshore regions. ADCIRC-predicted velocities and water levels were used to develop storm and non-storm hydrodynamic conditions in the river and on the ebb shoal. The accuracy of the model was evaluated using available tidal data at Fort Pulaski, in Tybee Creek, and offshore. In addition, Acoustic Doppler Current Profiler (ADCP) current data provided by Applied Technology and Management, Inc. (2001), were used to evaluate the model.

During that study, the ADCIRC hydrodynamic model was applied for the following simulations: a) December 1999 was simulated as the model calibration period. The hydrodynamic simulations included tidal, river flow, and atmospheric forcing; b) Hurricane Hugo (hypothetically re-tracked to strike Savannah), which occurred during 14-22 September 1989, was simulated to represent an extreme storm event. An atmospheric model was applied to develop the wind and pressure fields; c) November 1979, which included a number of storms, was simulated to represent an active month. The hydrodynamic simulations included tidal, river flow, and atmospheric forcing; d) January 1992 was simulated to represent a typical dredging window operational month. The hydrodynamic simulations included tidal, river flow, and atmospheric forcing; and e) July 1999 was simulated to represent a low wind condition summer month, in which forcing with tidal constituents were included.

The purpose of the present circulation modeling effort is to evaluate the changes in the water surface elevation and depth-averaged velocity patterns in the vicinity of the channel entrance between the existing and channel deepening conditions. The results of the Savannah Harbor Entrance Channel: Nearshore Placement of Dredged Material Study were utilized in the present effort to represent the exiting conditions. The development of the ADCIRC model grid, boundary forcing functions, and the model verifications are presented in detail within the Savannah Harbor Entrance Channel: Nearshore Placement of Dredged Material Study Report.

The tasks to examine and compare pre- and post-channel deepening hydrodynamics include reconstituting the ADCIRC model grid, input, and output files; repeating the December 1999 calibration exercise; modifying the ADCIRC grid to represent channel deepening; and the comparison of the pre- and post-channel deepening hydrodynamic model results for the five simulation periods described above. Table 3-1 summarizes the ADCIRC simulation parameters (see Luettich and Westerink 2005). The final ADCIRC model simulations included the application of wave radiation stress gradients provided by the STWAVE model (Chapter 4).

Table 3-1. ADCIRC Simulation Parameters	
Coordinate system	Spherical
Model run type	Two dimensional, depth integrated
Nonlinear Terms	Nonlinear quadratic bottom friction, finite amplitude terms included, advective terms included (including time derivative portion)
Forcing	Tidal potential, wind, pressure (for re-tracked Hugo), river inflow, and wave stresses
Ramp	One day, hyperbolic tangent ramp
τ_0 (generalized wave continuity equation weight)	0.01
Time Step	1 sec for all runs except July 1999 (deepened), which is 0.5 sec
Flood and dry parameters	Nominal water depth for dry node = 0.1 m, minimum number of time steps cell must remain dry before rewetting = 150, minimum number of time steps node must remain wet before drying = 0, minimum velocity for wetting 0.05 m/sec
Bottom friction coefficient	0.0025
Lateral eddy viscosity	3.0 m^2/sec
Tidal Constituents	K1, O1, Q1, M2, S2, N2, K2

Calibration

The results of the December 1999 model calibration simulation are shown in Figure 3-1, in which water surface elevation field measurements at Fort Pulaski (blue line) are compared to model predictions (red line). Comparison of the present model calibration with Figure 8 of the Savannah Harbor Entrance Channel: Nearshore Placement of Dredged Material Study Report demonstrates that the reconstitution of the original calibrated ADCIRC grid and input files was successful.

Additional model verification comparisons are presented for the re-tracked Hurricane Hugo and November 1979. Figure 3-2 presents measured and predicted water surface elevations at Fort Pulaski during the re-tracked Hurricane Hugo simulation period. The figure shows that the measured and predicted water surface elevation compare well up to the time when the storm track was altered to directly impact the area (0000 to 1200 UTC 22 September 1989). Finally, a validation comparison of measured and predicted water surface elevations for the November 1979 simulations is presented in Figure 3-3, in which it is seen that model predictions compare well to the gauge data.

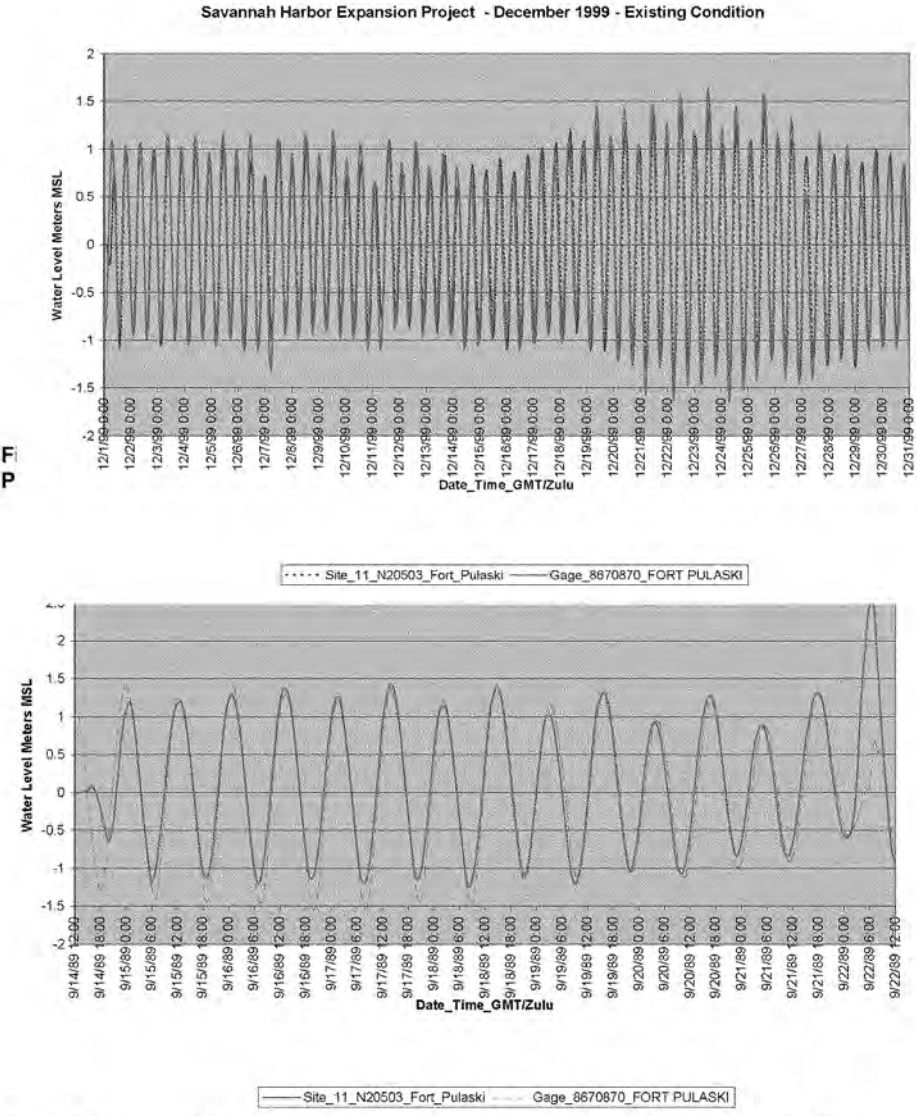


Figure 3-2. Comparison of measured and predicted water surface elevations for the retracked Hurricane Hugo. Note the divergence from measurements on 22 September when the storm track was altered to strike Savannah.

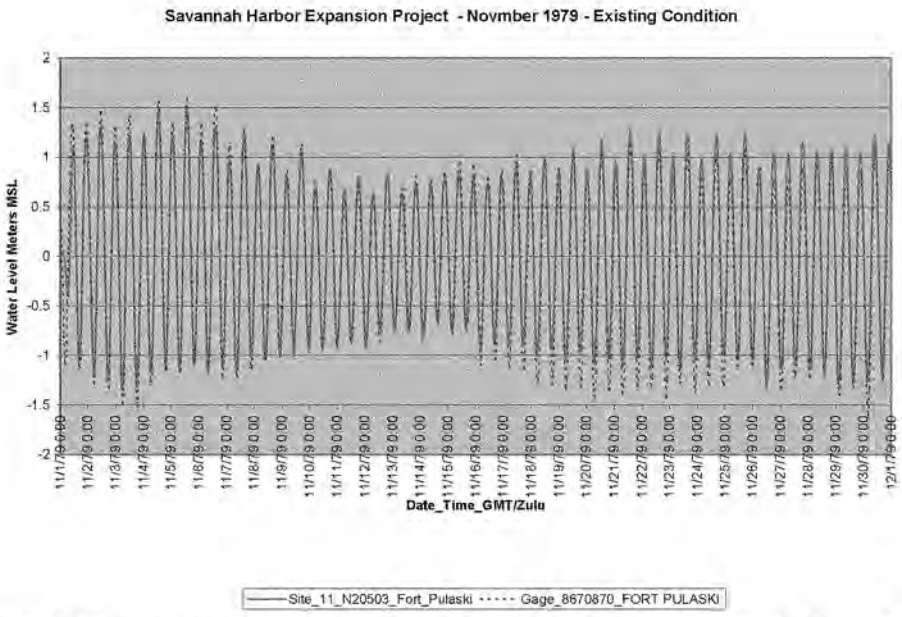


Figure 3-3. Comparison of measured and predicted water surface elevations for the November 1979 simulation period.

Circulation Model Results

Figure 3-4 shows the water levels and current vectors for the existing bathymetry at the peak of the re-tracked Hurricane Hugo. The maximum current velocities are 2 m/sec and the maximum water surface elevations (WSE) range from 2.8 m at Tybee Island to 3.3 m at the southern end of Hilton Head Island. Figure 3-5 shows an expanded view of the surge and longshore currents at Tybee Island at the peak of the storm. Figure 3-6 shows the maximum water surface elevation over the entire simulation for each node in the domain. Differences in the water surface elevations and depth-averaged velocity patterns were obtained by subtracting the global maximum value fields of the existing simulation results from the channel deepening simulation results. The differences, thus, are difference in maximum values over an entire simulation. Figure 3-7 shows the difference in maximum water surface elevation for the deepened channel simulation minus the existing condition simulation. The nearshore peak water level is approximately 0.20 m lower for the deepened channel. The deepened channel provides slightly less resistance to flow (more conveyance) to the nearshore, so the surge peaks earlier and at a slightly lower level. The difference in maximum depth-averaged current magnitude is shown in Figure 3-8. The maximum current magnitudes are 0.15 to 0.20 m/sec stronger in the channel for the deepened channel. The maximum currents along Tybee Island are generally slightly weaker with the deepened channel. In other very shallow areas (e.g., at the shoreline and on ebb shoal), there are localized maximum current differences on the order of 0.5 m/sec. These are most likely a remnant of the nonlinearity of flooding and drying or accelerations in very shallow water and are not representative of mean processes.

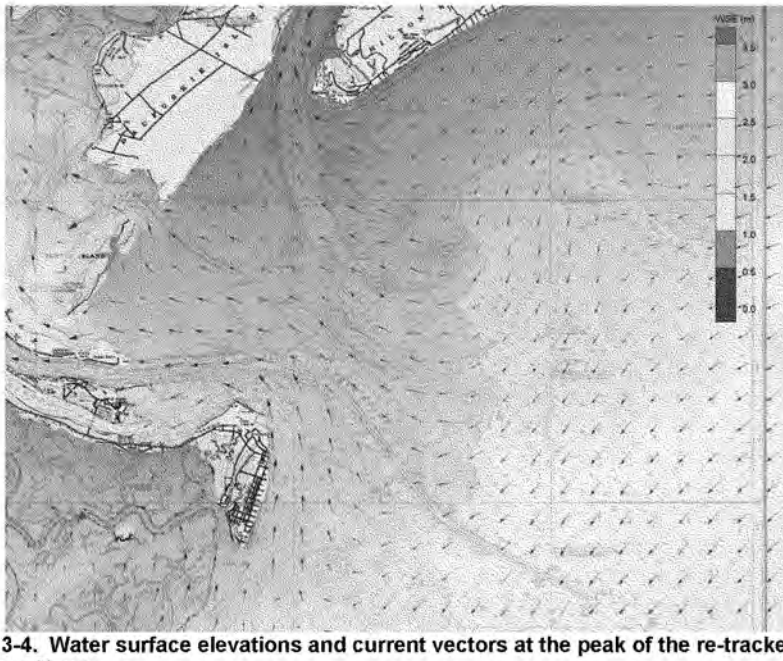


Figure 3-4. Water surface elevations and current vectors at the peak of the re-tracked Hurricane Hugo.

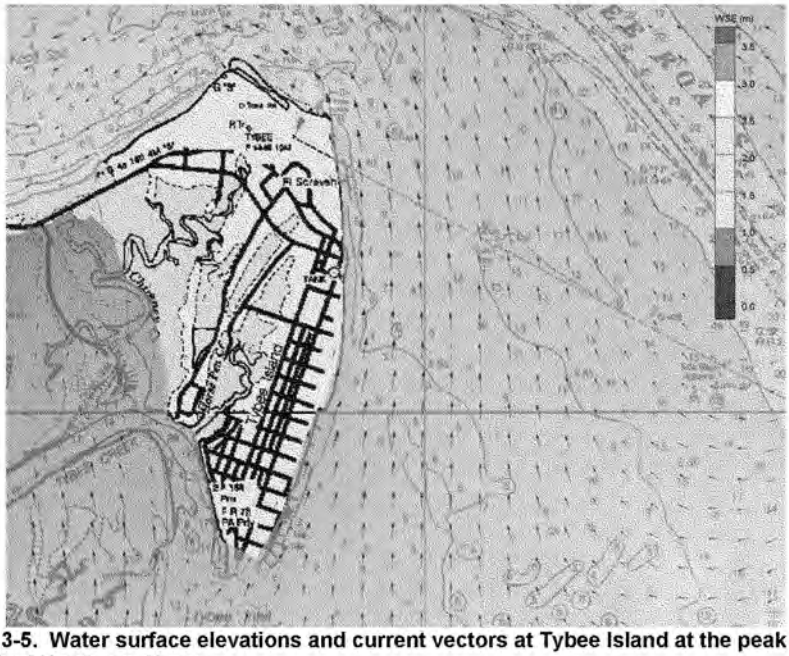


Figure 3-5. Water surface elevations and current vectors at Tybee Island at the peak of the re-tracked Hurricane Hugo.

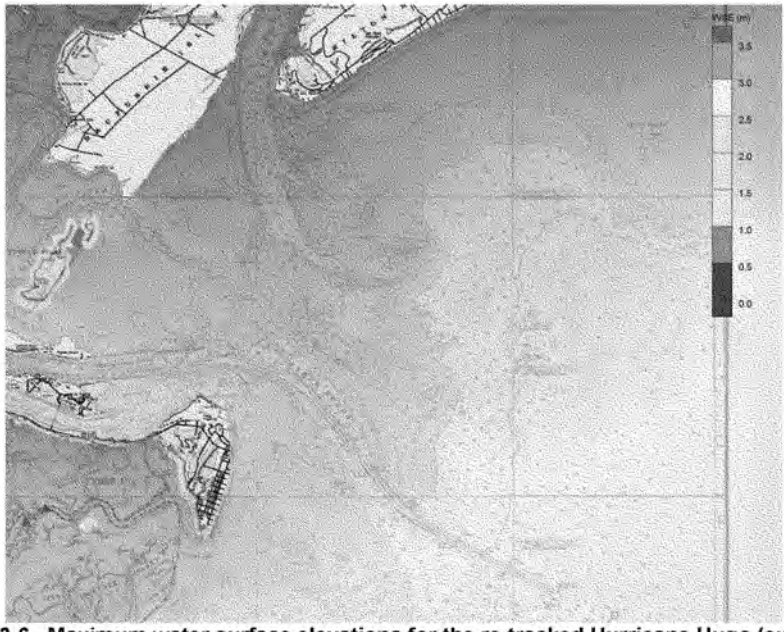


Figure 3-6. Maximum water surface elevations for the re-tracked Hurricane Hugo (existing).

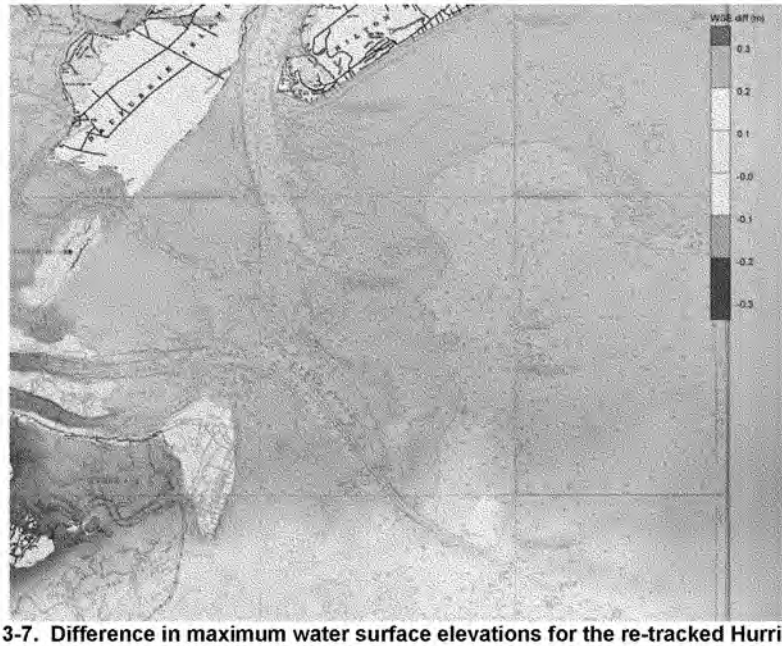


Figure 3-7. Difference in maximum water surface elevations for the re-tracked Hurricane Hugo (deepened channel minus existing bathymetry).

Figure 3-8. Difference in maximum current magnitudes for the re-tracked Hurricane Hugo (deepened channel minus existing bathymetry).

The inclusion of wave stresses in the ADCIRC simulations has a significant effect and is included in both the existing and deepened channel simulations. Figure 3-9 shows the increase in water surface elevation when wave stresses are included in the model forcing for the re-tracked Hurricane Hugo at the peak of the storm (existing condition). Water surface elevations increase by as much as 0.5 m at the Tybee Island shoreline and 0.2 to 0.3 m on the platform seaward of Tybee Island. Currents along the shoreline increase up to 1 m/sec (Figure 3-10). Comparing Figures 3-9 and 3-10, it is seen that the wave stresses manifest themselves more strongly in wave setup on the southern end of the island and longshore currents on the northern end at the peak of the storm. This is due to the curvature of the island at the northern end and the relatively more oblique wave angles forcing the current.

Figure 3-11 shows the residual currents for the re-tracked Hugo simulation. The residual currents are average currents calculated for each grid node for the entire simulation (a few points are excluded at the beginning and end of the simulation to match the phasing of the tide at the beginning and end of the simulation). The residual current patterns for all simulations are similar, although the patterns for the re-tracked Hugo are somewhat more chaotic because of the intensity of the event. The residual patterns show ebb dominance in the channels and generally flood dominance on the shoals. A divergence point in the residual currents is seen along the mid Tybee Island shoreline, with residual currents toward the north on the north end and toward the south on the south end. The southern trend is weaker in the other simulations. Figure 3-12 shows the difference in residual currents for the deepened channel (deepened – existing). The residual current are stronger in the channel (flowing offshore) and weaker on the shoals (including north Tybee) with the deepened channel. The maximum differences for this extreme event is approximately 0.1 m/sec

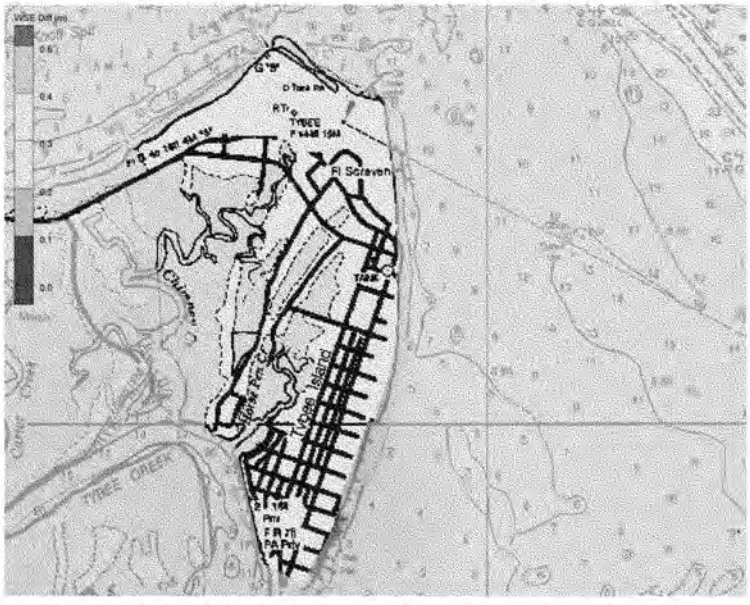


Figure 3-9. Difference in water surface elevation at the peak of the re-tracked Hurricane Hugo due to inclusion of wave stresses.

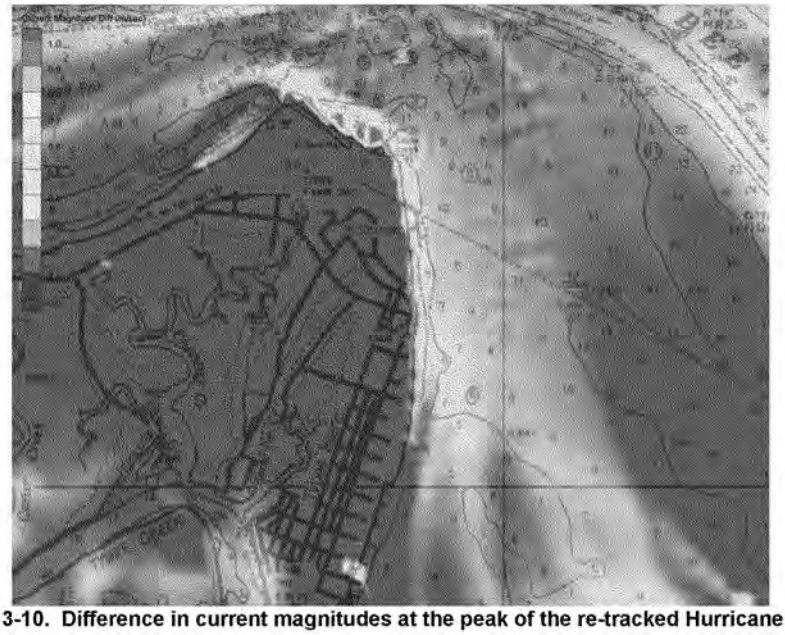


Figure 3-10. Difference in current magnitudes at the peak of the re-tracked Hurricane Hugo

due to inclusion of wave stresses.

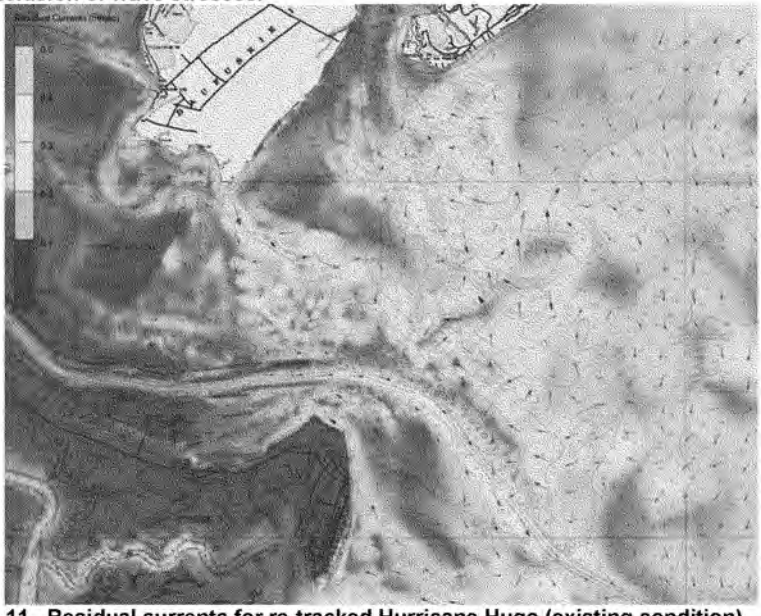


Figure 3-11. Residual currents for re-tracked Hurricane Hugo (existing condition).

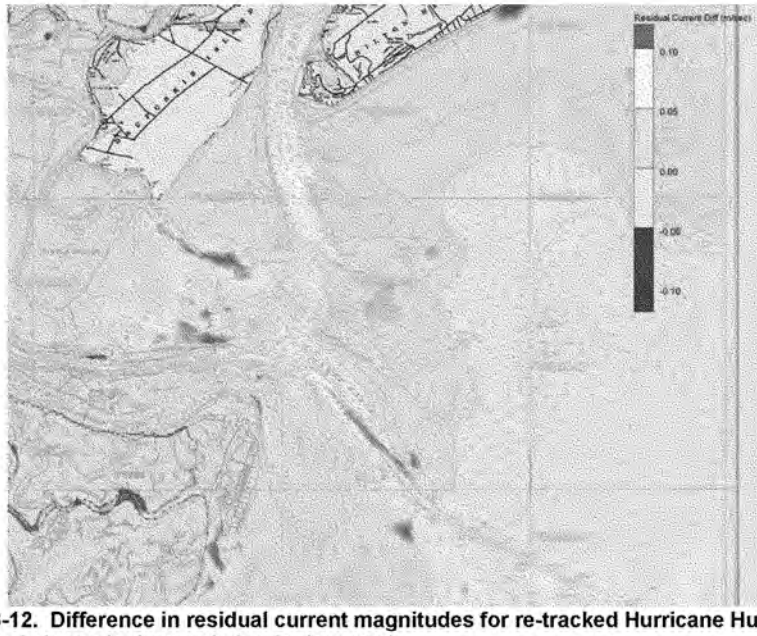


Figure 3-12. Difference in residual current magnitudes for re-tracked Hurricane Hugo (deepened channel minus existing bathymetry).

Figure 3-13 shows the difference in maximum water surface elevations for November 1979. The pattern of differences is more localized and variable than for the re-tracked Hurricane Hugo. The maximum water surface elevations are minimally lower at Tybee Island (0.01 m) and slightly higher at Turtle and Daufuskie Islands (0.012 m and 0.014 m, respectively). These magnitudes of differences are negligible. In areas of flooding and drying, larger local maximum differences are seen, on the order of 0.5 m. The differences in maximum depth-averaged current magnitude for November 1979 are shown in Figure 3-14. In the deepened channel, increases in maximum current magnitude are less than 0.08 m/sec. Maximum currents beside the channel are slightly decreased. Again, localized differences in current maxima occur in very shallow areas. Figure 3-15 shows the differences in residual current magnitude for November 1979. Although the maximum currents increased for the deepened channel, the residual currents tend to decrease slightly in the inner channel and increase slightly in the outer channel (generally less than +/-0.01 m/sec). Residual currents along northern Tybee Island are also slightly reduced.

Figures 3-16 and 3-17 show the maximum water surface elevation and current magnitude differences for January 1992. The maximum water surface elevations are generally 0.02 m lower on the inner shelf for the deepened channel, but 0.01 to 0.03 m higher in the inner channels and estuaries. Current magnitudes are a maximum of 0.09 m/sec larger in the channel. Figure 3-18 shows the differences in residual current magnitude for January 1992. The trends are similar to November 1979, with slight reductions in residual currents in the channel and north of Tybee.

Figures 3-19 and 3-20 show the maximum water surface elevation and current magnitude differences for July 1999. The maximum water surface elevations are generally 0.03 m higher at Turtle and Daufuskie Islands and lower by up to 0.02 m at southern Tybee Island for the deepened channel. Current magnitudes are a maximum of 0.07 m/sec larger in the channel. Figure 3-21 shows the differences in residual current magnitude for July 1999. The trends are similar to the previous simulations, with slight reductions in residual current in the channel and north of Tybee.

Figures 3-22 and 3-23 show the maximum water surface elevation and current magnitude differences for December 1999. The maximum water surface elevations are minimally lower at Tybee Island (0.01 m) and slightly higher at Turtle and Daufuskie Islands (0.007 m and 0.005 m, respectively). This pattern is similar to November 1979. Current magnitudes are a maximum of 0.06 m/sec larger in the channel. Figure 3-24 shows the differences in residual current magnitude for December 1999. The trends are similar to the previous simulations, with slight reductions in residual current in the channel and north of Tybee.

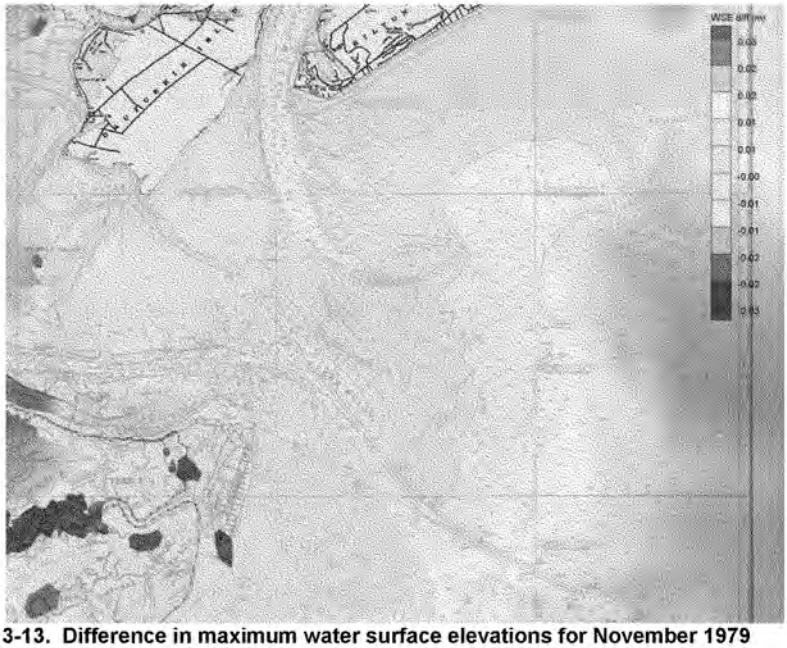


Figure 3-13. Difference in maximum water surface elevations for November 1979 (deepened channel minus existing bathymetry).

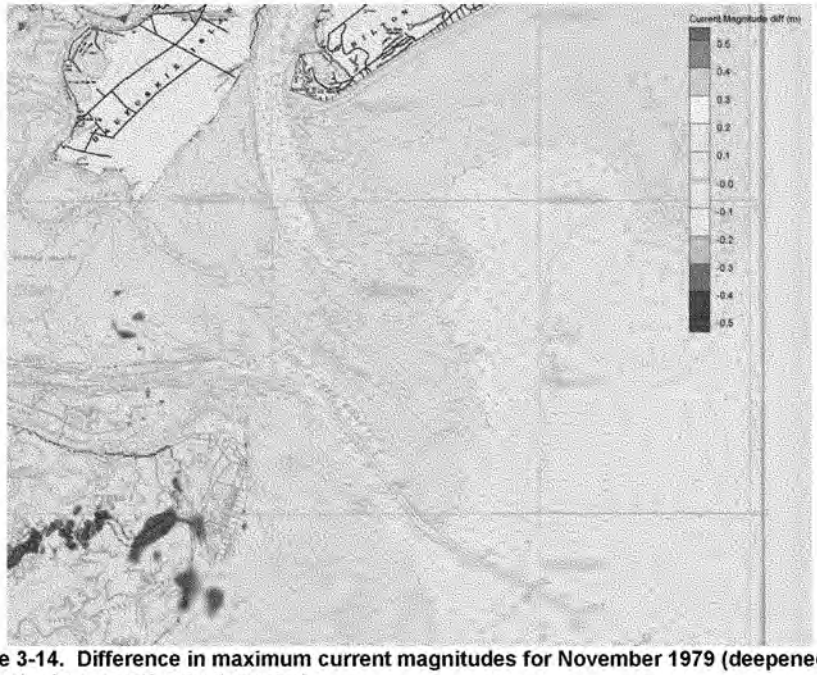


Figure 3-14. Difference in maximum current magnitudes for November 1979 (deepened channel minus existing bathymetry).

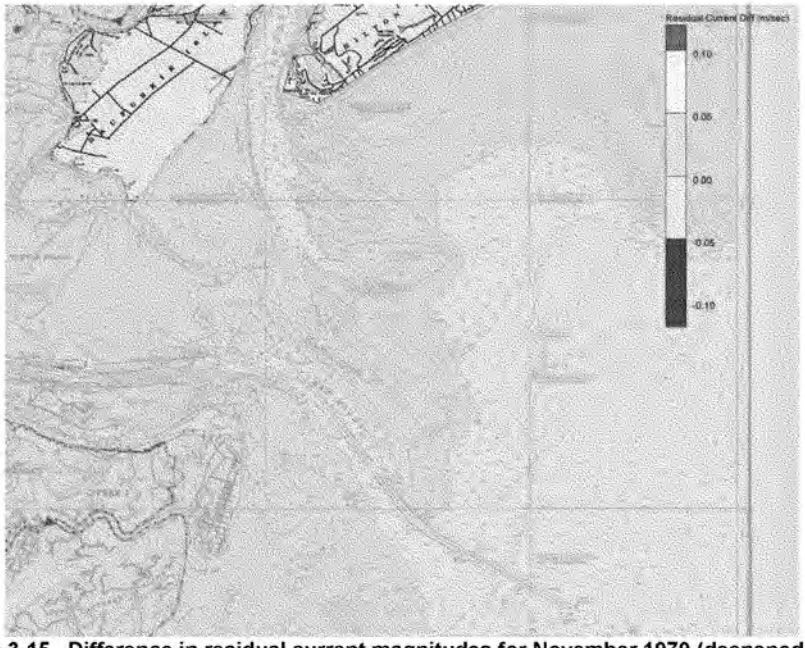


Figure 3-15. Difference in residual current magnitudes for November 1979 (dedeepened channel minus existing bathymetry)

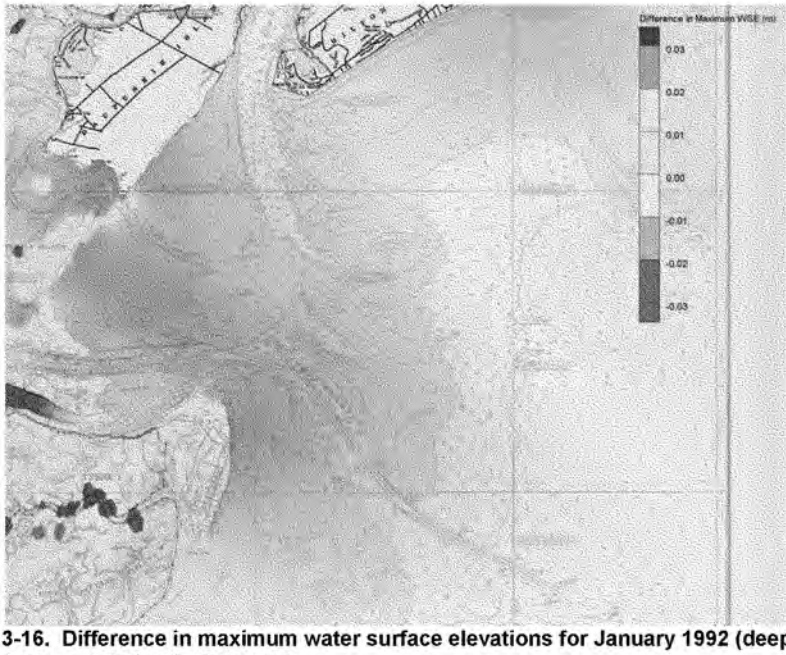


Figure 3-16. Difference in maximum water surface elevations for January 1992 (deepened channel minus existing bathymetry).

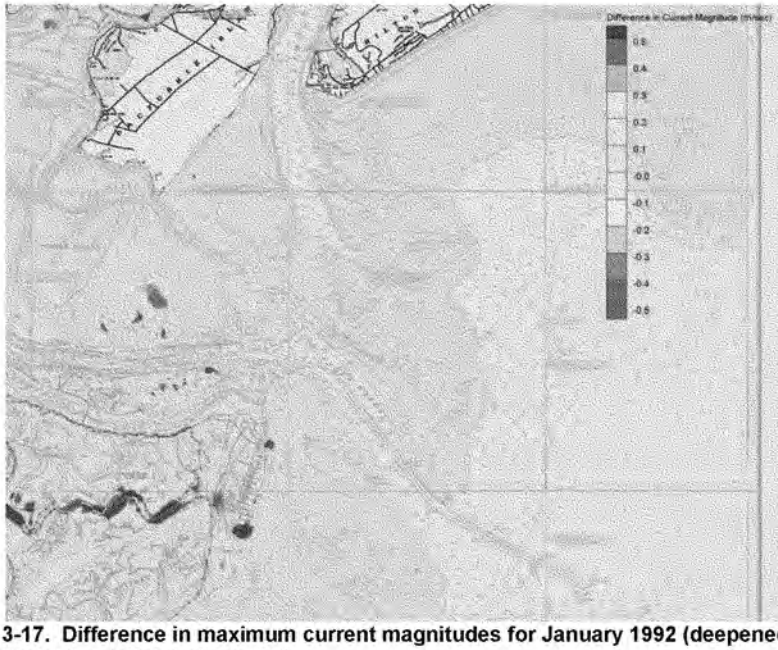


Figure 3-17. Difference in maximum current magnitudes for January 1992 (deepened channel minus existing bathymetry).

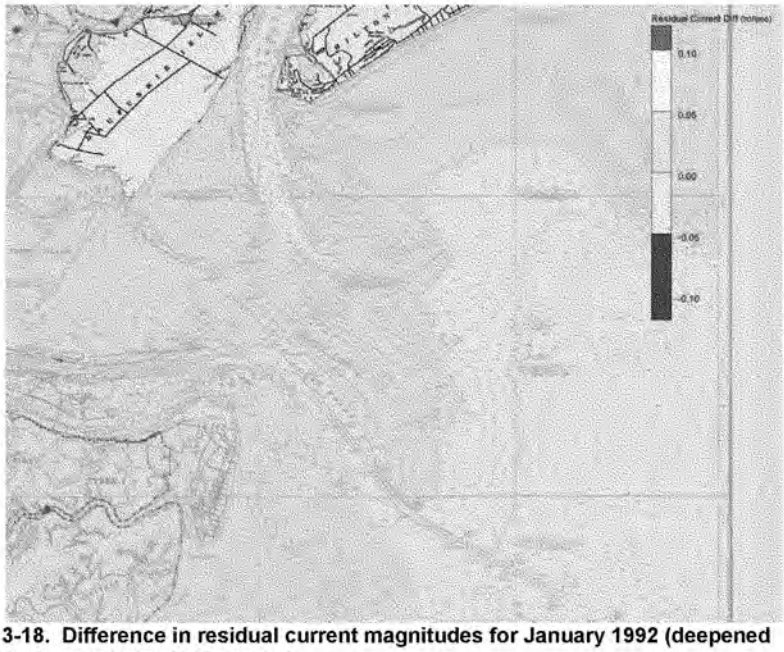


Figure 3-18. Difference in residual current magnitudes for January 1992 (deepened channel minus existing bathymetry).

Figure 3-19. Difference in maximum water surface elevations for July 1999 (deepened channel minus existing bathymetry).

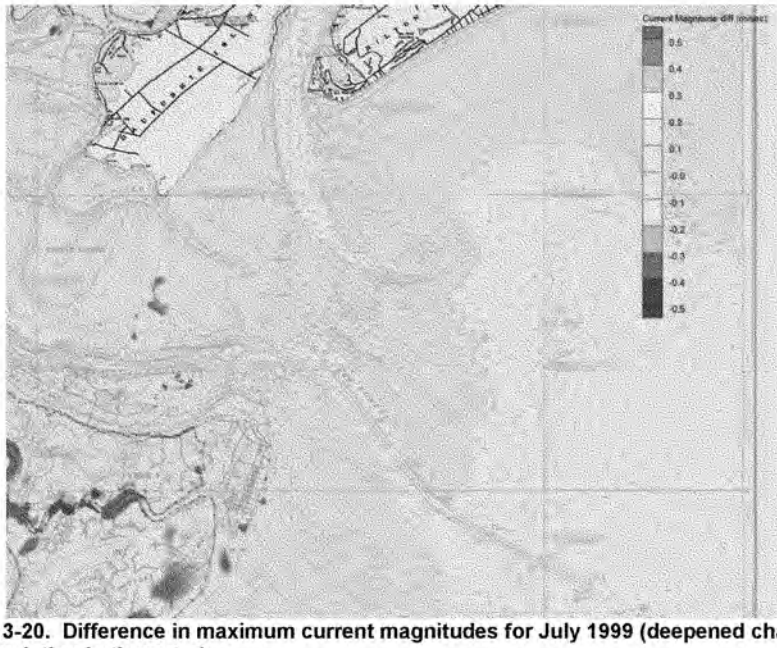


Figure 3-20. Difference in maximum current magnitudes for July 1999 (deepened channel minus existing bathymetry).

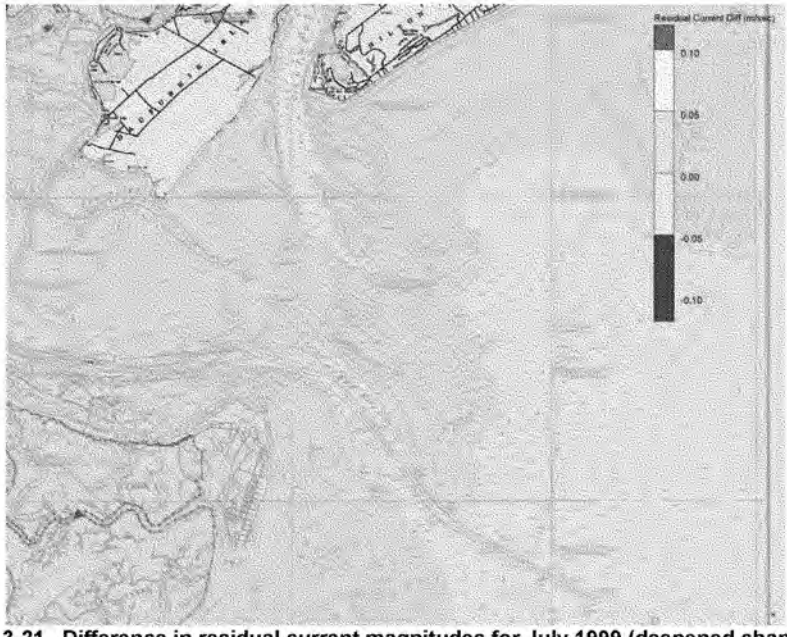


Figure 3-21. Difference in residual current magnitudes for July 1999 (deepened channel minus existing bathymetry).

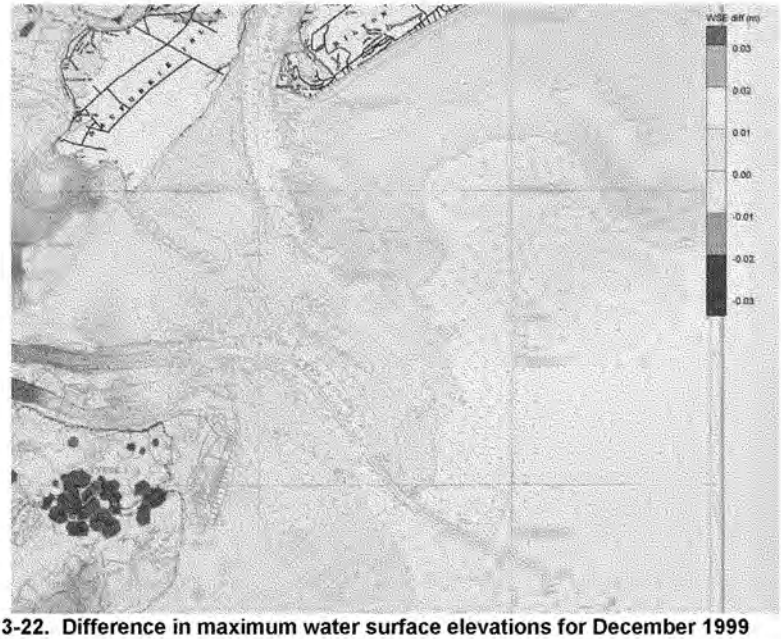


Figure 3-22. Difference in maximum water surface elevations for December 1999 (deepened channel minus existing bathymetry).

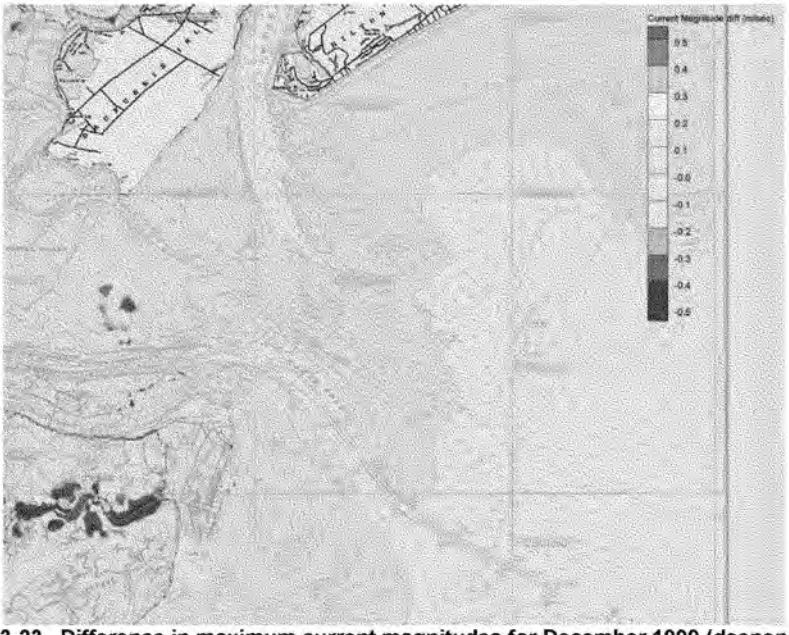


Figure 3-23. Difference in maximum current magnitudes for December 1999 (deepened channel minus existing bathymetry).

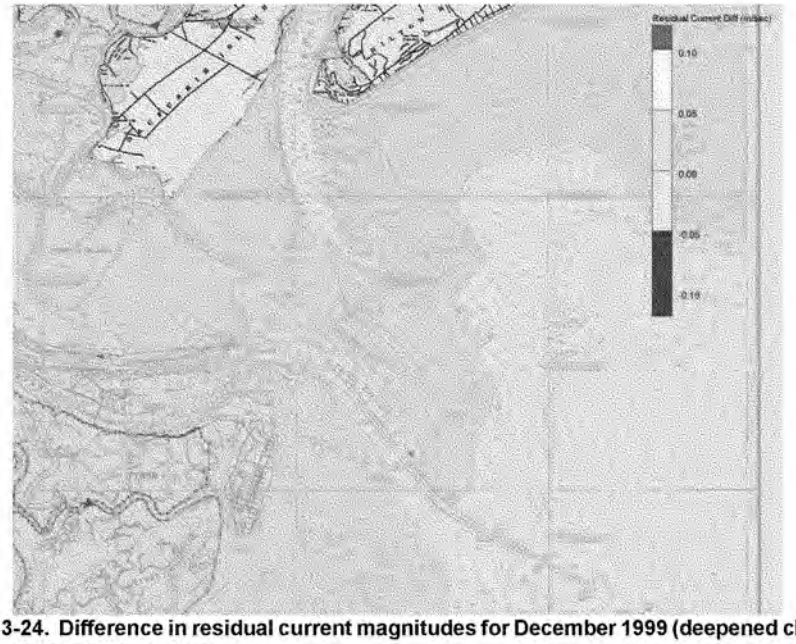


Figure 3-24. Difference in residual current magnitudes for December 1999 (deepened channel minus existing bathymetry).

Summary of Circulation Results

ADCIRC was applied for five time periods to cover a large range of conditions at Savannah. Forcing for ADIRC includes tides, wind, atmospheric pressure, river inflow, and wave stresses. ADCIRC was applied to provide water surface elevations to the wave model (Chapter 4) and tidal current and water depths to the sediment model (Chapter 5). The model results were also used to investigate the channel deepening impact on maximum water surface elevations and currents. In general, the channel deepening had a minimal influence on the maximum water surface elevation over a simulation (~ one month). Maximum differences were generally on the order of a few centimeters, but were as large at 0.2 m for the re-tracked hurricane Hugo. The maximum nearshore water surface elevations decreased for the deepened channel for Hugo because the peak water level near the shore arrived earlier, but with a slightly lower elevation. Hugo was a relatively fast-moving hurricane at landfall, so the reduced surge for the deepened channel will likely be minimal for a slow moving storm. Maximum current magnitudes generally increased in the deepened channel (up to 0.2 m/sec), but differences were generally very small elsewhere. The five time periods included large variations in forcing conditions and different patterns for small increases and decreases in surge, but differences between the existing and deepened channel maximum water surface elevations were insignificant (on the order of 0-3 cm). Maximum current magnitudes increased on the order of 0.1 m/sec, which again is insignificant. Residual currents generally decreased in the inner channel and along north Tybee and increased in the outer channel, but these differences were generally negligible (+/- 0.01 m/sec). The circulation model does give localized differences in maximum water level and current velocities in very shallow water and areas of flooding and drying, due to the nonlinearity of the processes and changes in phasing of flooding and drying, however, these effects are artifacts of the coarse resolution in those areas. The tidal creeks and marshes were not fully resolved in the model, but were designed to provide the proper inflow/outflow volumes.

4 Wave Modeling

Waves, together with tidal currents, drive sediment transport in the areas adjacent to the Savannah Federal navigation channel. Numerical model simulations of wave transformation were required to evaluate changes in the magnitude and spatial variation of wave parameters due to the deepened Savannah navigation channel. The wave results also serve as an input to estimates of sediment transport described in Chapter 5. The steady-state spectral wave model STWAVE (Smith, Sherlock, and Resio 2001) was applied for wave transformation modeling. STWAVE was forced with directional wave spectra based on typical and storm waves hindcast by the Wave Information Studies (WIS). The simulations include representative tide and surge water levels. This section describes the STWAVE wave transformation model, the model input, and model results.

STWAVE Model Description

The numerical model STWAVE was used to transform waves to the project sites. STWAVE numerically solves the steady-state conservation of spectral action balance along backward-traced wave rays:

$$(C_{ga})_x \frac{\partial}{\partial x}\frac{C_a C_{ga}\cos(\mu-\alpha)E(f,\alpha)}{\omega_r} + (C_{ga})_y \frac{\partial}{\partial y}\frac{C_a C_{ga}\cos(\mu-\alpha)E(f,\alpha)}{\omega_r} = \Sigma\frac{S}{\omega_r} \quad (4\text{-}1)$$

where

C_{ga} = absolute wave group celerity

x,y = spatial coordinates, subscripts indicate x and y components

C_a = absolute wave celerity

μ = current direction

α = propagation direction of spectral component

E = spectral energy density

f = frequency of spectral component

ω_r = relative angular frequency (frequency relative to the current)

S = energy source/sink terms

The source terms include wind input, nonlinear wave-wave interactions, dissipation within the wave field, and surf-zone breaking. The terms on the left-hand side of Equation 4-1 represent

wave propagation (refraction and shoaling), and the source terms on the right-hand side of the equation represent energy growth or decay in the spectrum.

The assumptions made in STWAVE are as follows:

a. Mild bottom slope and negligible wave reflection.

b. Steady waves, currents, and winds.

c. Linear refraction and shoaling.

d. Depth-uniform current.

The version of STWAVE applied here is a half-plane model, meaning that only waves propagating toward the coast are represented. Waves reflected from the coast or waves generated by winds blowing offshore are neglected. Wave breaking in the surf zone limits the maximum wave height based on the local water depth and wave steepness:

$$H_{mo_{max}} = 0.1L \tanh kd \tag{4-2}$$

where

H_{mo} = zero-moment signficant wave height

L = wavelength

k = wave number

d = water depth

STWAVE is a finite-difference model and calculates wave spectra on a rectangular grid with square grid cells. The model outputs zero-moment wave height, peak wave period (T_p), and mean wave direction (α_m) at all grid points and two-dimensional spectra at selected grid points.

Wave Model Inputs

The inputs required to execute STWAVE are as follows:

a. Bathymetry grid (including shoreline position and grid size and resolution).

b. Incident frequency-direction wave spectrum on the offshore grid boundary.

c. Current field (optional).

d. Tide elevation, wind speed, and wind direction (optional).

Bathymetry grids. Two STWAVE Cartesian grids were generated for this study. The first grid represents the existing condition bathymetry, and the second grid represents the with-project bathymetry (deepened channel). The only differences between the existing condition and with-project STWAVE grids are the channel improvements. The STWAVE grids were created by combining the ADCIRC model mesh in and around the Federal navigation channel with a February 2005 bathymetric survey offshore of Tybee Island and topography and bathymetry previously used for the Savannah Harbor Entrance Channel: Nearshore Placement of Dredged Material study (Gailani et al. 2003). Significant improvements to the ADCIRC mesh were made to more accurately capture both the existing navigation channel conditions and the with-project channel geometry. These efforts produced a channel with smoothly sloping sides and proper

depths in the appropriate channel sections. The grid origin is x = 538104.6 m and y = 3548280.0 m in UTM NAD83 Zone 17, and the grid orientation is 140 deg (which is the orientation of the grid x-axis measured counter-clockwise from East). The grid domain is 21.7 km (cross shore, 434 cells) by 31.6 km (alongshore, 631 cells) with a resolution of 50 m. The grid extends seaward to approximately 12-15 m water depth. The bathymetry grids are shown in Figures 4-1 and 4-2.

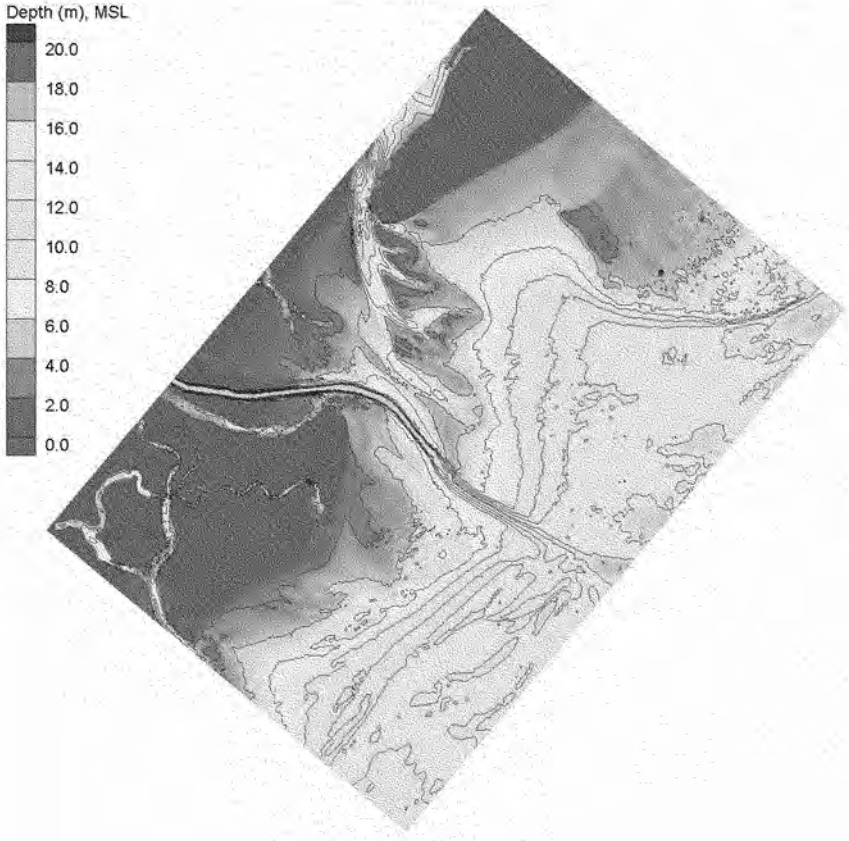


Figure 4-1. Existing condition grid (depths in meters, MSL). Land is shown in brown.

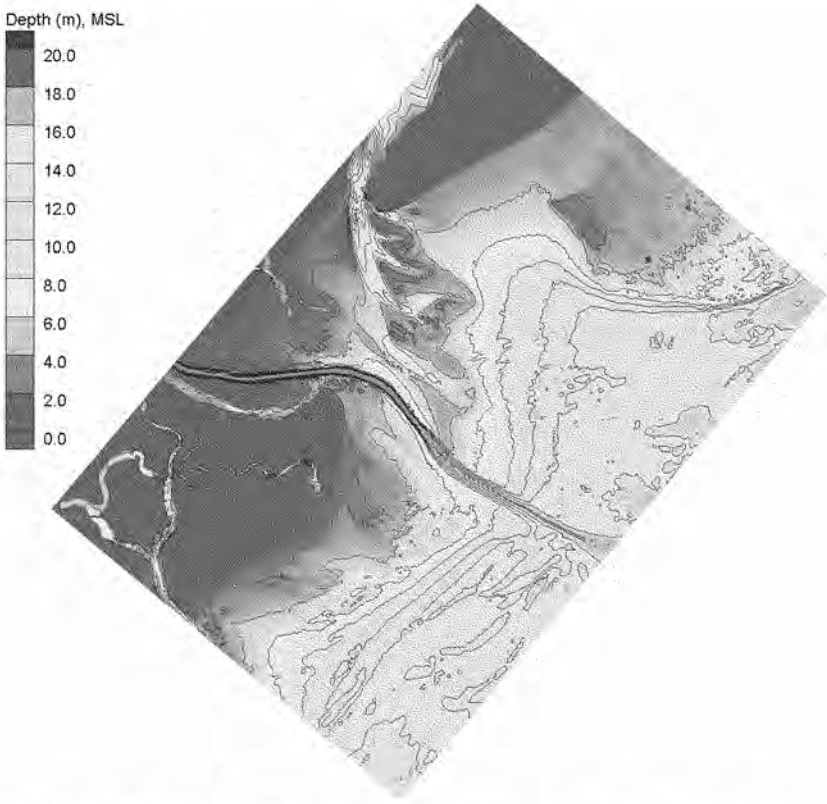


Figure 4-2. With-project grid (depths in meters, MSL). Land is shown in brown.

Input wave conditions. Five time periods were selected for wave simulation: a) December 1999 was simulated to represent the ADCIRC calibration period; b) a re-tracked Hurricane Hugo (tracked to hit near Savannah), 14-22 September 1989, was simulated to represent an extreme storm event; c) November 1979, which included a number of storms, was simulated to represent a stormy month; d) January 1992 was simulated to represent a typical winter month; and e) July 1999 was simulated to represent a typical summer month. The offshore wave information for all these simulations were hindcast by the Wave Information Studies (WIS) using the wave generation and propagation model WISWAVE (Hubertz 1992). For the January 1992, December 1999, and July 1999 simulations, hourly offshore wave conditions were taken from the latest WIS hindcast (1980-1999) at Station 368 (http://frf.usace.army.mil/cgi-bin/wis/atl/atl_main.html). WIS Station 368 is located at 32.0 deg North, 80.58 deg West in a water depth of approximately 15 m which is approximately on the offshore boundary of the STWAVE grids. The November 1979 time period is not included in the most recent WIS hindcast period, so it was necessary to use the 4-hourly data from the previous WIS study (Brooks and Brandon 1995) at Station 33 located at 32.0 deg North, 80.5 deg West in a water depth of approximately 13 m. Hurricane Hugo struck Charleston in September 1989 at a Category 4 storm. To evaluate the impact of an intense tropical storm, the Savannah Harbor nearshore placement of dredged material study

(Gailani et al. in prep.) simulated a hypothetical re-tracked Hurricane Hugo striking Savannah. The offshore waves for the re-tracked Hugo were generated using the WIS methodology. These same re-tracked Hugo offshore waves were used in this study. The re-tracked Hurricane Hugo wave information was available at 4-hour intervals. The simulation start and end times are summarized in Table 4-1.

Table4-1. Start and end times for STWAVE model simulations

Simulation	Start Date/Time (yyyymmddhh)	End Date/Time (yyyymmddhh)	Interval (hours)
Nov 79	1979110100	1979113021	3
Sep 89	1989091414	1989092209	3
Jan 92	1992010101	1992013100	1
Dec 99	1999120101	1999123100	1
Jul 99	1999070101	1999073100	1

Figures 4-3 to 4-7 show the time histories of offshore significant wave height, peak wave period, and mean wave direction for the five simulation time periods. Wave direction is reported in meteorological convention with waves from the north at 0 deg and waves from the east at 90 deg. The November 1979 and January 1992 simulations both have offshore wave heights exceeding 3 m and the re-tracked Hurricane Hugo has a maximum offshore wave height of 8 m (which is near depth-limited breaking at the offshore STWAVE grid boundary). Summary statistics of the offshore wave parameters are given in Table 4-2.

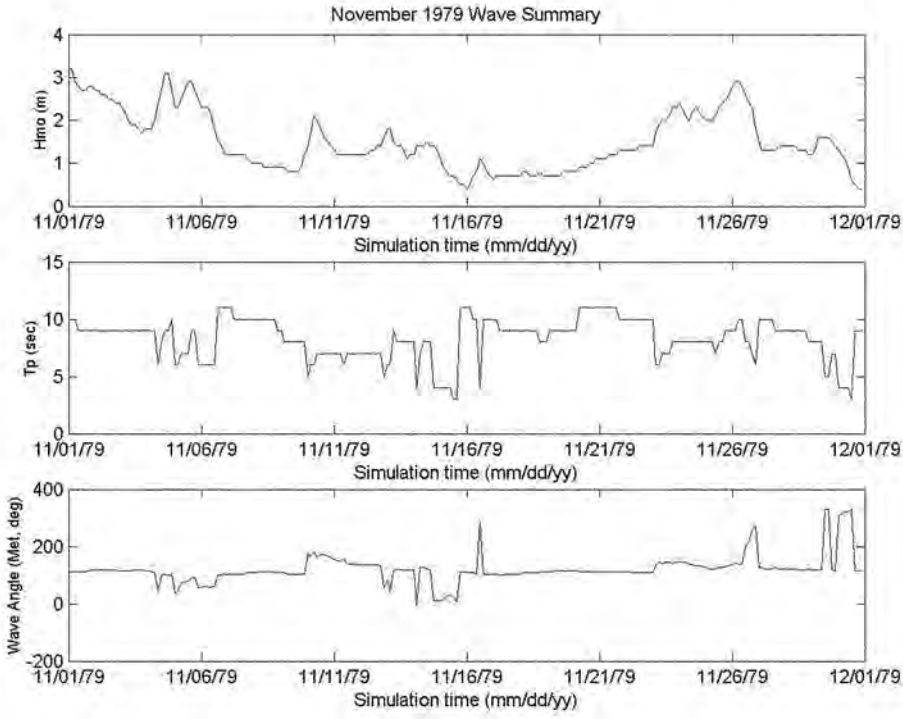


Figure 4-3. Offshore wave conditions for November 1979 at WIS Station 33.

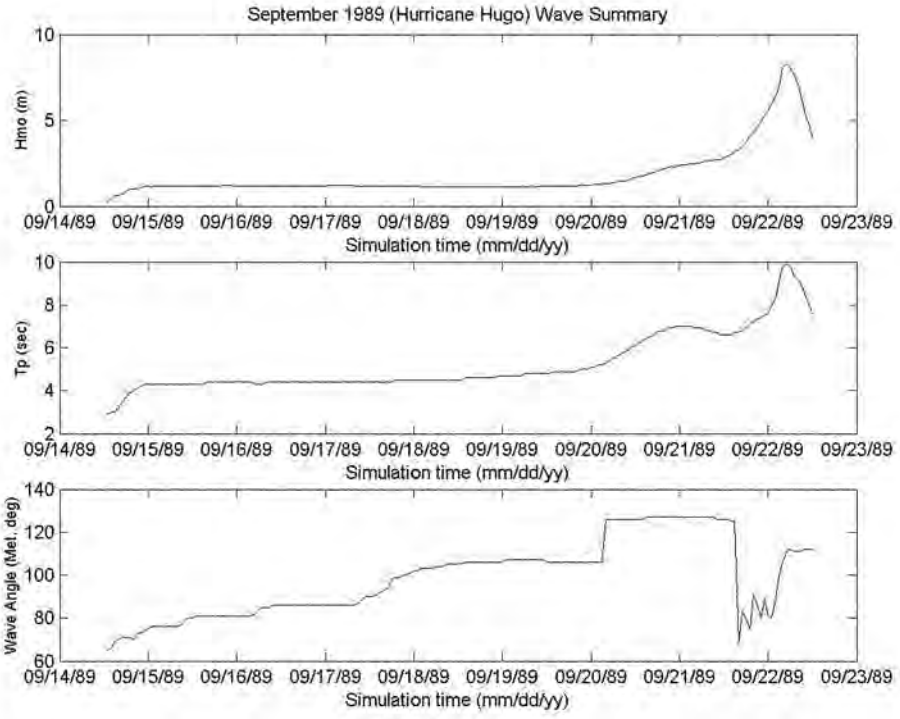


Figure 4-4. Offshore wave conditions for re-tracked Hurricane Hugo, September 1989.

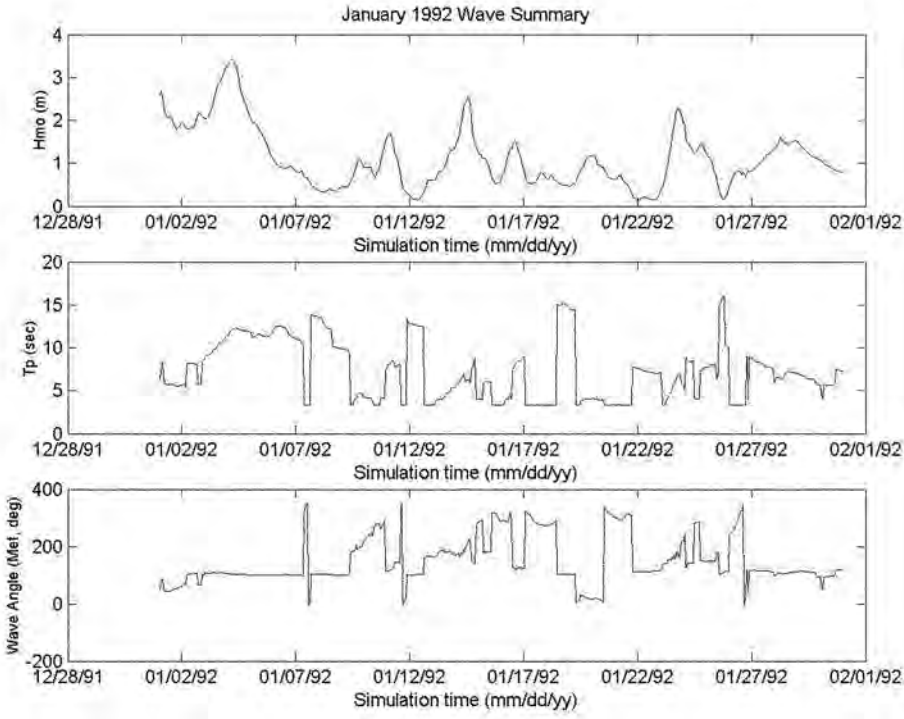


Figure 4-5. Offshore wave conditions for January 1992 at WIS Station 368.

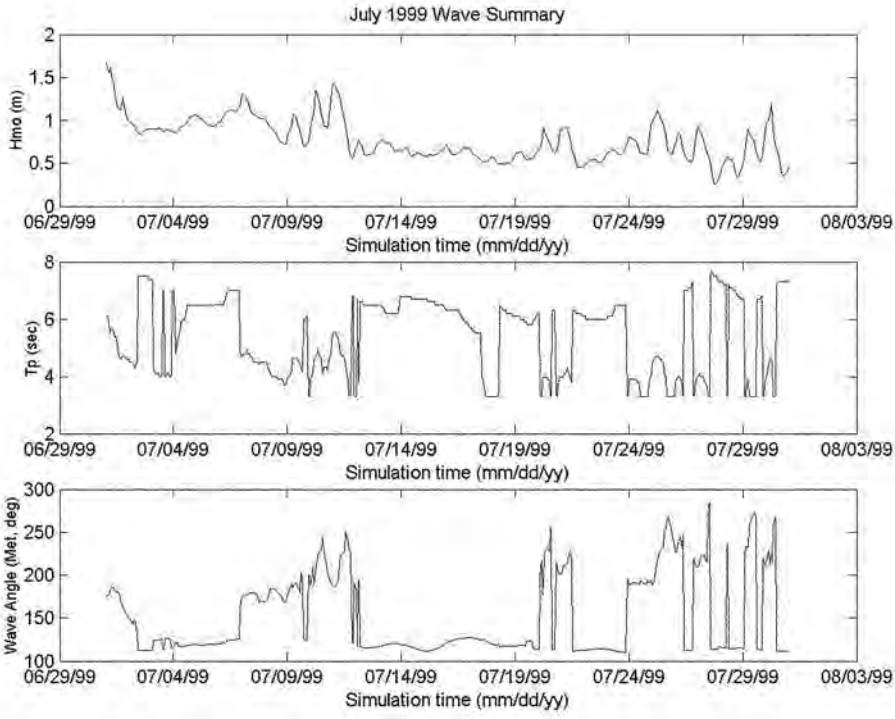


Figure 4-6. Offshore wave conditions for July 1999 at WIS Station 368.

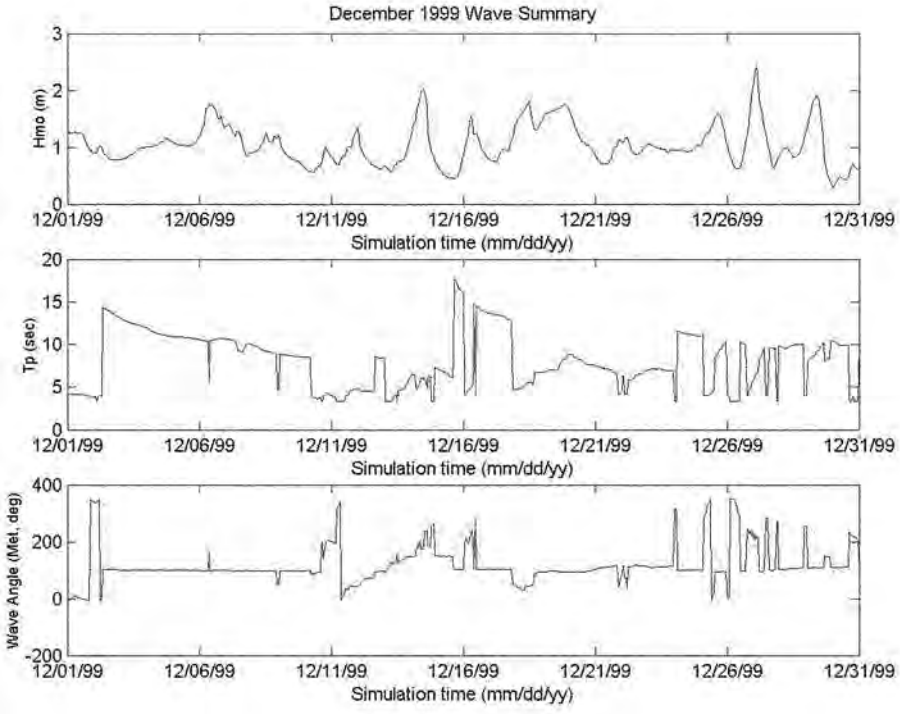


Figure 4-7. Offshore wave conditions for December 1999 at WIS Station 368.

Table 4-2. Statistical Summary of Offshore (WIS) Hindcast Wave Characteristics

Simulation	Max Wave Height (m)	Mean Wave Height (m)	Median Wave Height (m)	Min Wave Height (m)	Max Wave Period (sec)	Mean Wave Period (sec)	Median Wave Period (sec)	Min Wave Period (sec)
Nov 79	3.20	1.51	1.30	0.40	11.00	8.32	9.0	3.0
Sep 89	8.01	1.81	1.18	0.43	17.00	7.78	6.0	3.0
Jan 92	3.41	1.12	0.94	0.12	16.02	7.26	6.87	3.33
Dec 99	2.46	1.04	0.99	0.29	17.71	8.06	8.29	3.33
Jul 99	1.68	0.78	0.72	0.26	7.69	5.41	5.93	3.33

Input wave spectra are required to drive STWAVE on the offshore grid boundary. Parametric spectral shapes were used to generate the input spectra from the offshore wave parameters. The wave energy is distributed in frequency using the TMA spectral shape with a spectral peakedness parameter of 3.3 to 7 (Bouws et al. 1984) and in direction using a $\cos^{nn}(\alpha-\alpha_m)$ distribution, where α_m is the mean wave direction, with nn of 4 to 26. The input spectra for all cases except the re-tracked Hurricane Hugo have 30 frequencies, starting with 0.04 Hz and incrementing by 0.01 Hz. For the re-tracked Hurricane Hugo, 20 frequencies were used starting at 0.04167 Hz and incrementing exponentially to 0.333 Hz. The directional resolution for all simulations is 5 deg.

Water level. The water levels (combination of tide and storm surge) applied in STWAVE were determined by the ADCIRC model simulations (Chapter 3). The water levels were extracted from ADCIRC at the STWAVE boundary (WIS station location) and applied over the entire grid. The water level was updated with each new wave boundary condition (either every 1 or 3 hrs).

Winds and currents. Local wind wave generation within the STWAVE domain was not included in these simulations. A sensitivity analysis was performed to determine the importance of wave-current interaction (current-induced shoaling and refraction) within the model domain. The December 1999 time period was used for the sensitivity analysis. For this analysis, the input waves were generated as describe previous, water levels were taken from NOAA observations at Fort Pulaski, and currents were interpolated from the ADCIRC simulations. The conditions investigated included a range of wave heights (0.5 to 2.0 m), peak periods (4-14 sec), and wave directions. The majority of wave height differences (simulations with currents minus without currents) were in the range of +/- 0.01 to 0.05 m. The maximum increase in wave height was 0.40 m and the maximum decrease was 0.56 m. The maximum differences occurred locally in the channels were the currents were strongest. Based on this analysis and the result that current velocities changed minimally for the existing condition and with-project ADCIRC simulation, currents were not included in the STWAVE simulations.

A spectral wave model was selected for these simulations to realistically include the directional and frequency spread of wave energy in this open coastal setting (in contrast, monochromatic models generally have sharp gradients in wave parameters that are not seen in nature). These simulations include variations in water level (tide and surge), but neglect wave-current interaction because the impact is small and localized in the channel. Bottom friction was also neglected. The wave simulations were run for extended time periods (Table 4-1), which include a very wide range of incident conditions (wave heights, periods, directions, and water levels). STWAVE output is used to examine the impact of channel deepening on the waves, to provide radiation stress gradients to force wave-driven currents in the circulation model (Chapter 3), and to provide input to the sediment transport modeling (Chapter 5).

Wave Model Results

Some sample STWAVE results are shown is this section to illustrate the range of conditions simulated and the impact of the channel deepening. Figure 4-8 shows the wave height at the peak of the re-tracked Hugo simulation over the existing bathymetry. Offshore wave heights exceed 8 m at the grid boundary and the peak period is 14 sec. These are the most severe wave conditions simulated. The wave height decreased toward the shore due to depth-limited wave breaking. Wave heights along Tybee Island are in the range of 3-4 m. Figure 4-9 shows the differences in wave heights for the deepened channel minus the existing condition at the peak of the storm (22 September 0600 UTC). The wave heights in the outer channel are decreased by about 0.7 m and

increased on the edge of channel by up to 0.2 m. The decrease in the outer channel is due to decreased shoaling, and the increase on the edges of the channel is due to focusing as waves refract along the deeper channel. The Tybee Island area is shown in greater detailed at a magnified scale in Figure 4-10. Wave heights at the northern portion of Tybee are generally 0.05 to 0.1 m lower for the deepened channel and the wave heights on the southern portion of Tybee are unchanged. On the shallow shoal to the northeast of Tybee, the wave heights increase 0.03 to 0.05 m. These differences in wave height are small (maximum of 15 percent decrease in the channel and 5 percent decrease near the shore). Figures 4-10 and 4-11 show the maximum increases and decreases in wave height for each grid cell over the entire re-tracked Hugo simulations (9-22 September 1989). The maximum increases are generally along the edges of the outer channel; with a maximum increase is 0.25 m. The maximum decreases are generally within the outer channel; with a maximum decrease of 0.71 m. There are also small maximum decreases in wave height along the north Tybee shoreline. Figures 4-10 and 4-11 are plotted at the same scale for direct comparison. The mean differences at all points over the entire grid, calculated for the entire simulation are less than 0.01 m.

Although the highest rate of sediment transport occurs during storms, it is important to investigate a wide range of incident wave conditions. In addition to the retracked Hurricane Hugo, four months were simulated which include both winter and summer conditions with a wide range of incident wave height, period, and direction (Table 4-2, and Figures 4-3 to 4-7). Figures 4-12 through 4-19 show the maximum increases and decreases in wave height at each grid cell for each simulation period. All plots are provided on the same scale (maximum of 0.35 m, half the scale for the re-tracked Hugo plots), so they can be directly compared. The patterns of the maximums are generally very similar. The wave height increases are focused on the edges of the outer channel and generally larger north of the channel. The maximum increases ranged from 0.05 m (July 1999) to 0.25 m (re-tracked Hugo). The wave height decreases are largest in the outer channel and generally extend further south of the channel, including the nearshore area off of Tybee Island. The maximum decreases ranged from 0.10 m (July 1999) to 0.71 m (re-tracked Hugo). The nearshore maximum differences are small, in the range of 0.05 to 0.10 m. Mean differences in wave height at each grid cell over each simulation were less than 0.01 m.

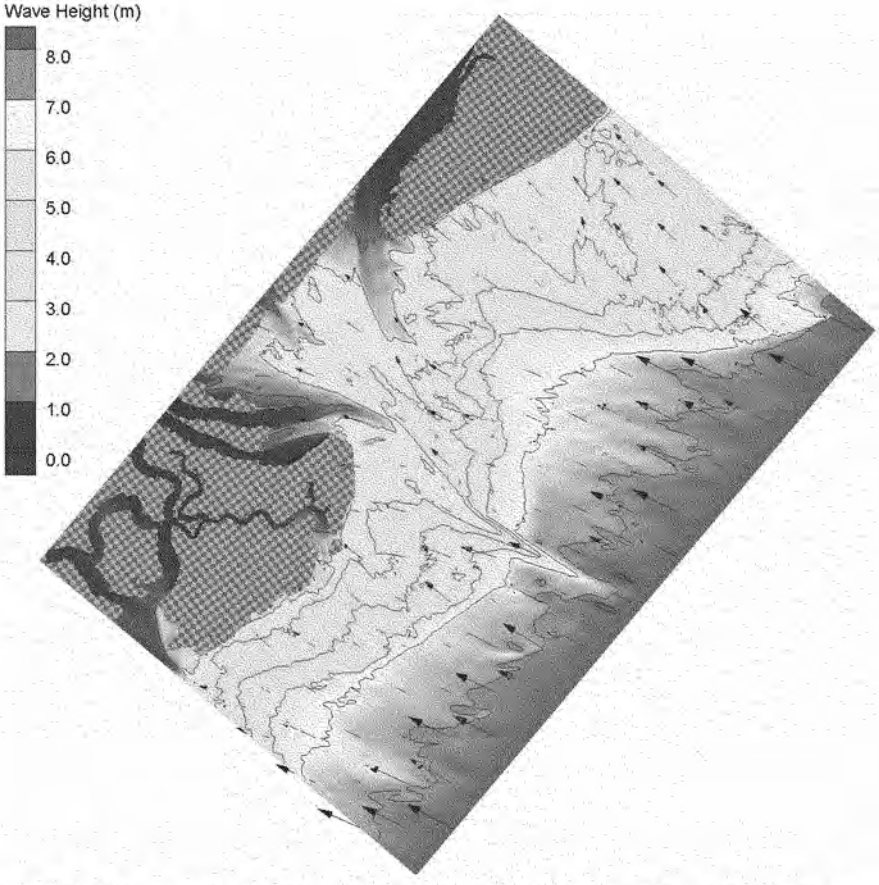


Figure 4-8. Wave Height for Existing Bathymetry at Peak of Hypothetical Retracked Hurricane Hugo, 22 September 1989.

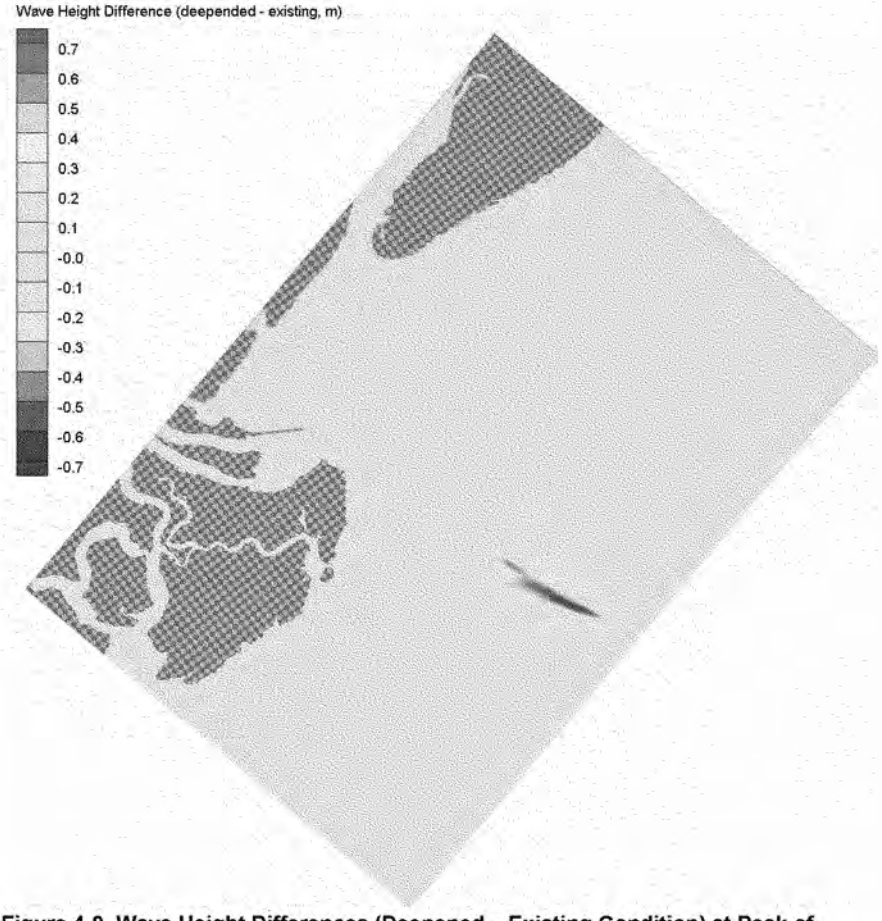


Figure 4-9. Wave Height Differences (Deepened – Existing Condition) at Peak of Hypothetical Retracked Hurricane Hugo, 22 September 1989.

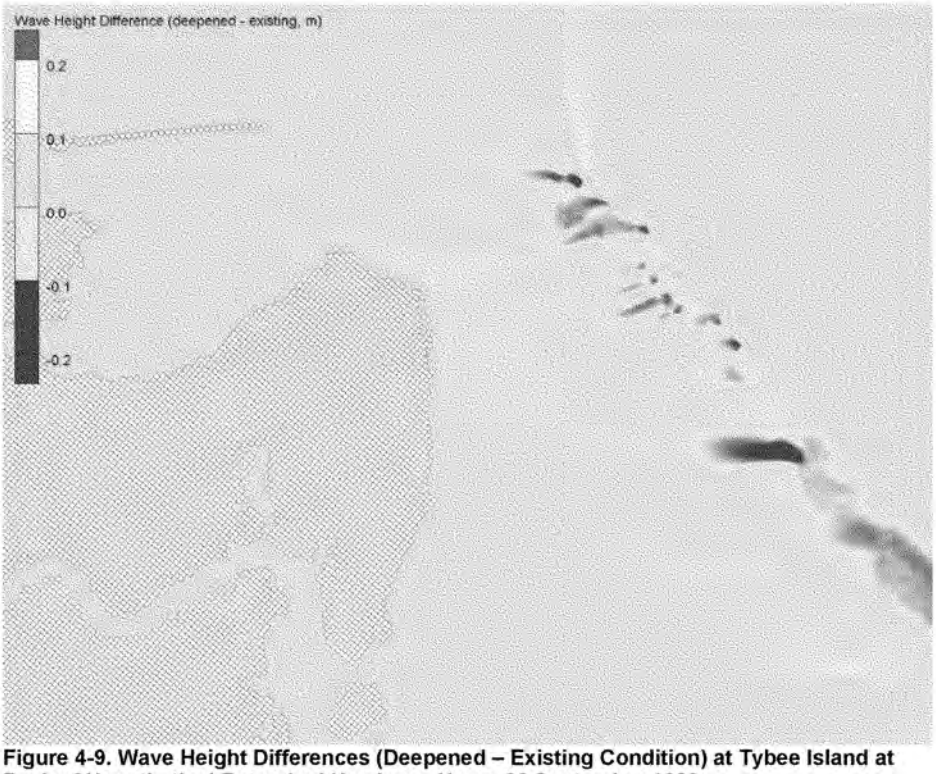


Figure 4-9. Wave Height Differences (Deepened – Existing Condition) at Tybee Island at Peak of Hypothetical Retracked Hurricane Hugo, 22 September 1989.

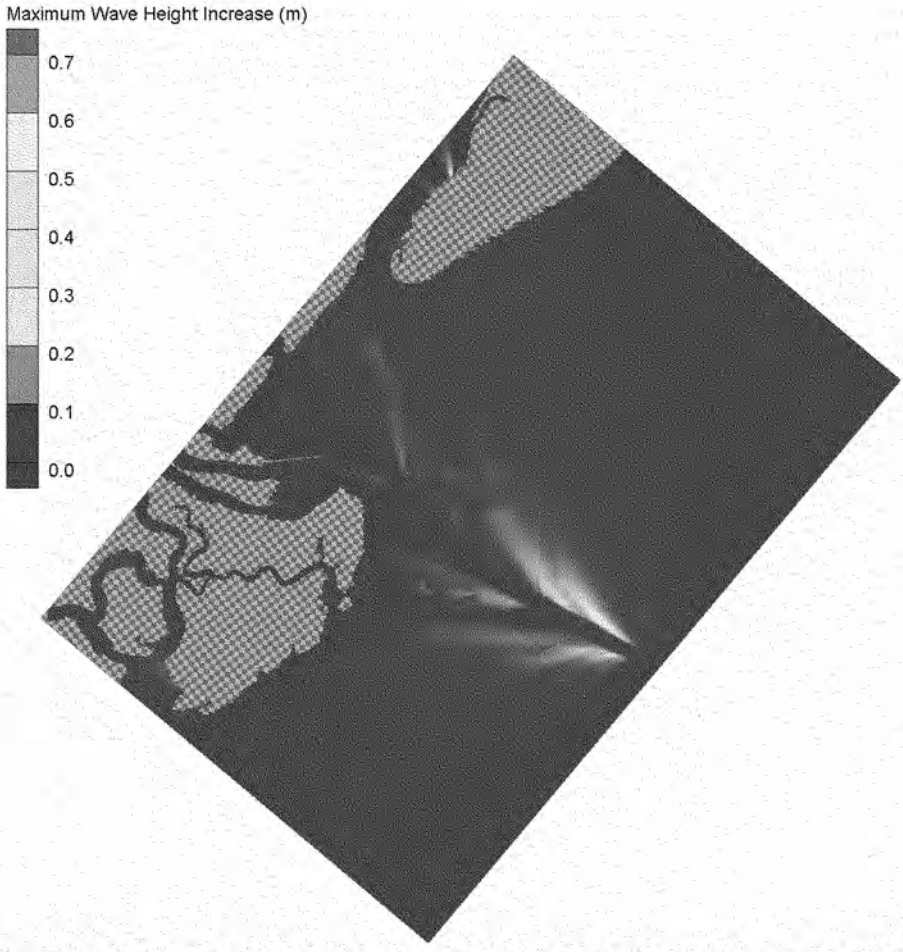


Figure 4-10. Maximum Wave Height Increases for Each Grid Cell for 9-22 September 1989 (Hypothetical Retracked Hurricane Hugo). Maximum Increase of 0.25 m.

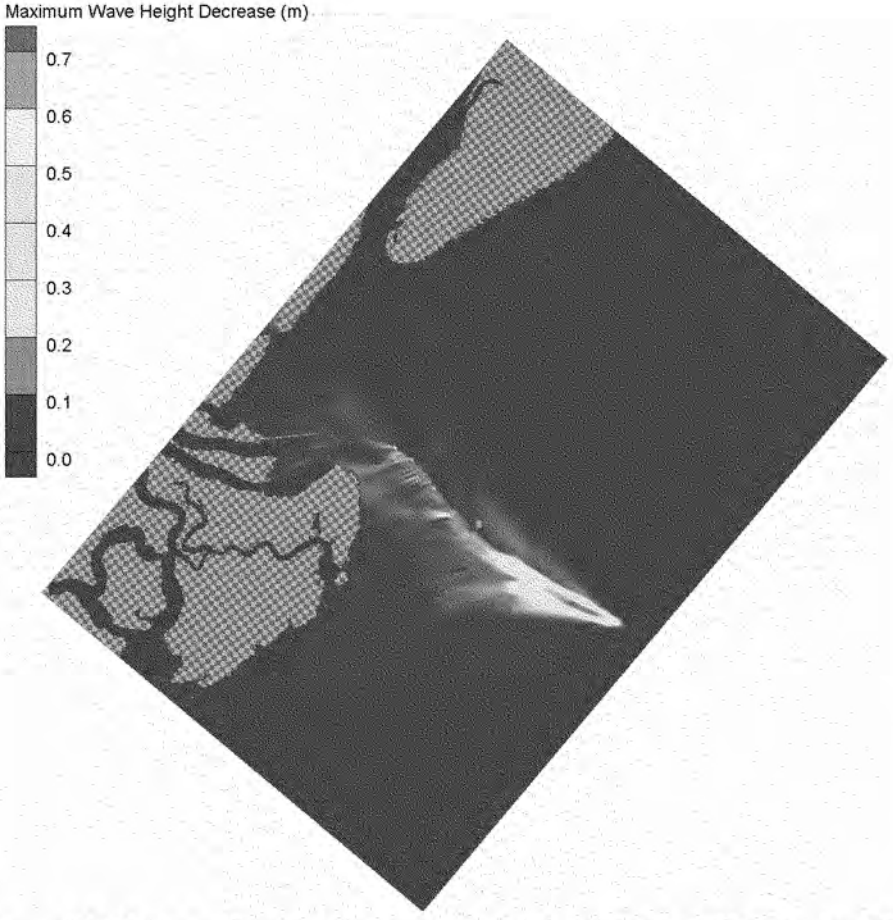


Figure 4-11. Maximum Wave Height Decreases for Each Grid Cell for 9-22 September 1989 (Hypothetical Retracked Hurricane Hugo). Maximum Decrease of 0.71 m.

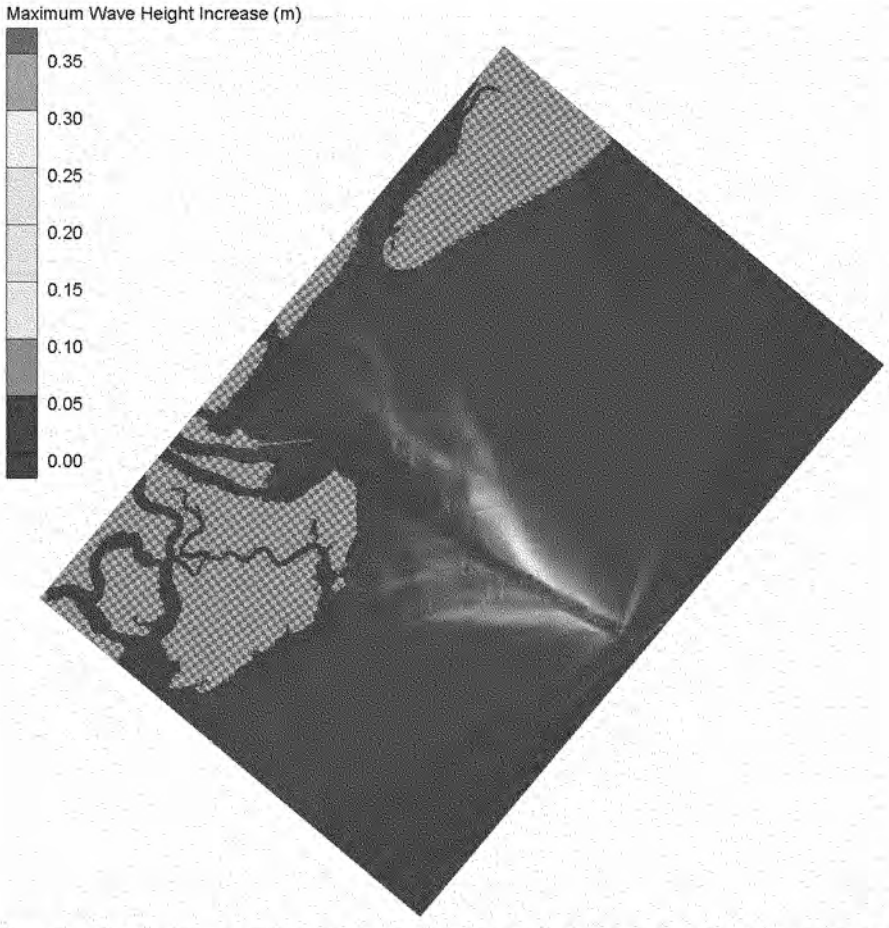


Figure 4-12. Maximum Wave Height Increases for Each Grid Cell for 1-30 November 1979. Maximum Increase of 0.12 m.

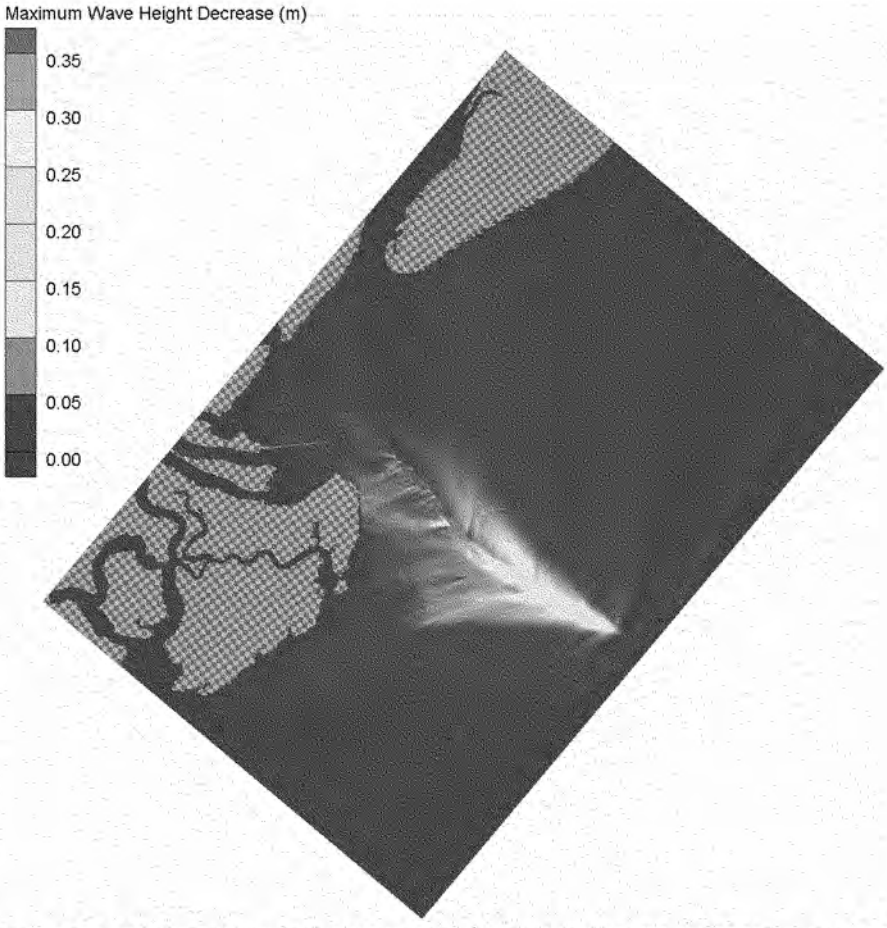


Figure 4-13. Maximum Wave Height Decreases for Each Grid Cell for 1-30 November 1979. Maximum decrease of 0.20 m.

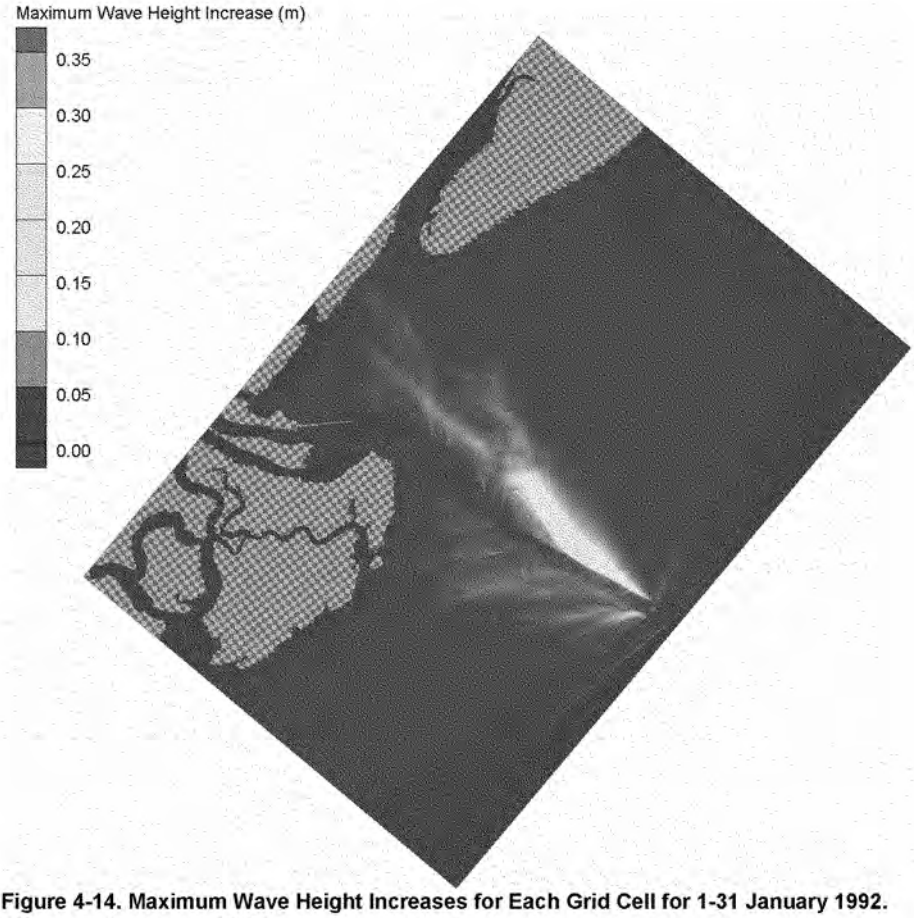


Figure 4-14. Maximum Wave Height Increases for Each Grid Cell for 1-31 January 1992. Maximum Increase of 0.21 m.

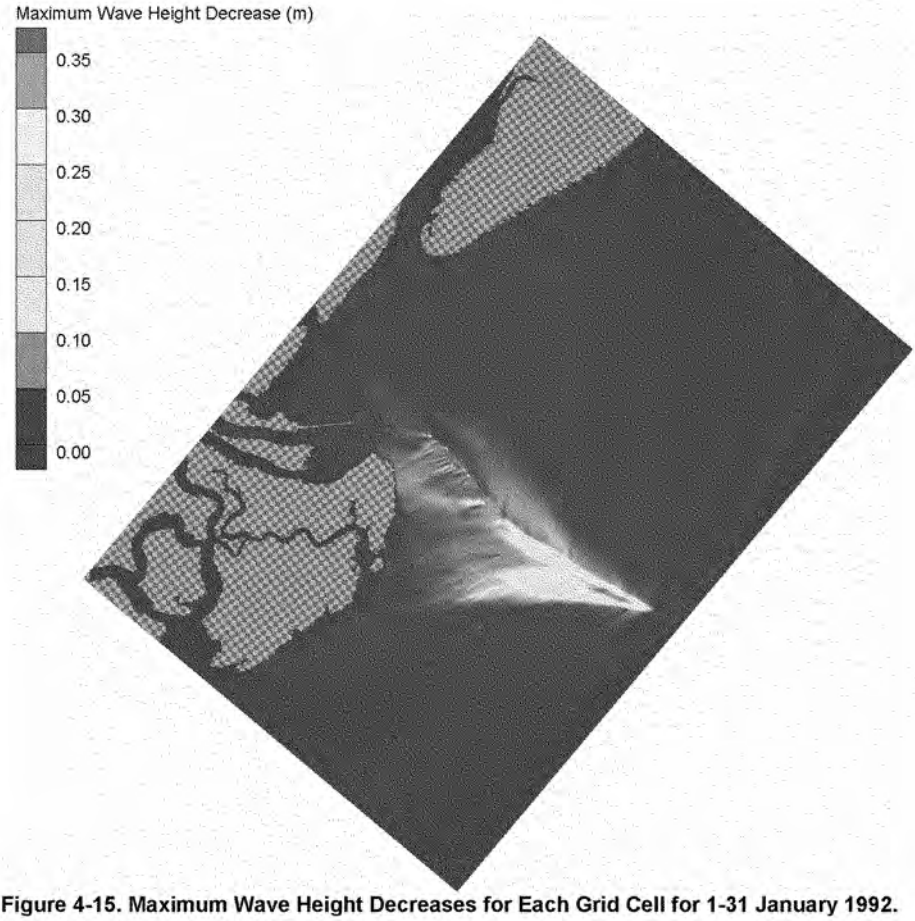


Figure 4-15. Maximum Wave Height Decreases for Each Grid Cell for 1-31 January 1992. Maximum Decrease of 0.35 m.

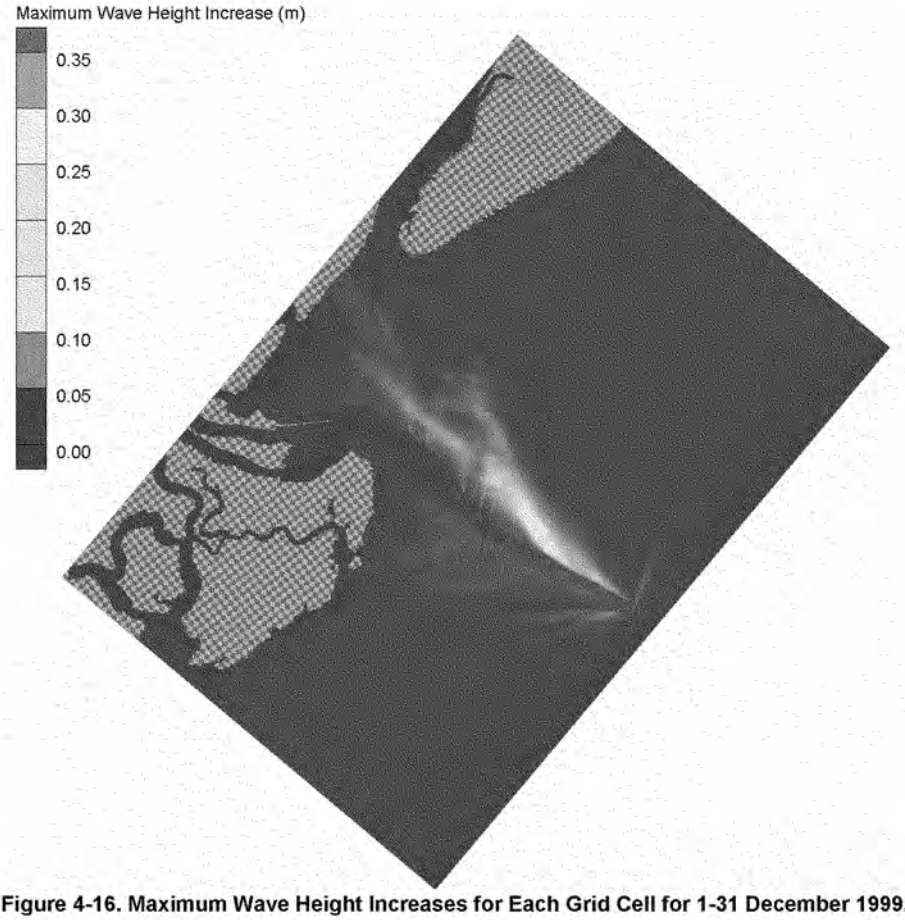


Figure 4-16. Maximum Wave Height Increases for Each Grid Cell for 1-31 December 1999. Maximum Increase of 0.13 m.

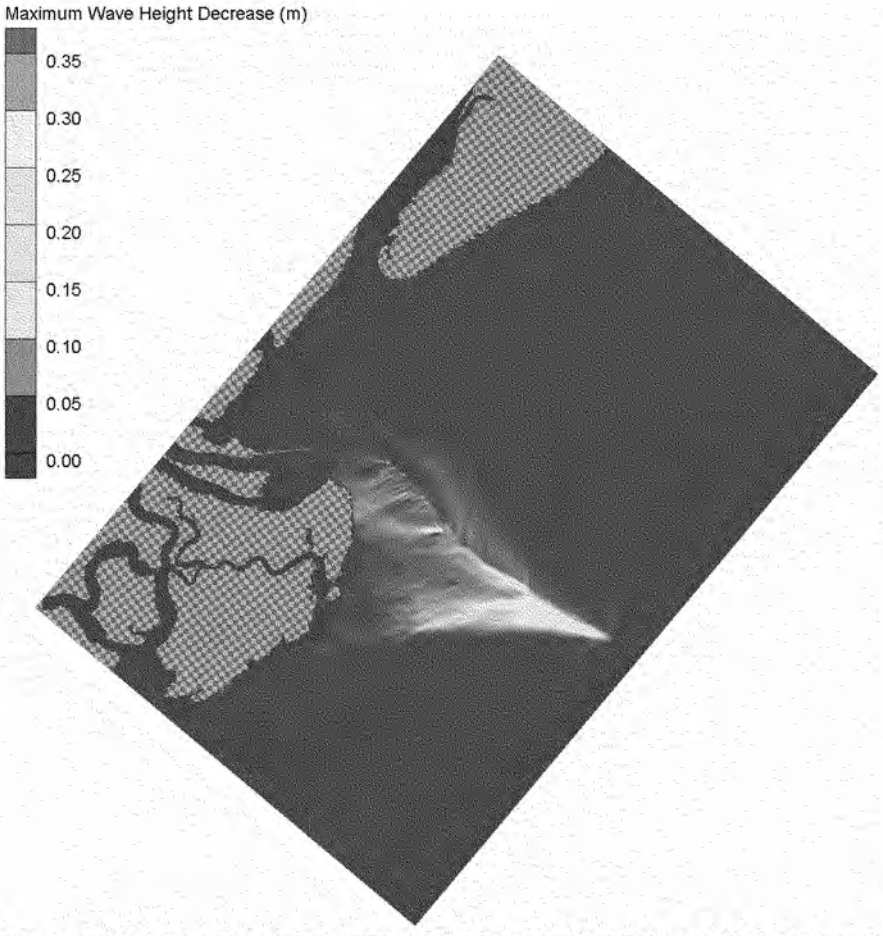


Figure 4-17. Maximum Wave Height Decreases for Each Grid Cell for 1-31 December 1999. Maximum Decrease of 0.17 m.

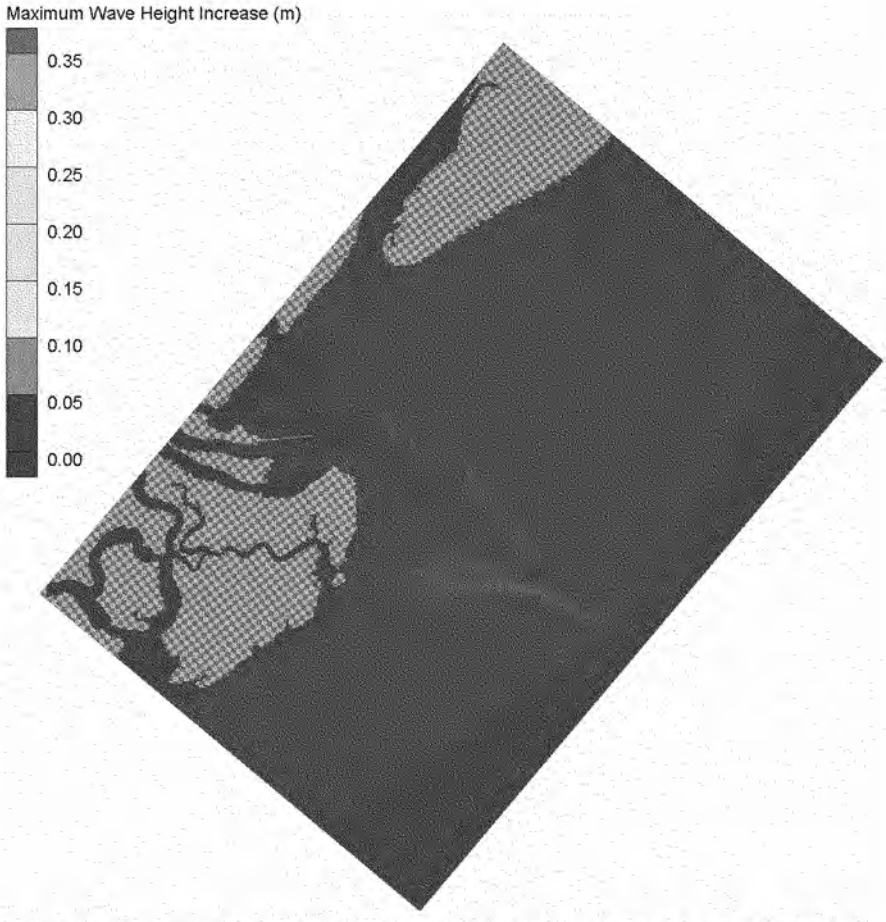


Figure 4-18. Maximum Wave Height Increases for Each Grid Cell for 1-31 July 1999. Maximum Increase of 0.05 m.

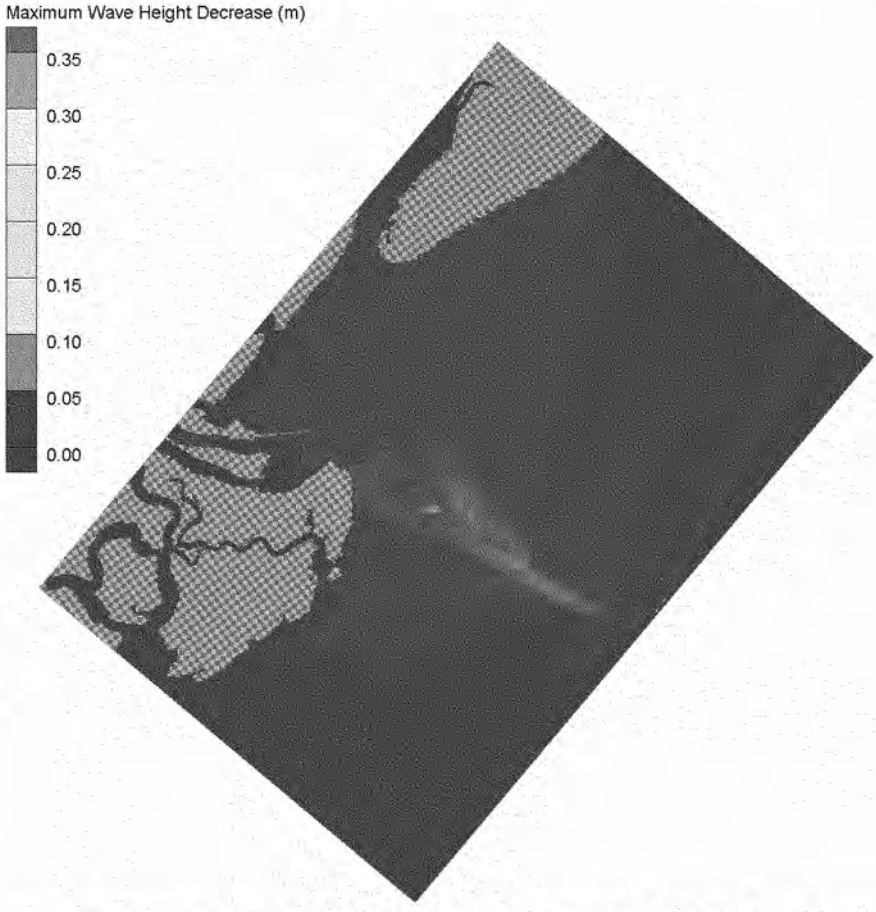


Figure 4-19. Maximum Wave Height Decreases for Each Grid Cell for 1-31 July 1999. Maximum Increase of 0.10 m.

Summary of Wave Results

Waves are one of the primary drivers of sediment transport. The impacts of deepening the Savannah navigation channel were investigated by applying the STWAVE wave model. Model simulations were made for the existing bathymetry and the deepened channel bathymetry for four historical time periods (November 1979, January 1992, December 1999, and July 1999) and a hypothetical extreme event (Hurricane Hugo re-tracked to strike Savannah). These simulations cover a wide range of incident wave height, period, and direction and water levels. The impact of the channel on waves was evaluated by comparing the wave height differences between the existing bathymetry and the deepened channel. The maximum wave height difference patterns are generally similar for all simulations. The maximum wave height increases are focused on the edges of the outer channel and are generally larger north of the channel. The maximum increases ranged from 0.05 m (July 1999) to 0.25 m (re-tracked Hugo). The wave height decreases are

largest in the outer channel and generally extend further south of the channel, including the nearshore area off of Tybee Island. The maximum decreases ranged from 0.10 m (July 1999) to 0.71 m (re-tracked Hugo). The nearshore maximum differences are small, in the range of 0.05 to 0.10 m. Mean differences in wave height at each grid cell over each simulation were less than 0.01 m. The main impact of the channel deepening is a decrease in wave height in the outer channel and an increase in wave height on the edges of the outer channel. On average, these differences are small (less than 15 percent of the wave height). In the Tybee nearshore region, the channel deepening impact is generally a small decrease in the maximum wave height (0.05 to 0.10 m).

5 Sediment Transport Modeling

This chapter describes modeling efforts to estimate sediment transport rates and the potential for changes in transport rates due to deepening the Savannah navigation channel. The simulations of sediment transport described in this chapter rely on the estimated environmental conditions at the site, specifically the ADCIRC circulation simulations (Chapter 3) and STWAVE wave simulations (Chapter 4). The first part of this section describes GTRAN (Jensen et al. 2002) simulations of sediment transport patterns over the entire nearshore. The second part analyzes the patterns of the existing conditions and deepened channel model runs for potential changes in sediment transport patterns.

Nearshore Sediment Transport Model

To estimate the transport in the nearshore, predictive techniques are applied with available knowledge of the environmental conditions and sediment properties. The sediment transport model GTRAN was supplied modeled currents, water levels, and waves to predict transport pathways in the study area. GTRAN is a point model, which estimates potential transport and does not solve continuity of mass, i.e., it is a gross transport and not net transport model. GTRAN includes effects of waves and current on transport of non-cohesive sediment. Tidal-, wind-, and wave-generated circulation and wave parameters are provided to GTRAN through the external simulations with ADCIRC and STWAVE. Sediment properties of the bed in the study area were determined from information available from: USACE, NOAA, the Skidaway Institute, and others. These data sources are discussed in more detail in the chapter on the sediment budget (Chapter 2). From input hydrodynamic, wave, and sediment bed conditions, GTRAN calculates sediment transport through a collection of sediment transport methods. A detailed description of the GTRAN sediment transport methods, including sediment transport equations, is provided in Appendix 5A.

To numerically estimate sediment transport, simplifying assumptions and representations of the natural processes must be developed. Making such approximations is standard practice in the field of numerical modeling and is not unique to sediment transport models. The following discussion of the approximations developed for estimating transport rates is limited to general descriptions of the approximations applied.

Wave-Generated Current and Transport.

ADCIRC simulations include currents driven by the tide, wind, waves, and river. Wave-generated currents (longshore currents and undertow) and asymmetry in the wave orbital motions are a significant or dominant factor in nearshore hydrodynamics at many sites and must be

considered in nearshore transport studies. This section will address the treatment of wave-induced hydrodynamics included in this study and the implications of neglecting certain components of the hydrodynamic forcing on model results.

Longshore Current. Longshore transport is defined as the quantity of nearshore sediment transport generated along the coast by the effects of breaking waves and the associated longshore currents. At Savannah, the shore parallel tidal and wind-driven currents augment this transport. The distinction between transport in the nearshore region and offshore (deep water) region is primarily in the transport processes of the two regions. In offshore transport, waves produce additional bottom shear stresses and increase turbulence that suspends sediment near the bottom. Surface waves contribute little to transport direction. Ocean circulation currents transport the suspended sediment (and sediment near the bed). In the most general terms, the waves act as a stirring mechanism, and the currents transport the sediment. In the case of nearshore transport, breaking waves also impart an increased shear stress and turbulence on the bottom sediments. In addition, breaking waves exert a stress that generates longshore currents and transport along with tidal and wind-driven currents. Depth-averaged wave-generated longshore currents are included in the ADCIRC simulation through forcing by gradients in radiation stresses calculated by STWAVE (see Chapters 3 and 4).

Undertow. In addition to longshore currents, waves generate an offshore-directed current or 'undertow' near the bottom to balance the shoreward mass flux that occurs above wave troughs. Undertow is a primary factor in offshore sediment transport in the surf zone during storms (Miller et al. 1999, Smith and Miller, in review). Undertow exists in the lower water column, influencing the sediment bed and is therefore a strong mechanism for offshore sediment transport during large wave events.

A simple estimation of undertow derived through mass balance was implemented in the GTRAN simulations. The undertow estimate (called stokes velocity), U_{Stokes} as described by Nielsen (1992) is:

$$U_{Stokes} = -\frac{gH^2}{8cD}$$

where: g = gravitational acceleration
H = wave height
c = wave celerity
D = water depth

Wave Asymmetry. Wave asymmetry is the imbalance of forward (onshore) and backward (offshore) components of the bottom orbital velocities resulting from the nonlinearity of surface waves in shallow water. Wave asymmetry becomes a mechanism for shoreward sediment transport primarily during milder wave conditions (when undertow is small). In deep water, waves have a sinusoidal form and generate equal backward and forward bottom velocities. As the waves approach shallow water, wave crests become short and steep, while the troughs become long and flat. Near the bottom, orbital velocities include short-bursts of strong, onshore velocity under the steep wave crest and weaker, longer duration offshore velocity under the trough. These onshore bursts generally move more sand than the longer-duration, lower-magnitude offshore velocities. The transport methods in GTRAN include the effect of wave asymmetry on transport.

Bed Sediment Characteristics

In addition to the ADCIRC and STWAVE model output previously discussed, GTRAN requires bed sediment information. Areas with similar sediment qualities must be defined spatially and characterized by a median grain size diameter and sorting parameter.

GTRAN model runs rely on historic sediment sample information compiled during the sediment budget analysis. The historic samples are concentrated within the navigation channel and immediately offshore of Tybee Island. Figure 5-1 provides the location of and mean grain size information for sediment samples taken by USACE, NOAA, the Skidaway Institute and others. Mean grain sizes are given in millimeters and in phi (ϕ) units. The phi unit can be related to the grain size using Equation 5-1 below.

$$\phi = -\log_2(d) \tag{5-1}$$

Conversely, the grain size (d) in millimeters can be determined from phi units using Equation 5-2.

$$2^{-\phi} = d \tag{5-2}$$

Another sediment quality required to generate a grain size distribution is the sediment sorting. The sorting of a sediment sample refers to the range of grain sizes present. A perfectly sorted sample contains sediment of a uniform diameter, while a poorly sorted sample contains widely varying sizes.

In order to incorporate the available data and best represent the sediment transport pathways in the study area, a spatially uniform mean grain size of 0.2 mm (2.25 phi) was selected to characterize the area's bed sediment. The sediment was also selected as moderately to poorly sorted, with a sorting parameter of 1.0. Figure 5-2 provides the grain size distribution generated from the selected sediment parameters.

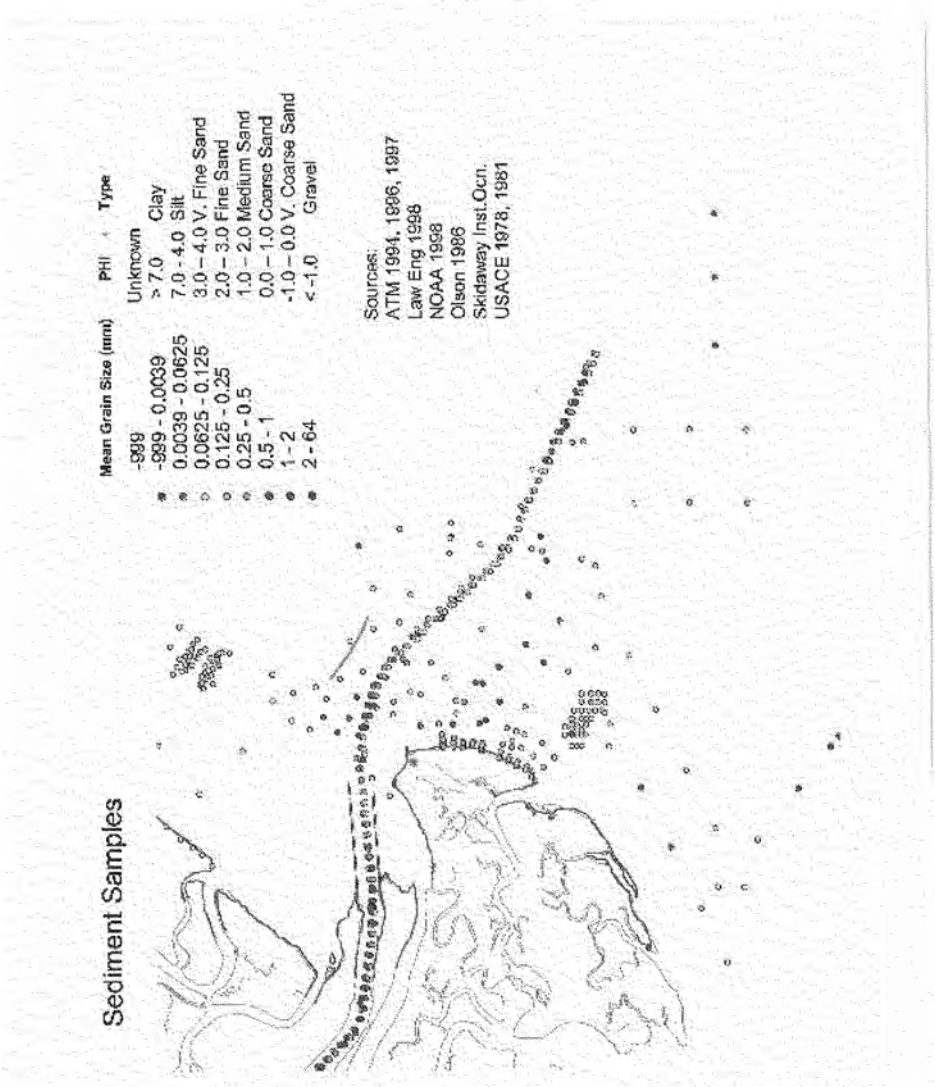


Figure 5-1. Locations and mean grain sizes of sediment samples taken within and around the federal navigation channel and Tybee Island.

Figure 5-2. Grain size distribution of spatially uniform bed characteristics for GTRAN modeling.

Sediment Transport Patterns

Since GTRAN is a point model, the model requires that the locations where sediment transport is to be calculated be defined by X, Y, and Z coordinates. The computational domain of the model was defined by 239 calculation points selected within and adjacent to the channel and offshore of the surrounding islands to represent the variations in hydrodynamics (both waves and currents) with water depth. Figure 5-3 illustrates the calculation locations selected for the Savannah Harbor Expansion Project study.

Five distinct time periods were modeled in ADCIRC and STWAVE prior to the GTRAN modeling. Four of the time periods, November 1979, January 1992, July 1999, and December 1999 were month-long simulations, while September 1989 represented only the week surrounding a re-tracked Hurricane Hugo simulation. All of these time periods were modeled with the existing bathymetry and the deepened navigation channel and bathymetry. The cumulative transport plots (representing the integral of the point transport over the simulation period) should be cross referenced to the bathymetry change (Figure 2-21) for a more complete picture of the transport processes.

The cumulative sediment transport vectors and rose plots (directional distribution of transport) for these calculation points are presented in Appendices 5B and 5C, respectively. The reader should pay special attention to the vector scale for each simulation period. The scales vary between plots. The scale is based on the maximum cumulative sediment transport for each specific simulation. Therefore, the scale for the November 1979 simulation is different than the scale for the September 1989 simulation.

November 1979

Cumulative sediment transport (integral of point sediment fluxes over the month) in the existing condition November 1979 simulation is characterized by ebb dominated transport in and immediately adjacent to the federal navigation channel (Figures 5B-1). The largest cumulative sediment transport magnitude is approximately 380 m^3/m and is located offshore of New River at calculation point 25. Similar magnitudes are found at points 168 and 169 (375 and 350 m^3/m, respectively) in the Tybee Roads area of the channel. The area offshore of Turtle Island between New River and the federal channel is characterized by onshore directed cumulative transport in the north and offshore directed cumulative transport closer to the channel. The area immediately offshore of New River is ebb dominated and the magnitude of cumulative transport is larger than the surrounding areas. Offshore of Tybee Island, the southern areas demonstrate onshore cumulative transport and the northern areas show towards the North and Northwest. There is also a clockwise recirculation cell south and east of the finger shoal feature. Farther offshore near the Tybee Range portion of the federal navigation channel, transport within the channel remains ebb dominated, but areas to the north and south of the channel are characterized by onshore or channel-ward directed transport.

Cumulative sediment transport patterns in the November 1979 deepened channel simulation are very similar to the patterns exhibited during the existing conditions simulation. The largest cumulative sediment transport magnitude is 410 m^3/m and is located in the Tybee Roads area of the channel (calculation point number 168). Dominant transport directions in all areas of the model domain are consistent. In instances where cumulative transport differs from the existing conditions simulation, those differences are most often slight differences in the magnitude of cumulative transport. Figures 5B-1 through 5B-2 provide the cumulative sediment transport

vectors for the two November 1979 simulations and Figures 5C-1 through 5C-8 provide the sediment transport rose plots. Rose plots show the full distribution of transport over the simulation.

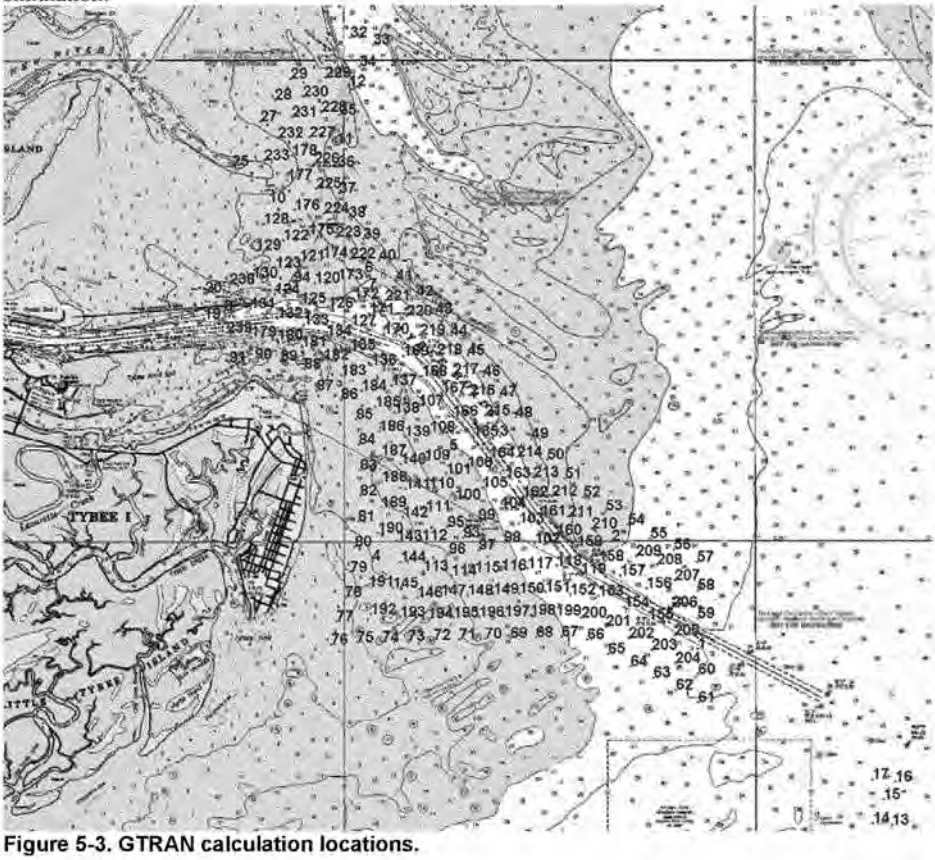


Figure 5-3. GTRAN calculation locations.

September 1989

Cumulative sediment transport in the existing conditions September 1989 simulation is similar to the November 1979 results. The cumulative transport is characterized by ebb dominated transport in and immediately adjacent to the federal navigation channel. The largest cumulative sediment transport magnitude is 300 m^3/m and is located in the channel between the Tybee Knoll and Jones Island Ranges at calculation point 132. Unlike the November 1979 simulation, transport offshore of the southern portion of Tybee Island is mostly westerly (onshore), while transport closer to Tybee Inlet is southwesterly. Farther offshore near the Tybee Range portion of the federal navigation channel, transport within the channel remains ebb dominated. However, transport in the area north of Tybee Range is flood or onshore directed and towards the channel. In addition, transport in the area south of Tybee Range is offshore and directed slightly south and away from the channel.

Cumulative sediment transport patterns in the September 1989 deepened channel simulation are very similar to the patterns exhibited during the existing conditions simulation. The largest cumulative sediment transport magnitude is 650 m^3/m and is located in the Tybee Roads area of the channel at calculation point number 168. Dominant transport directions in all areas of the model domain are consistent. Figures 5B-3 through 5B-4 provide the cumulative sediment transport vectors for the September 1989 simulations and Figures 5C-9 through 5C-16 provide the sediment transport rose plots.

January 1992

Cumulative sediment transport patterns during the existing conditions January 1992 simulation are very similar to the November 1979. The largest cumulative sediment transport magnitude is approximately 290 m^3/m and is located offshore of New River at calculation point 25.

Cumulative sediment transport patterns during the January 1992 deepened channel simulation are very similar to the patterns exhibited during the existing conditions simulation. The largest cumulative sediment transport magnitude is approximately 300 m^3/m and is located offshore of New River at calculation point 25. Dominant transport directions in all areas of the model domain are consistent. Where cumulative transport differs from the existing conditions simulation, those differences are generally slight differences in the magnitude of cumulative transport. Figures 5B-5 through 5B-6 provide the cumulative sediment transport vectors for the two January 1992 simulations and Figures 5C-17 through 5C-24 provide the sediment transport rose plots.

July 1999

Like the other simulations, cumulative sediment transport in the existing conditions July 1999 simulation is characterized by ebb dominated transport in and immediately adjacent to the federal navigation channel. The largest cumulative sediment transport magnitude is approximately 340 m^3/m and is located offshore of New River at calculation point 25. The magnitude of transport in the area offshore of Turtle Island between New River and the federal channel is less than most of the other simulation periods and there is little discernable pattern to the transport in this area. The area immediately offshore of New River is ebb dominated and the magnitude of cumulative transport is much larger than the surrounding areas. Offshore of Tybee Island, cumulative transport magnitudes are relatively small and uniformly northwesterly (onshore). Cumulative transport magnitudes continue to decrease farther offshore near the Tybee Range portion of the federal navigation channel, both within and adjacent to the channel. Transport within the channel remains ebb dominated. In general the cumulative sediment transport fluxes in all regions are less in the July simulation than the winter simulations, but the patterns are similar.

Cumulative sediment transport patterns in the July 1999 deepened channel simulation are very similar to the patterns exhibited during the existing conditions simulation. The largest cumulative sediment transport magnitude is approximately 350 m^3/m and is located offshore of New River at calculation point 25. Dominant transport directions in all areas of the model domain are consistent. In instances where cumulative transport differs from the existing conditions simulation, those differences are most often slight differences in the magnitude of cumulative transport. Figures 5B-7 through 5B-8 provide the cumulative sediment transport vectors for the two July 1999 simulations and Figures 5C-25 through 5C-32 provide the sediment transport rose plots.

December 1999

Cumulative sediment transport patterns during the existing conditions December 1999 simulation are similar to the winter months discussed above. The largest cumulative sediment transport magnitude is approximately 345 m^3/m and is located offshore of New River at calculation point 25.

Cumulative sediment transport patterns during the December 1999 deepened channel simulation are very similar to the patterns exhibited during the existing conditions simulation. The largest cumulative sediment transport magnitude is approximately 355 m^3/m and is located offshore of New River at calculation point 25. Dominant transport directions in all areas of the model domain are consistent. In instances where cumulative transport differs from the existing conditions simulation, those differences are most often slight differences in the magnitude of cumulative transport. Figures 5B-9 through 5B-10 provide the cumulative sediment transport vectors for the two December 1999 simulations and Figures 5C-33 through 5C-40 provide the sediment transport rose plots.

Changes to Sediment Transport Patterns

Changes in cumulative sediment transport due to deepening the channel were determined from the differences in cumulative sediment transport from the existing condition and deepened condition GTRAN model runs for each of the simulation periods. Differences were calculated by subtracting the existing conditions results from the deepened conditions results. Vector plots of changes to the cumulative sediment transport due to the deepening of the navigation channel for each of the simulations are presented in Appendix 5D. Again, the vector scales differ for each simulation period. With the exception of September 1989, the scale for the difference vectors are much smaller than the cumulative vectors in Appendix 5B.

The majority of the simulation periods show little difference in cumulative sediment transport outside of the federal navigation channel itself. The areas offshore of Tybee Island and Turtle Island show minor differences in cumulative transport, when any differences are present at all. Table 5-1 gives the average change in cumulative sediment transport magnitude (ΔQ, or deepened channel minus existing condition) for 10 regions. The regions are defined in Figure 5-4. The existing condition cumulative transport magnitude averaged over the region is also given for reference. The changes in cumulative transport magnitude are generally small ($< \pm 1$ m^3/m), except in the federal channel, where the cumulative transport magnitudes are large. September 1989 (re-tracked hurricane Hugo) is also an exception, with significant change in cumulative transport in most regions.

Figures 5-5 through 5-7 show the transport vectors for the Tybee Shelf area of the GTRAN computation domain for the December 1999 existing conditions, deepened conditions, and the vectors differences, respectively. The entire channel is ebb dominated in both the existing and deepened conditions results, but the difference vectors within the inner channel in Figure 5-8 point in the flood direction. These difference vectors indicate that the existing conditions magnitude is larger than the deepened condition magnitude. Most calculation points show very little change in transport angle between the existing and deepened conditions.

The changes in cumulative sediment transport vectors in Figure 5-7 are typical of the other changes during the other simulation periods. The exception is the re-tracked Hurricane Hugo (September 1989) simulation. The differences in cumulative sediment transport due to the

deepening during September 1989 are unique because larger magnitude changes are present adjacent to the channel and even extend offshore between the Tybee Roads and Tybee Range sections of the channel. The differences immediately on the Tybee Island shelf are minor except for the area between the southern jetty and the northern end of Tybee Island. All of the simulation periods and their associated changes in sediment transport are discussed in more detail below.

November 1979

Figure 5D-1 provides the changes in cumulative sediment transport vectors between the two November 1979 simulations. The ranges of differences in point magnitudes are -60 m^3/m to 50 m^3/m in the channel and -3 m^3/m to 6 m^3/m on the Tybee Island shelf. Cumulative transport magnitude decreased due to the deepening inside the channel from the jetties seaward to the beginning of the Tybee Roads area. The number of points exhibiting increases in cumulative sediment transport within the channel is balanced by those exhibiting decreases. The average magnitude differences over regions are given in Table 5-1. The deepening tends to decrease the ebb dominance in the inner channel (decrease is average cumulative transport magnitude of 16 m^3/m) and increase the ebb dominance in the Tybee Roads section of the channel (increase is cumulative transport magnitude of 3 m^3/m).

Table 5-1. Average Cumulative transport Rate Changes for Deepened Channel
(ΔQ = Deepened – Existing Sediment Flux, Q_{exist} = Sediment Flux for Existing Bathymetry)

Location	Nov 1979		Sep 1989		Jan 1992		Jul 1999		Dec 1999	
	ΔQ (m^3/m)	Q_{exist} (m^3/m)	ΔQ (m^3/m)	Q_{exist} (m^3/m)	ΔQ (m^3/m)	Q_{exist} (m^3/m)	ΔQ (m^3/m)	Q_{exist} (m^3/m)	ΔQ (m^3/m)	Q_{exist} (m^3/m)
Tybee Island Shelf	0.3	25.	0.2	14.	0.0	13.	0.1	7.0	0	8.8
North Tybee	-0.6	19.	7.4	18.	-0.7	12.	-1.0	17.	-0.5	13.
Tybee Knoll Bar Channel	-15.6	105	102.	203.	-9.7	52.	-11.7	54.	-10.1	69.
Tybee Roads	3.0	84.	93.	163.	0.8	34.	1.1	26.	2.0	42.
Tybee Range	0.7	16.	11.	49.	-0.2	10.	0	1.0	-0.2	3.9
North of Channel	-0.6	35.	16.	40.	-0.6	31.	0.2	5.2	0.2	20.
Turtle Island	0.1	23	16.	26.	0	10.	0.2	7.7	0.4	14.
New River	0.9	72.	76.	123.	0.9	48.	1.2	53.	1.5	58.
Daufuskie Island	0.2	8.	5.6	10.	0	4.2	0.1	5.2	0.1	6.7
Offshore	0.4	13.	41.0	138.	0.9	8.5	0	0.1	0.5	3.0

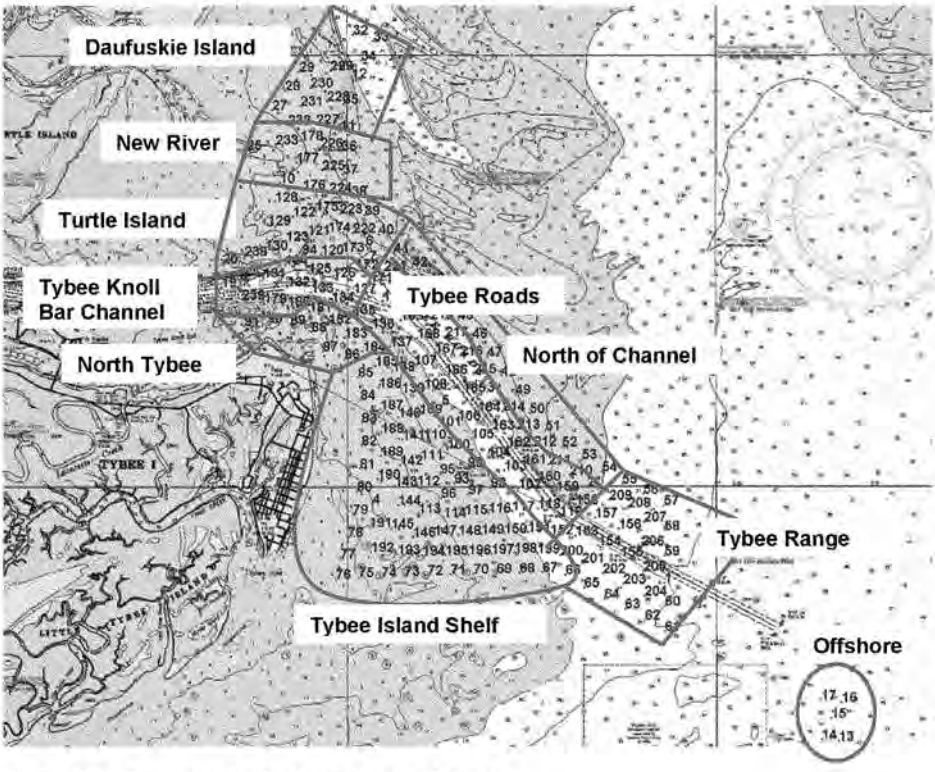


Figure 5-4. Summary of Regions Used in Table 5-1.

September 1989

Figure 5D-2 provides the changes in cumulative sediment transport vectors between the two September 1989 simulations. The ranges of differences in point magnitudes are -9 m^3/m to 390 m^3/m in the channel and -13 m^3/m to 10 m^3/m on the Tybee Island shelf. Unlike the other simulations, cumulative offshore transport increased throughout the channel due to the deepening. The average cumulative transport magnitude increases throughout the modeling for the deepened channel (Table 5-1). The largest increases are in the Tybee Knoll Bar and Tybee Roads sections of the channel (approximately 100 m^3/m).

January 1992

Figure 5D-3 provides the changes in cumulative sediment transport vectors between the January 1992 simulations. The ranges of differences in point magnitudes are -40 m^3/m to 22 m^3/m in the channel and -2 m^3/m to 1 m^3/m on the Tybee Island shelf. Cumulative transport magnitude decreased due to the deepening inside the channel from the jetties seaward to the beginning of the Tybee Roads area. The largest regional average difference in magnitudes is a decrease of 10 m^3/m in the inner channel (Table 5-1). The average differences by region are similar to November 1979.

July 1999

Figures 4D-4 provides the changes in cumulative sediment transport vectors between the two July 1999 simulations. The ranges of differences in point magnitudes are -53 m^3/m to 19 m^3/m in the channel and -0.4 m^3/m to 0.6 m^3/m on the Tybee Island shelf. Cumulative transport magnitude decreased due to the deepening inside the channel from the jetties seaward to the beginning of the Tybee Roads area. The largest regional average difference in magnitudes is a decrease of 12 m^3/m in the Tybee Knoll bar channel (Table 5-1). The average differences by region are similar to November 1979 and January 1992.

December 1999

Figure 5D-5 provides the changes in cumulative sediment transport vectors between the two December 1999 simulations. The ranges of difference in point magnitudes are -45 m^3/m to 31 m^3/m in the channel and -1.0 m^3/m to 1.1 m^3/m on the Tybee Island shelf. Cumulative transport magnitude decreased due to the deepening inside the channel from the jetties seaward to the beginning of the Tybee Roads area. The largest regional average difference in magnitudes is a decrease of 10 m^3/m in the Tybee Knoll bar channel (Table 5-1). The average differences by region are similar to November 1979, January 1992, and July 1999.

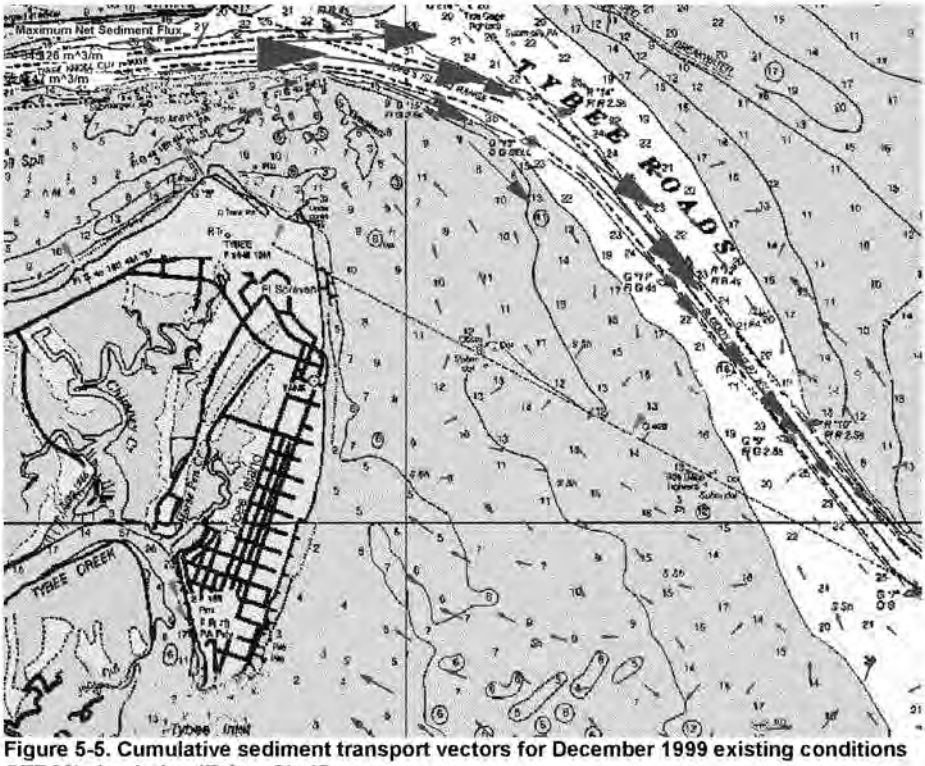


Figure 5-5. Cumulative sediment transport vectors for December 1999 existing conditions GTRAN simulation (Tybee Shelf).

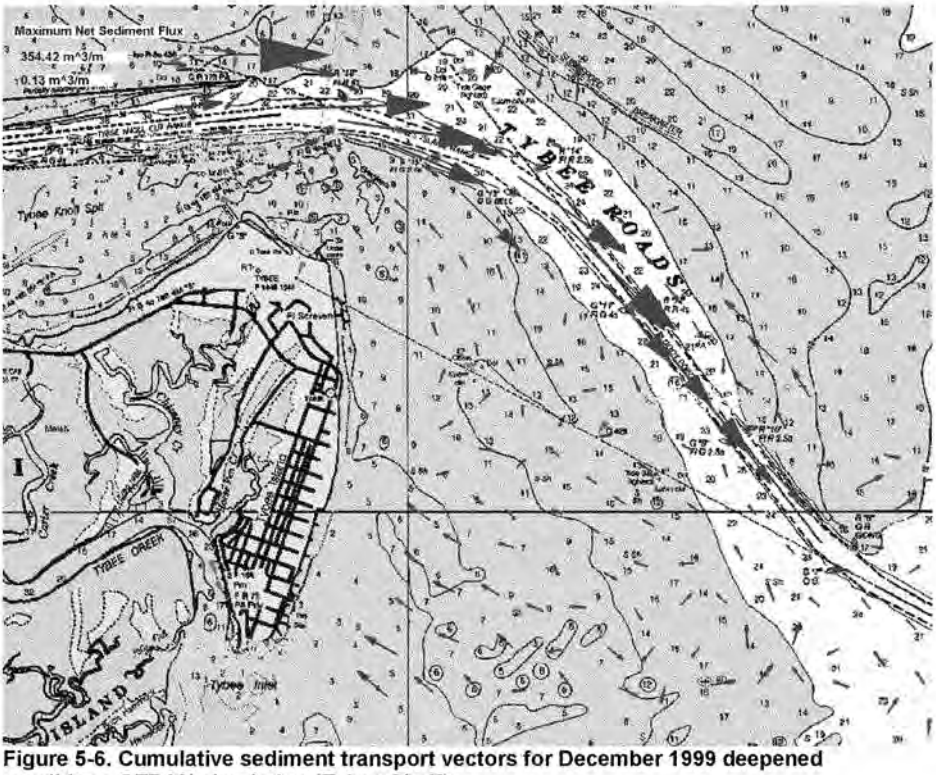


Figure 5-6. Cumulative sediment transport vectors for December 1999 deepened conditions GTRAN simulation (Tybee Shelf).

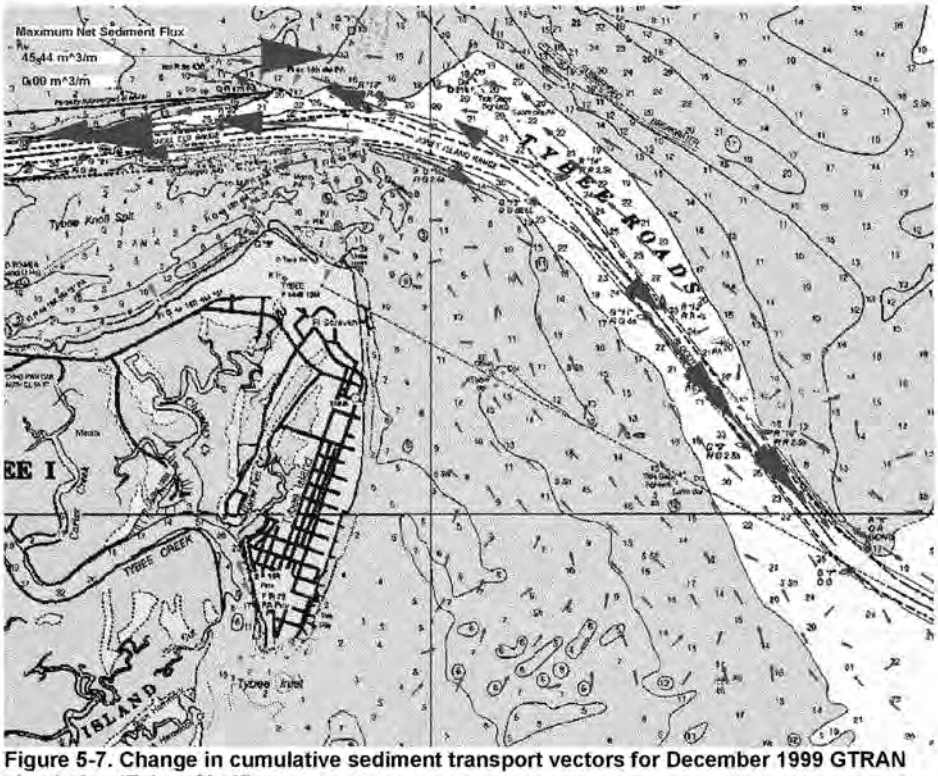


Figure 5-7. Change in cumulative sediment transport vectors for December 1999 GTRAN simulation (Tybee Shelf).

Sediment Transport Summary

With the exception of the re-tracked Hurricane Hugo (September 1989), changes in cumulative sediment transport due to deepening the federal channel show similar patterns and magnitudes across all GTRAN simulation periods. The November 1979, January 1992, July 1999, and December 1999 simulations show differences in average cumulative sediment transport magnitude inside the channel of between -16 to +3 m^3/m (point differences of -60 to +50 m^3/m) and differences in average cumulative sediment transport around Tybee Island of between -1.0 to +0.3 m^3/m (point differences of -3.2 to +5.9 m^3/m). The general trend is a decrease in ebb-directed cumulative sediment transport in the Tybee Knolls bar channel (10 to 16 m^3/m, 15-20 percent) and a slight increase in ebb-directed cumulative sediment transport in the Tybee Roads and Range sections of the channel (0-3 m^3/m, 0-5 percent). The other nearshore areas had small changes in the average cumulative transport: 0-1 percent increase in transport on the Tybee Island Shelf, 3-6 percent decrease on north of Tybee; 0-3 percent increase off Turtle Island, New River and Daufuskie Island; and 2 percent decrease to 4 percent increase north of the channel

The high intensity forcing (waves and currents) during the re-tracked Hurricane Hugo results in positive (increase) transport rates throughout the deepened channel. The increases in averaged cumulative sediment transport magnitude during September 1989 range from +11 to +102 m^3/m in the channel (point differences of -90 to +390 m^3/m). The increased transport is directed offshore in the channel. Increases in average cumulative sediment transport magnitude were seen in all regions, 0.3 m^3/m on the Tybee Island shelf, 5.5 m^3/m in north Tybee, 35 m^3/m north of the outer channel, 23 m^3/m off Turtle Island, 72 m^3/m at New River, and 8 m^3/m off of Daufuskie Island. The rates for the other simulation periods are averaged over one month simulation, and the re-tracked Hugo simulations are averaged only over 1 week, making any local differences (in space or time) more prominent. Hurricane Hugo is an extreme event, and the potential transport rates calculated with GTRAN do not account for evolution of the bathymetry through the storm or the response of waves and currents to the evolution of bathymetry (which would be significant in a hurricane).

These results support the hypothesis that the additional deepening will not have a major impact on the system, including north Tybee. The circulation and wave modeling indicated very small changes associated with the proposed deepening. GTRAN results for the existing condition and the deepened-channel condition indicate that the additional channel deepening will not change the general overall pattern of sediment transport in the region. The most noticeable changes were computed in the channel.

Appendix 5A. GTRAN Sediment Transport Methods

This section describes the sediment transport methods incorporated into the sediment transport model. These descriptions aim to provide a general overview of the predictive techniques.

Transport Methods

Algorithms that estimate sediment movement under specific wave and current conditions are referred to as transport methods. Presently there are no sediment transport methods that are universally applicable to all environments and sediment types. For instance, a transport method developed for cobbles and boulders in an alpine stream is not likely to correctly represent sediment transport in an estuary or open-coast application. To correctly and reliably estimate sediment transport, the transport method must represent the important transport processes within the region of application. A general description and overview will be given for each transport method applied.

Wikramanayake and Madsen. Under contract with the U.S. Army Corps of Engineers, Dredging Research Program (DRP), researchers at Massachusetts Institute of Technology developed non-cohesive sediment transport algorithms for combined wave-current environments. The algorithms include the effects of variation between current and wave directions. The methods are outlined in DRP reports (Madsen and Wikramanayake, 1991; Wikramanayake and Madsen, 1994a) and were specifically designed for nearshore transport in high-energy regions, although the initial validation and calibration were performed outside the surf zone. User input includes near-bottom orbital velocity, mean currents, bed slope, and grain size.

The method uses a time-invariant turbulent eddy viscosity model and a time-varying near-bottom concentration model to estimate suspended sediment transport fluxes. The method first calculates the bed roughness, using methods outlined by Wikramanayake and Madsen (1994b). Bed load and suspended sediment concentrations are then calculated using bottom shear stress. Estimates of vertical variation in suspended sediment concentration are based on a non-dimensional, time-varying, near-bottom reference concentration, $C_r(t)$. This concentration can be estimated as:

$$C_r(t) = \frac{C_b \gamma_o (|\Psi^*(t)| - \Psi_{cr})}{\Psi_{cr}} \tag{5A-1}$$

where C_b is the volume fraction of sediment in the bed, γ_o is an empirical resuspension coefficient, $\Psi^*(t)$, the Shield's parameter based on instantaneous, skin-friction shear stress, and Ψ_{cr}, the critical Shield's parameter. Laboratory experiments have demonstrated that γ_o decreases with increasing Shield's parameter or wave skin friction shear stress. However, data were insufficient to develop empirical methods to relate the resuspension coefficient to Shield's parameter and constant values of γ_o are applied for rippled and flat beds, respectively. The Shield's parameters are defined by:

$$\Psi^*(t) = \frac{u^*(t)}{(s-1) g d_{50}} \tag{5A-2}$$

$$\Psi_{cr} = \alpha_1 \tan(\phi) \tag{5A-3}$$

where $u^*(t)$ is the bed shear velocity, α_1 is a coefficient dependent on the local Reynolds number, s is the specific gravity of sediment, d_{50} is the median grain diameter, g is gravitational acceleration, and ϕ is the angle of repose of the sediment grains. The reference concentration is used to estimate vertically varying concentrations in the water column due to steady and oscillatory currents. The estimated suspended sediment concentration is coupled with the vertically varying velocities to estimate the total suspended sediment flux.

The Wikramanayake and Madsen model also includes a method for estimating the instantaneous bed-load flux based on the Meyer-Peter and Müller (1948) formula. This instantaneous bed-load flux, Q_b ($cm^3/cm \cdot s$), is estimated by:

$$\vec{Q}_b(t) = \frac{d_{50}\sqrt{(s-1)gd_{50}}}{2\pi} \frac{8(|\Psi^*(t)| - \Psi_{cr})}{1 + \tan\beta_L \dfrac{\cos(\Phi_f - \Phi_{sw})}{\tan\Phi_f}} \frac{\vec{\tau}_b'(t)}{|\vec{\tau}_b'(t)|} \tag{5A-4}$$

where $\beta_L = h/6\delta$, h is the water depth, δ is the boundary layer length scale, Φ_f is the angle between the current and the wave direction, Φ_{sw} is the angle between the wave direction and bottom slope, and $\tau_b'(t)$ is the instantaneous skin friction shear stress.

Wikramanayake and Madsen (1994a) performed several tests to compare their results to field measurements in wave/current environments and found that the model accurately predicted the current-related and wave-related sediment fluxes and distributions in the water column. No verification was performed for the bed-load model estimates. Field verification of the transport method has been performed by CHL against data sets from the Columbia River mouth (Gailani et al. in preparation) and in the surf zone at the Field Research Facility, Duck, North Carolina, with favorable comparisons to field data. However, the Wikramanayake and Madsen transport method is unsuitable for conditions in which sediment suspension and/or wave-induced shear stresses are small, therefore other methods of approximating sediment transport were applied under bedload-dominated or current-dominated transport conditions.

Soulsby bedload transport method. Soulsby (1997) developed a formula for combined wave-current bedload by integrating the current-only bedload formula of Nielsen (1992) over a single sinusoidal wave cycle. The formula is expressed as follows:

$$\Phi_{x1} = 12\theta_m^{1/2}(\theta_m - \theta_{cr}) \tag{5A-5a}$$

$$\Phi_{x2} = 12(0.95 + 0.19\cos 2\phi)\theta_w^{1/2}\theta_m \tag{5A-5b}$$

$$\Phi_x = \text{maximum of } \Phi_{x1} \text{ and } \Phi_{x2} \tag{5A-5c}$$

$$q_{bx} = \Phi_x \left[g(s-1)d_{50}^3\right]^{1/2} \tag{5A-5d}$$

subject to $\Phi_x = 0$ if $\theta_{cr} \geq \theta_{max}$
where:

q_b = mean volumetric bedload transport rate per unit width
θ_m = mean Shield's parameter over a wave cycle
θ_w = amplitude of oscillatory component of θdue to waves
θ_{max} = maximum Shield's parameter from combined wave-current stresses
θ_{cr} = critical Shield's parameter for initiation of motion
ϕ = angle between current direction and direction of wave travel

Soulsby's combined wave-current bedload transport method was applied when sediment suspension was estimated to be near zero.

Van Rijn current-dominated transport method. The Van Rijn (1984) current-only total transport method was parameterized from Van Rijn's comprehensive theory of sediment transport in rivers. Although the method was developed for sediment transport in the riverine environment, the method may also be appropriately applied in the marine environment under conditions for which waves contribute little to the bottom shear stress. The simpler, parameterized formulae presented here approximate the full theory within ±25 percent and were developed for water depths between 1-20 m, velocities between 0.5 and 5 m/s, d50 between 0.1 and 2 mm, and for fresh water at 15 deg C. The resulting parameterized method estimates transport by the following simpler formulation:

$$q_t = q_b + q_s \tag{5A-6}$$

$$q_b = 0.005\overline{U}h\left\{\frac{\overline{U}-\overline{U}_{cr}}{\left[(s-1)gd_{50}\right]^{1/2}}\right\}^{2.4}\left(\frac{d_{50}}{h}\right)^{1.2} \tag{5A-7}$$

$$q_s = 0.012\overline{U}h\left\{\frac{\overline{U}-\overline{U}_{cr}}{\left[(s-1)gd_{50}\right]^{1/2}}\right\}^{2.4}\left(\frac{d_{50}}{h}\right)(D_*)^{-0.6} \tag{5A-8}$$

where,

$$\overline{U}_{cr} = 0.19(d_{50})^{0.1}\log_{10}\left(\frac{4h}{d_{90}}\right)\left\{0.1 \le d_{50} \le 0.5\text{ mm}\right.$$

$$\overline{U}_{cr} = 8.50(d_{50})^{0.6}\log_{10}\left(\frac{4h}{d_{90}}\right)\left\{0.5 \le d_{50} \le 2.0\text{ mm}\right.$$

$$D_* = \left[\frac{g(s-1)}{\nu^2}\right]^{1/3} d_{50}$$

q_b = bedload transport
q_s = suspended transport
$\overline{U}$ = depth-averaged current
h = water depth
d_{90} = sediment diameter for which 90 percent is finer by weight

Transport Model

Sediment transport processes along the length of the channel vary both spatially and temporally. A prime example of this variation is the difference between transport inside and outside of the surf zone. Waves and currents inside and outside the surf zone are responsible for transporting the sediment, but the transport mechanisms are different. Inside the surf zone, breaking waves increase turbulence and enhance sediment suspension while the wave-generated longshore currents transport the suspended sediment. Outside the surf zone, turbulence is much smaller, but the waves may suspend sediment over bedforms and the larger-scale, ocean circulation transports the sediment. Clearly, it would be difficult to represent the sediment transport in both of these regions with one transport method. The sediment transport model selects the appropriate transport method, develops the required input conditions, and tracks the spatial relationships, sediment characteristics, environmental conditions, and estimated sediment transport.

With the initial bed conditions specified, the model next distributes environmental forcing conditions from large-domain wave and circulation models to each of the computational points. The temporal resolution of the wave and current information is one-hour or three-hours as is the time step of the model. This resolution is adequate to define the temporal changes in wave and current conditions for representing sediment transport. With local wave and current conditions determined, the model proceeds to estimate the combined wave-current bottom shear stresses and to estimate the depth of the active sediment layer. The active sediment layer is defined as the depth of the sediment bed that is mobilized by sediment suspension and bed-load movement. Bottom shear stresses and non-cohesive sediment characteristics are further evaluated to determine the regime of sediment transport and the appropriate sediment transport method is selected to estimate the sediment transport rates. Jensen et al. (2002) give additional information regarding model development and application.

Appendix 5B. GTRAN Cumulative Sediment Transport Vectors

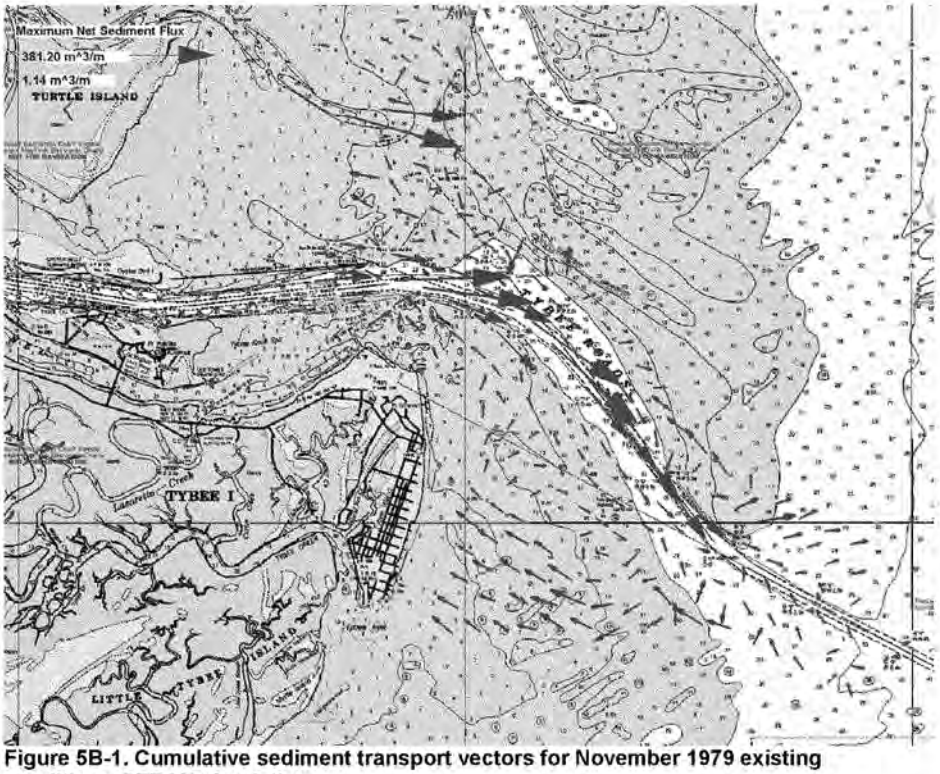


Figure 5B-1. Cumulative sediment transport vectors for November 1979 existing conditions GTRAN simulation.

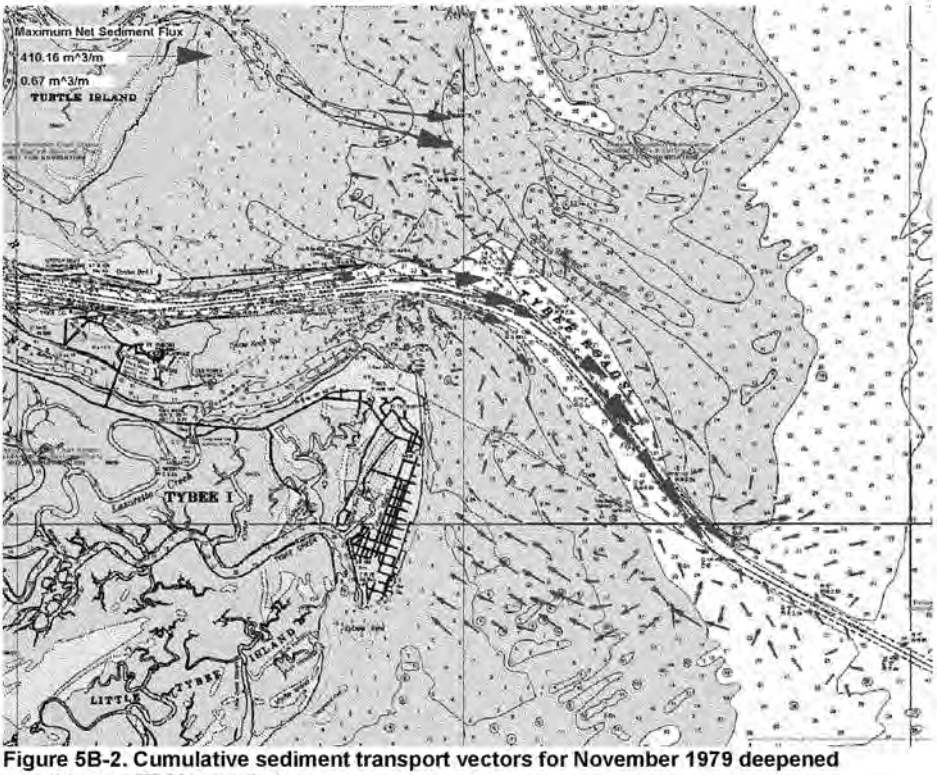


Figure 5B-2. Cumulative sediment transport vectors for November 1979 deepened conditions GTRAN simulation.

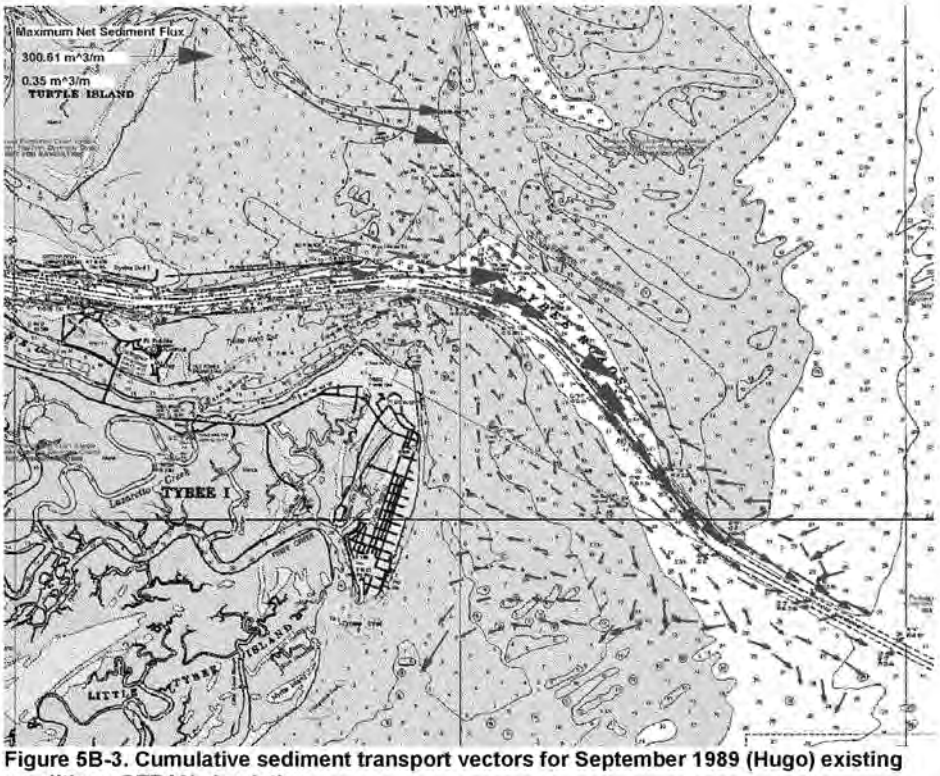


Figure 5B-3. Cumulative sediment transport vectors for September 1989 (Hugo) existing conditions GTRAN simulation.

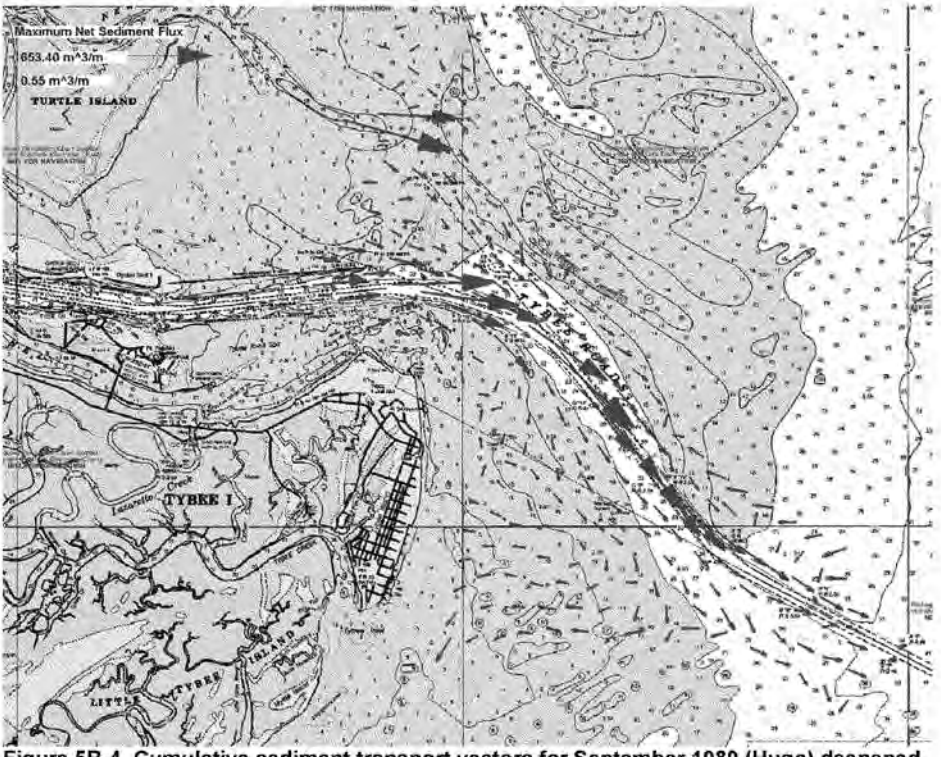


Figure 5B-4. Cumulative sediment transport vectors for September 1989 (Hugo) deepened conditions GTRAN simulation.

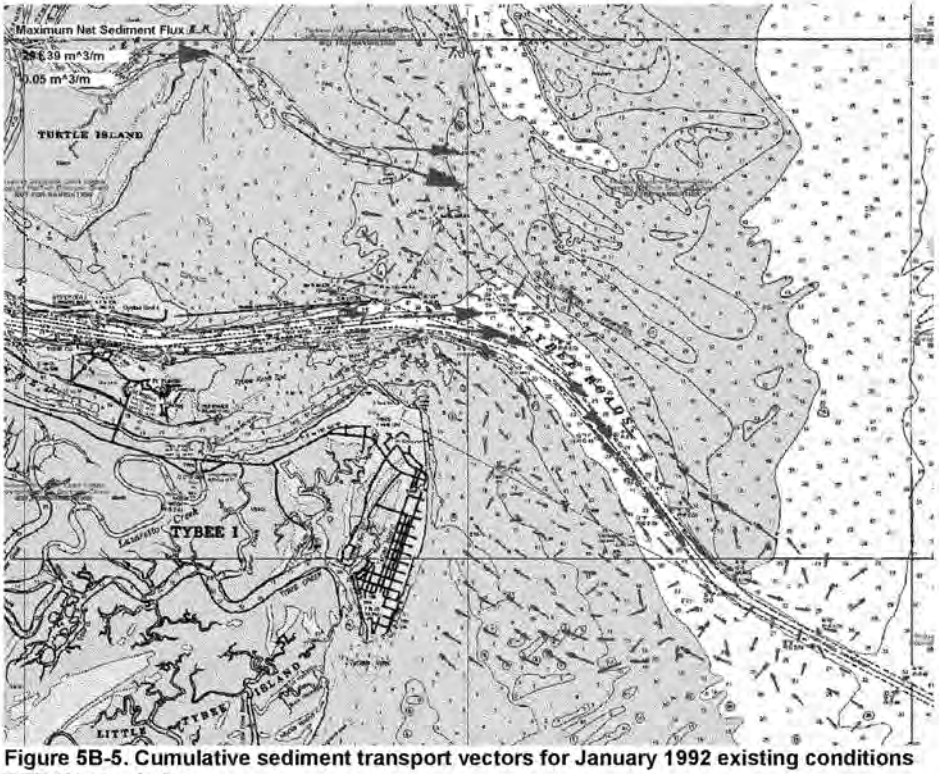


Figure 5B-5. Cumulative sediment transport vectors for January 1992 existing conditions GTRAN simulation.

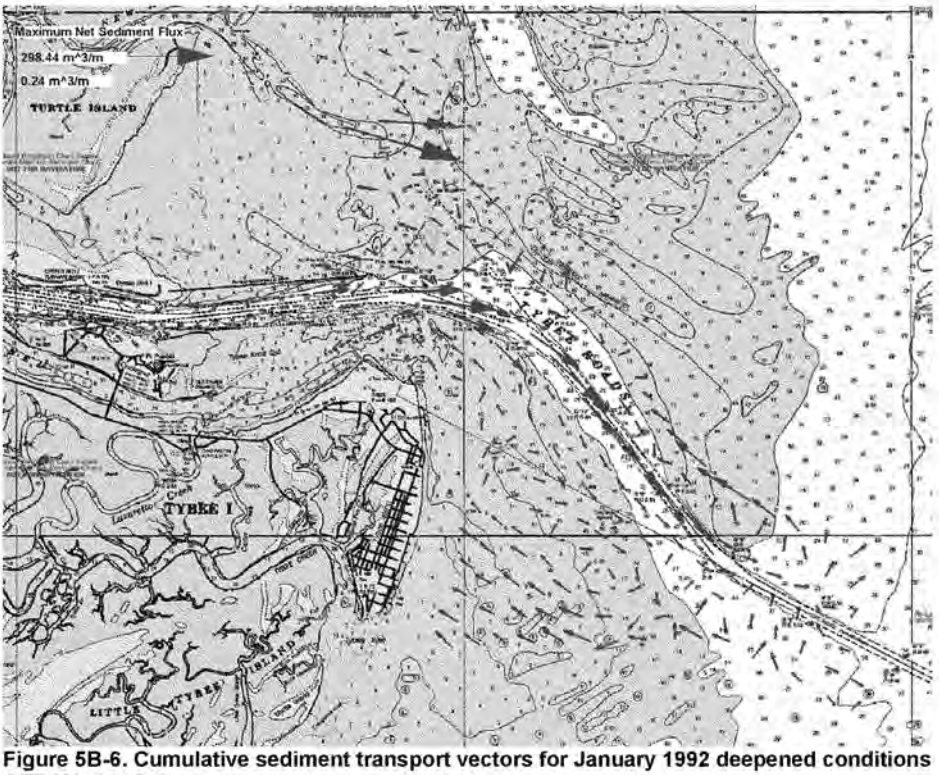


Figure 5B-6. Cumulative sediment transport vectors for January 1992 deepened conditions GTRAN simulation.

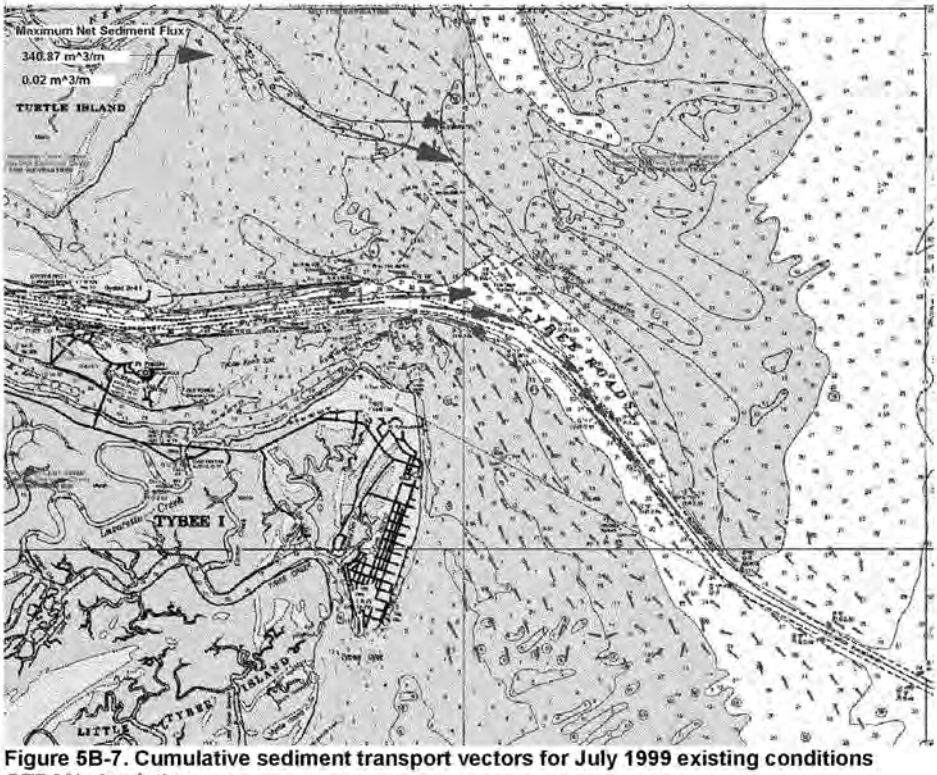


Figure 5B-7. Cumulative sediment transport vectors for July 1999 existing conditions GTRAN simulation.

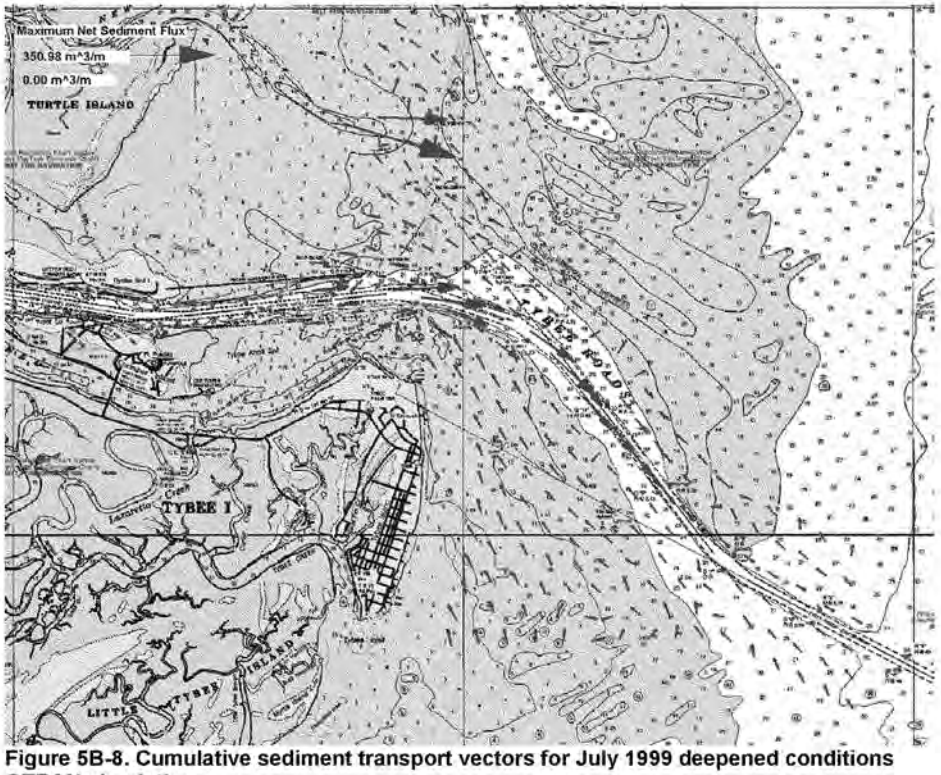


Figure 5B-8. Cumulative sediment transport vectors for July 1999 deepened conditions GTRAN simulation.

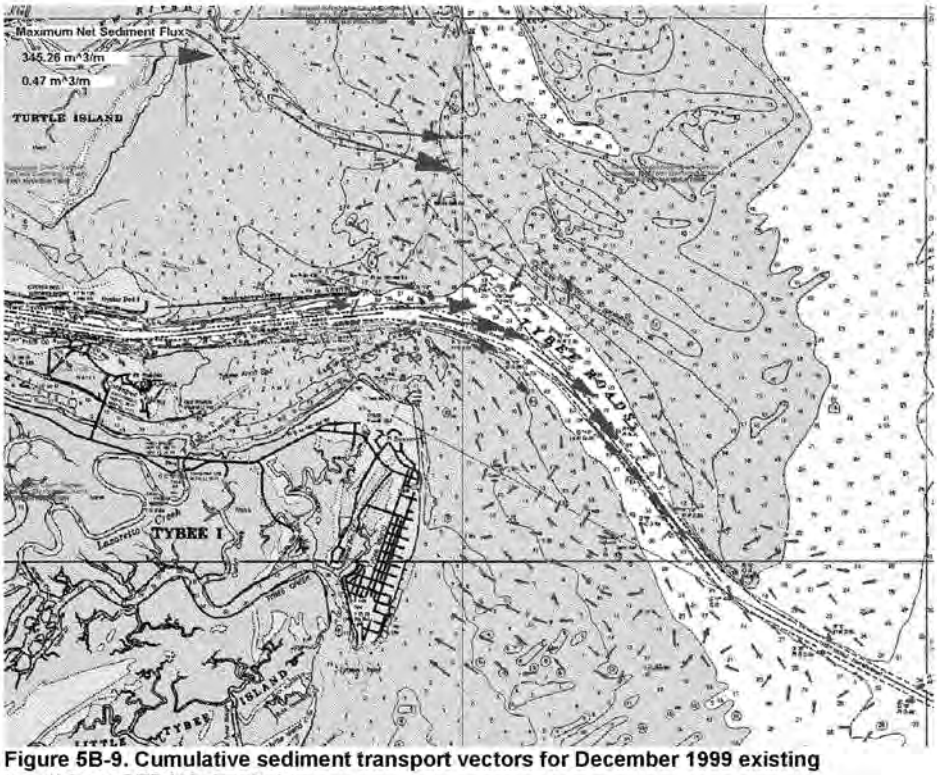


Figure 5B-9. Cumulative sediment transport vectors for December 1999 existing conditions GTRAN simulation.

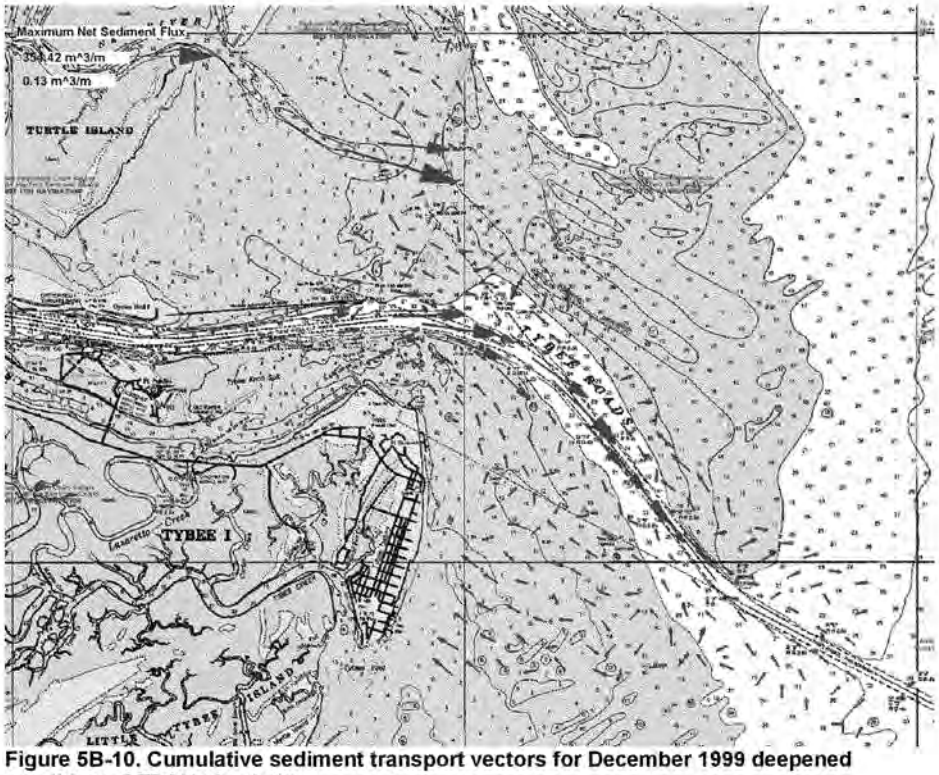


Figure 5B-10. Cumulative sediment transport vectors for December 1999 deepened conditions GTRAN simulation.

Appendix 5C. GTRAN Sediment Transport Rose Plots

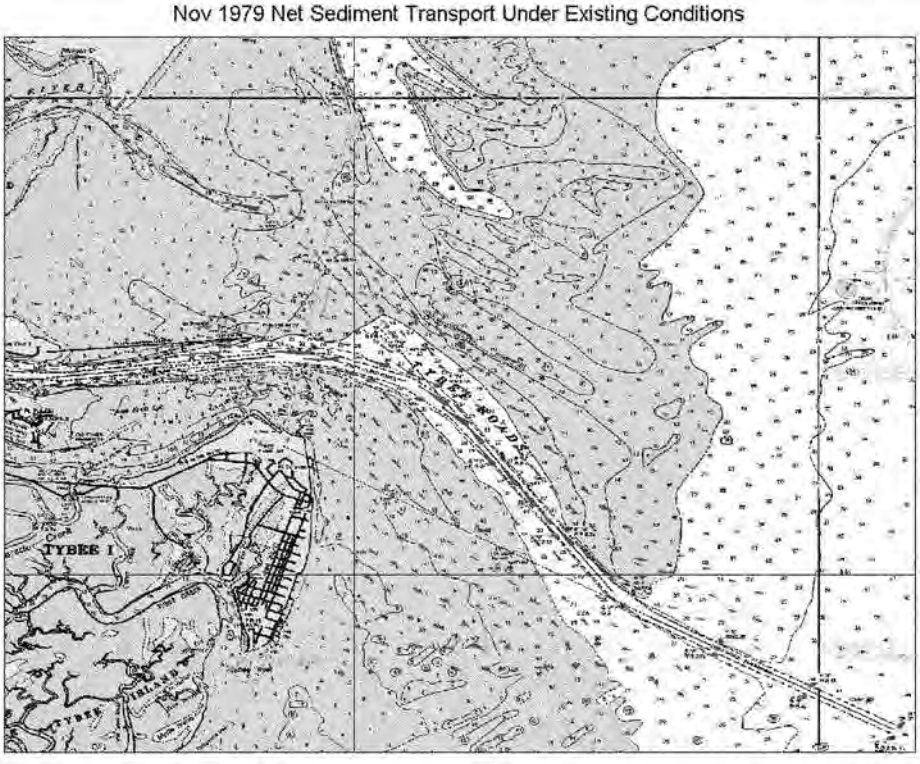


Figure 5C-1. Cumulative sediment transport rose plots for November 1979 existing conditions GTRAN simulation (full domain).

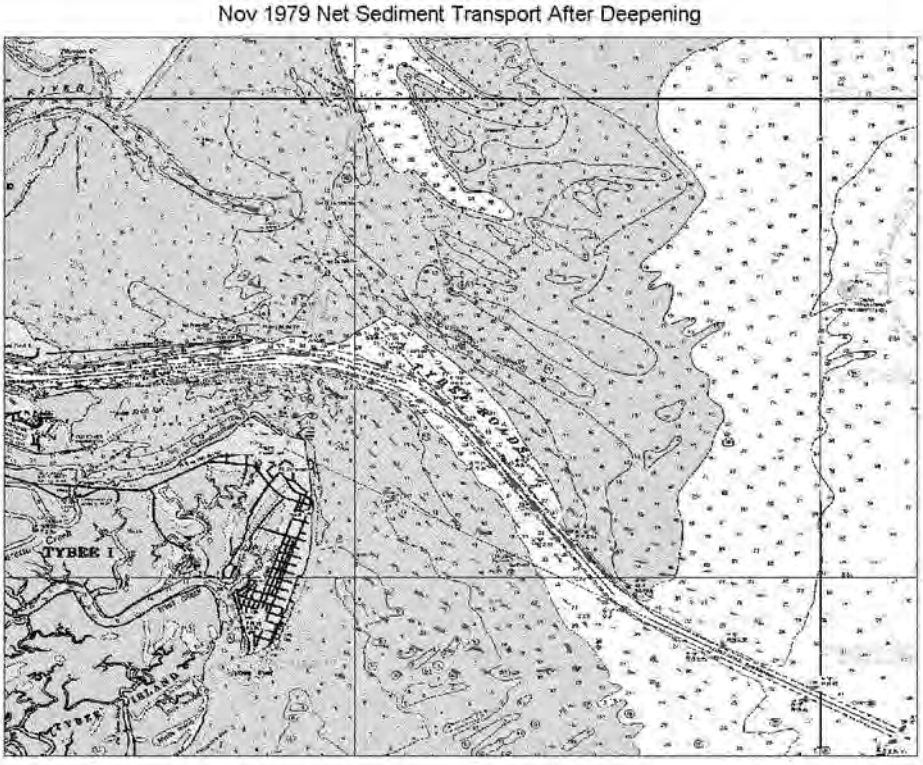


Figure 5C-2. Sediment transport rose plots for November 1979 deepened conditions GTRAN simulation (full domain).

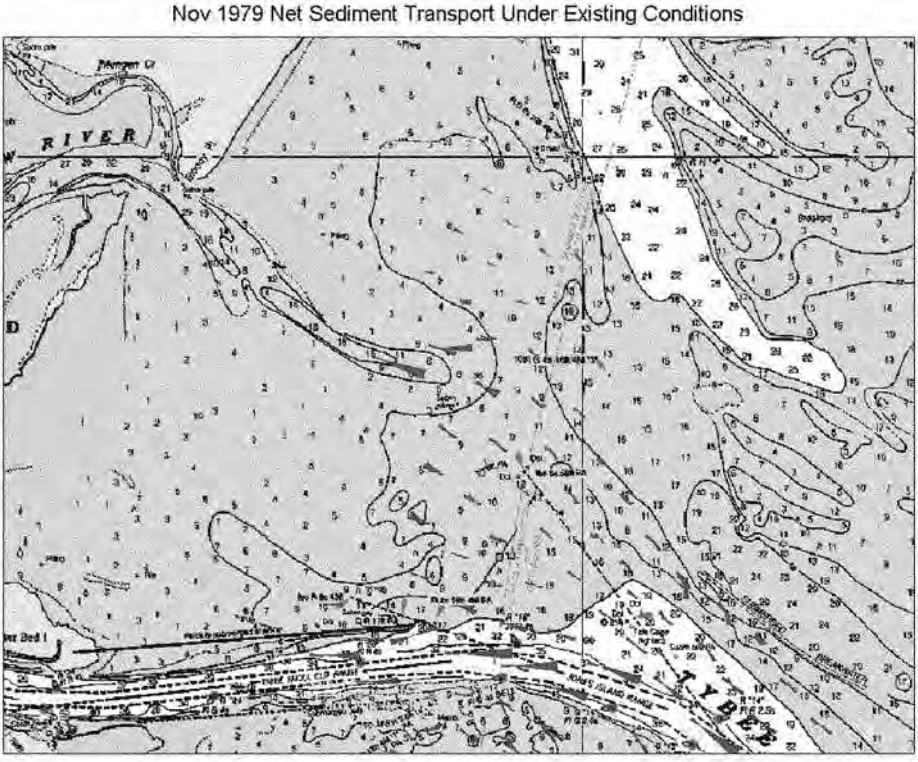


Figure 5C-3. Sediment transport rose plots for November 1979 existing conditions GTRAN simulation (northern domain).

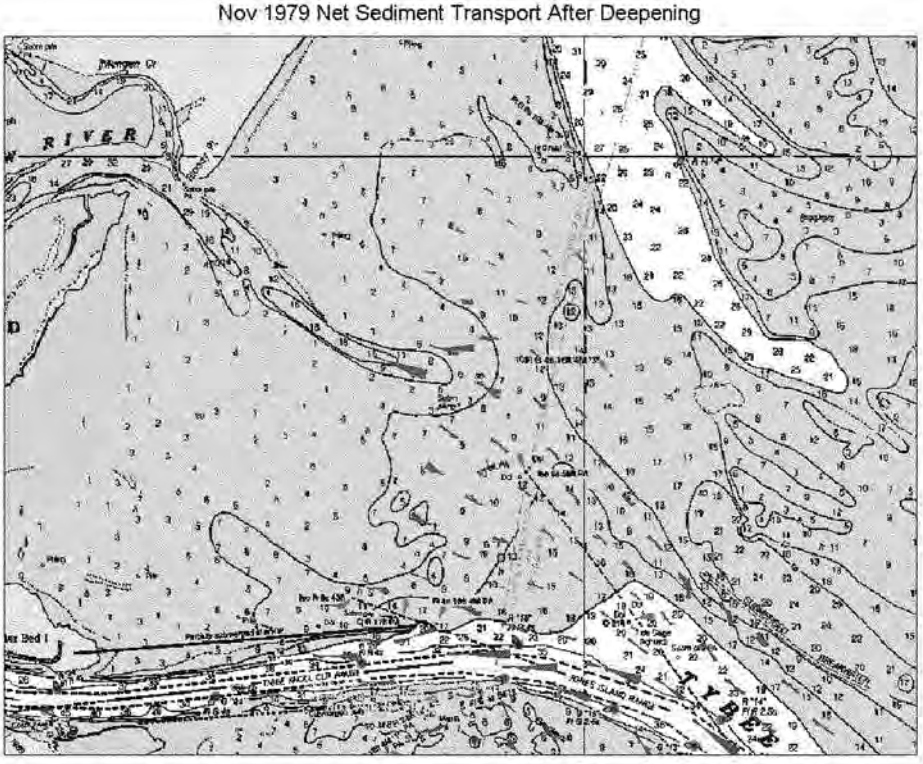


Figure 5C-4. Sediment transport rose plots for November 1979 deepened conditions GTRAN simulation (northern domain).

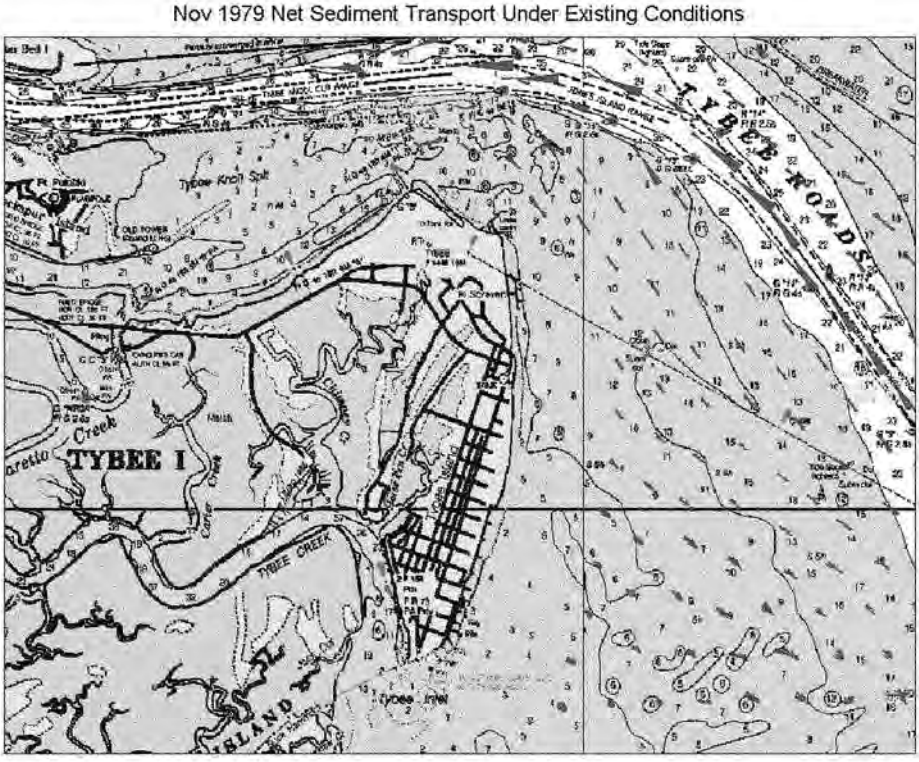


Figure 5C-5. Sediment transport rose plots for November 1979 existing conditions GTRAN simulation (southern domain).

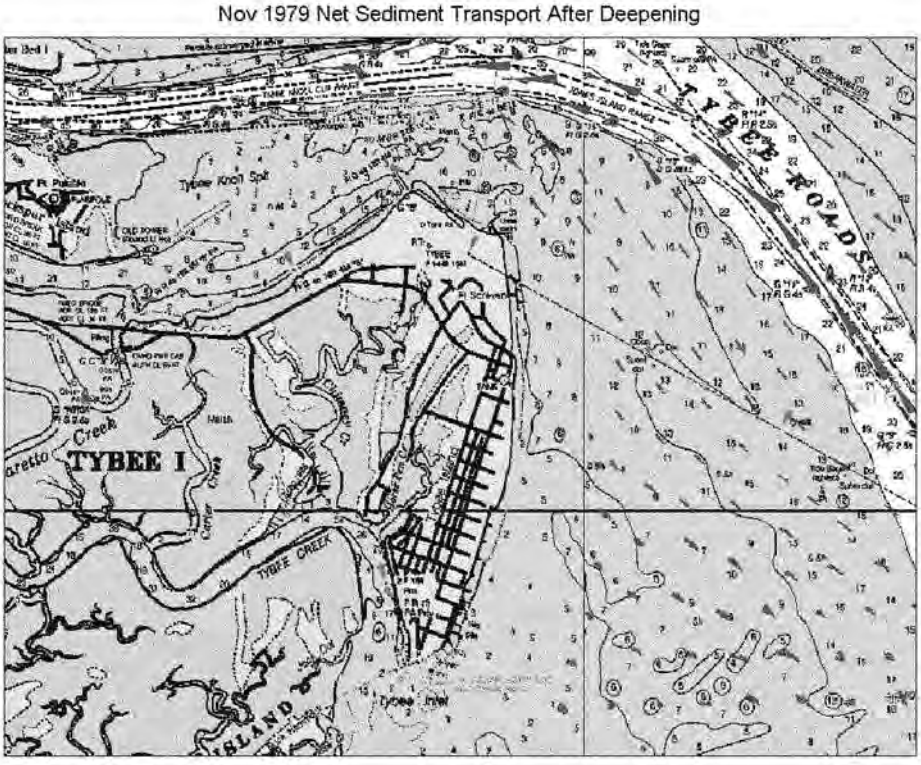


Figure 5C-6. Sediment transport rose plots for November 1979 deepened conditions GTRAN simulation (southern domain).

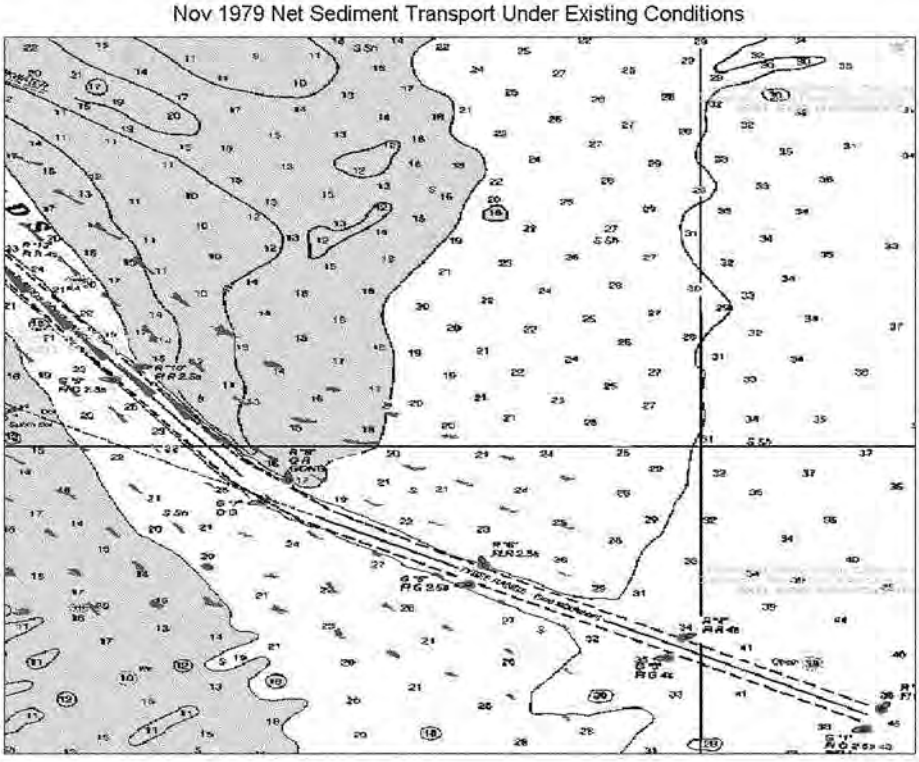


Figure 5C-7. Sediment transport rose plots for November 1979 existing conditions GTRAN simulation (southeastern domain).

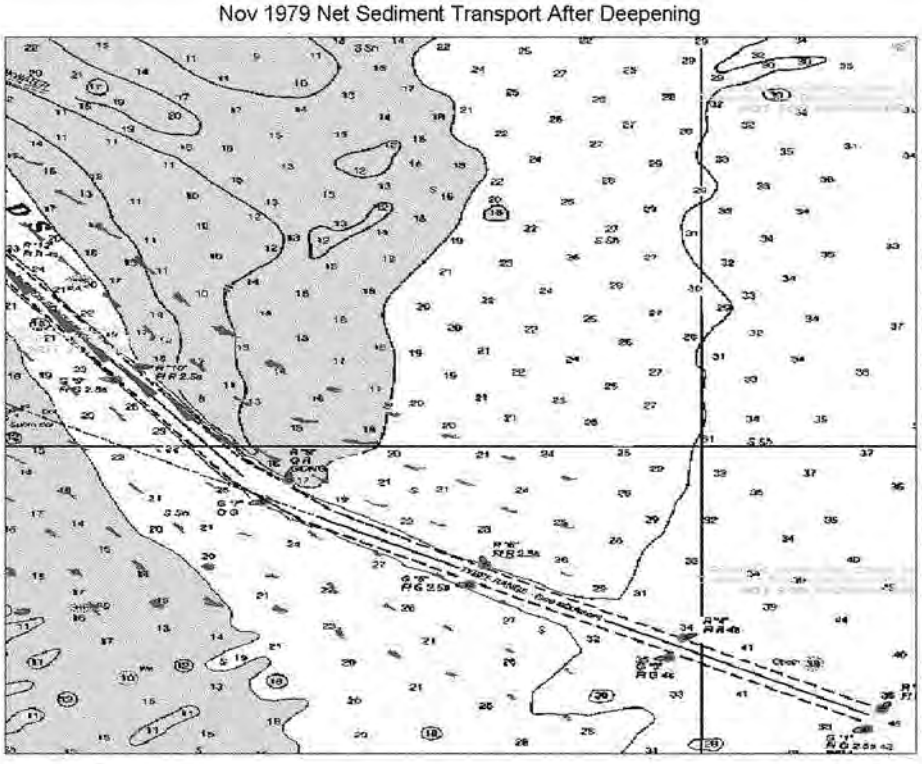


Figure 5C-8. Sediment transport rose plots for November 1979 deepened conditions GTRAN simulation (southeastern domain).

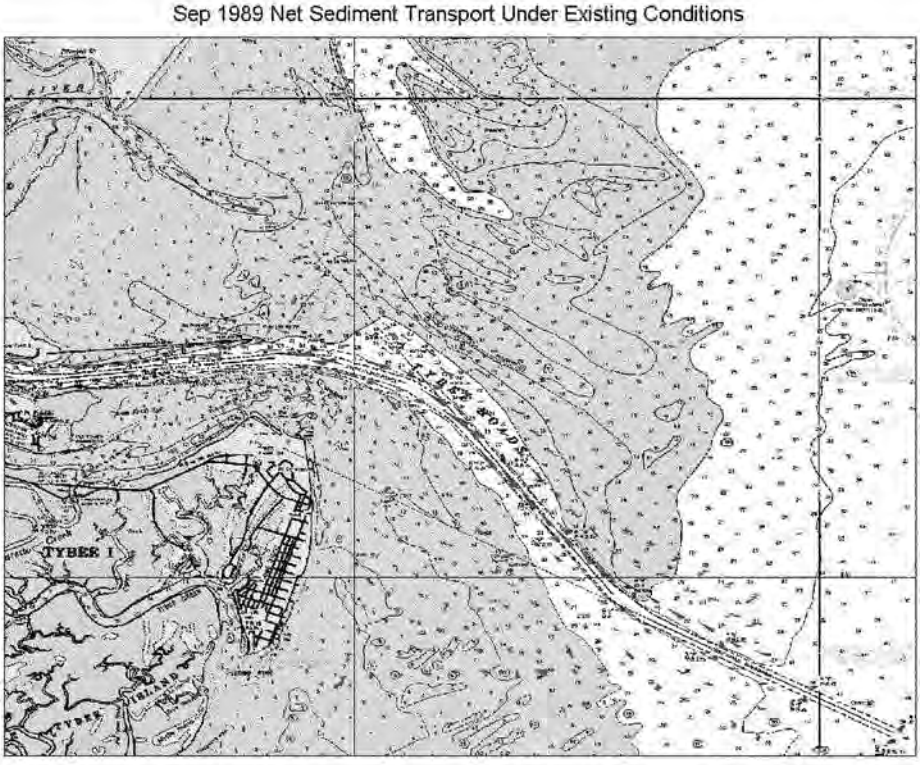


Figure 5C-9. Sediment transport rose plots for September 1989 (Hugo) existing conditions GTRAN simulation (full domain).

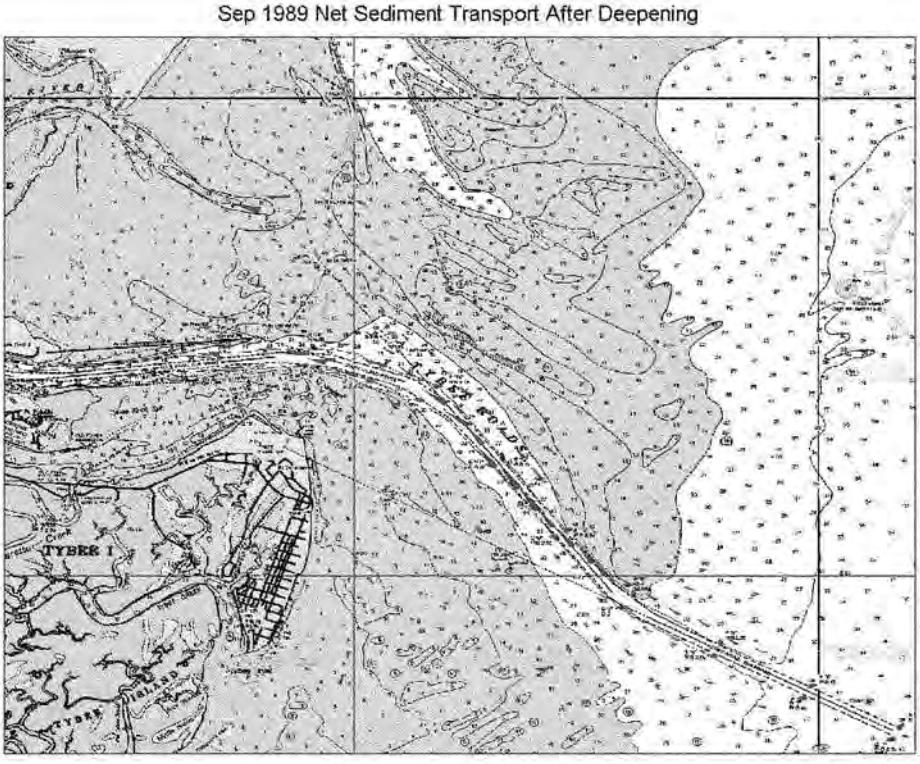


Figure 5C-10. Sediment transport rose plots for September 1989 (Hugo) deepened conditions GTRAN simulation (full domain).

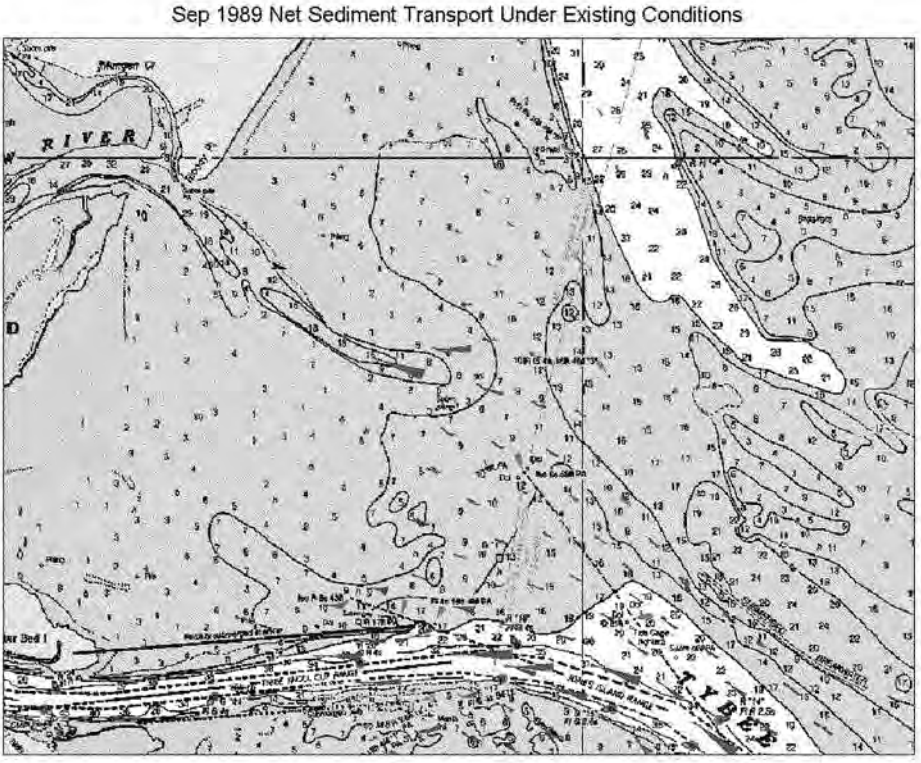


Figure 5C-11. Sediment transport rose plots for September 1989 (Hugo) existing conditions GTRAN simulation (northern domain).

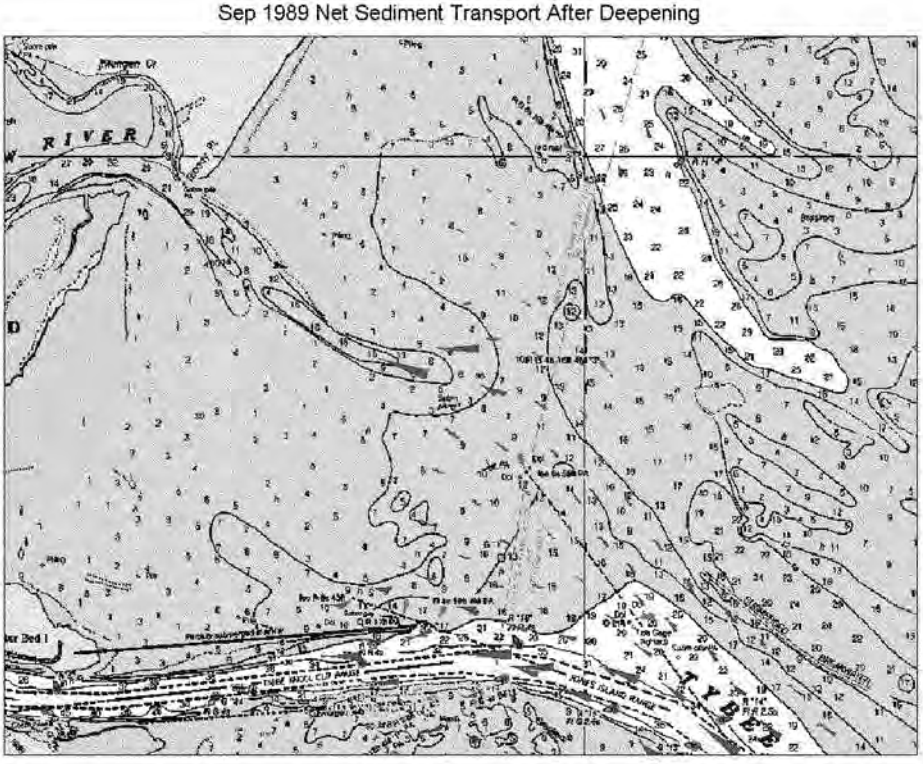


Figure 5C-12. Sediment transport rose plots for September 1989 (Hugo) deepened conditions GTRAN simulation (northern domain).

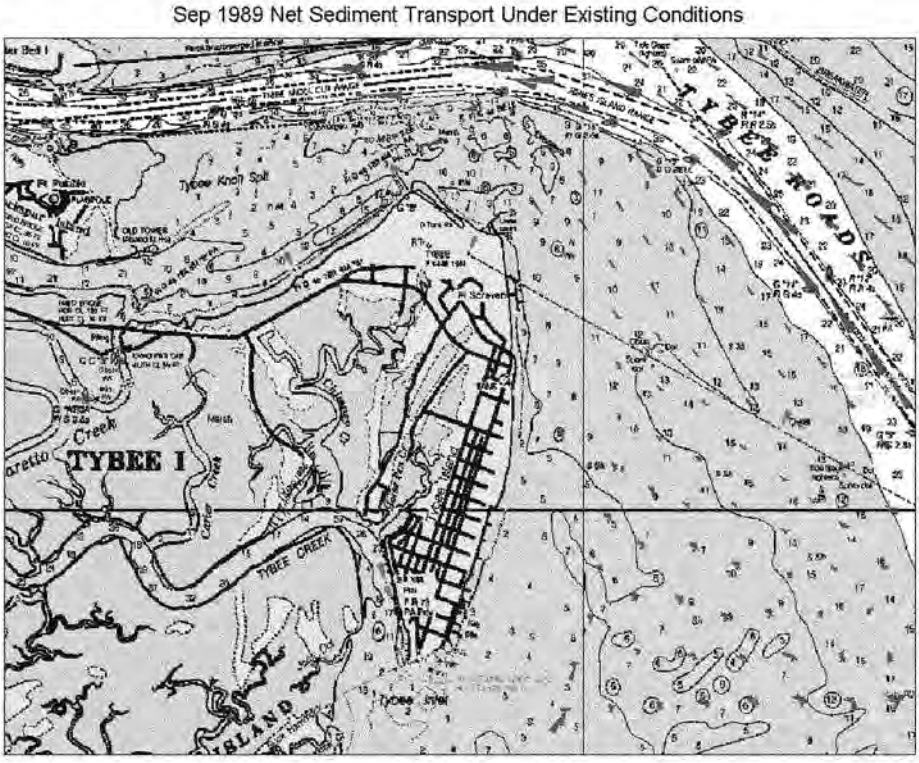


Figure 5C-13. Sediment transport rose plots for September 1989 (Hugo) existing conditions GTRAN simulation (southern domain).

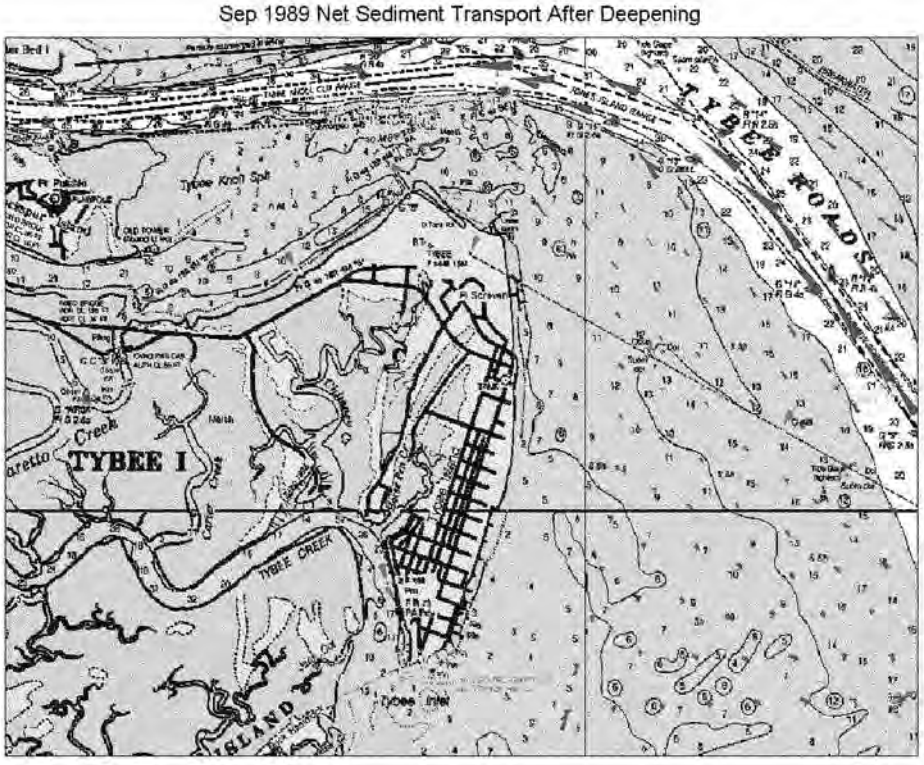


Figure 5C-14. Sediment transport rose plots for September 1989 (Hugo) deepened conditions GTRAN simulation (southern domain).

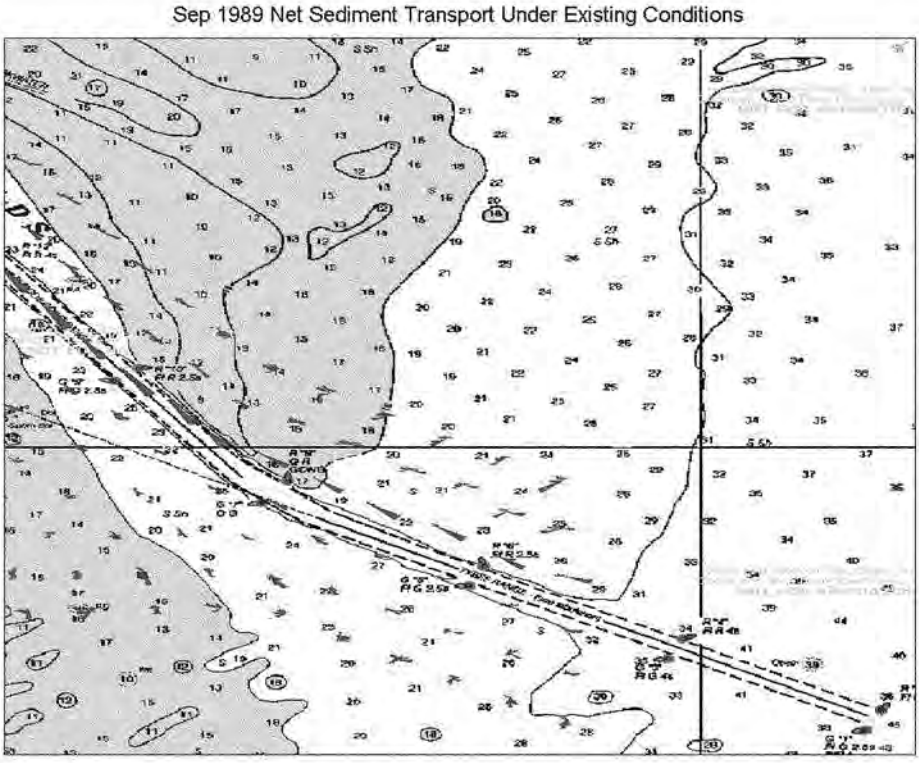


Figure 5C-15. Sediment transport rose plots for September 1989 (Hugo) existing conditions GTRAN simulation (southeastern domain).

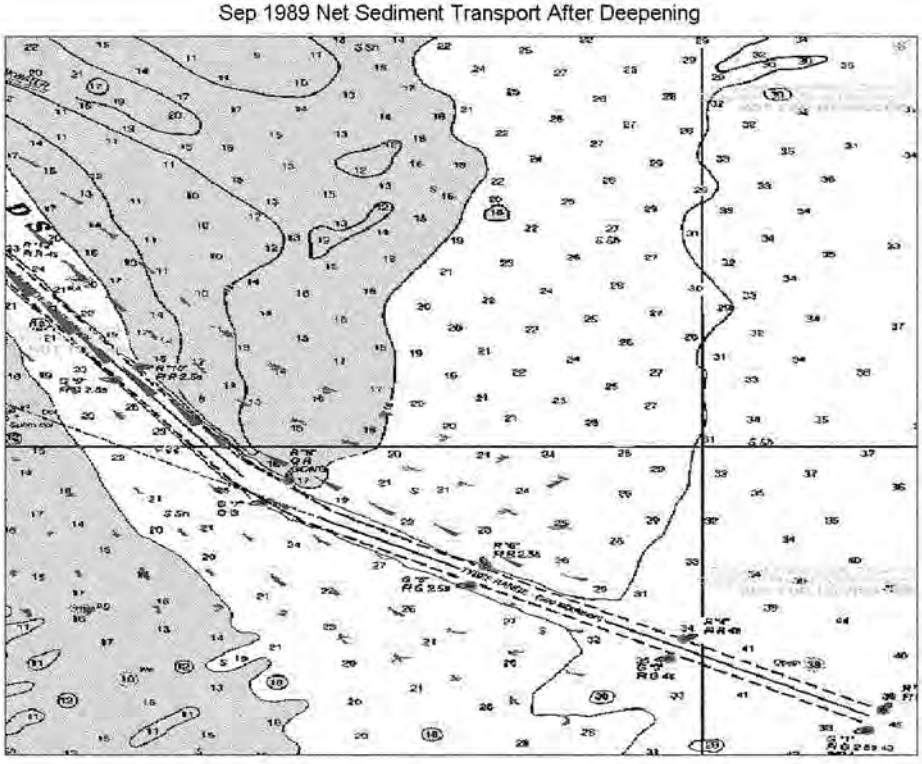


Figure 5C-16. Sediment transport rose plots for September 1989 (Hugo) deepened conditions GTRAN simulation (southeastern domain).

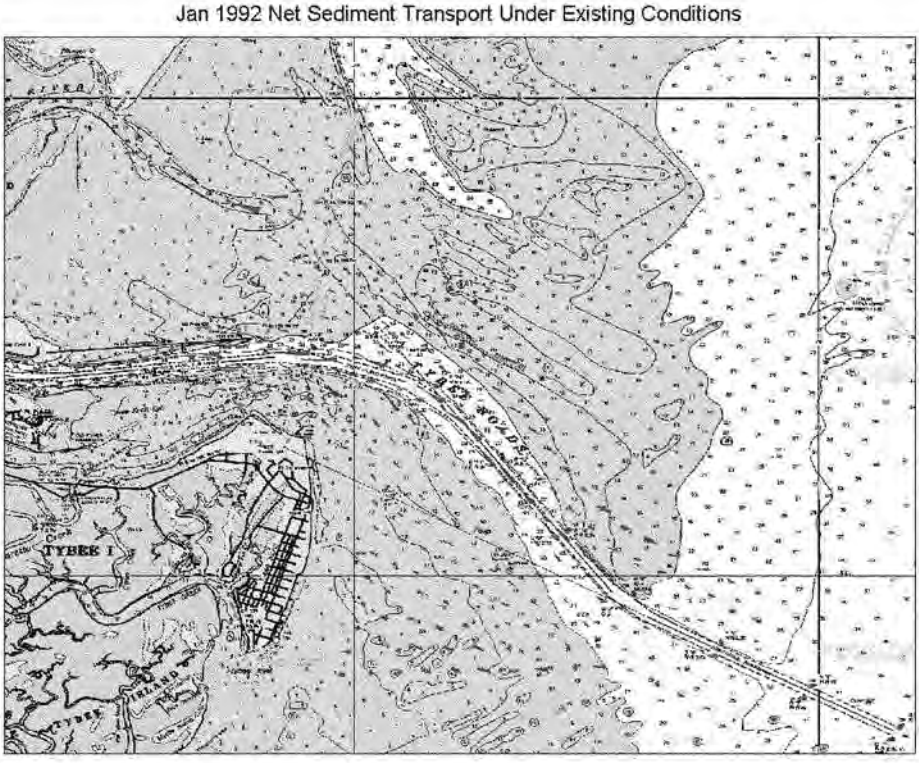


Figure 5C-17. Sediment transport rose plots for January 1992 existing conditions GTRAN simulation (full domain).

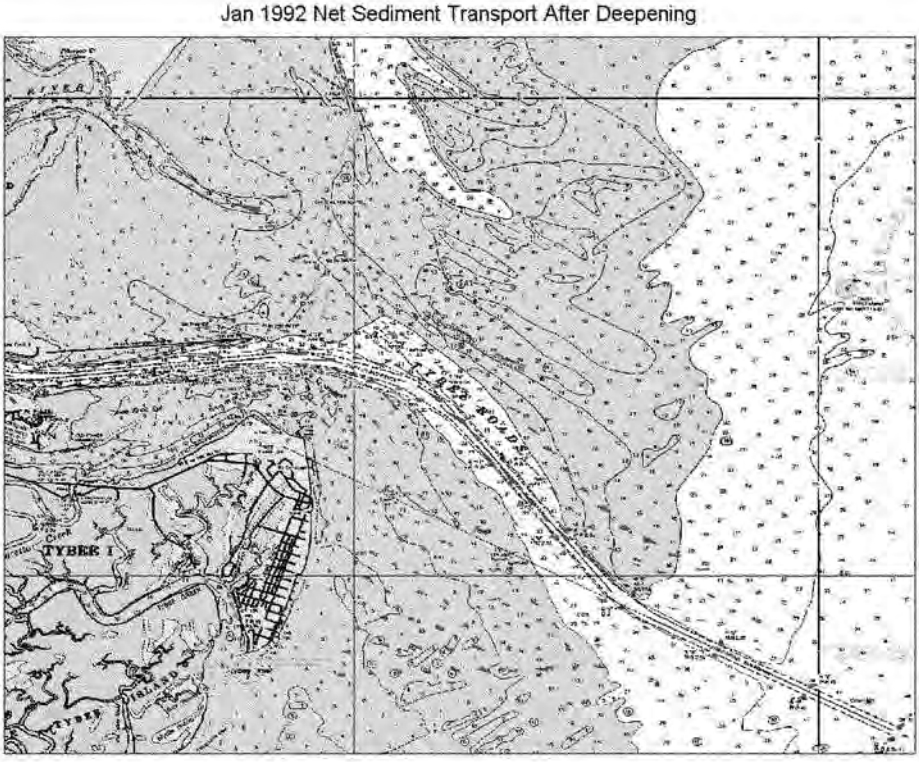


Figure 5C-18. Sediment transport rose plots for January 1992 deepened conditions GTRAN simulation (full domain).

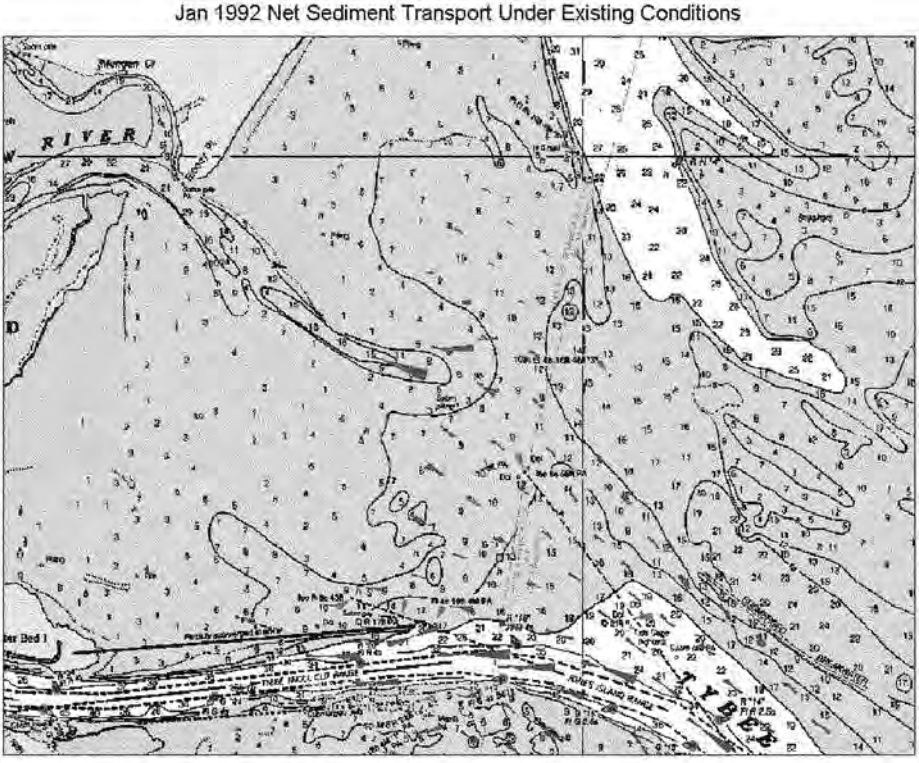


Figure 5C-19. Sediment transport rose plots for January 1992 existing conditions GTRAN simulation (northern domain).

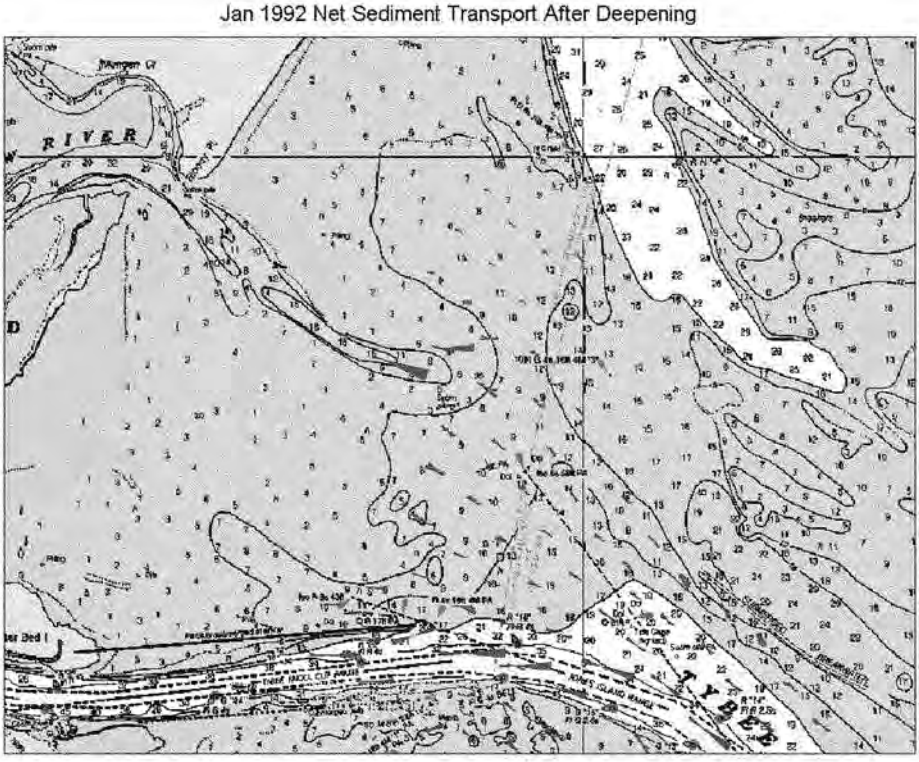


Figure 5C-20. Sediment transport rose plots for January 1992 deepened conditions GTRAN simulation (northern domain).

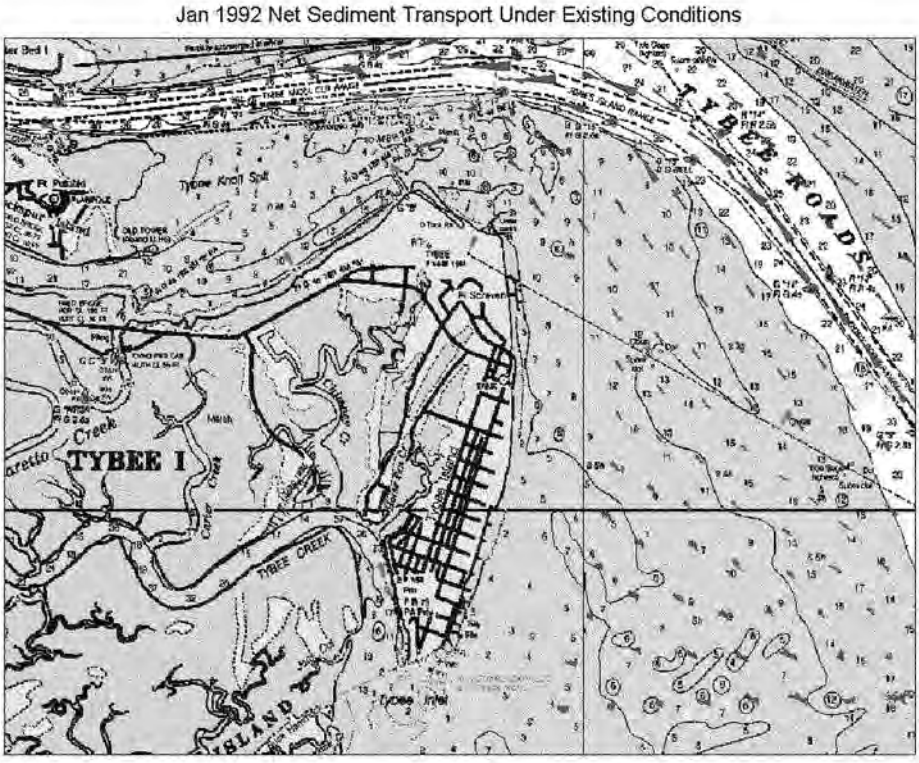


Figure 5C-21. Sediment transport rose plots for January 1992 existing conditions GTRAN simulation (southern domain).

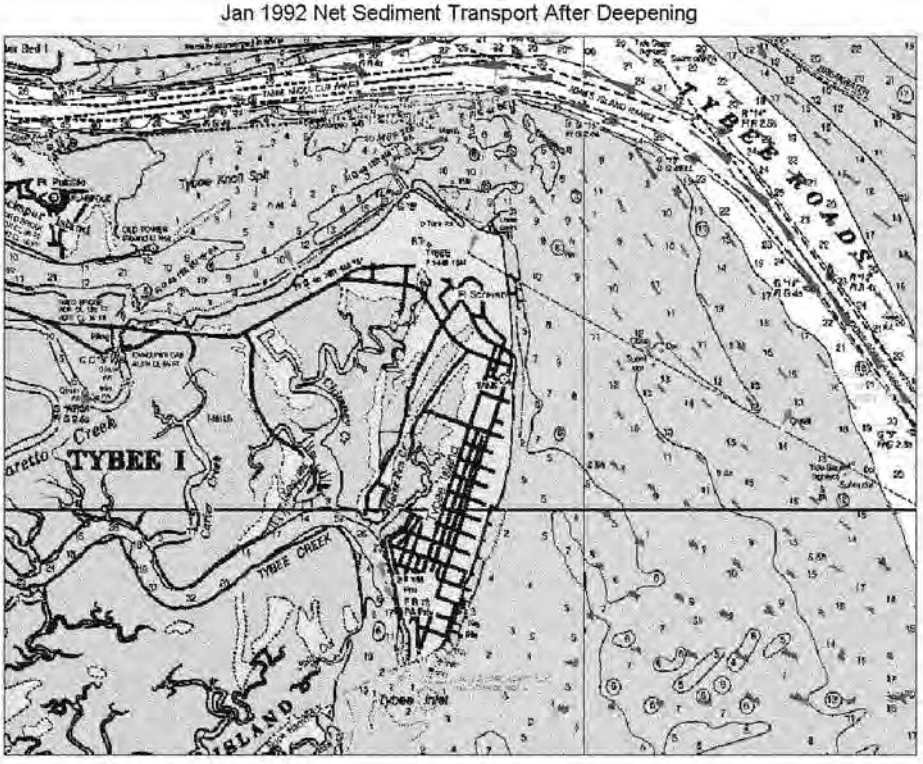


Figure 5C-22. Sediment transport rose plots for January 1992 deepened conditions GTRAN simulation (southern domain).

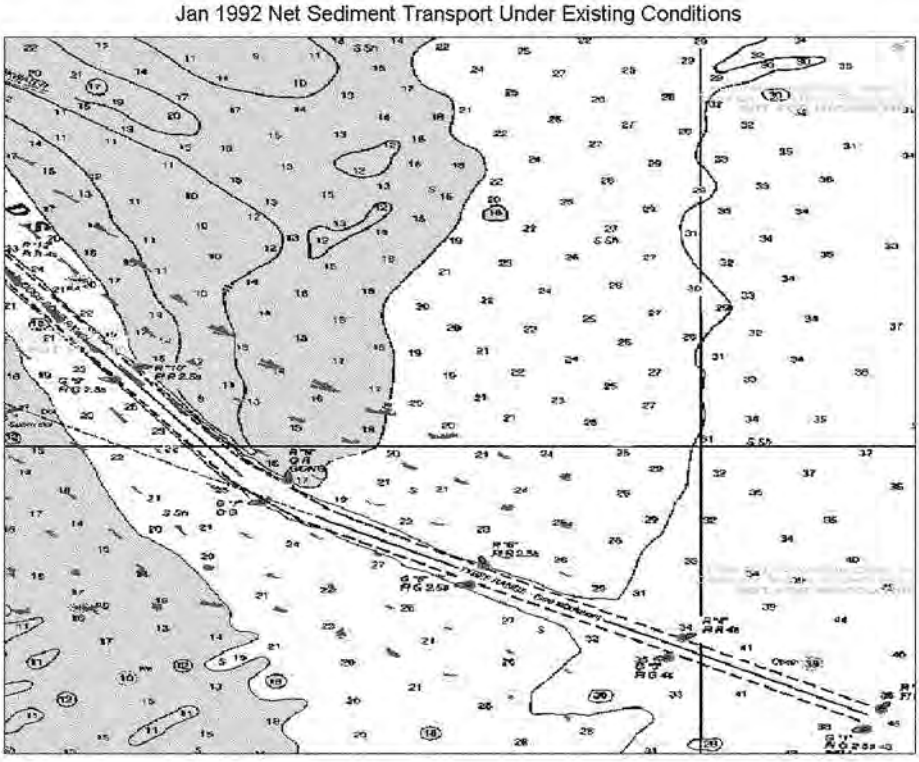


Figure 5C-23. Sediment transport rose plots for January 1992 existing conditions GTRAN simulation (southeastern domain).

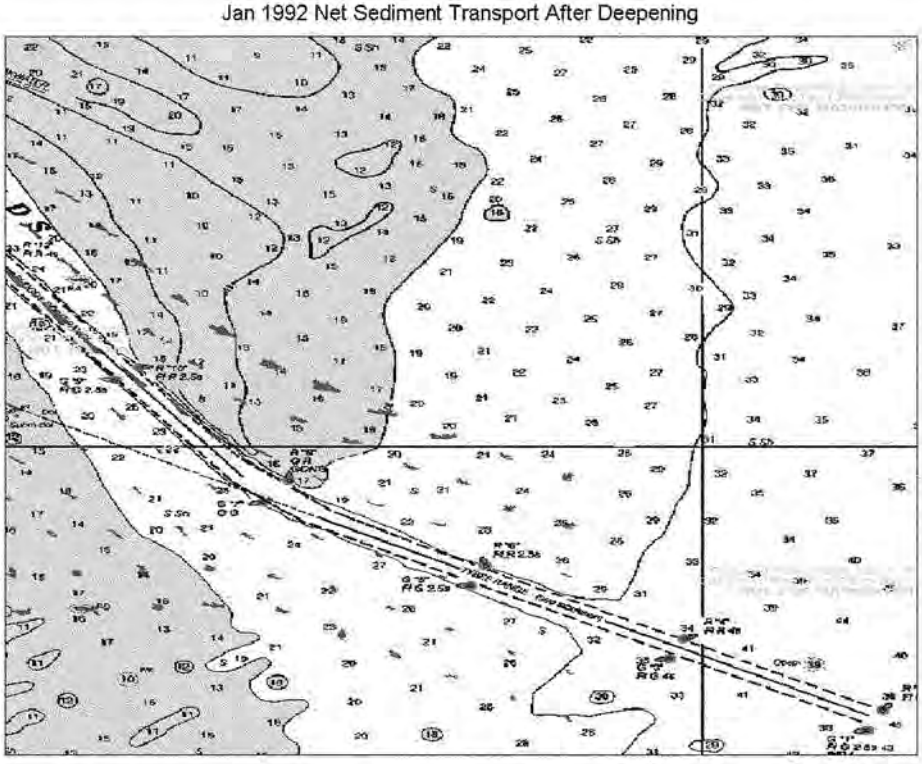


Figure 5C-24. Sediment transport rose plots for January 1992 deepened conditions GTRAN simulation (southeastern domain).

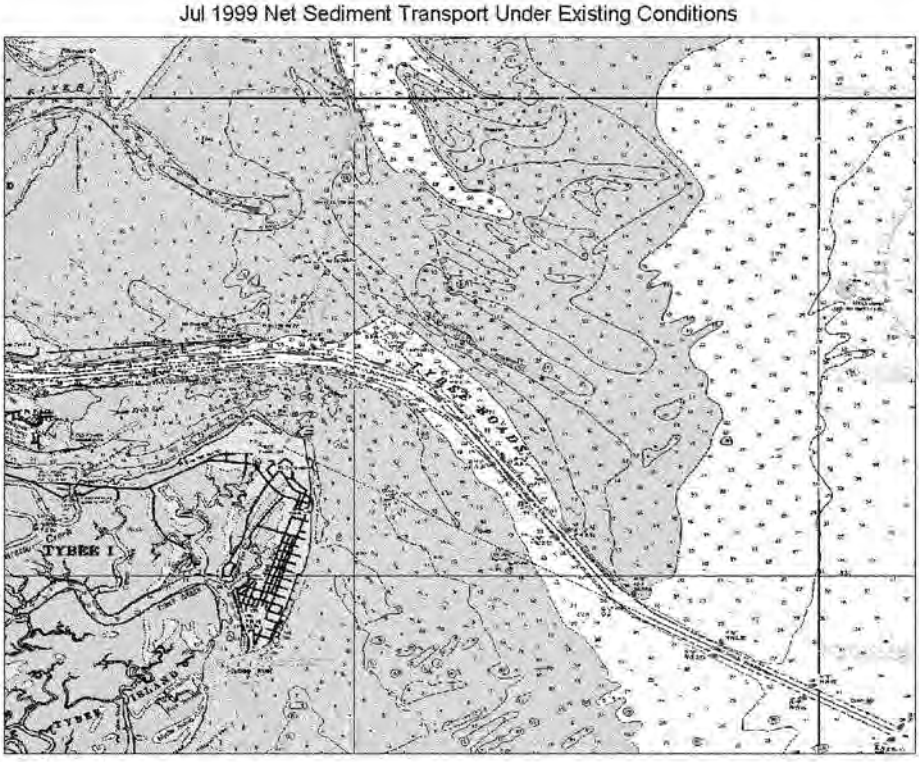


Figure 5C-25. Sediment transport rose plots for July 1999 existing conditions GTRAN simulation (full domain).

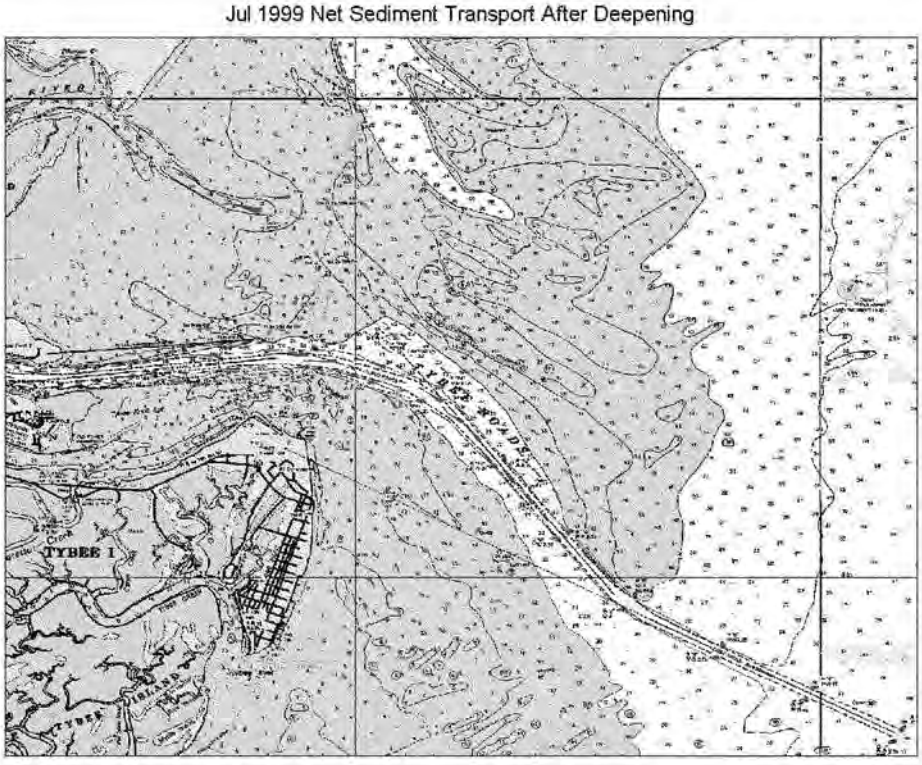


Figure 5C-26. Sediment transport rose plots for July 1999 deepened conditions GTRAN simulation (full domain).

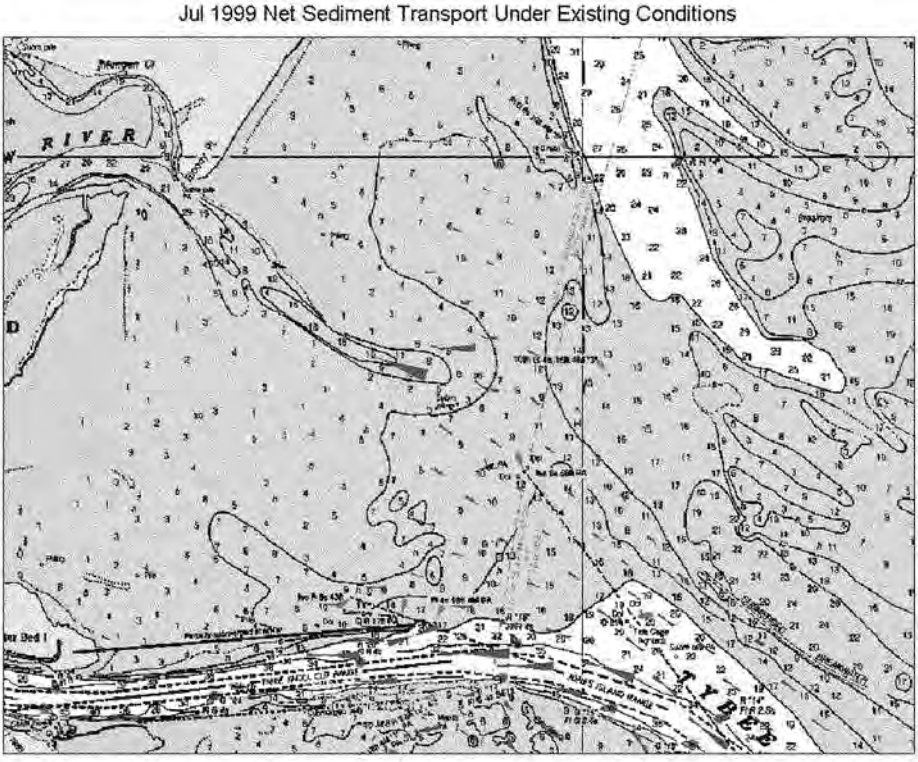


Figure 5C-27. Sediment transport rose plots for July 1999 existing conditions GTRAN simulation (northern domain).

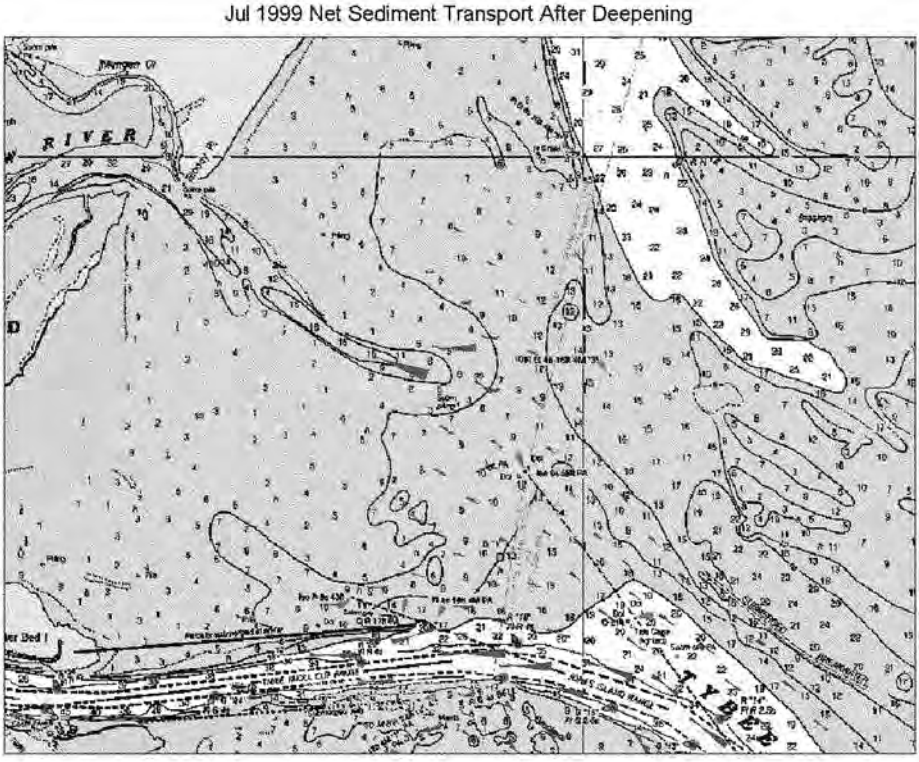


Figure 5C-28. Sediment transport rose plots for July 1999 deepened conditions GTRAN simulation (northern domain).

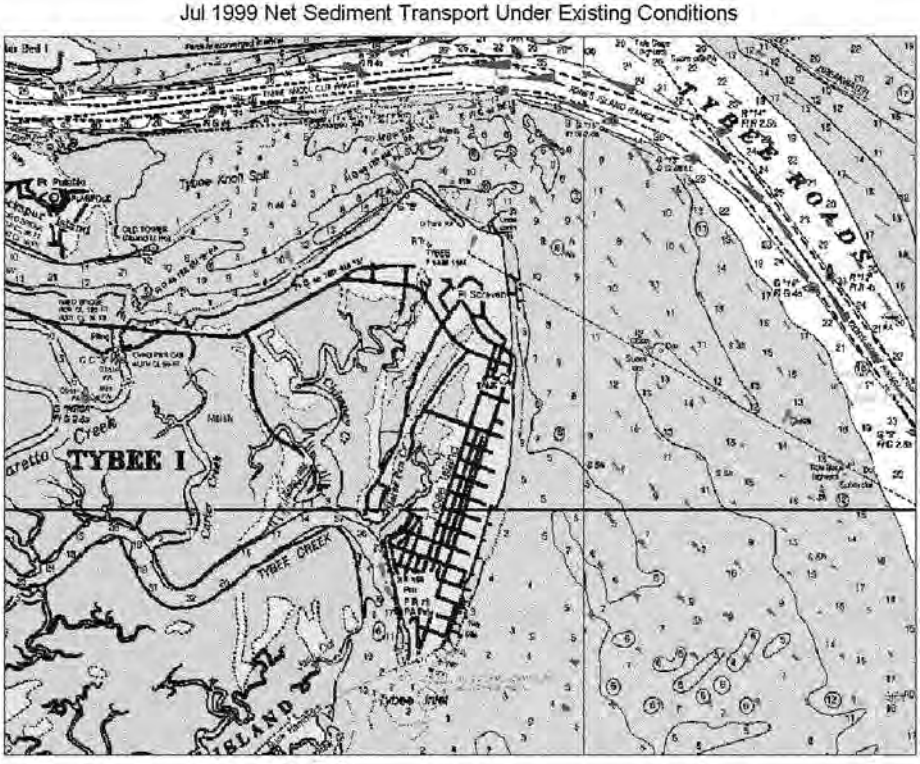


Figure 5C-29. Sediment transport rose plots for July 1999 existing conditions GTRAN simulation (southern domain).

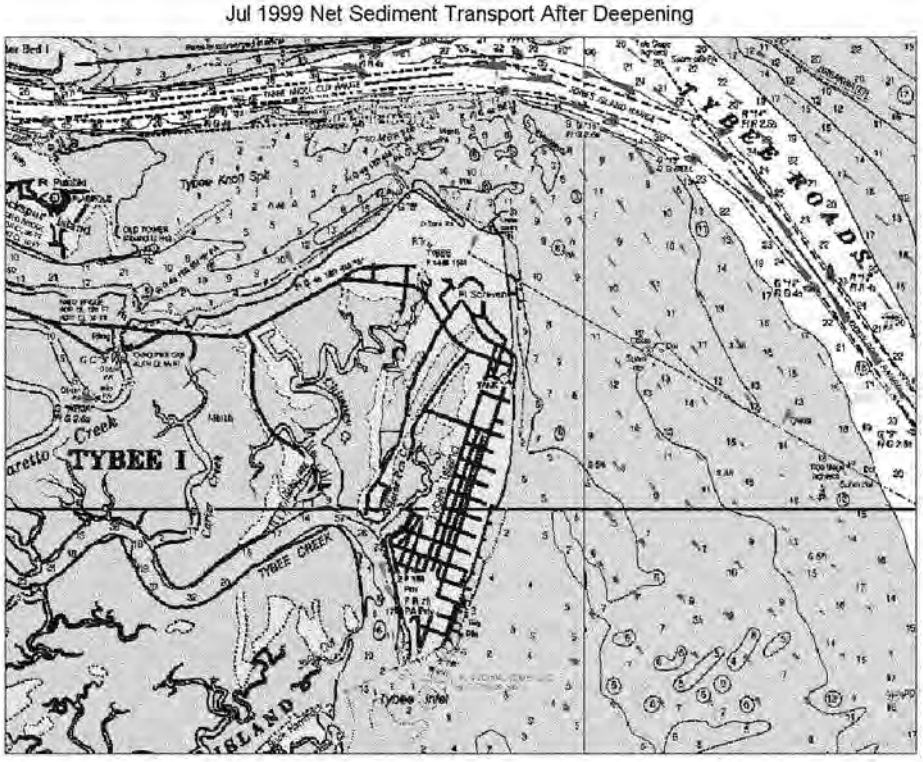


Figure 5C-30. Sediment transport rose plots for July 1999 deepened conditions GTRAN simulation (southern domain).

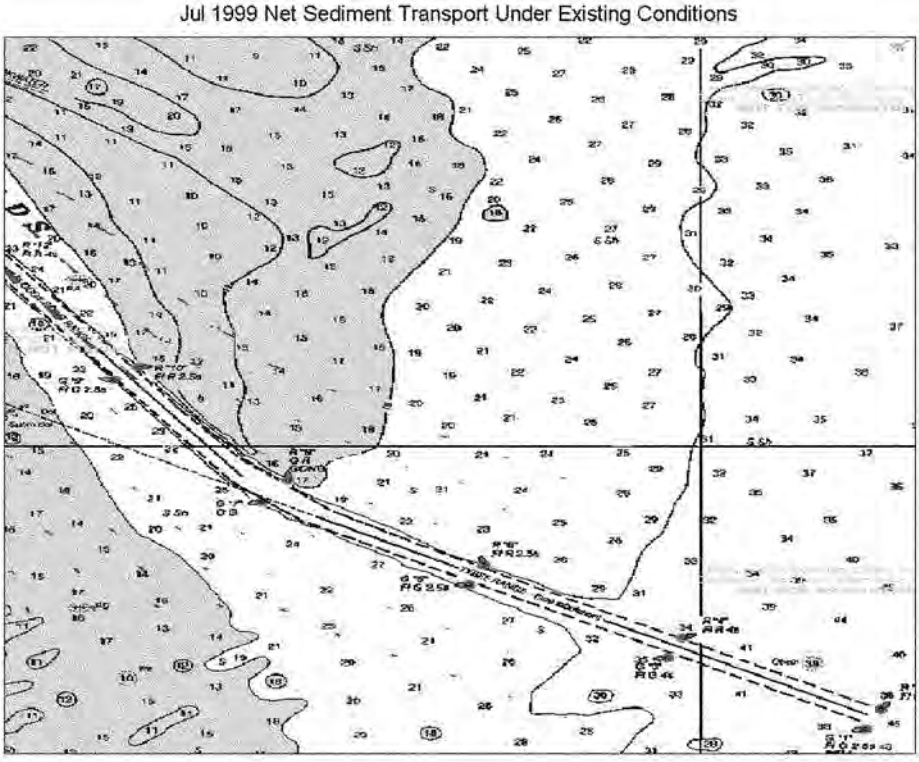


Figure 5C-31. Sediment transport rose plots for July 1999 existing conditions GTRAN simulation (southeastern domain).

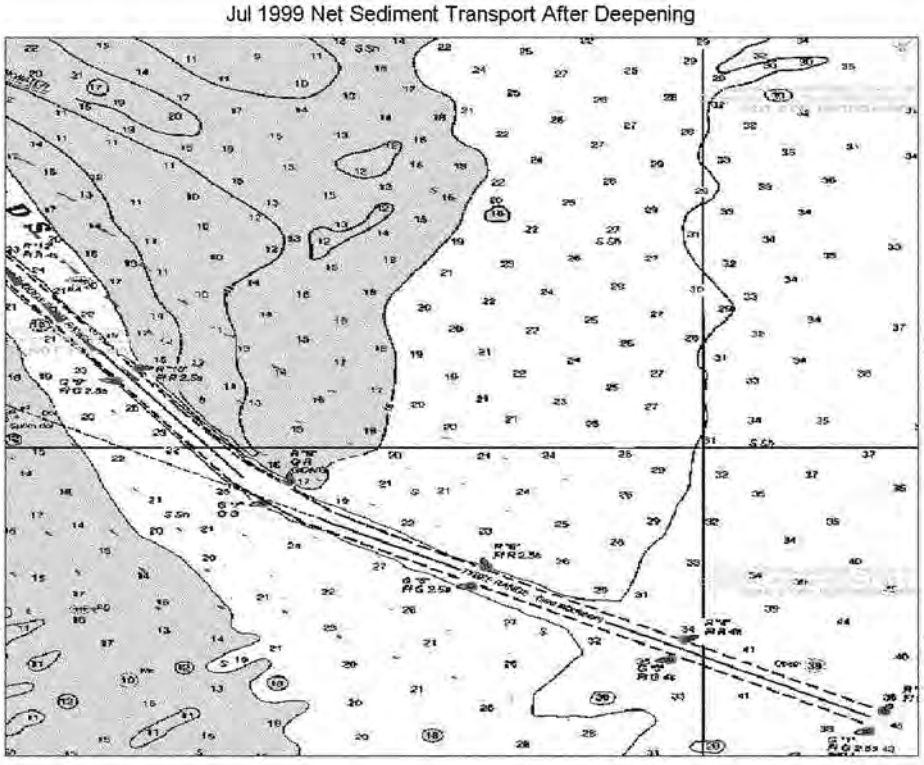


Figure 5C-32. Sediment transport rose plots for July 1999 deepened conditions GTRAN simulation (southeastern domain).

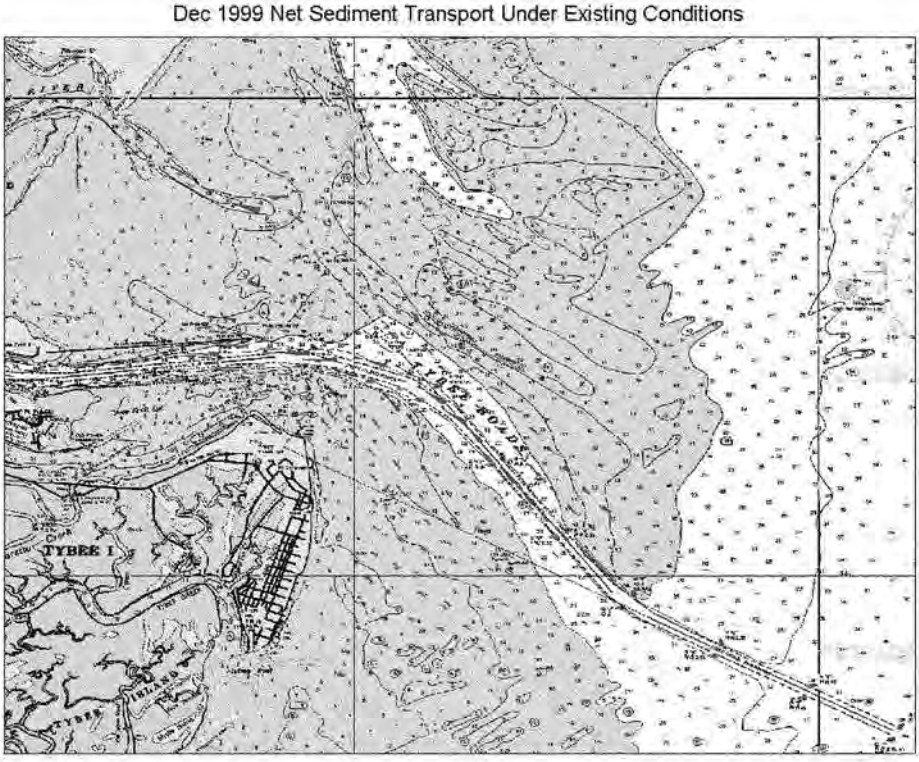


Figure 5C-33. Sediment transport rose plots for December 1999 existing conditions GTRAN simulation (full domain).

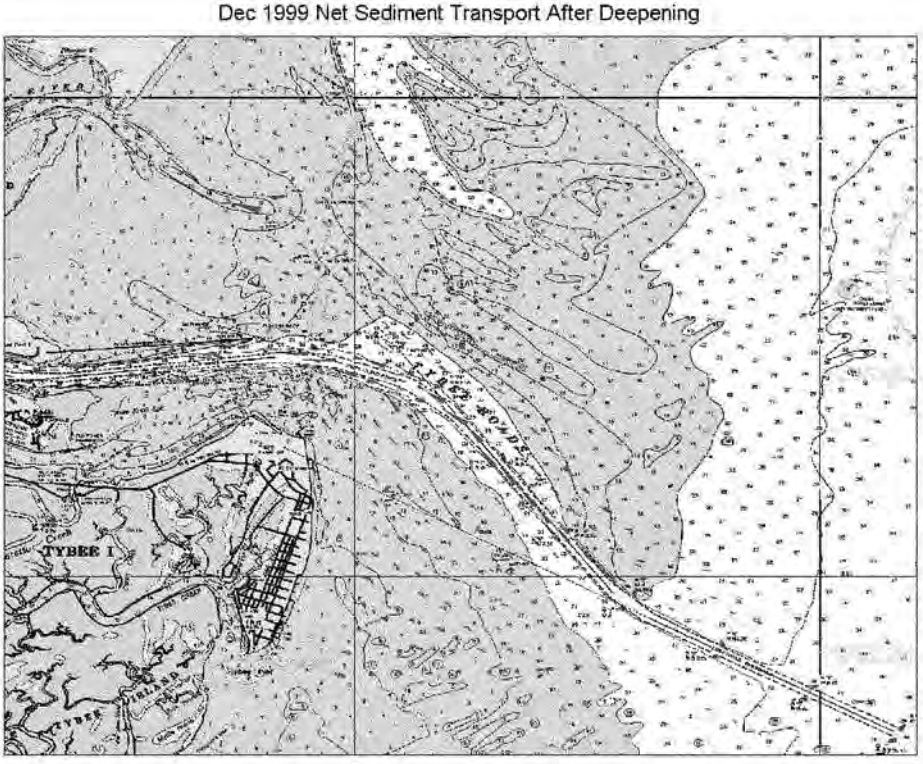


Figure 5C-34. Sediment transport rose plots for December 1999 deepened conditions GTRAN simulation (full domain).

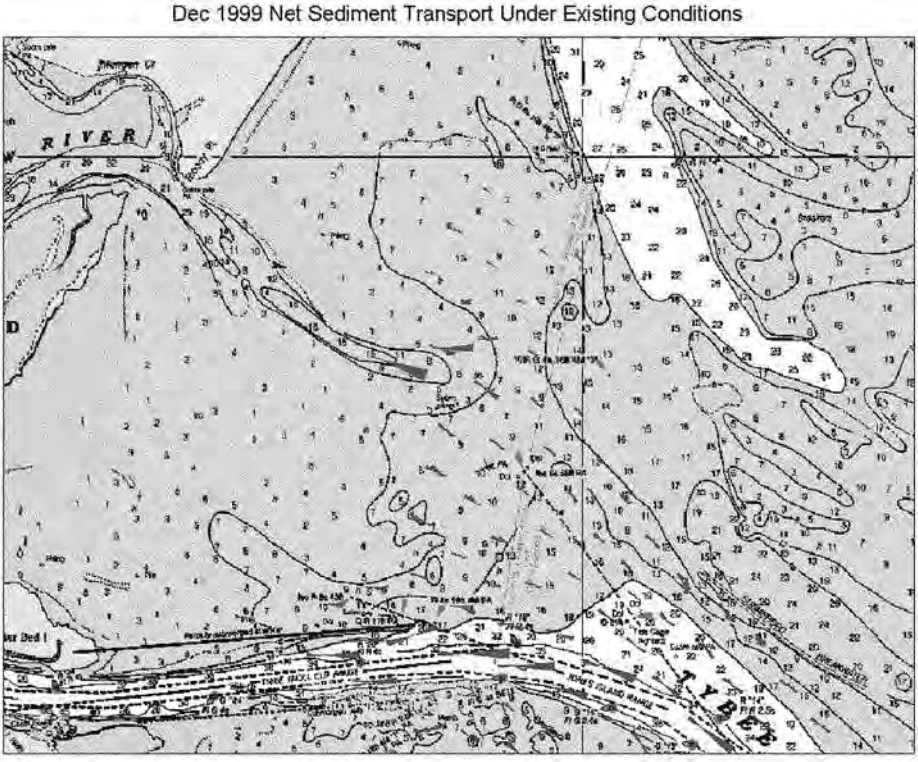


Figure 5C-35. Sediment transport rose plots for December 1999 existing conditions GTRAN simulation (northern domain).

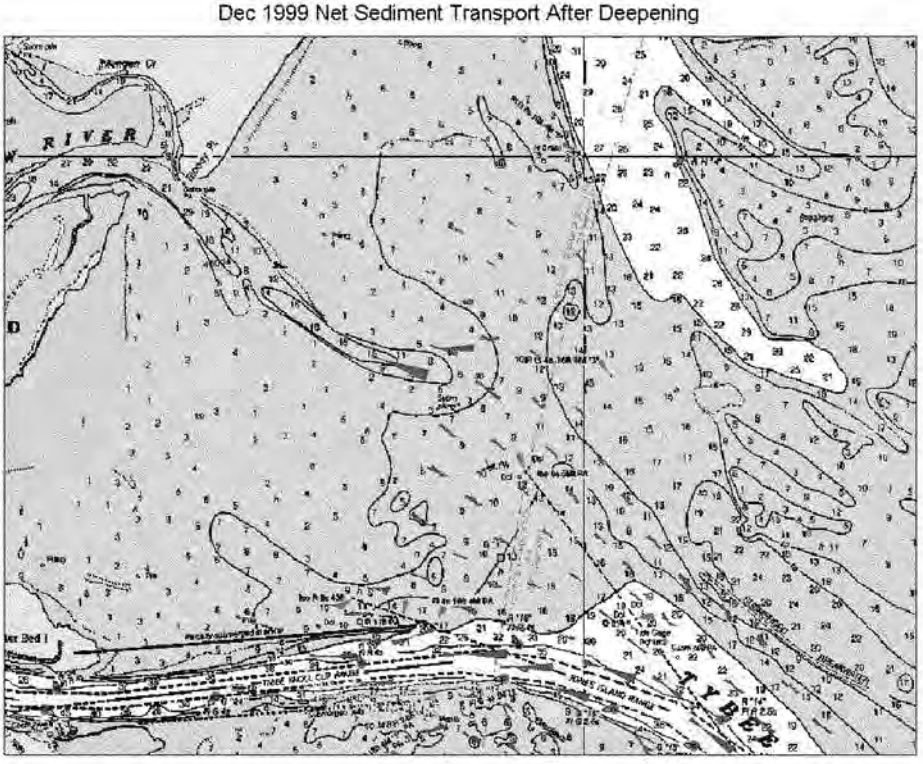


Figure 5C-36. Sediment transport rose plots for December 1999 deepened conditions GTRAN simulation (northern domain).

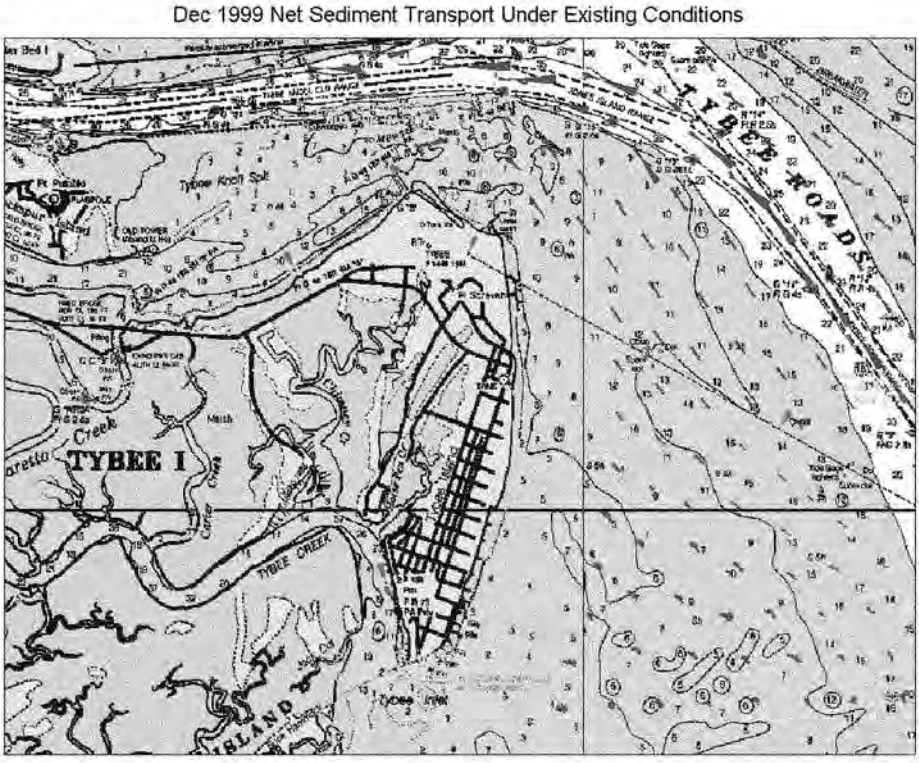


Figure 5C-37. Sediment transport rose plots for December 1999 existing conditions GTRAN simulation (southern domain).

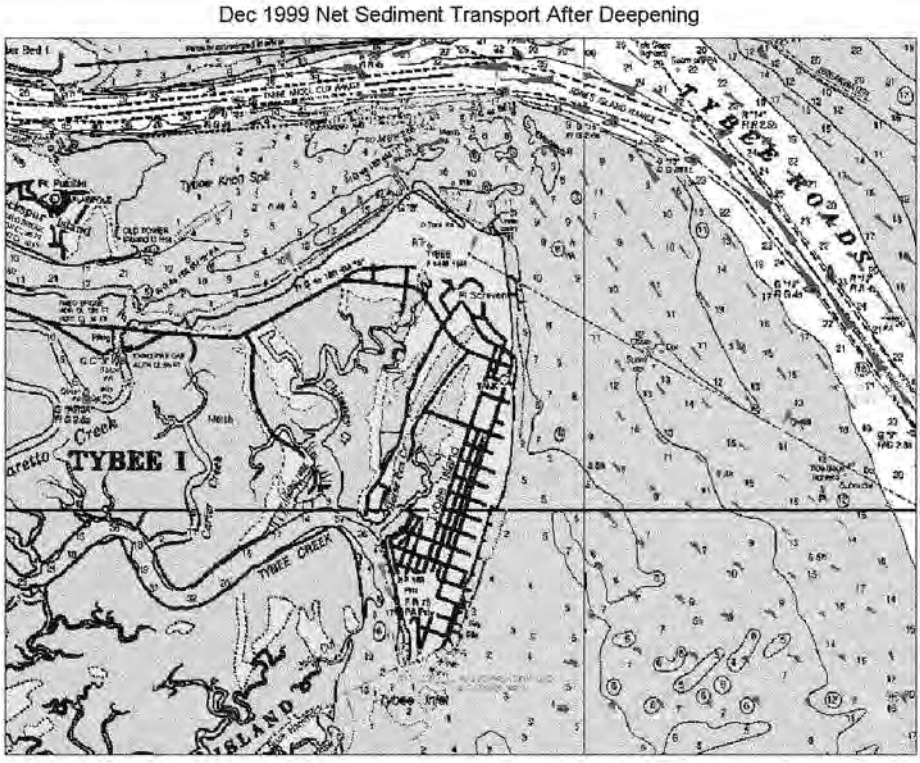


Figure 5C-38. Sediment transport rose plots for December 1999 deepened conditions GTRAN simulation (southern domain).

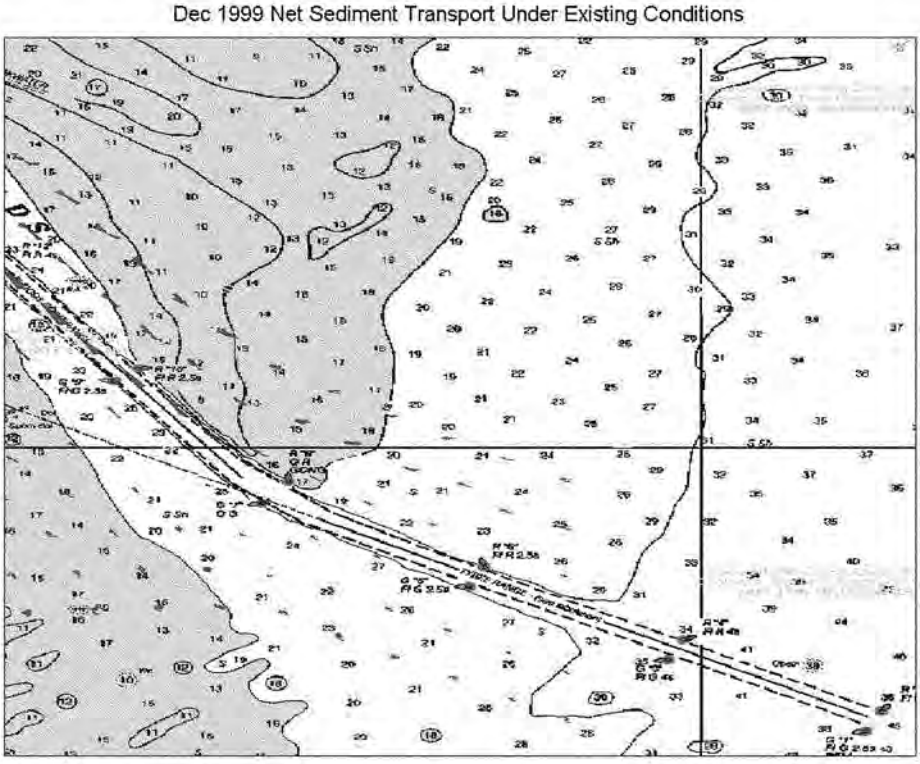


Figure 5C-39. Sediment transport rose plots for December 1999 existing conditions GTRAN simulation (southeastern domain).

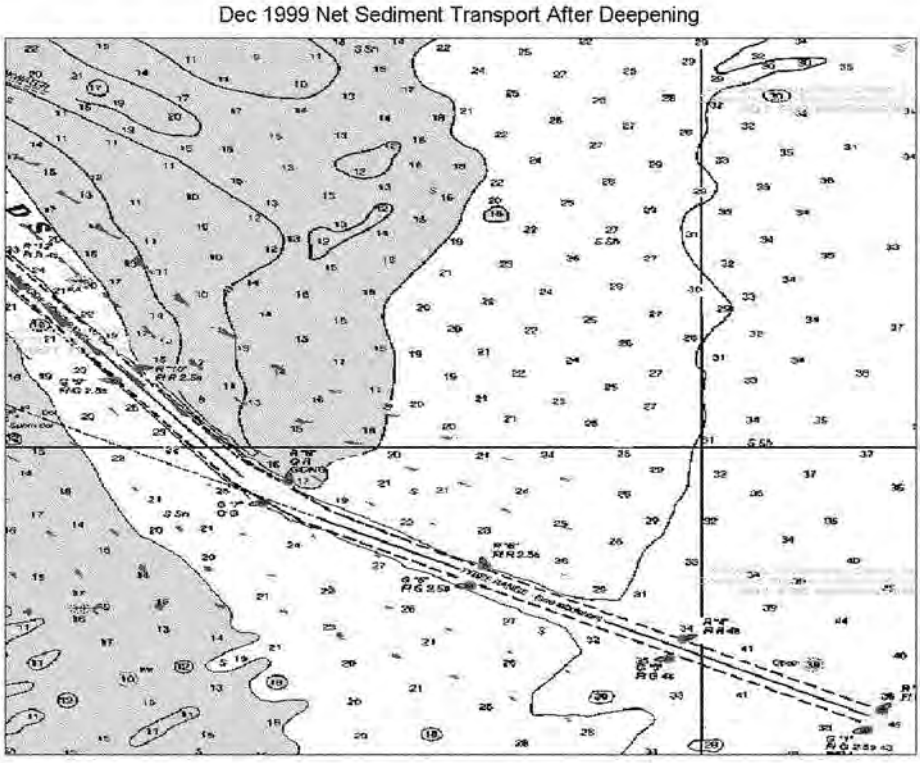


Figure 5C-40. Sediment transport rose plots for December 1999 deepened conditions GTRAN simulation (southeastern domain).

Appendix 5D. Change in Cumulative Sediment Transport Vectors from GTRAN Due to Deepening

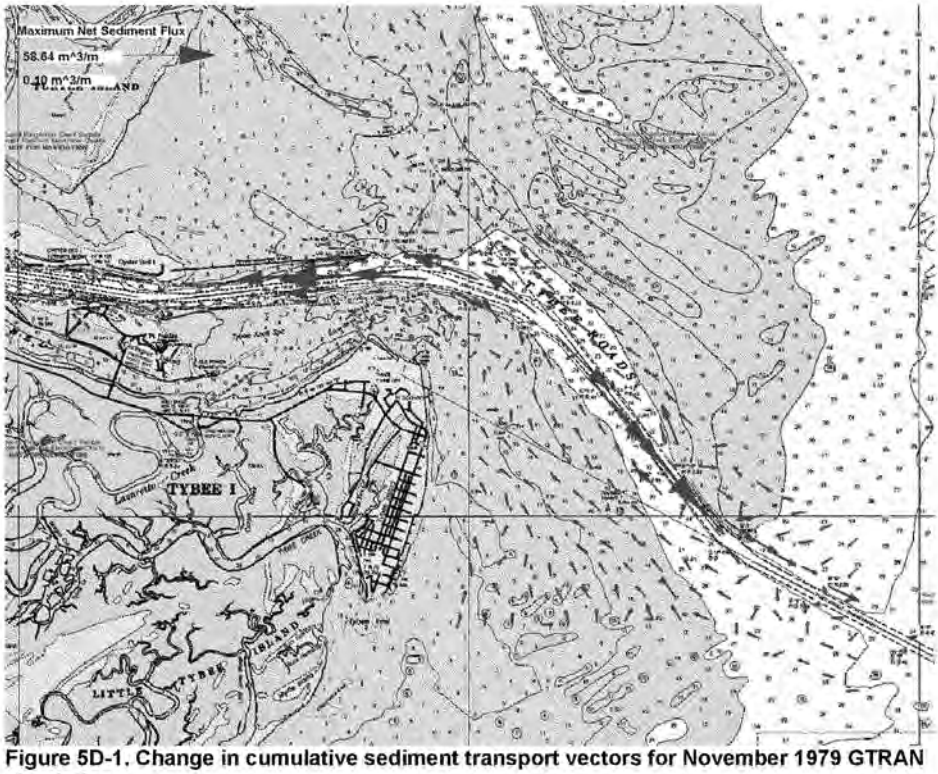


Figure 5D-1. Change in cumulative sediment transport vectors for November 1979 GTRAN simulation.

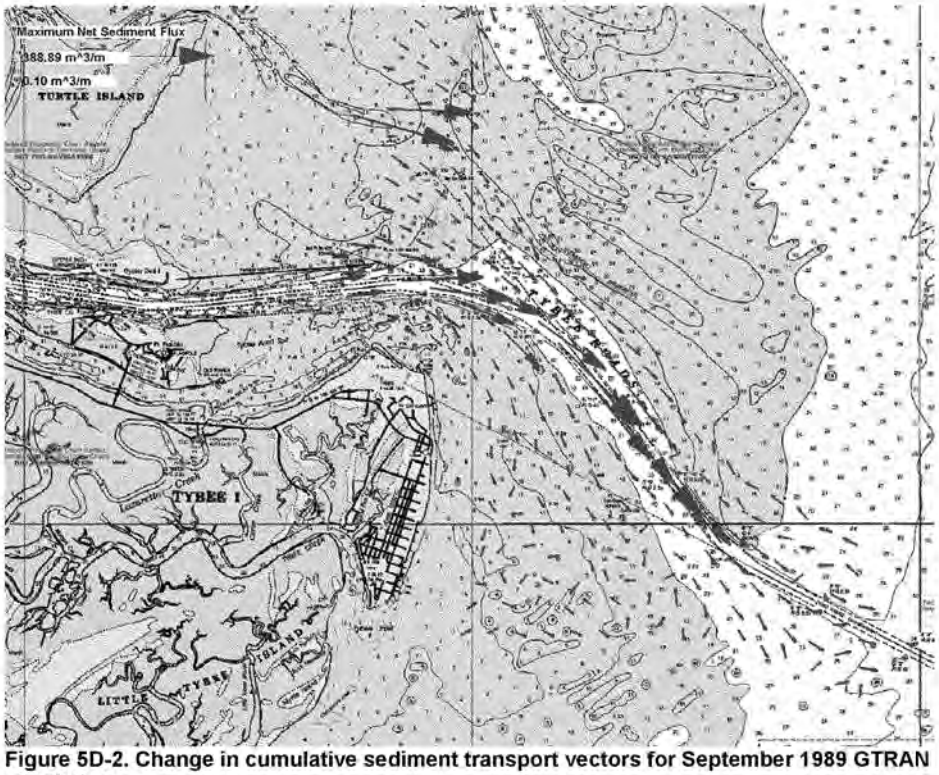


Figure 5D-2. Change in cumulative sediment transport vectors for September 1989 GTRAN simulation.

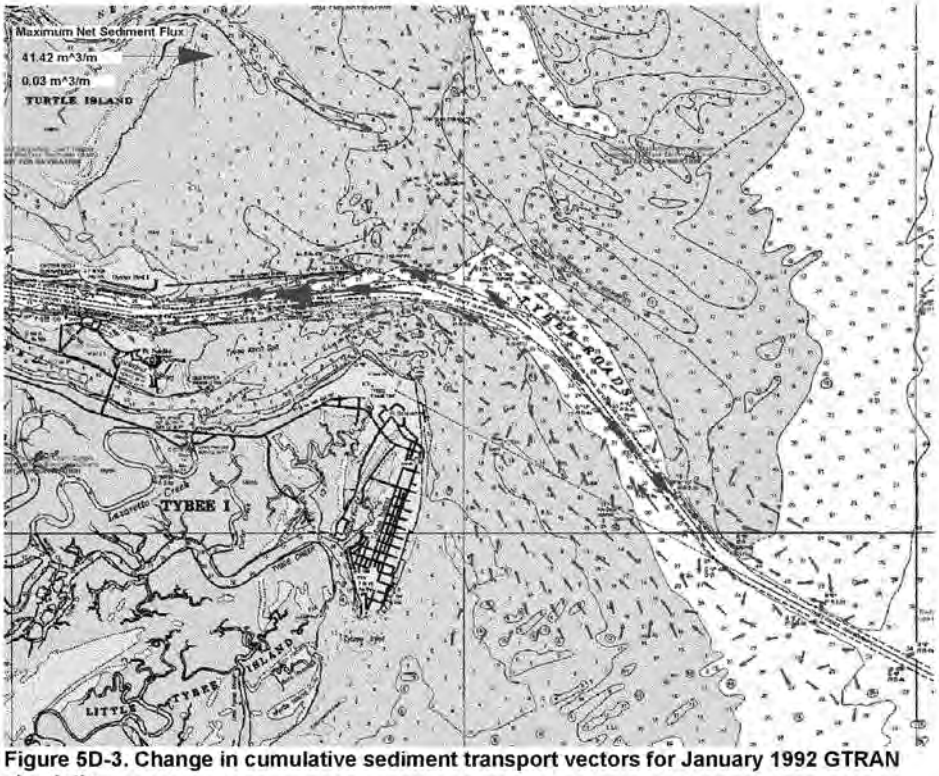


Figure 5D-3. Change in cumulative sediment transport vectors for January 1992 GTRAN simulation.

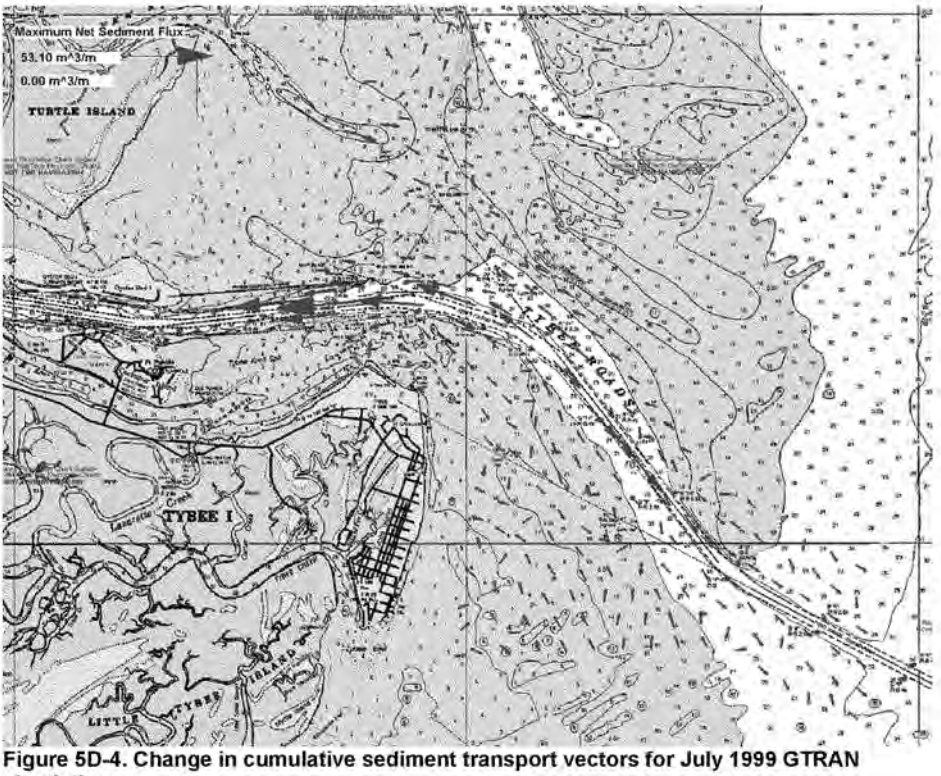


Figure 5D-4. Change in cumulative sediment transport vectors for July 1999 GTRAN simulation.

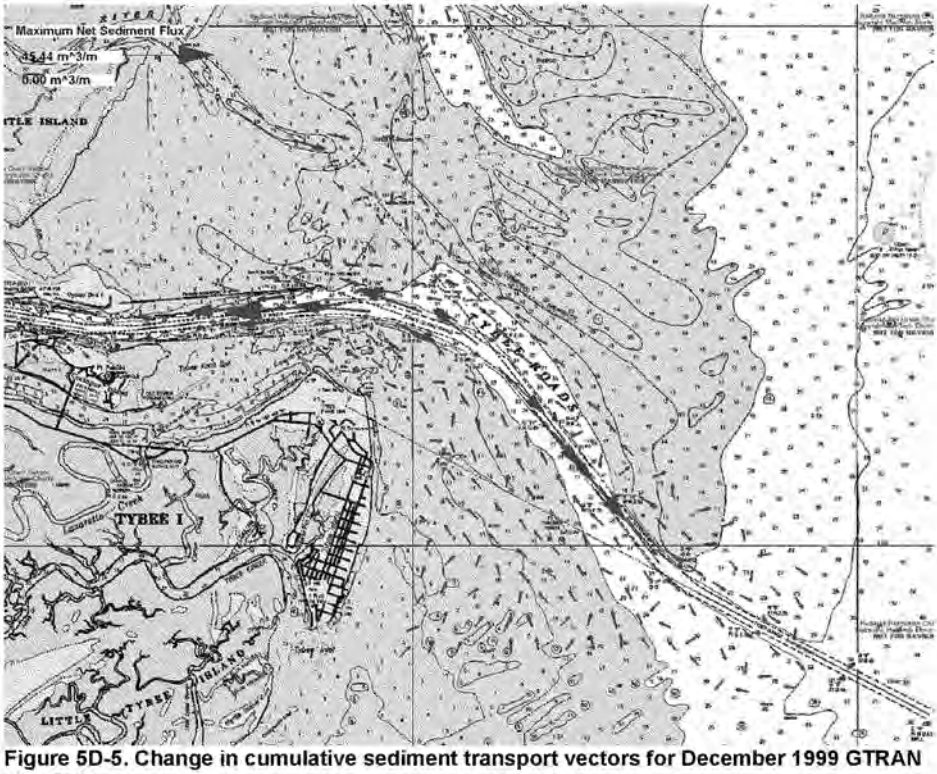


Figure 5D-5. Change in cumulative sediment transport vectors for December 1999 GTRAN simulation.

6 Summary and Conclusions

This study evaluated the impact of the proposed deepening of the Savannah Harbor navigation channel. A bathymetry and volume change analysis was conducted to provide the historical perspective of the Savannah nearshore evolution and to address review comments related to the ATM report. Numerical modeling of circulation, waves, and sediment transport was performed to compare pre- and post-deepening of the channel impacts on the coastal processes.

Deepening of the navigation channel, beginning in the 1870s, and subsequent construction of dual parallel jetties to stabilize the position of the navigation channel (1886-1897 time frame) are most likely the trigger for the changes in Tybee Island shoreline position that were observed between 1854/63 and 1900, and for the pattern of changes that has taken place since that time. There are no historical shoreline and bathymetric data available between 1854/63 and 1900 that would allow the details of that evolution, any variability in its rate of change during that time period, and a more direct linkage between navigation project construction and shoreline/morphology changes, to be examined or discerned further. However results of the historic shoreline analysis and volume change analysis, in addition to results from the circulation and GRTRAN sediment transport models, provide a consistent picture of circulation and sediment transport processes at work. We believe the following hypothesis to be the most likely explanation for evolution of the inlet since construction of the navigation project.

Deepening of the navigation channel and construction of the dual parallel jetties appear to have concentrated the ebb tidal flow into a narrower, more concentrated, stronger ebb tidal jet. The navigation project also has fixed the location of the channel, as intended, as has construction of the submerged breakwater. Fixing the location of the channel reinforces the morphological response that occurs in response to the ebb and tidal currents that enter and flow through the channel. Concentration of the flow by the project produces higher ebb currents within the jet. Prior to project construction, ebb velocities in this vicinity were probably weaker. Associated with enhanced ebb jet formation is increased gyre formation adjacent to the jet, i.e. on either side of the jet. This flow feature is observed at many structured inlets with high ebb currents. Enhanced gyre formation produces, at peak ebb within the channel, a return current on the flanks of the inlet that flows back toward the inlet entrance, in the same direction as that experienced during typical flood flow conditions. During the flood flow here, currents are directed toward the entrance throughout the ebb shoal region. Thus a situation is created where currents adjacent to the channel are directed toward the entrance (in the flood flow direction) a much larger percentage of the time. The duration of flood flow is greater than the duration of ebb flow along the flanks of the inlet. The north Tybee Island Shelf is the southern flank of the inlet. This change in predominance of flow direction adjacent to the ebb jet is expected to produce a corresponding change in the sediment transport patterns and morphology in these same regions, compared to conditions that existed prior to deepening and jetty construction. These changes to the circulation and sediment transport patterns, created by the navigation project, are thought to

explain the shoreline and morphologic changes that have occurred on Tybee Island, along with changes to sediment supply to the island from Barrett Shoals.

At present, the Tybee Island Shelf is in the flank of the jet, and is influenced by the return flow of the gyre. The GTRAN results show that the sediment transport regime in the channel and immediately adjacent to it are strongly ebb directed. The strong transport computed for the channel is consistent with the ebb dominance of this inlet system as evidenced by its massive ebb tidal delta. GTRAN results also show that a short distance away from the channel sediment net sediment transport is directed toward the entrance, both north and south of the channel, albeit with much smaller transport rates than those computed in the channel. The GTRAN results also indicate that on the Tybee Island Shelf to the east of northern Tybee Island, sediment transport is directed toward the northwest in a net sense. This direction of transport suggests that the sediment from this region moves toward the North Tybee Shoal. The accumulation of sediment in the North Tybee Shoal (and associated migration of the South Channel to the north which has likely happened in response to the sediment accumulation there), and deflation of the Tybee Island Shelf are consistent with the results of the GTRAN model. It is likely that the sediment transport regime in this region has been altered compared to the regime that existed prior to construction of the navigation project, in response to changes in the circulation patterns and local dominance of ebb/flood flow. Additional simulations of the wave, circulation, and GTRAN models for an inlet configuration representing the pre-construction condition could shed additional light on the working hypothesis for the shoreline and beach evolution observed on north Tybee.

The GTRAN results reflect conditions in deeper water where waves tend to agitate and suspend sediment and currents tend to move the sediment, not the shallow surf zone region along the Tybee Island shoreline. The very shallow nearshore region is much more wave dominated than the offshore region for which GTRAN was applied. Shoreline change modeling to examine this inner surf zone region was not part of the scope of this effort, but the minor changes in the nearshore wave results indicate that the deepening will have little impact on the shoreline. The historical shoreline change analysis showed the presence of a nodal zone around 2nd Street, north of which sand appears to be transported to the north by wave action, and south of which sand appears to be transported to the south. The hot-spot is in the region of the nodal zone, a divergent zone in which sediment tends to leave the region in both directions, in a net sense. The erosion within this nodal zone along north Tybee, is likely to be caused both by the ebb tidal deflation that occurs offshore as well as the gradients in alongshore transport created by the wave-dominated transport in the very nearshore zone.

Another possible factor in the evolution of the north half of Tybee Island is the unusually frequent and severe tropical storm activity during the period from 1879 to 1899. This increase in storm activity could have exacerbated the situation created by initial project construction and produced unusually high rates of sediment transport and morphology change. However, it seems unlikely that a single extreme event, or sequence of hurricane/tropical storm events in the region alone are capable of stimulating the shoreline and offshore morphology changes that have occurred on Tybee Island and in the Tybee Island Shelf. The GTRAN sediment modeling results indicate that the sediment transport regime during a single episodic event, like Hugo (which was re-tracked to have a much larger impact on the area than it actually had), is similar to the pattern seen for non-hurricane conditions, but is greater in magnitude in some locations (not all) than any of the months of normal winter storm activity that were examined. But where the magnitude was greater, the increase is only a factor of 1 to 5 greater. For this magnitude of difference, and in light of the infrequence and short duration of episodic events, the more typical month-to-month forcing in response to an increasingly deeper channel and tighter ebb tidal jet appears to be a more likely trigger for the shoreline and beach evolution that has taken place.

GTRAN results show that the net sediment movement on the southern half of the Tybee Island Shelf is toward the west, i.e. toward the island. This computed result is consistent with the relative health of the southern half of Tybee Island, compared to the northern half. Historic shoreline changes showed the southern half of the island to be accretionary for a significant time following construction of the project. Observations from other inlets suggest that as the ebb delta grows the down drift attachment bar migrates to the south. The attachment bar is the location on the ebb delta where sand moving around the ebb delta, from updrift to downdrift in a net sense, feeds the nearshore zone of the downdrift beach. This process may also be occurring at Tybee Island, and at present the feeding appears to be occurring at the southern half of the island. Some of the sediment eroded from the bulge in shoreline (present in 1854/1863, but not in 1900) appears to have moved south and accreted on the southern half of the island following project construction. The shoreline position of south Tybee prior to beach fill placement was well seaward of its position prior to construction of the navigation project. The current navigation channel appears to be a nearly complete sink for any sediment moving from north to south along the shelf (suggested by pre- and post-dredging surveys and the consistency of dredging volumes following deepenings). Placement of dredged material back into the nearshore zone of Tybee Island would be a means for restoring this supply of sand to the Tybee beach system.

The circulation and wave modeling indicate very small changes associated with the proposed deepening. The GTRAN results provide insight about what this deepening will do in terms of sediment transport regime, which is expected to be similar to that of past deepenings. GTRAN results for the existing condition and the with-deepened-channel condition indicate that the additional channel deepening will not change the general overall pattern of sediment transport in the region. The most noticeable changes were computed in the channel.

Transport in the Tybee Knoll Bar Channel reach showed decreases in magnitude for all four of the typical months of simulation, but conditions remain strongly ebb-dominant. The magnitude of change was greatest here (15-20 percent), compared to changes throughout the rest of the system (changes elsewhere were generally quite small, several percent). Some small increases to shoaling rates in this sector of the channel might be expected in light of these decreases, but gradients in transport (which dictate accumulation rates) do not appear to be altered very much. For the extreme hurricane event (expected to be a very rare event), conditions remain ebb dominant and transport rates increase (factor of 2 greater) rather than decrease as they do for the other four months.

Transport in the Tybee Roads Channel reach consistently shows increases for each of the typical months, but only very slight increases, a few percent. No significant changes in sedimentation are expected in this reach of the navigation channel. Transport rates increase in this portion of the channel for the re-tracked Hugo event (about a factor of 2 greater), as they do for all sections of the main channel. Transport remains strongly ebb dominant in this reach.

In the Tybee Range Channel reach, the outer limits of the navigation channel, changes in transport rate are also very small. The deepening increases rates for one month, shows zero change for one, and shows slight decreases for two of the months. All increases or decreases are small (a few percent). For re-tracked Hugo, the deepening only increases transport by about 20%, compared to a factor of 2 in the other channel reaches. This section of channel remains ebb-dominant. These changes do not suggest any significant changes in channel shoaling and they suggest that the channel region will remain strongly ebb-dominant in terms of sediment transport direction.

Average transport within the Tybee Island Shelf region consistently shows slight increases or no change for each of the four typical months, and an increase for the extreme event. No decreases were computed. Patterns appear unchanged and the net direction of movement appears

to remain to the northwest. Slight increases suggest a tendency for sediment to be transported from the shelf region to the northwest at a higher rate. This would be consistent with the hypothesized model for how sand has been moving to the northwest in response to initial project construction and subsequent deepening. This proposed deepening seems to produce a result consistent with that hypothesis. However, the magnitudes of change are quite small, in the range from 0 to 2 percent for all months and even for the extreme hurricane event. Zero change was computed for two of the four months. Computations show that channel deepening will have negligible effect on the Tybee Island Shelf.

For North Tybee Shoal region, computations show a consistent decrease in transport rate for all four months, about 5 percent or less; however, for the extreme hurricane event transport rates are increased by about 40%. These changes suggest that sediment being transported into the north Tybee shoal region will have less tendency to leave the region, but this is more dictated by changes to the transport gradients. Such a trend would be consistent with historic accumulation of sediment in these shoals.

References

Anders, F.J., Reed, D.W., and Meisbeurger, E.P., 1990. Shoreline Movements, Report 2, Tybee Island, Georgia to Cape Fear, North Carolina, 1851-1983. Technical Report CERC-83-1, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Applied Technology and Management, Inc. 2001. Draft Savannah Harbor Beach Erosion Study: Savannah Harbor Expansion Project. Prepared for the Georgia Port Authority. Charleston, SC.

Bouws, E., Gunther, H., Rosenthal, W., and Vincent, C. L. 1985. Similarity of the wind wave spectrum in finite depth waves; 1. Spectral form. *Journal of Geophysical Research*, 90(C1), 975-986.

Brooks, R. M., and Brandon, W. A. 1995. Hindcast Wave Information for the U.S. Atlantic Coast: Update 1976-1993 with Hurricanes. WIS Report 33, U.S. Army Engineer Waterway Experiment Station Vicksburg, MS.

Byrnes, M. R., Baker, J. L., and Li, F. 2002. Quantifying Potential Measurement Errors and Uncertainties Associated with Bathymetric Change Analysis. ERDC/CHL CHETN-IV-50, U.S. Army Engineer Research and Development Center, Vicksburg, MS.

Gailani, J.Z., Smith, S.J., and Kraus, N.C. In preparation. Monitoring dredged material disposal at the mouth of the Columbia River, Washington/Oregon, USA. US Army Engineer Research and Development Center. Vicksburg, MS.

Gailani, J.Z., Smith, S.J., Raad, L., and Ebersole, B.A. In prep. Savannah Harbor Entrance Channel: Nearshore Placement of Dredged Material. Technical Report ERDC/CHL TR-03-X. US Army Engineer Research and Development Center, Vicksburg, MS.

Gibbs, A. E., and Gelfenbaum, G. 1999. Bathymetric change off the Washington-Oregon Coast. Proceedings, Coastal Sediments'99, ASCE, 1627-1642.

Hubertz, J. M. 1992. User's Guide to the Wave Information Studies (WIS) Wave Model, Version 2.0. WIS Report 27, U.S. Army Engineer Waterway Experiment Station Vicksburg, MS.

Jensen, R., Scheffner, N., Smith, S.J., Webb, D., and Ebersole, B.A. 2002. Engineering studies in support of Delong Mountain Terminal project. Technical Report ERDC/CHL TR-02-26. US Army Engineer Research and Development Center, Vicksburg, MS.

Komen, G. L, Cavaleri, L., Donelan, M., Hasselmann, K., Hasselmann, S., Janssen, P. A. E. M. 1994. *Dynamics and Modelling of Ocean Waves*. Cambridge University Press, 522 pp.

Kraus, N. C., and Rosati, J. D. 1998. Estimation of Uncertainty in Coastal-Sediment Budgets at Inlets. Coastal Engineering Technical Note IV-16, US Army Engineer Research and Development Center, Vicksburg, MS.

Luettich, R. A., Jr., and Westerink, J. J. 2005. A (Parallel) Advanced Circulation Model for Oceanic, Coastal, and Estuarine Waters. On-Line User's Guide. http://www.marine.unc.edu/C_CATS/adcirc/document/ADCIRC_title_page.html

Luettich, R. A., Jr., and Westerink, J. J. 2004. Formulation and Numerical Implementation of the 2D/3D ADCIRC Finite Element Model Version 44.XX, Theory Report and Formulation, http://www.marine.unc.edu/C_CATS/adcirc/adcirc_theory_2004_12_08.pdf

Luettich, R. A., Westerink, J. J., and Scheffner, N. W. 1992. ADCIRC: An advanced three-dimensional circulation model for shelves, coasts, and estuaries, Report 1: Theory and methodology of ADCIRC-2DDI and ADCIRC-3DL, Technical Report DRP-92-6, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

Madsen, O.S., and Wikramanayake, P.N. 1991. Simple models for turbulent wave-current bottom boundary layer flow. Contract Report DRP-91-1, US Army Engineer Waterway Experiment Station, Vicksburg, MS.

McNeil, J., Taylor, C., and Lick, W. 1996. Measurements of erosion of undisturbed bottom sediments with depth. *Journal of Hydraulic Engineering*, ASCE, 122(6): 316-324.

Meyer-Peter, E. and Müller, R. 1948. Formulas for bed-load transport. Second International Association of Hydraulic Engineering and Research (IAHR) Congress, Stockholm, Sweden. IAHR, Delft, Netherlands.

Miller, T.L., Morton, R.A. and Sallenger, A.H., 2005. The National Assessment of Shoreline Change: A GIS Compilation of Vector Shorelines and Associated Shoreline Change Data for the U.S. Southeast Atlantic Coast, USGS Open File Report 2005-1326, United States Geological Survey, St. Petersburg, FL.

Miller, H.C., Smith, S.J., Hamilton, D.G., and Resio, D.T. 1999. Cross-shore transport processes during onshore bar migration. Proceedings of Coastal Sediments '99, ASCE, 1065-1080.

Mills, J. 2006 personal communication. NOAA Office of Coastal Survey.

Oertel, G.F., Fowler, J.E., and Pope, J., 1985. History of Erosion and Erosion Control Efforts at Tybee Island, Georgia. Miscellaneous Paper CERC-85-1, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Nielsen, P. 1992. *Coastal Bottom Boundary Layers and Sediment Transport*. World Scientific Publishing, Singapore, Advanced Series on Ocean Engineering, vol. 4.

Reid, J.M., Reid, J.A., Jenkins, C.J., Hastings, M.E., Williams, S.J., and Poppe, L.J. 2005. usSEABED: Atlantic coast offshore surficial sediment data release: U.S. Geological Survey Data Series 118, version 1.0. Online at http://pubs.usgs.gov/ds/2005/118/

Sargent, F.E. 1988. Case Histories of Corps Breakwater and Jetty Structures, Report 2 South Atlantic Division. WES TR-REMR-C0-3, US Army Corps of Engineers Waterways Experiment Station, Vicksburg, MS.

Smith, J. M., Sherlock, A. R. and Resio, D. T. 2001. STWAVE: Steady-State spectral Wave Model User's manual for STWAVE, Version 3.0. ERDC/CHL SR-01-1, US Army Corps of Engineers Engineer Research and Development Center, Vicksburg, MS. http://chl.wes.army.mil/research/wave/wavesprg/numeric/wtransformation/downld/erdc-chl-sr-01-11.pdf

Soulsby, R.L., 1997. *Dynamics of marine sands*. Thomas Telford, London. 249 pp.
Van Rijn, L. C. 1984. Sediment transport: Part i: bed load transport; Part ii: suspended load transport; Part iii: bed forms and alluvial roughness. *Journal of Hydraulic Engineering* 110(10): 1431-1456; 110(11): 1613-1641, 110(12): 1733-1754.

Valverde, H.R., Trembanis, A.C. and Pilkey, O.H., 1999, Summary of Beach Nourishment Episodes on the U.S. East Coast Barrier Islands, *Journal of coastal Research*, V15, No4, 1100-1118.

Wikramanayake, P.N., and Madsen, O.S. 1994a. Calculation of suspended sediment transport by combined wave-current flows. Contract Report DRP-94-7, US Army Engineer Waterway Experiment Station, Vicksburg, MS.

Wikramanayake, P.N., and Madsen, O.S. 1994b. Calculation of movable bed friction factors. Contract Report DRP-94-5, US Army Engineer Waterway Experiment Station, Vicksburg, MS.

ERDC/CHL TR-03-X

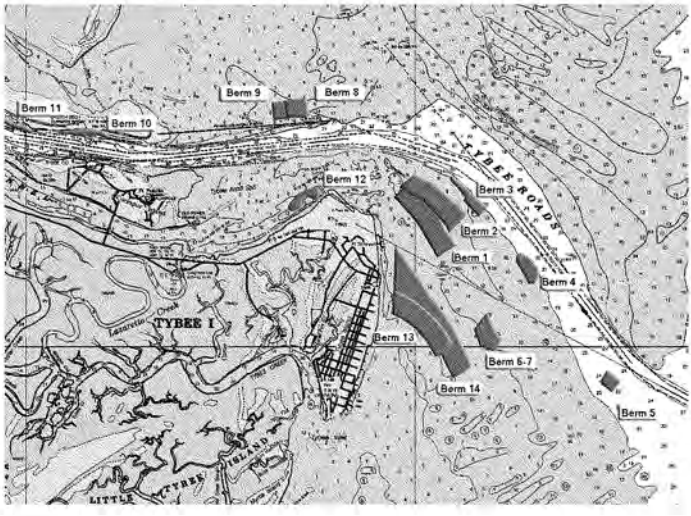
DRAFT

US Army Corps
of Engineers®
Engineer Research and
Development Center

Savannah Harbor Entrance Channel: Nearshore Placement of Dredged Material Study

July 2003

By: Joseph Z. Gailani, S. Jarrell Smith,
Layla Raad, Bruce A. Ebersole



Coastal and Hydraulics Laboratory

Approved for public release; distribution is unlimited.

Contents

1—Introduction 1-1

2—Wave Transformation Modeling 2-1

3—Circulation Modeling 3-1

4—Sediment Transport 4-1

5—Sediment Suspension and Deposition during Dredging and Placement Operations 5-1

6—Summary and Conclusions 6-1

1 Introduction

Background

The Savannah River serves as the boundary between South Carolina and Georgia for much of their common border. Much of the lower River is divided into north and south channels. The river flows directly into the Atlantic Ocean, not into a bay or sound. The Savannah River Entrance is an important commercial waterway. Nearest the coast, the main navigation channel is in the river's north channel (Figure 1).

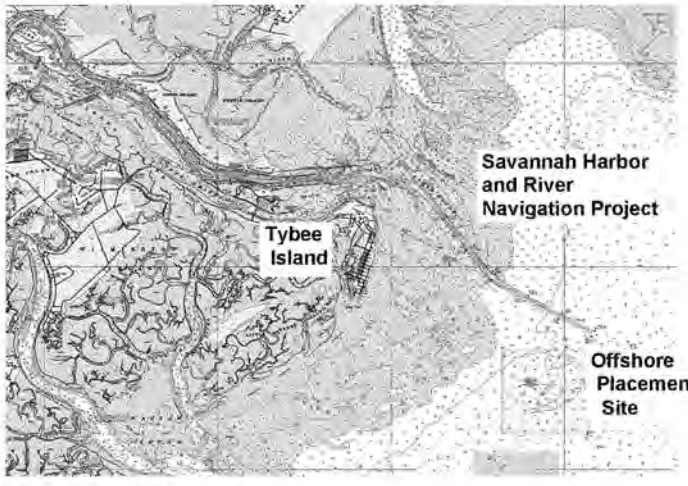


Figure1. Map of Savannah River Entrance, Lower Portions of the Federal Navigation Project, and Tybee Island

The coast and ebb shoal complex at the Savannah River Entrance is a network of rivers, creeks, marshlands and islands. Significant wetting and drying of the marsh occurs during the approximately 2 m tidal range. The wetlands and associated creeks add additional sources of sediment and energy to this complex ebb shoal system. Contributions to the ebb shoal are made not only by the Savannah River, but also by Tybee Creek, which borders Tybee Island on its south side, the creeks draining Turtle and Daufuskie Islands to the north, and

Calibogue Sound, which has its main entrance channel north of the Savannah River Entrance (visible at the top of the figure). The community of Tybee Island is on the south side of the river mouth and unpopulated Oyster Bed Island is on the north side of the River, immediately adjacent to the river.

The area between the coast and ebb shoal is broad and relatively flat. Water depths are generally less than 4 m except near the channel. The south attachment bar of the ebb shoal intersects Tybee Island approximately half way down the island, south of the channel. The north attachment bar is on Hilton Head Island, SC well north of the channel. Evolution of the ebb shoal attachment bar at Tybee Island over the last century is provided in Oertel et al (1995) and reviewed briefly in Chapter 4.

The Savannah River Entrance Channel (or Bar Channel) dredged through the river's ebb shoal is approximately 19 km long, starting in a west/northwest direction offshore of the Savannah River ebb shoal, turning northwest as it cuts through the ebb shoal and Tybee Roads and then turning west at the entrance to the River. At the River mouth, the entrance channel is protected from shoaling by a north jetty that protects it from longshore transport. The north jetty/training wall is slightly less than 4 km long. The partially submerged south jetty is approximately 2.5 km long and protects the channel from shoaling generated by sediment exiting the south channel of the river. Fort Pulaski, which includes a tide gage, is near the land terminus of the south jetty. From the landward end of the north jetty, it is over 20 km to the city of Savannah and Savannah Harbor. A review of the development of the channel over the past century is provided in the Draft Savannah Harbor Beach Erosion Study (ATM, 2001).

Dredging is required annually to maintain the Bar Channel to the Federally authorized channel depth of 44 ft. Much of the dredging occurs on Tybee Roads, where longshore transport from the north fills the channel with a predominately sandy material. This is mixed with fine-grained sediment transported by the river. The U.S. Army Engineer District, Savannah (SAS), which oversees the Savannah Harbor and River Federal Navigation Project, has been investigating alternate disposal locations to place the estimated 500,000 yd^3/yr dredged annually from the ebb shoal navigation channel. This material is predominately sand, but is not considered beach quality because of the 12-30% fine content. In addition, SAS is preparing to dredge $1.3x10^6$ yd^3 of advance maintenance material that will be almost all pure sand.

Typical dredging practice has included offshore placement of ebb channel material. This process isolates the material from the regional sediment system. Placement within the littoral zone would keep some of the material within the coastal sediment system and could provide benefit to adjacent beaches. The goal of this study is to identify and evaluate nearshore placement alternatives that represent reasonable cost alternatives while providing benefit to the littoral system. Included among the disposal site options are several sites between the ebb shoal channel and Tybee Island shoreline. All ebb shoal dredged material is considered acceptable for open-ocean placement without management according to the procedures outlined in the "Evaluation of Dredged Material Proposed for Ocean Disposal – Testing Manual".

At the request of SAS, the U.S. Army Engineering Research and Development Center, Coastal and Hydraulics Laboratory (CHL) conducted studies that involved use of numerical models to characterize water level, current, and wave conditions in areas being considered for nearshore placement; and using the models, identified sediment pathways around the Savannah Harbor Entrance Channel and the surrounding ebb shoal. Specifically, CHL was tasked with preparing recommendations for nearshore placement of dredged material. Of specific interest is nearshore placement that maximizes benefit to the littoral system and the beaches along Tybee Island. Concerns with nearshore placement include increased nearshore turbidity during and after placement, movement of the dredged material back into the navigation channel, and influence of a nearshore berm on adjacent shorelines. The conclusions of this study will assist SAS in developing a Dredged Material Management Plan (DMMP) for the Savannah Harbor and River Federal Navigation channel and will assist the district in developing methods for utilizing dredged material beneficially within the context of a Regional Sediment Management (RSM) plan for the Savannah River/north Georgia coastline.

Study Objectives

The primary objectives of this study are:

1. Develop, calibrate, and apply a fine-grid hydrodynamic model of the Savannah River Entrance Channel and the surrounding ebb shoal and coast.
2. Develop and apply a fine-grid wave model to simulate transformation of offshore waves over the entire ebb shoal.
3. Simulate dredged material mound movement in the nearshore and lower river regions
4. Develop methods for assessing sediment pathways in the region between Tybee Island and the channel
5. Predict magnitude of turbidity during the dredging and placement operations
6. Provide guidance and recommendations for nearshore placement for feeding sand to the littoral system and beach, while minimizing re-handling (dredged material re-entering the channel), and minimizing any adverse impact on adjacent shorelines

Study Approach

Meetings between ERDC and SAS staff were used to develop project goals and an initial scope of work (SOW) covering areas of interest to the district. The original SOW included study of offshore placement sites and a few nearshore mound locations. As the study progressed, goals were modified to meet evolving questions and the focus was placed on nearshore placement for maintaining dredged material in the littoral zone/beach area.

Current and wave conditions expected during placement operations, i.e., typical non-storm wave and tidal conditions, and active high-energy (storm) periods are critical for evaluating all locations being considered for placement. Therefore, as part of this project, SAS requested a comprehensive review and

modeling of current and wave conditions across the ebb shoal as well as current conditions in the river and around the jetties. In addition, sediment properties of the dredged material must be assessed for transport predictions. The dredged material is a mixture of sand, silt, and clay. Some of these mixed sediments will behave as non-cohesive sand, but some material will display cohesive properties. Erosion, transport and dispersion properties of cohesive material depends on multiple factors, including grain size distribution, mineralogy, pore water chemistry, organic content, bulk density, and other factors. Although these bulk properties are easily assessed, there are no theoretically valid methods available to accurately quantify sediment transport processes based on the sediment properties for mixed cohesive sediments. Therefore, a second part of this study was laboratory testing of sediments collected on site to quantify the erodability and transport characteristics of the dredged material (expected maintenance material). The third part of this study was assessing placement options for maintaining the material in the littoral system. The final part addresses turbidity due to dredging and placement operations.

The remainder of this section briefly describes each of the study components.

a. ADCIRC modeling of tidal circulation, wind-driven currents, and storm surge. The ADvanced CIRCulation (ADCIRC) model (Luettich et al, 1992) was used to generate tidal currents, wind driven currents and storm surges needed for the for the sediment transport and wave models. ADCIRC is a two-dimensional, depth-integrated, finite element, ocean circulation model that has been proven to accurately simulate tidal and storm conditions in near-shore regions. ADCIRC-predicted velocities and water levels were used to develop storm and non-storm hydrodynamic conditions in the river and on the ebb shoal. The ADCIRC modeling effort is described in Chapter 2. The accuracy of the model was evaluated using available tidal data at Fort Pulaski, in Tybee Creek, and offshore. In addition, current data provided by ATM, which were collected using an Acoustic Doppler Current Profiler (ADCP) (ENSR, 1999) were used to evaluate the model.

b. STWAVE modeling of wave transformation over the ebb shoal. Databases exist for offshore wave conditions near Savannah (Brooks and Brandon, 1995), produced by the U.S. Army Corps of Engineers Wave Information Studies (WIS). These data reflect conditions well offshore of Tybee Island, in deeper water, and do not accurately reflect conditions in shallower water. Also, wave transformation over a complex channel/ebb shoal region cannot be predicted using simple refraction and shoaling equations because the bottom bathymetry is so irregular. Therefore, the STWAVE model was applied over the entire ebb shoal to predict wave refraction and shoaling, and to characterize wave conditions at the potential nearshore placement sites and along Tybee Island. The offshore WIS wave data were used to define the offshore boundary conditions needed as input by STWAVE. A two-step STWAVE modeling approach was adopted, using nested grids, in light of the wide shelf seaward of the ebb shoal and the complexity of the bathymetry. The STWAVE model was also used, along with the GENESIS shoreline change model, to investigate the potential impacts of a nearshore berm on local wave transformation, longshore sand transport processes, and shoreline change.

c. Sediment properties analysis. Historical data available from dredging records and previous studies were used to estimate grain size distributions, dredging volumes, and ebb shoal evolution. These data provide significant information on the ebb shoal and channel processes which can be used as input to transport models and to verify transport model results. As stated previously, site-specific cohesive sediment erosion tests were required to understand critical stresses for initiation of transport and transport rates of mixed dredged material. These experiments involved applying an erosion-testing flume, SEDFLUME (McNeil et al, 1996), to examine erodability of dredged material collected from various stretches of the channel. The erosion data are then used to develop site-specific erosion algorithms that are incorporated into the sediment transport models. The algorithms define sediment erosion rates as a function of bulk density, shear stress, and depth of burial. Algorithms were developed for each stretch of channel, for which sediments were acquired and tested.

d. Modeling of mound erosion and sediment pathways. The GTRAN model was used to simulate mound erosion at each proposed nearshore and riverine mound during storm and normal hydrodynamic conditions. The cohesive sediment erosion algorithms were incorporated into GTRAN and erosion from various mound configurations was simulated. In addition, a mesh of points was established between the channel and Tybee Island. Sand erosion magnitude and direction time series were developed at each point to assist in determining sediment pathways. This provided needed information for assessment of various nearshore placement locations. Hydrodynamic and wave time series required to estimate transport were developed from ADCIRC and STWAVE simulations.

e. Modeling of dispersion of material during dredging and placement operations. A significant amount of fine material is stripped from the sediment/water mixture during dredging and placement. This material is free to move through the water column. Transport of material released during the dredging process was modeled using the SSFATE model (Clarke ****). Various dredging methods, sediment types, dredging rates, and loss rates were simulated to provide a comprehensive understanding of sediment plume concentration and migration. In addition, the D-CORMIX model was used to predict loss of sediment during a pipeline placement operation. Placement is especially a concern in the nearshore where released sediment could migrate toward the beach.

2 Wave Transformation Modeling

Waves influence sediment transport along the Tybee Island shoreline and also over the ebb shoal where nearshore placement of dredged material is being evaluated. The sediment transport models described in Chapter 4 require temporal and spatial descriptions of the nearshore wave climate to make sediment transport estimates. Representative and long-term wave conditions were extracted from the Wave Information Study (WIS) 1976-1995 hindcast (Brooks and Brandon, 1995) and these conditions were transformed from the offshore hindcast station to the nearshore through the STeady-state spectral WAVE model (STWAVE). Nearshore wave conditions were extracted for point sediment transport modeling and shoreline change modeling described in Chapter 4.

STWAVE

STWAVE (Resio 1987, 1988a, 1988b; Smith et al. 2001) is a half-plane, phase-averaged, spectral wave transformation model. STWAVE simulates depth-induced refraction and shoaling, current-induced refraction and shoaling, depth- and steepness-induced wave breaking, wave growth from wind input, non-linear wave-wave interactions, and energy dissipation due to white capping. Assumptions applied in the governing equations include 1) mild bottom slope and negligible wave reflection, 2) spatially homogeneous offshore wave conditions, 3) steady-state waves, currents, and winds, 4) linear refraction and shoaling, 5) depth-averaged current, and 6) bottom friction is neglected.

STWAVE has been successfully compared to field and laboratory measurements of wave transformation over ebb shoals and near tidal inlets (Smith and Smith 2002, Smith and Harkins 1997, and Cialone and Kraus 2002.)

Model Application Near Savannah River Entrance

Waves were transformed from WIS sta 33 to the nearshore through a nested grid approach. Support of grid nesting in STWAVE was recently developed as described by Smith and Smith (2002). Waves are transformed from the offshore over a typically coarse "parent" grid and the transformed wave spectra are saved along the offshore boundary of the more finely resolved "nested" grid. Nested grid simulations begin with the saved conditions from the parent grid and transform these waves over a more finely resolved grid towards shore.

The parent and nested grids for the present study are presented in Figure 2-1. The parent grid has dimensions of 36 km x 67 km with a resolution of 200 m. The nested grid covers a smaller area with dimensions of 15 km x 30 km but with finer resolution of 50 m. Bathymetry for both grids was developed from the National Geophysical Data Center's (NGDC) coastal relief model which is constructed from the National Ocean Service (NOS) hydrographic database. The coastal relief model compared favorably to the November 1997 NOAA Navigation Chart 11512 and to available survey data obtained from the Savannah District.

Winter Month Simulations

Offshore wave conditions were developed from the 20-year (1976-1995) WIS hindcast at sta 33 (Figure 3-1). For the requirements of the sediment transport study, the hindcast record was analyzed to identify statistically representative wave conditions during the winter dredging season (defined as the months of November to March). The hindcast record was analyzed to identify a mean winter month and a winter month with a two-year return interval. As the focus of the sediment transport study was on movement of mounds placed in the nearshore, a measure of wave properties more directly related to sediment transport in the nearshore was sought. Wave energy (proportional to H^2) is more directly related to bottom shear stresses and was evaluated instead of wave height. Wave energy density is given by

$$\overline{E} = \frac{\rho g H^2}{8} \tag{2-1}$$

where,

ρ = density of water

g = gravitational acceleration

H = wave height.

Table 2-1 presents the monthly mean wave energy density for the 20-year hindcast.

To represent the wave conditions during dredging operations and frequently recurring wave conditions, two months of wave information were selected from the WIS hindcast (1976-1995). Operational conditions were selected as the month with average wave energy density nearest the median value for the dredging season (considered October through March). The median of average monthly wave energy density during the dredging season is 2080 J/m^2, corresponding to the month of January 1992. Similarly, the 2-year return month based on wave energy density was November 1979. Offshore wave conditions for these two months are presented in Figures 2-3 and 2-4.

Parametric spectra of TMA form (Bouws 1985) were developed for the conditions of the January 1992 and November 1979 WIS hindcast. These wave spectra were then applied to the offshore boundary of the parent grid and transformed shoreward and saved at the position of the offshore boundary of the nested grid. The spectra saved at the offshore boundary of the nested grid then served as input conditions for each berm scenario simulated in the sediment transport study (Chapter 4). Water level for the winter month simulations was obtained from simulations of the same period of time in the hydrodynamic model (Chapter 3) at a position on the offshore boundary.

Long-Term Wave Climate Simulations

For the evaluation of longshore transport and shoreline change effects resulting from nearshore placement of dredged material, a longer-term simulation was required. For this purpose, statistics were developed from the 20-year wave hindcast to define the wave climate at WIS station 33. The wave climate was characterized by "binning" the offshore wave conditions by wave height, wave period, and wave direction. Bin boundaries are presented in Table 2-2 and a summary of the analysis is presented in Appendix 2A. The analysis resulted in the population of 277 unique wave height, wave period, and wave direction bins.

The tide range (high-mesotidal) at the site and the shallow, complex shoal structure at the Savannah River Entrance require that water-level be considered in wave transformation. Figures 2-5 and 2-6 illustrate the influence of water level on nearshore wave conditions. Identical wave conditions were applied to the offshore boundary of the parent grid, but significant differences in nearshore wave height and wave direction are evident over the ebb shoal and the nearshore. Each of the 277 wave conditions were simulated with 3 water levels: average low tide (-1.05 m Mean Tide Level (MTL)), mean tide (0.00 m MTL), and average high tide (+1.05 m MTL). The resulting 831 wave and water-level conditions were simulated on the parent grid and saved at the offshore boundary of the nested grid. These saved spectra were then transformed across the nested grid for each of the ocean-side berm scenarios presented in Chapter 4.

Summary

To support sediment transport studies of nearshore placement of dredged material, a numerical wave transformation model was applied. The offshore wave climate was analyzed from the WIS hindcast record at station 33 offshore of the Savannah River entrance. Statistically significant months of wave conditions were selected from the 20-year hindcast record and simulated to provide nearshore wave conditions for the sediment transport study. In addition, for long-term simulations, the wave climate was binned into unique wave height, wave period, wave direction, and water level combinations to characterize the nearshore wave climate. These wave conditions were then applied to sediment transport models as described in Chapter 4.

REFERENCES

Bouws, E., Gunther, H. , Rosenthal, W., and Vincent, C.L. 1985. "Similarity of the wind wave spectrum in finite depth waves; 1. Spectral form." J. Geophys. Res., 90(C1), 975-986.

Brooks, R.M. and Brandon, W.A. (1995) "Hindcast Wave Information for the U.S. Atlantic Coast: Update 1976-1993," WIS Report 33, U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, MS.

Cialone, M. A. and Kraus, N. C. 2002, Wave Transformation at Grays Harbor, WA with Strong Currents and Large Tide Range. Proc 4th Waves Conf., ASCE, 794-803.

Resio, D. T. 1987. "Shallow-water waves. I: Theory." *Journal of Waterway, Port, Coastal, and Ocean Engineering*, ASCE, 113(3), 264–281.

Resio, D. T. 1988a. "Shallow-water waves. II: Data Comparisons." *Journal of Waterway, Port, Coastal, and Ocean Engineering*, ASCE, 114(1), 50–65.

Resio, D. T. 1988b. "A steady-state wave model for coastal applications." *Coastal Engineering*-1998, ASCE, New York, 929–940.

Smith, J. M., and Smith, S. J. 2002. "Grid nesting with STWAVE," ERDC/CHL CHETN I-66, U.S. Army Engineer Research and Development Center, Vicksburg, MS. http://chl.wes.army.mil/library/publications/chetn/

Smith, J. M., Sherlock, A. R., and Resio, D. T. 2001. "STWAVE: Steady-State Spectral Wave Model, user's guide for STWAVE Version 3.0," ERDC/CHL SR-01-01, U.S. Army Engineer Research and Development Center, Vicksburg, MS.
http://chl.wes.army.mil/research/wave/wavesprg/numeric/wtransformation/downld/erdc-chl-sr-01-11.pdf

Smith, S.J. and Harkins, G.S. 1997. "Numerical wave model evaluations using laboratory data." *Proc., Ocean Wave Measurement and Analysis, Waves'97*, Virginia Beach, Va., ASCE, Reston, Va., 271-285.

Smith, S.J. and Smith, J.M 2001. "Numerical Modeling of waves at ponce de leon inlet, Florida." *Journal of Waterway, Port, Coastal, and Ocean Engineering*, ASCE 127 (3), 176-184.

TABLES

Table 2-1 Monthly Averaged Wave Energy Density (kJ/m^2)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg
1976	2.43	2.21	1.80	1.55	1.70	1.53	0.49	2.34	0.99	2.60	1.64	2.58	1.82
1977	1.86	1.89	2.43	2.44	1.16	0.49	0.54	0.87	0.70	2.02	3.03	2.14	1.63
1978	3.32	2.09	2.06	1.31	1.33	0.94	0.80	1.00	1.95	1.89	2.24	3.00	1.83
1979	3.62	3.33	3.11	2.98	1.97	1.87	1.44	1.08	5.05	1.75	3.46	2.28	2.66
1980	2.32	1.93	3.49	2.11	0.83	1.09	0.68	1.75	1.92	2.19	2.29	2.90	1.96
1981	1.29	4.69	2.35	1.85	1.25	1.01	0.83	1.38	1.78	1.83	1.61	1.57	1.79
1982	1.18	2.86	1.81	1.68	0.78	0.83	0.64	0.62	1.22	1.78	1.92	2.16	1.46
1983	2.71	3.54	3.27	1.92	1.54	1.21	0.96	0.91	1.38	2.29	2.15	3.68	2.13
1984	3.06	2.99	2.29	1.96	1.29	0.51	1.05	0.61	4.65	1.81	4.29	1.52	2.17
1985	1.78	2.11	2.24	1.78	1.16	0.67	1.31	0.99	4.39	3.55	2.98	1.55	2.04
1986	2.42	1.30	2.61	1.16	0.92	1.27	0.68	1.07	1.85	1.65	2.86	2.95	1.73
1987	2.92	2.97	2.31	1.26	1.33	1.03	0.76	0.85	1.07	1.39	1.91	1.48	1.61
1988	1.85	1.34	1.23	0.76	0.93	0.84	1.08	1.17	1.96	1.50	1.83	0.90	1.28
1989	2.17	1.92	1.79	1.44	1.00	1.11	1.01	1.37	6.93	2.23	1.74	1.32	2.00
1990	1.53	2.72	2.02	2.25	1.27	1.10	1.48	0.95	1.62	2.53	1.51	2.46	1.79
1991	1.61	1.58	2.34	1.93	1.65	1.44	0.76	0.92	2.65	2.42	1.42	1.70	1.70
1992	2.08	1.56	2.04	1.28	0.88	0.68	0.61	0.98	1.17	1.46	2.58	1.77	1.42
1993	3.60	1.86	3.23	1.60	1.18	0.88	0.55	1.29	0.87	1.95	3.13	1.58	1.81
1994	2.06	2.30	1.94	1.27	1.20	0.79	0.71	0.87	0.78	2.27	2.31	2.72	1.60
1995	2.56	1.35	1.44	1.07	0.93	1.06	0.56	2.16	1.95	2.34	1.61	1.43	1.54
Avg	2.32	2.33	2.29	1.68	1.21	1.02	0.85	1.16	2.25	2.07	2.33	2.08	1.80

Table 2-2. Wave Climate Definition

Bin	Wave Height (m)	Wave Period (sec)	Wave Direction (deg true)
1	0.0 to 0.5	3 to 6	50.5 to 65.5
2	0.5 to 1.0	6 to 8	65.5 to 80.5
3	1.0 to 1.5	8 to 10	80.5 to 95.5
4	1.5 to 2.0	10 to 12	95.5 to 110.5
5	2.0 to 2.5	12 to 14	110.5 to 125.5
6	2.5 to 3.0	14 to 16	125.5 to 140.5
7	3.0 to 4.0	16 to 18	140.5 to 155.5
8	> 4.0	> 18	155.5 to 170.5

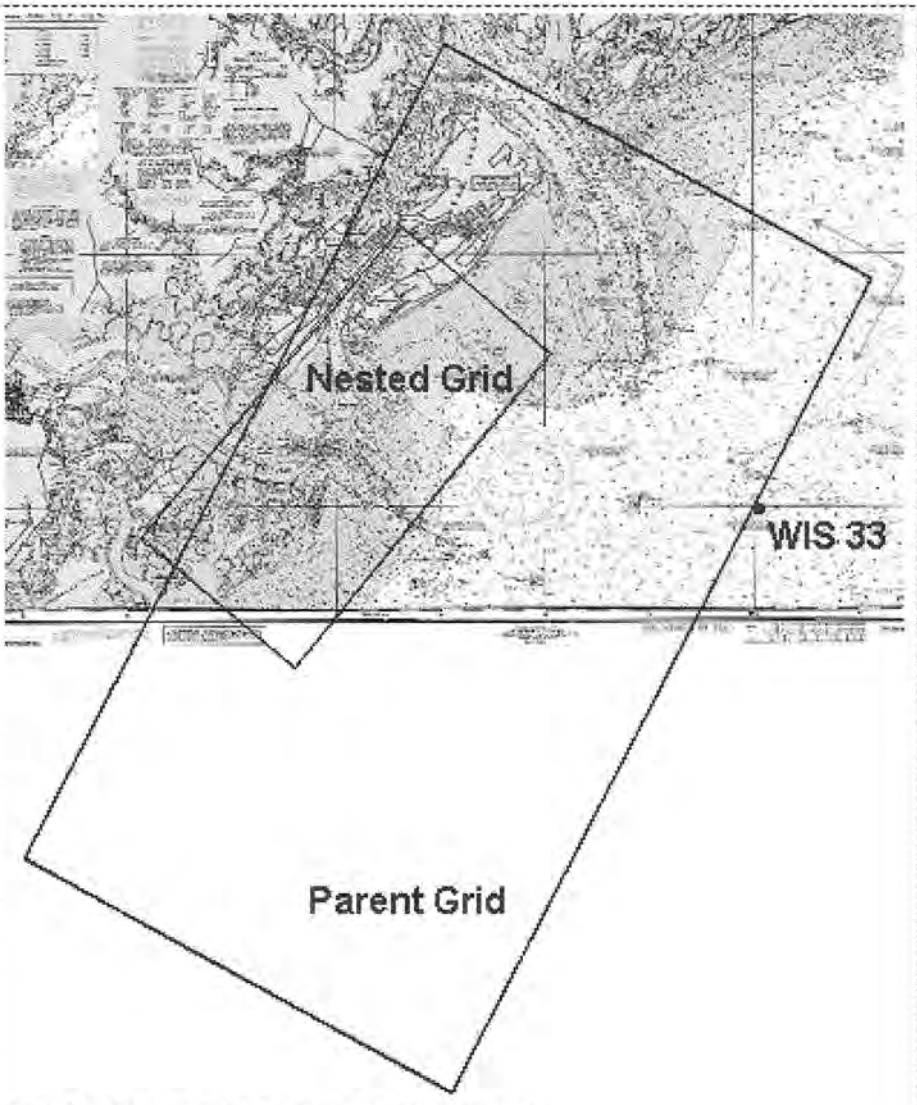


Figure 2-1. STWAVE parent and nested grid model boundaries.

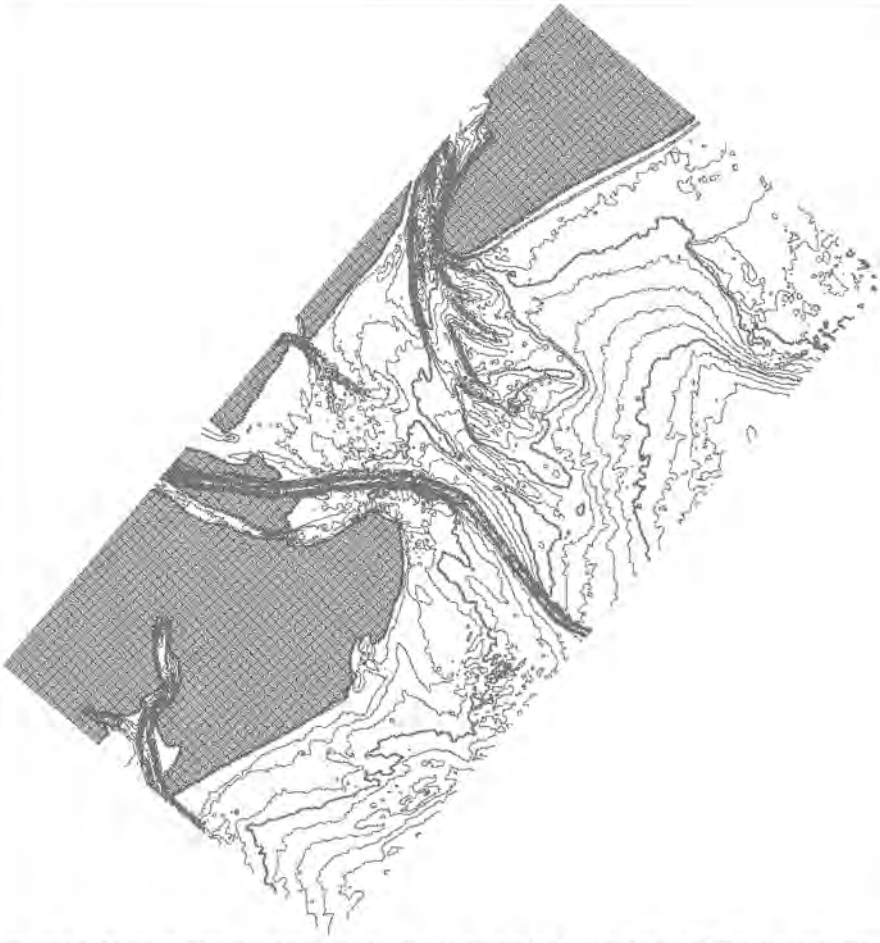


Figure 2-2. STWAVE nested grid bathymetry. Depths relative to Mean Sea Level (MSL). Contour interval 1 m and bold contours at 5 and 10-m depth.

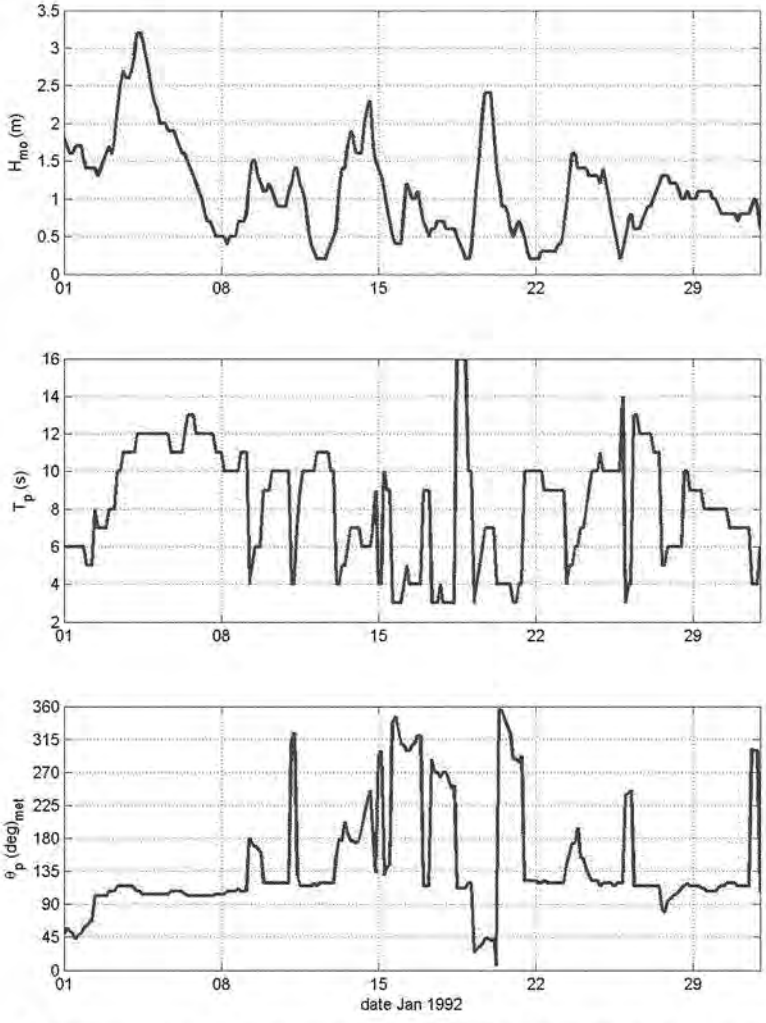


Figure 2-3. Offshore wave conditions for month of January 1992 at WIS sta 33. H_{mo} is energy-based wave height, T_p is the spectral peak period, θ_p is the meteorological-convention wave direction (direction from which waves are approaching).

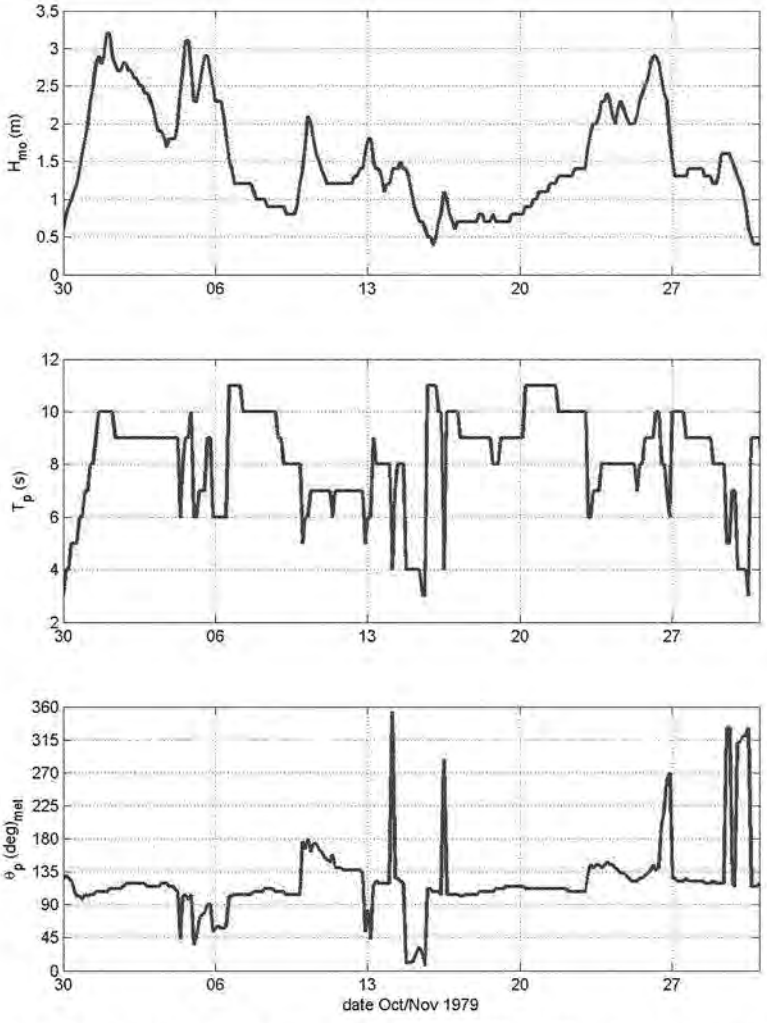


Figure 2-4. Offshore wave conditions for month of November 1979 at WIS sta 33. H_{mo} is energy-based wave height, T_p is the spectral peak period, θ_p is the meteorological-convention wave direction (direction from which waves are approaching).

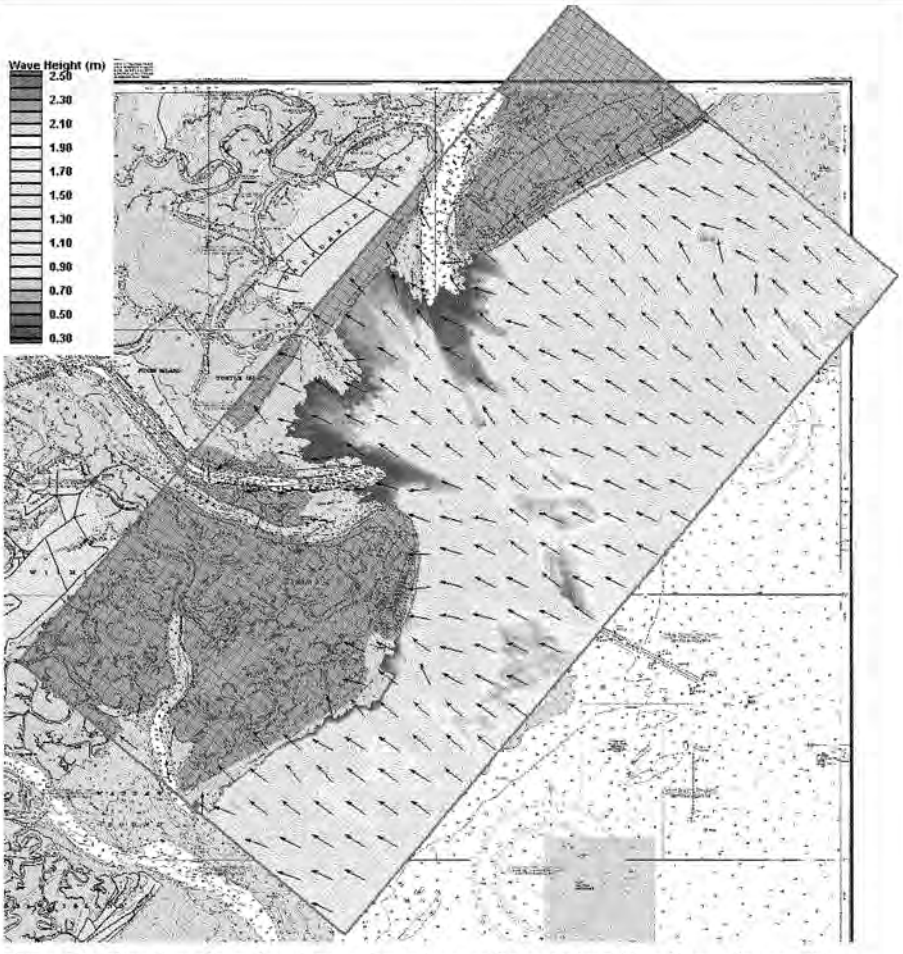


Figure 2-5. Wave transformation at mean low water over the nested grid for a frequently occurring energetic wave condition (Offshore wave conditions: H_{mo} = 1.75, T_p = 9 sec, θ_p = 118 deg true)

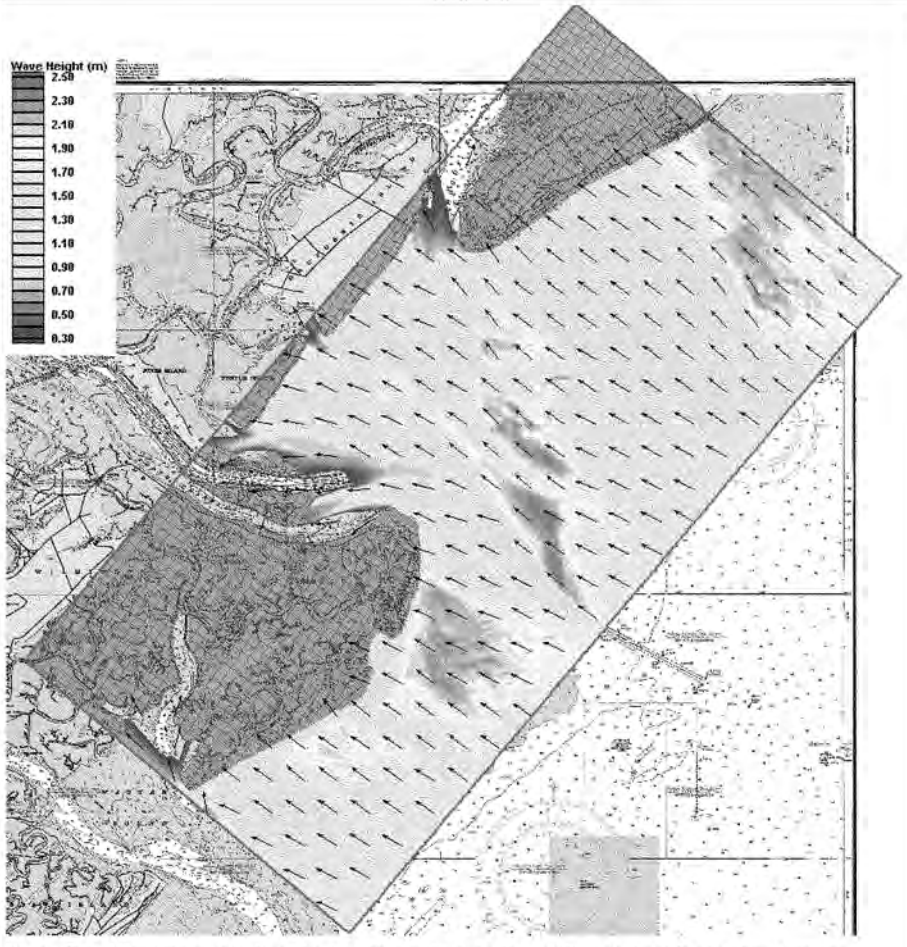


Figure 2-5. Wave transformation at mean high water over the nested grid for a frequently occurring energetic wave condition (Offshore wave conditions: H_{mo} = 1.75, T_p = 9 sec, θ_p = 118 deg true)

3 Circulation Modeling

Currents from wind, tides, and flow from the Savannah River strongly influence sediment transport near the Savannah River Entrance. Sediment transport models described in Chapters 4 and 5 require accurate representation and high spatial and temporal resolution of circulation within the study area. Because the study area is influenced by numerous, complex tidal inlets, marshes, structures, and shoals, a high-resolution finite-element mesh was developed for application with the Advanced CIRCulation (ADCIRC) model. Representative time periods for environmental conditions were selected as described in Chapter 2 and these periods were simulated with wind, astronomical tide, and river flow boundary conditions on the calibrated mesh. The resulting hydrodynamics were supplied to the sediment transport models described in Chapters 4 and 5. The areas of interest for this study are indicated in Figure 1 and defined as follows:
Nearshore disposal sites off Tybee Island: sites 1,3,4 and 5
Near Oysterbed Island and along northern jetty: site 2
Near Jones Island: site 6
Site 7 is located between the main navigation channel and Hilton Head.

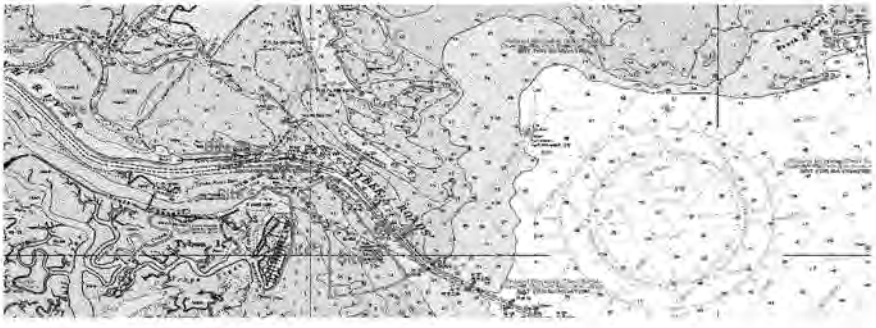


Figure 1. Potential sites for sediment placement

This task mainly consisted of applying the hydrodynamic model Advanced CIRCulation (ADCIRC) to calculate water-surface and current in the study area (Luettich, Westerink, Scheffner 1992). ADCIRC is a system of computer programs for solving time dependent, free surface circulation and transport problems in two and three dimensions. These programs utilize the finite element method in space and therefore can be run on highly flexible, irregularly spaced grids. Fine resolution can be specified in the area of interest and coarse resolution can be

specified in areas distant from the region of interest. The ADCIRC hydrodynamic model was used to simulate:

1- December 1999. December 1999 was chosen as the model calibration period. Specifications for simulations of hydrodynamics at the study area included forcing with tidal constituents, river flow, and wind.

2- One extreme storm. Hurricane Hugo, which occurred during September 14-22 1989, was chosen to represent the extreme storm. An atmospheric model was applied to compute wind and pressure fields from Hurricane Hugo.

3- One-month active period characterizes by a number of more frequent storms. November 1979 was chosen as the active period month. Specifications for simulations of hydrodynamics at the study area included forcing with tidal constituents, river flow, and wind.

4- One-month operational period that represents a typical dredging window. January 1992 was chosen as the operational month. Specifications for simulations of hydrodynamics at the study area included forcing with tidal constituents, river flow, and wind.

5- One-month summer period. July 1999 was chosen as the summer month. Specifications for simulations of hydrodynamics at the study area included forcing with tidal constituents only.

ADCIRC Domain Extent

The model domain extent was selected based on several types of information. The first consideration is the area of interest for a particular application. The domain boundaries must be sufficiently far from the area of interest so that localized inaccuracies near boundaries do not influence calculations in the study area. A second consideration for domain extent is the conditions under which the model will be run. In representing hurricanes, storm surge may be underpredicted if the domain is not sufficiently large to simulate the large-scale storm-driven processes (Militello, 1998).

The circulation model will be used to simulate extreme storm. Therefore, the study area was centered within a coastline which extended about 200 miles to accurately simulate extreme storm conditions. The coastline was chosen in a geographic range defined by longitude of 82°-79° W and latitude of 30.5°-33.5° N. Two coastlines were extracted using the National Oceanic and Atmospheric Administration (NOAA) Coastline Extractor. The first coastline is defined by longitude of 82°-79° W and latitude of 30.5°-33.5° N and its digitized shoreline coordinates were obtained from the World Vector Shoreline. To obtain more details in the study area, a refined coastline defined by longitude of 81.3°-80.7° W and latitude of 31.85°-32.6° N was obtained from the Medium Resolution Coastline. The two coastlines were merged together to represent the land boundary of the domain. The ocean boundary is created by connecting the end points of the land boundary with a half circle shape.

ADCIRC was forced with normal flow boundary at the upstream of the Savannah River where no tidal influence was detected. The tidal influence along the river was observed by examining the U S geological Survey (USGS) stations along the Savannah River and no tidal

influence was detected at the USGS Savannah Near Clyo Station. Therefore the normal flow was forced at the Savannah Near Clyo Station which is about 60 miles inland. Figure 2 shows the model domain and its boundaries.

ADCIRC Grid

The quality of the bathymetric data in grid generation plays a significant role in the accuracy of the hydrodynamic calculations. Because the bottom topography can change significantly over a relatively short time, bathymetric data collected closest to the simulation time should be incorporated in grid generation (Militello, 1998).

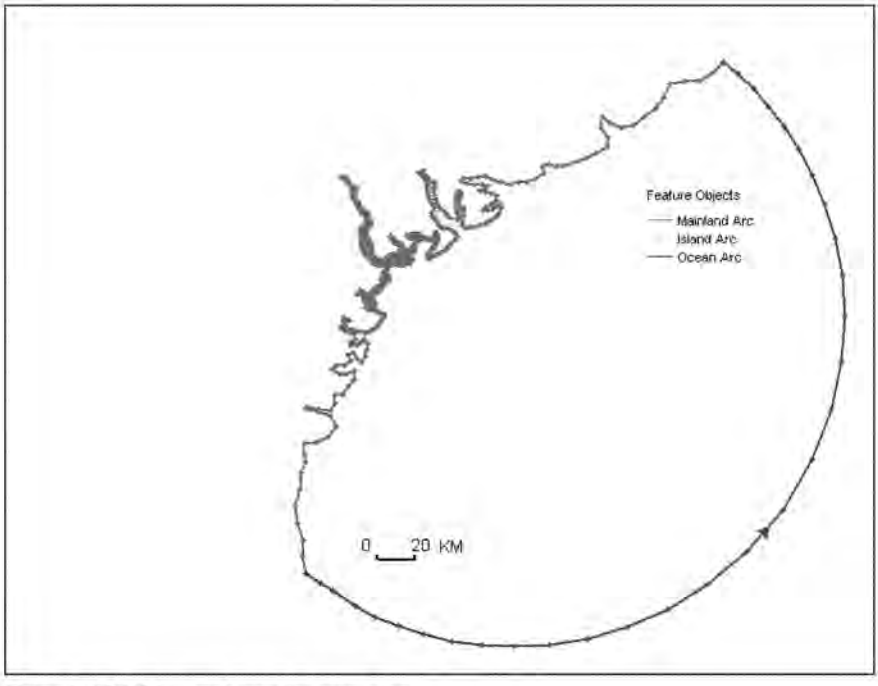


Figure 2. ADCIRC domain and its boundaries

Bathymetric data was obtained from different sources. The bathymetric data for the region defined by 31° - 40° N latitude (US Southeast Atlantic Coast) is obtained from GEOphysical Data System (GEODAS) developed by National Geophysical Data Center. GEODAS contains area

survey data from the National Ocean Service (NOS), the National Imagery & Mapping Agency (NIMA), and international sources. The GEODAS data includes bathymetric data from different time periods and some data was collected since 1930. Detailed sea and land data was obtained in the region defined by longitude of 81.3°-80.7° W and latitude of 31.85°-32.6° N. The grid cell was chosen as 6 seconds and the data was referenced to Mean Sea Level (MSL). Coarser sea bathymetric data was obtained for the region defined by longitude of 81.3°-80.7° W and latitude of 31°-32.6° N. The grid cell was chosen as 1 minute and the data was referenced to MSL.

More detailed bathymetric data collected closest to the calibration period of December 1999 were used. The bathymetric data for the main channel, south channel and Savannah River were obtained from (SAS) and the data was adjusted to the MSL vertical datum and to the NAD83 horizontal datum. The district bathymetric data was chosen closest to December 1999. The upstream portions of the Savannah River, which were not covered by SAS surveys, were extracted from NOAA Charts 11512 and 11514. The location and the elevation of the main channel jetties were extracted from NOAA Chart 11512. NOAA Chart 11512 was the 56th edition of 1999. The partially submerged northern jetty elevation was set to Mean High Water (MHW) and the southern submerged jetty was set to Mean Low water (MLW).

The region of the mesh not covered by the GEODAS data was obtained from:

- Local surveys collected between 1954 and 2000.
- NOAA Navigation Chart number 11503 for areas not covered by the local surveys.
- The Eastcoast 2001 tidal database and grid.

Grids should be coarse in the open ocean and fine resolution should be specified in the direct areas of interest. Grid resolution must be sufficient to distinguish major channels from adjacent shallower areas. Navigational channels should usually be modeled with one to three elements across the channel, depending on the level of interest in the calculated velocities within the channel. Higher resolution within the channel can be specified if details of the flow field are of interest (Militello, 1998).

Grid resolution can vary spatially, and grading between coarse and fine resolution should be done with regard to transition between element areas. A general rule is that adjacent elements should not differ in size by more than 50 percent (Donnell et al. 1996).

Areas having fine resolution in relatively deep water often dictate the maximum time-step that can be applied to achieve stability. Stability depends on the Courant number Cr given by:

$$Cr = \frac{\Delta t \sqrt{gh}}{\Delta s}$$

where,

Δt = time-step
Δs = grid spacing
g = gravity acceleration
h = ambient depth

Model stability requires that $Cr < 1$.

Highest resolution is within the study sites and minimum node spacing is approximately 40 m in a depth of about 15 m. Therefore a time step of 2.0 sec was chosen in compliance to the Courant number. The regional grid is shown in Figure 3 with coarse resolution over the open ocean and increasing resolution toward the shore. Details of the grid for the study area and the tidal marshes around it are shown in figure 4. The adjacent elements did not change in size by more than 50 percent and the number of nodes and elements of the mesh were 29767 and 57066 respectively.

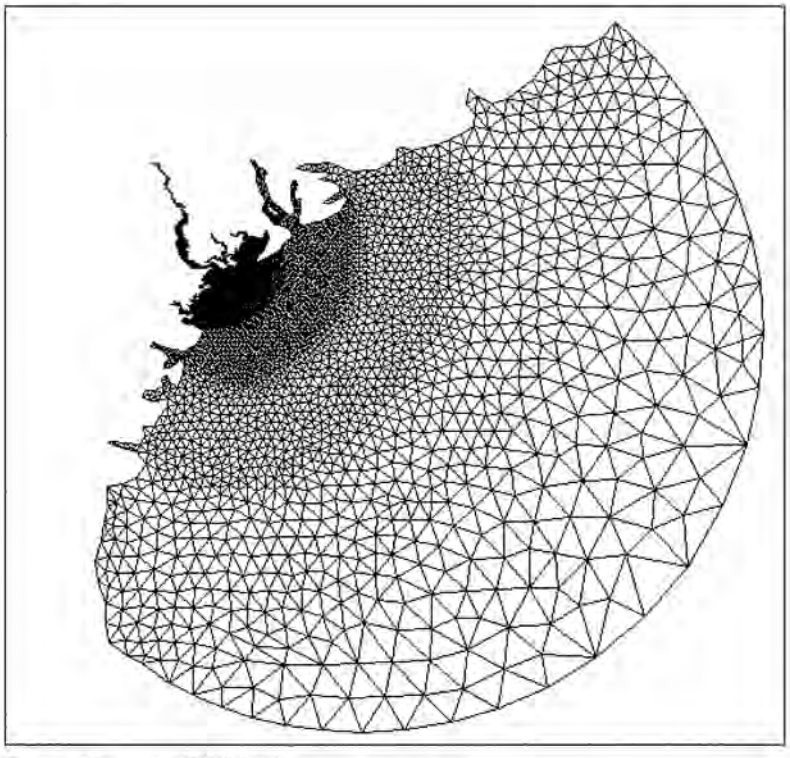


Figure 3. Regional ADCIRC grid

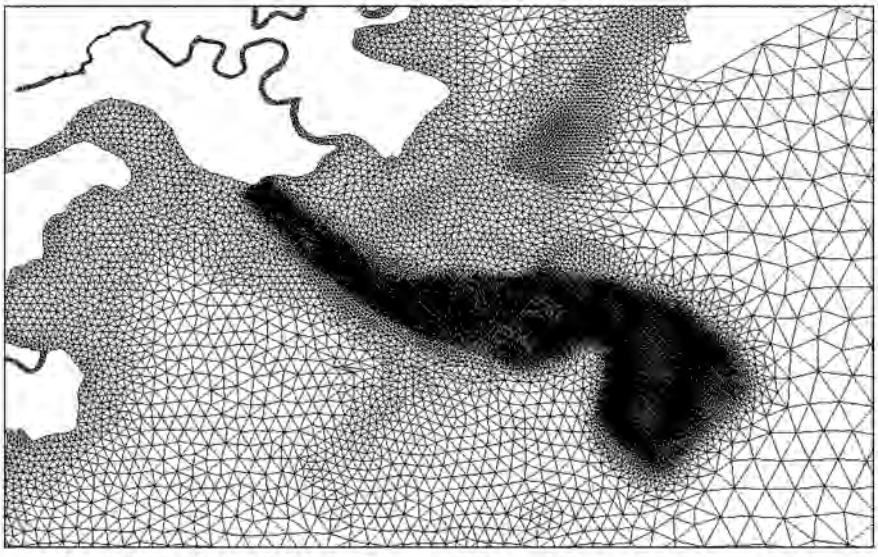


Figure 4. Details of ADCIRC grid for the Savannah area

ADCIRC Forcing Boundaries

Hydrodynamic forcing at the study area includes forcing with two types of boundaries. The first applies time series of water-level forcing constructed from astronomical tidal constituents at the open ocean boundary obtained from the Eastcoast 2001 tidal database (Mukai, Westerink, Luettich 2002). The control file specifies values corresponding to different parameters used by ADCIRC. For tidal Forces the following options were used in the control file:

- Tidal potential was set on.
- Hyperbolic tangent ramp was set on.
- K1, O1, M2, N2, S2, K2, and Q1 minor constituents were used to simulate the semi-diurnal tide.

The second applies river flow at the upstream of the Savannah River. The river flow was obtained from the USGS Savannah Near Clyo Station. Daily river flow was assumed constant during the calibration period and was distributed over the nodes along the normal flow string.

Meteorological forcing of wind speed and direction was entered to a longitude, latitude grid and interpolated in space onto the ADCIRC for the three months of December 1999, November 1979 and January 1992. Fleet numeric wind format was set on and the NWS (the parameter controlling whether wind velocity or stress, wave radiation stress and atmospheric pressure are used to force ADCIRC) was set to 3.

For Hurricane Hugo, wind velocity and atmospheric pressure were interpolated in space onto the ADCIRC grid and in time to synchronize the wind and pressure information with the model time step. The NWS was set to 6 in the control file.

Simulation of December 1999

The time interval for calibration of the model was December 1999.

Model forcing

Water-level forcing constructed from astronomical tidal constituents at the open ocean boundary for December 1999 was obtained from Eastcoast 2001 tidal database (. River flow was obtained from the USGS Savannah Near Clyo Station. Figure 5 shows the daily discharge river flow for December 1999. Wind data during December 1999 was obtained from global National Centers for Environmental Prediction (NCEP) winds.

Model calibration

Initial calculations by the circulation model overpredicted the water level values during low tide. The model was calibrated by:

- Smoothing the irregularities in the marshes.
- Adjusting the values of NODEDRYMIN and NODEWETMIN in the model control file. NODEDRYMIN is the minimum number of time steps after a node dries that it must remain dry before it can wet again. This parameter helps to keep nodes/elements from repeatedly turning on and off during wetting process. NODEWETMIN is the minimum number of time steps after a node wets that it must remain wet before it can dry again. A value of 150 for NODEDRYMIN and 0 for NODEWETMIN produced good agreement between the measured and calculated water level values.
- Adjusting the friction factor. The friction coefficient was adjusted until good agreement between measured and calculated water levels was achieved. A friction factor of 0.05 was set to marshes with elevations more than 0.5 m (MSL) which represents the densely vegetated marshes. A friction factor of 0.0025 was set throughout the rest of the model domain.

Model verification

The circulation model was verified by comparing measured and calculated water level at nine monitoring stations. Measured and calculated current data were compared for a flood and ebb tides.

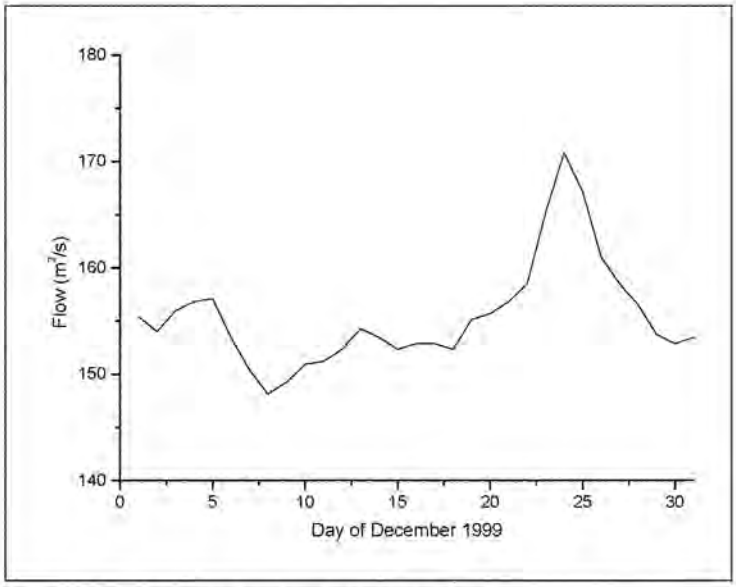


Figure 5. Daily discharge river flow for December 1999

Comparison of measured and calculated water level

The mean error and percent error calculations were used to quantify the comparison of measured and calculated water level at stations shown in figure 6.

The water level data collected in the open ocean was obtained from the South Atlantic Bight Offshore Observational Network (SABSOON) station (R2 Tower) operated by the NAVY. The station is located at 31.375 N and 80.5665 W and at a depth of 26.2 m. The data is obtained from a pressure sensor attached to the tower at a mean depth of 5.69 m below the surface. The data measured by SABSOON was collected in millibar every 6 minutes.

The water level data in the main channel was collected by NOAA station of Fort Pulaski, Savannah River, GA. The station is located at 32.033 N and 80.902 W and hourly data referenced to MSL was used in the comparison with model data.

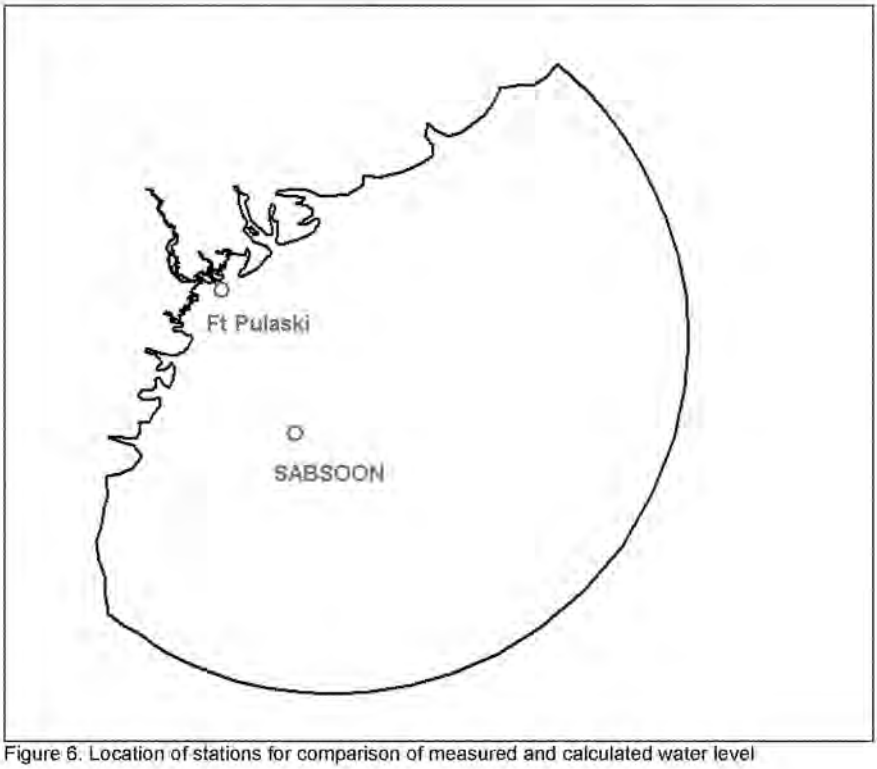


Figure 6. Location of stations for comparison of measured and calculated water level

The rms error E_{rms} provides an absolute measure of error and is given by:

$$E_{rms} = \sqrt{\frac{\sum_{i=1}^{N} X_c - X_m)^2}{N}}$$

where X_c is the calculated value of a variable X, X_m is the measured value of the variable, and N is the number of points.

Percent error E_{pct} is defined in terms of rms error as:

$$E_{pct} = 100 \frac{E_{rms}}{R}$$

where R is a representative range of values for the variable X. For percent error calculations of water level, the difference between MHHW and MLLW at a specified NOS station within the

study area is taken as R. Percent error of less than 10 are considered acceptable (Militello and Kraus, 2001).

To retain nontidal motion, time series of the measured water level were low-pass filtered using cutoff frequency of 0.5 cpd to eliminate motion with 2-day or shorter period. The calculated water level was corrected by adding the filtered data. The percent error at SABSOON was 8 and was 6.0 at Ft Pulaski.

Comparison of measured and calculated water level at SABSOON station, and FT Pulaski are shown in figures 7 and 8 respectively.

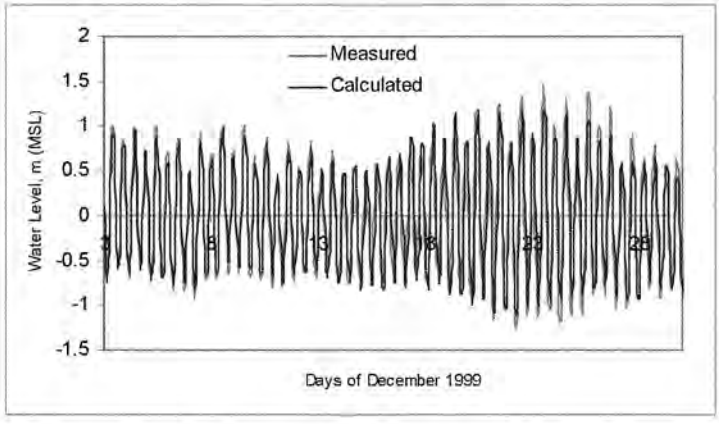


Figure 7. Comparison of measured and calculated water level at SABSOON

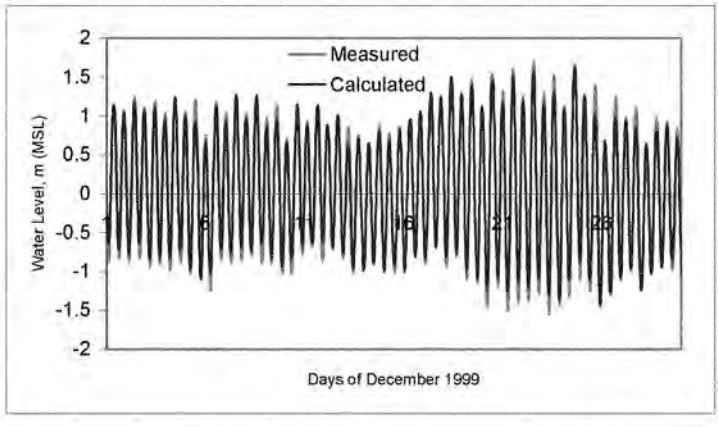


Figure 8. Comparison of measured and calculated water level at Ft Pulaski

Verification of the circulation model was also conducted by comparing measured and calculated water level at seven subordinate stations in the study area (Figure 9). The publication of fully daily tide predictions is limited to small number of stations referred to as "reference stations". Tide prediction at other locations can be obtained by applying time and height differences and ratios to daily tide predictions for the reference stations. Ft Pulaski was the reference station used to predict the tide at six subordinate stations. Figures 10 through 15 show the comparison of measured and calculated water level at the subordinate stations. It can be seen from the figures that calculated water level is in good agreement with measurements.

At Ft Jackson the measured and calculated spring tidal range is compared because no tidal data was found at the reference station of Savannah during December 1999. The ratio of the calculated mean tidal range to the measured one is 0.87 which shows good agreement with measurements.

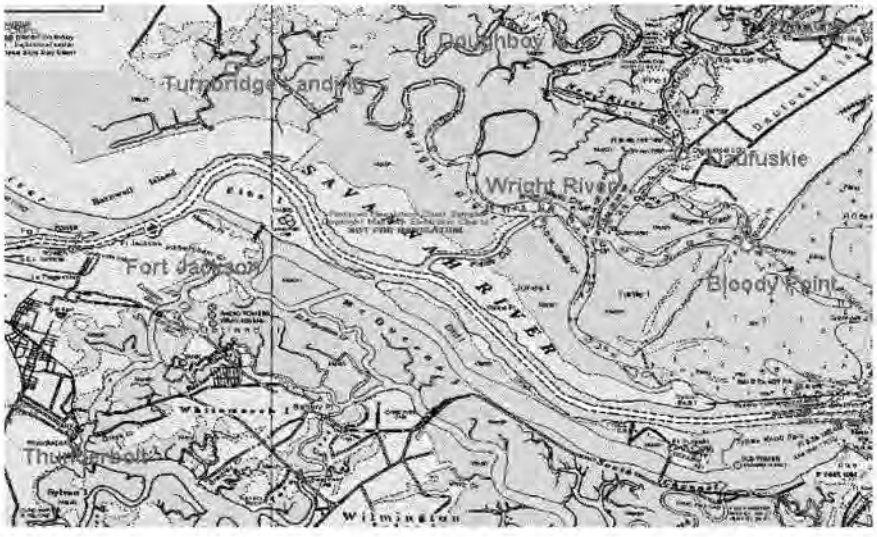


Figure 9. Location of subordinate stations for comparison of measured and calculated water level

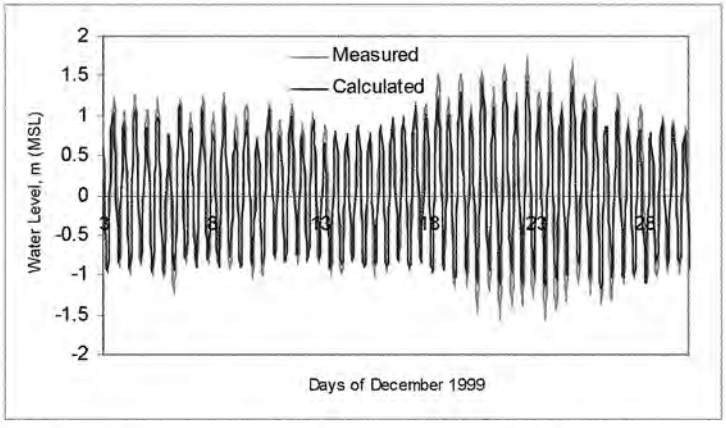


Figure 10. Comparison of measured and calculated water level at Daufuskie

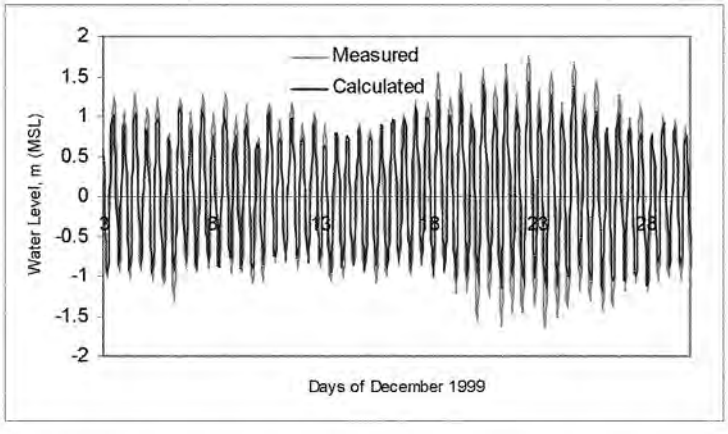


Figure 11. Comparison of measured and calculated water level at Wright River

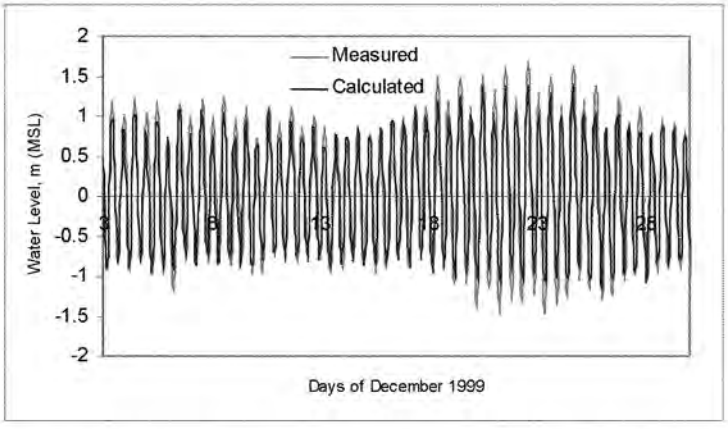


Figure 12. Comparison of measured and calculated water level at Bloody Point

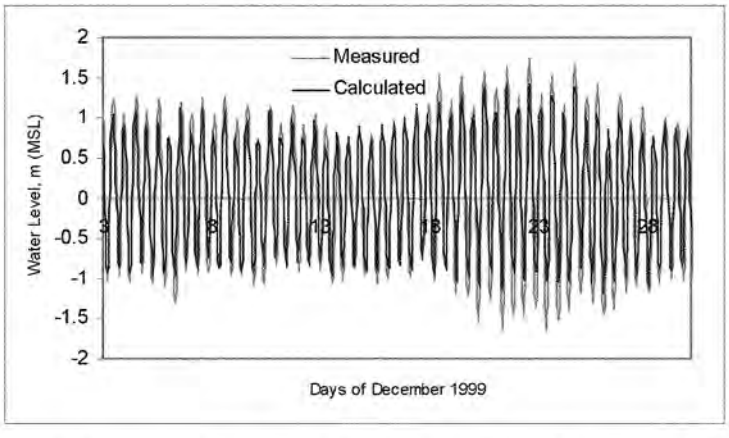


Figure 13. Comparison of measured and calculated water level at Doughboy

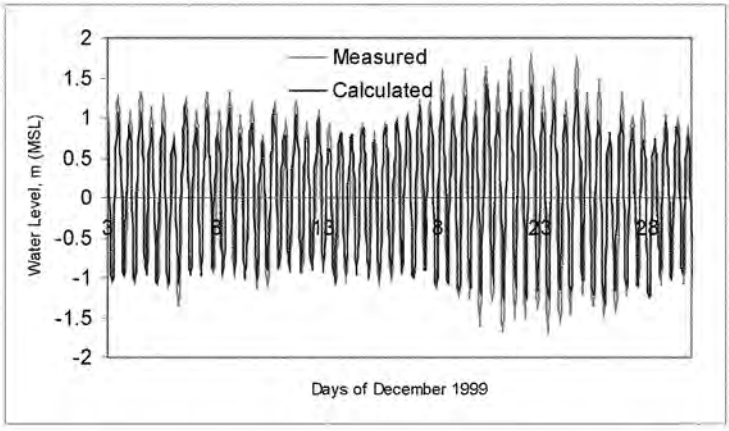


Figure 14. Comparison of measured and calculated water level at Turnbridge Landing

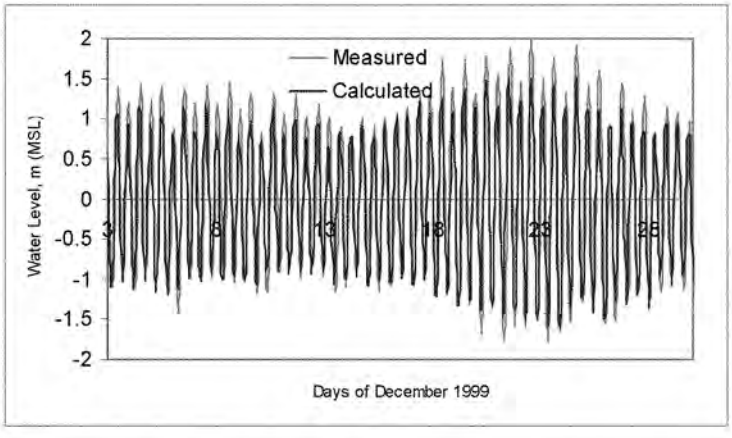


Figure 15. Comparison of measured and calculated water level at Thunderbolt

Comparison of measured and calculated current data

Current data collected by the Applied Technology & Management Inc. was compared to the model on flood and ebb tides as shown in figures 16 and 17 respectively.

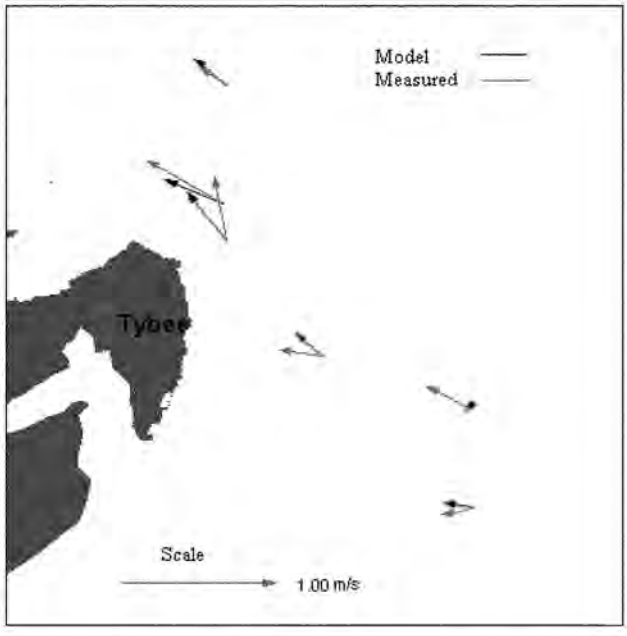


Figure 16. Comparison of measured and calculated current data during flood flow on December 9, 1999

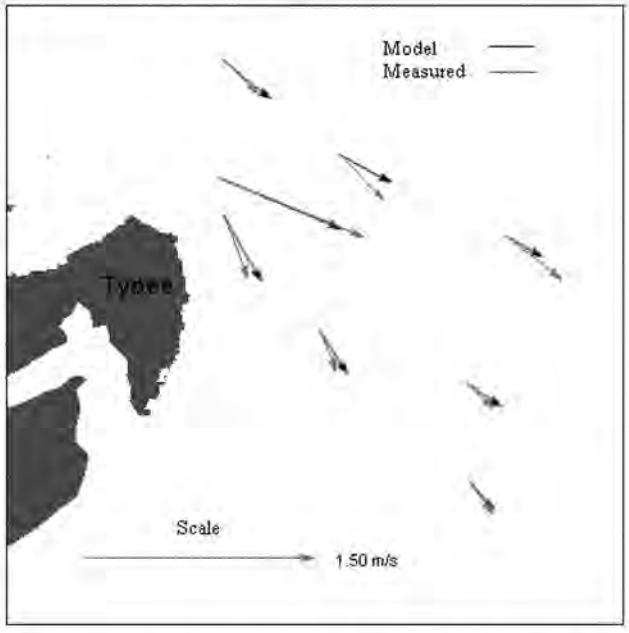


Figure 17. Comparison of measured and calculated current data during ebb flow on December 9, 1999

The measured data was collected on December 9, 1999 from 10:45 to 12:58 (EST) for the flood flow and from 16:16 to 17:00 (EST) for the ebb flow as shown in figure 18. The current data was collected using an Acoustic Doppler Current Profiler (ADCP). The current measurements were depth averaged and averaged over 1-minute.

The comparison between the measured and calculated data shows good agreement during the flood and ebb flows. In general the model is able to reproduce the measured currents. The comparison between the measured and calculated currents for the flood tide shows better agreement than for the ebb case. The measurement time during the flood tide extended for longer period (1.75 hr) compared to the ebb tide (0.75 hr). The flood tide case represents a peak flood and the ebb case was close to slack flow and does not represent peak ebb.

For the ebb case, and close to slack flow, the change in current direction occurs during short period of time. The model results were obtained every 15 minutes. Therefore, the deviation in current direction might be due to mismatching the exact measurement time.

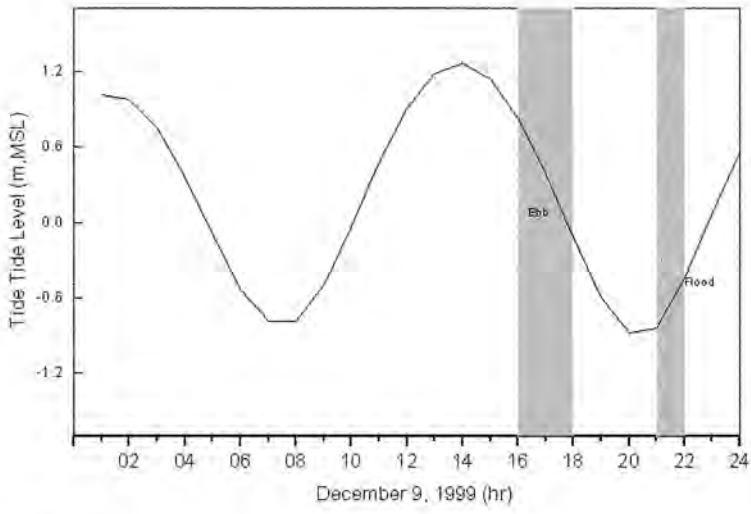


Figure 18. Duration of flood and ebb flow during December 9, 1999

Simulation of One Extreme Storm

Hurricane Hugo was chosen to represent the extreme storm. Hurricane Hugo occurred during September 14-22 1989 and it struck Charleston, South Carolina on September 21 as a category 4 storm. Hugo ranked as the eleventh most intense hurricane at time of landfall to strike U.S. this century and is rated as the second costliest hurricane with over $7 billion in damages. Hurricane Hugo weakened from its peak intensity by the time it smashed the U.S. Virgin Islands on Sept. 17, and then struck a glancing blow to Puerto Rico with winds gusting to 160 mph the next day. Weakened temporarily by its Caribbean island assault, Hugo intensified significantly prior to landfall as it crossed the Gulf Stream off the Southeast U.S. coast. Hugo blew into Charleston, S.C., on the evening of Sept. 21, the autumnal equinox, with winds of 138 mph and a 20 foot storm surge on top of astronomically high tides.

An atmospheric model was applied to compute wind and pressure fields from Hurricane Hugo during the period from September 14 at hour 12 GMT to September 22 at hour 12 GMT. Actual intensity parameters were used, but the locations of the storm for 22/00, 22/06 and 22/12 have been shifted to strike Savannah Harbor. Figure 19 shows the actual and the retracked Hurricane Hugo track. Wind and pressure fields for the "retracked" Hurricane Hugo 1989 were hindcasted every 15 minutes. Figures 20 through 22 show the pressure fields for the "retracked" Hurricane Hugo on 22/00, 22/06 and 22/12 respectively.

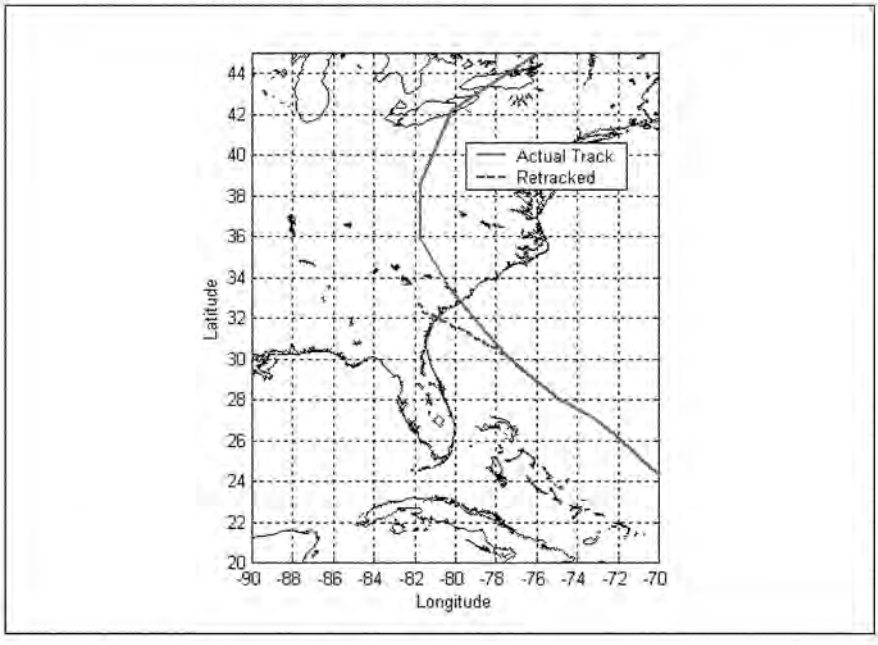


Figure 19. Actual and retracked Hurricane Hugo track

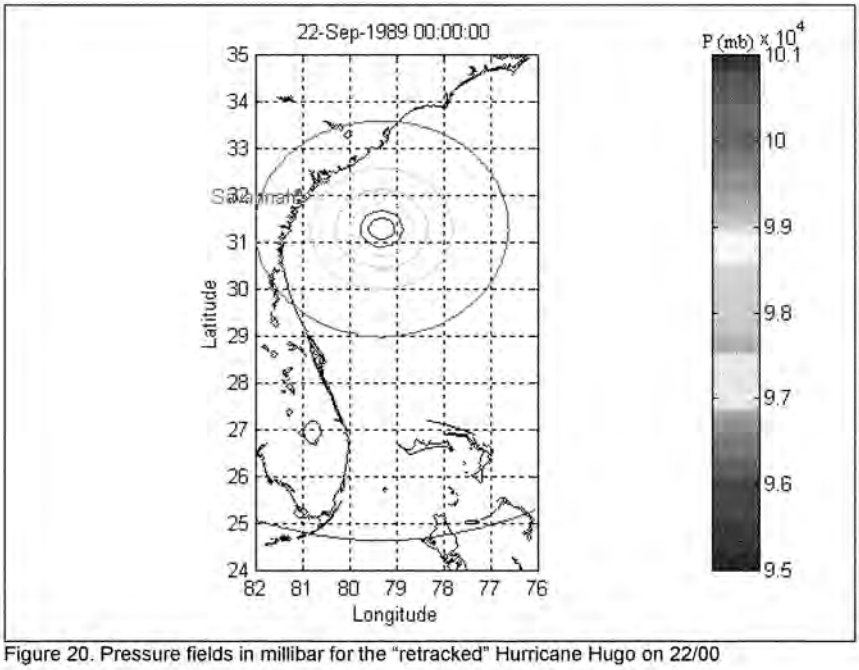


Figure 20. Pressure fields in millibar for the "retracked" Hurricane Hugo on 22/00

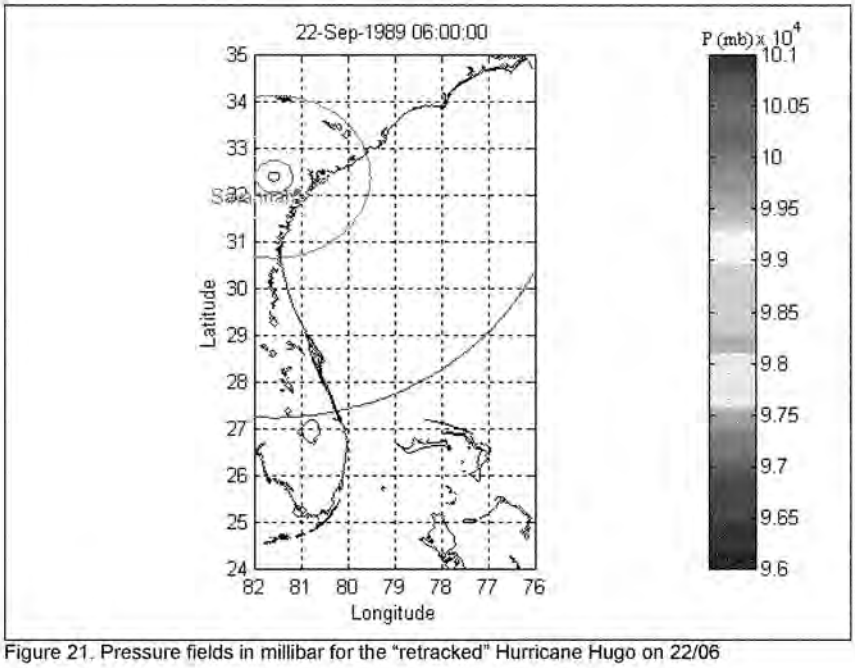


Figure 21. Pressure fields in millibar for the "retracked" Hurricane Hugo on 22/06

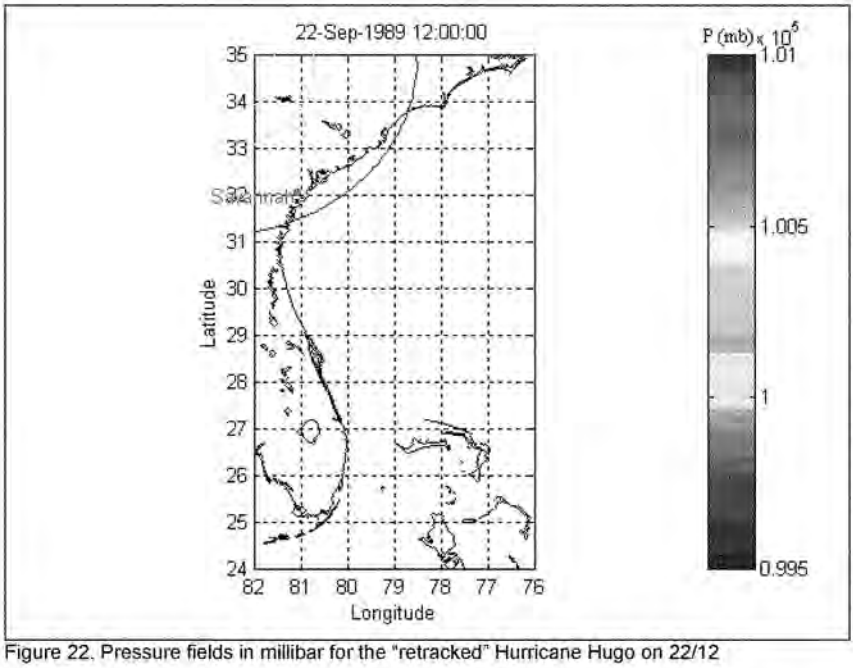


Figure 22. Pressure fields in millibar for the "retracked" Hurricane Hugo on 22/12

The ADCIRC model was forced with water level, river flow and wind and pressure fields. Water-level forcing constructed from astronomical tidal constituents at the open ocean boundary for September 1989 was obtained from the Eastcoast 2001 tidal database. The NODEDRYMIN was set to 30 to reduce the time that the node must remain dry before it can wet again. Daily river flow during the Hurricane at Clyo Station is shown in figure 23. The retracted wind and pressure fields from Hurricane Hugo were converted into an ADCIRC single meteorological input file. Wind velocity and atmospheric pressure are read in for a rectangular grid in Longitude- Latitude. This information is interpolated in space onto the ADCIRC grid and in time to synchronize the wind and pressure information with the model time step.

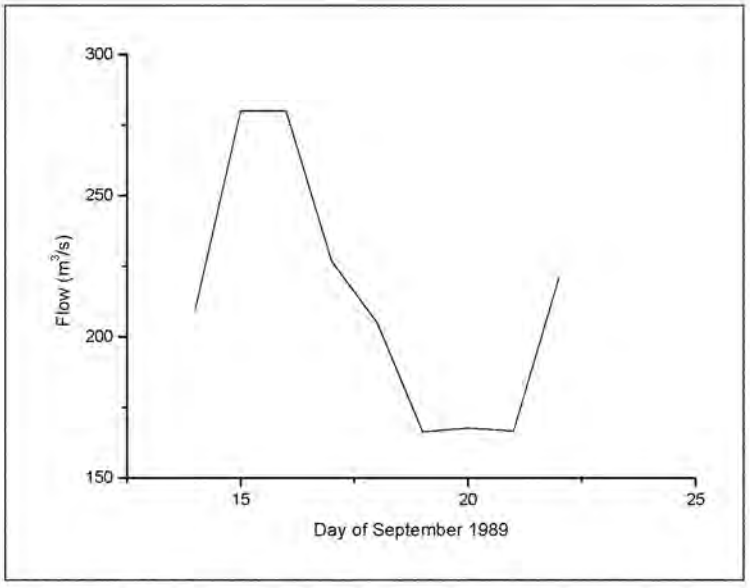


Figure 23. Daily discharge river flow for September 1989

The calculated water level at Ft Pulaski is shown in figure 24. A peak value of 3.1 m was calculated at Ft Pulaski. The circulation pattern during the peak water level at Ft Pulaski is shown in figure 25.

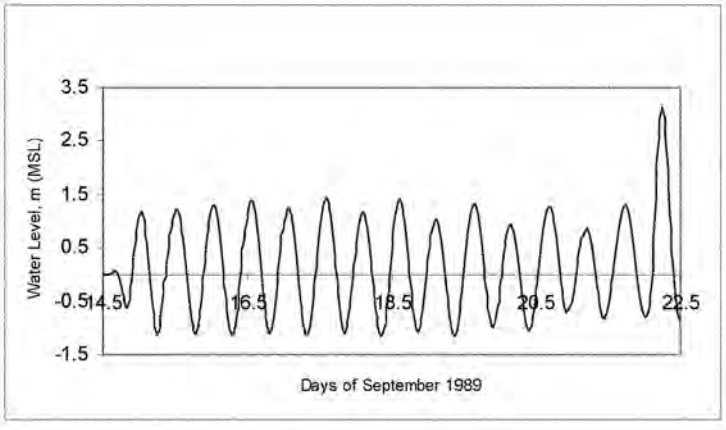


Figure 24. Calculated water level at Ft Pulaski

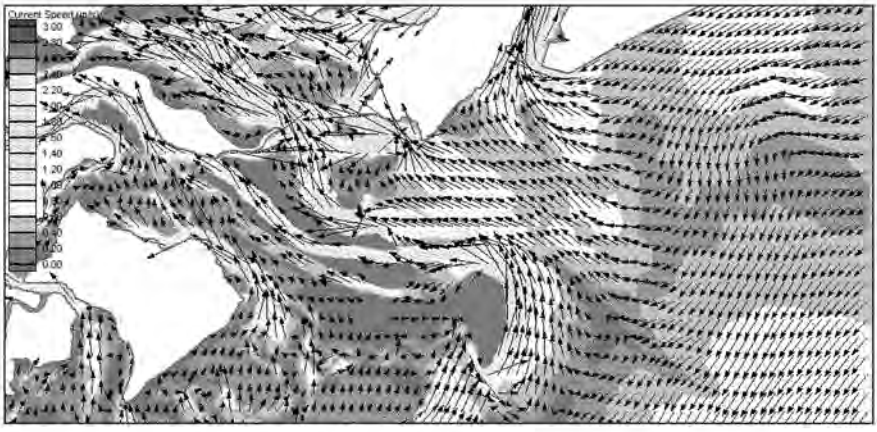


Figure 25. Circulation pattern in the study area during peak water level at Ft Pulaski

Current speed and direction at the seven proposed study sites are shown in figures 26 through 32 during the storm.

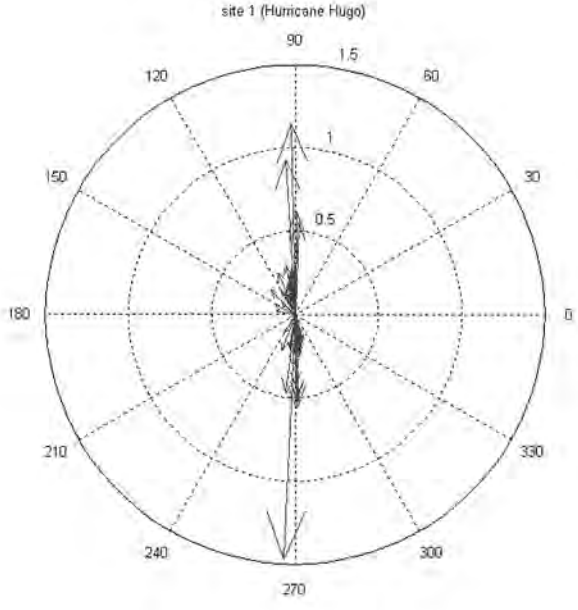


Figure 26. Current vectors at site 1 (current speed in m/s)

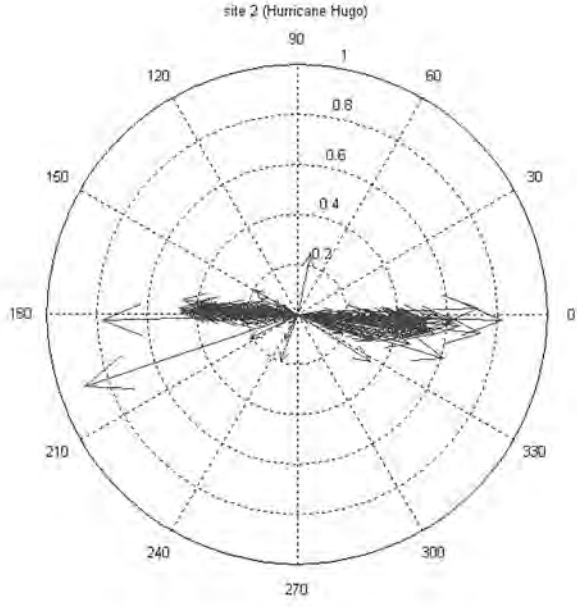


Figure 27. Current vectors at site 2 (current speed in m/s)

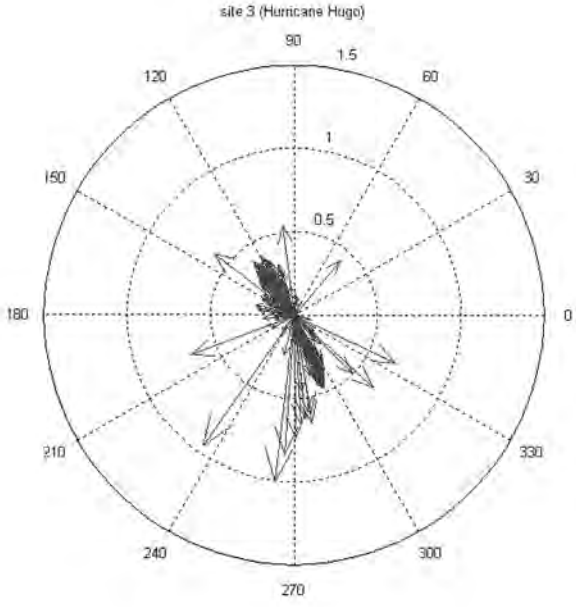


Figure 28. Current vectors at site 3 (current speed in m/s)

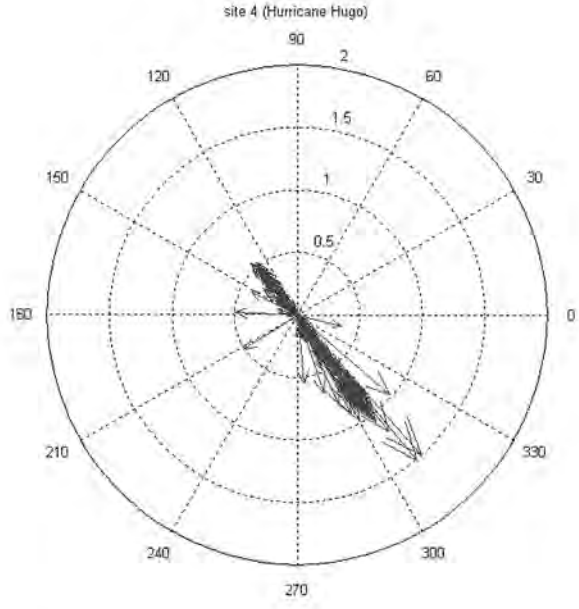


Figure 29. Current vectors at site 4 (current speed in m/s)

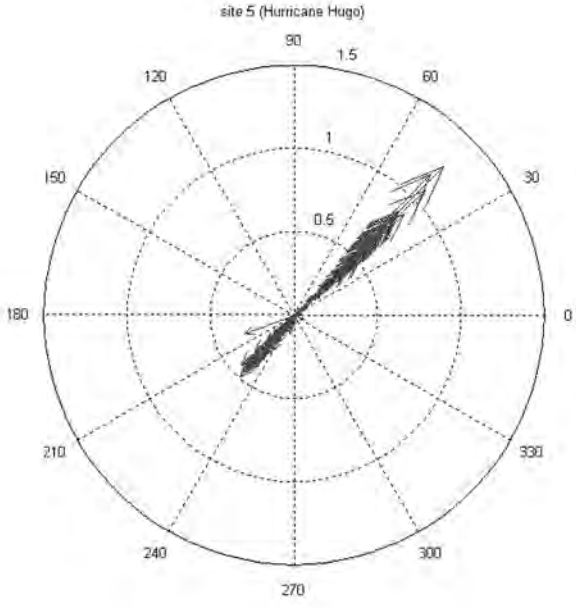


Figure 30. Current vectors at site 5 (current speed in m/s)

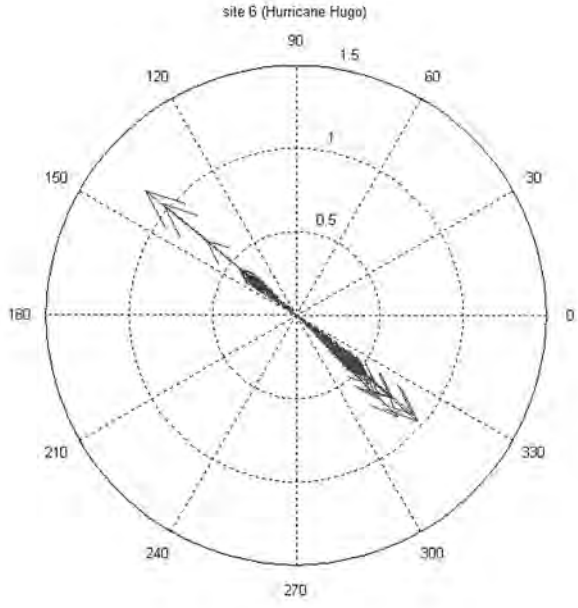


Figure 31. Current vectors at site 6 (current speed in m/s)

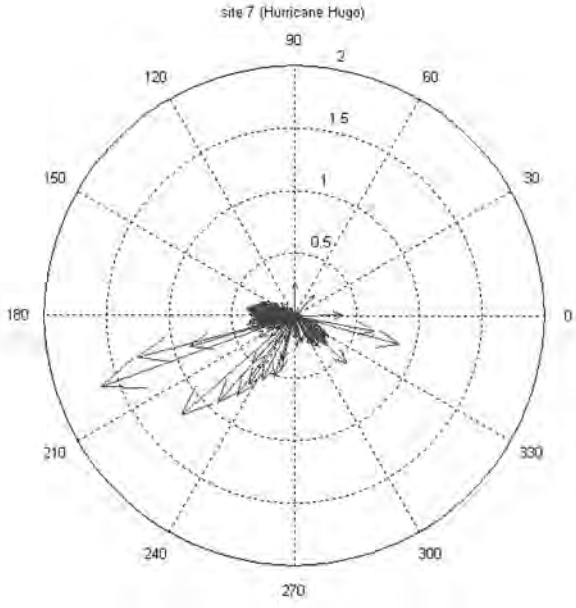


Figure 32. Current vectors at site 7 (current speed in m/s)

At site 1, the current is approximately parallel to the shoreline with maximum current speed of about 1.5 m/s. At site 2 the current is moving approximately parallel to the jetty with maximum speed of about 0.8 m/s. At site 3 the current is shows influence by the tide (toward northeast and southwest), but strong current of about 1.0 m/s moved toward Tybee Island. At site 4 the current is mainly influenced by the tide, the net direction was toward the southeast with maximum current speed of 1.5 m/s. At site 5 the current is parallel to the shore with net direction toward the northeast and with maximum speed of about 1.3 m/s. At site 6 the current is parallel to the shore with net direction toward the southeast and with maximum speed of about 1.2 m/s. At site 7 the current direction is influenced by the tide, but strong currents of about 1.5 m/s were moving toward the shore (northeast).

Simulation of One-Month Active Period

ADCIRC was run for November 1979 as the one-month active period characterizes by a number of more frequent storms. Figure 33 shows the energy-based zero-moment wave height (Hmo) and peak period and direction during November 1979.

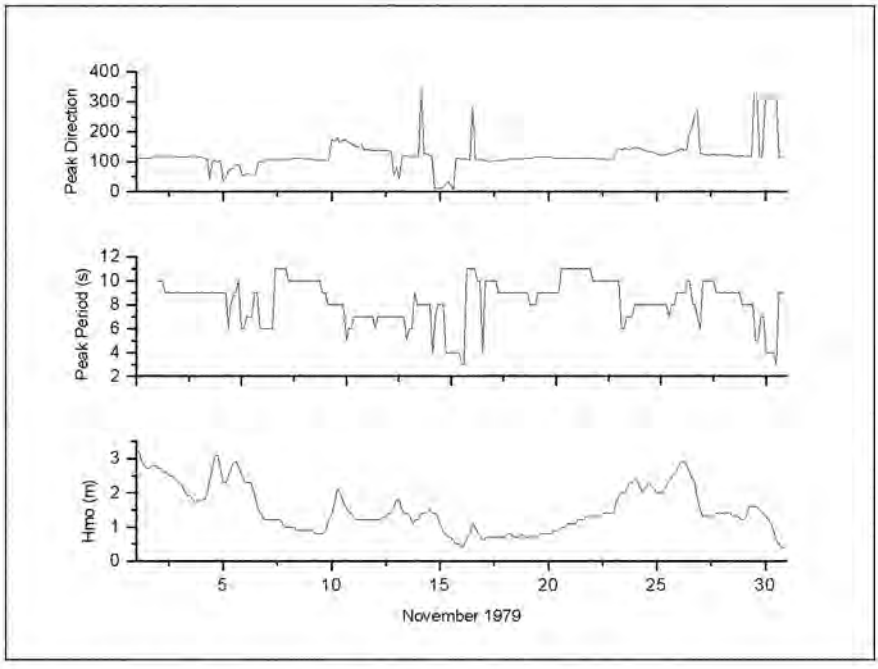


Figure 33. Wave height, period and direction during November 1979

The ADCIRC model was forced with water level, river flow and wind. Water level forcing constructed from astronomical tidal constituents at the open ocean boundary for November 1979 was obtained from the Eastcoast 2001 tidal database. Daily river flow for November 1979 is shown in figure 34. Wind speed and direction was entered to a longitude, latitude grid and interpolated in space onto the ADCIRC grid.

The percent error between measured and calculated water level at Ft Pulaski was 5.

Comparison of measured and calculated water level at Ft Pulaski is shown in figure 35.

Circulation patterns in the study area during peak flood and peak ebb flows are shown in figures 35 and 36 respectively.

Current speed and direction at the seven proposed study sites are shown in figures 38 through 44.

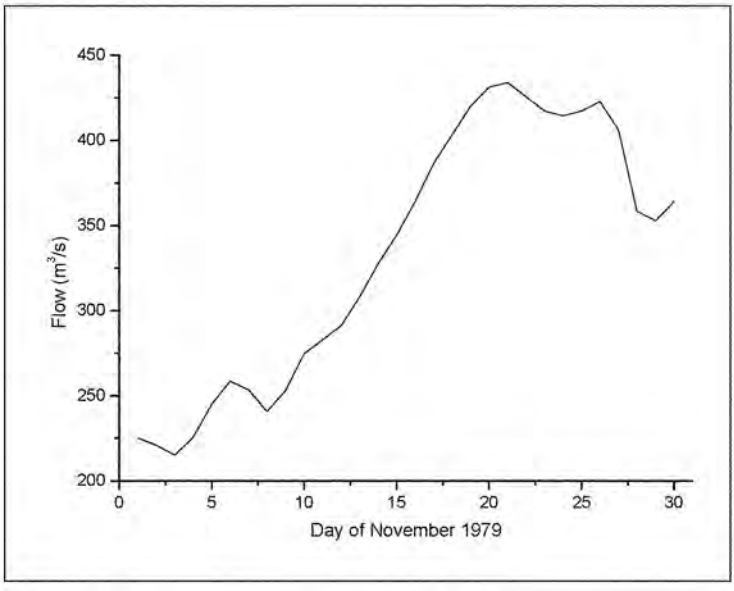


Figure 33. Daily discharge river flow for November 1979

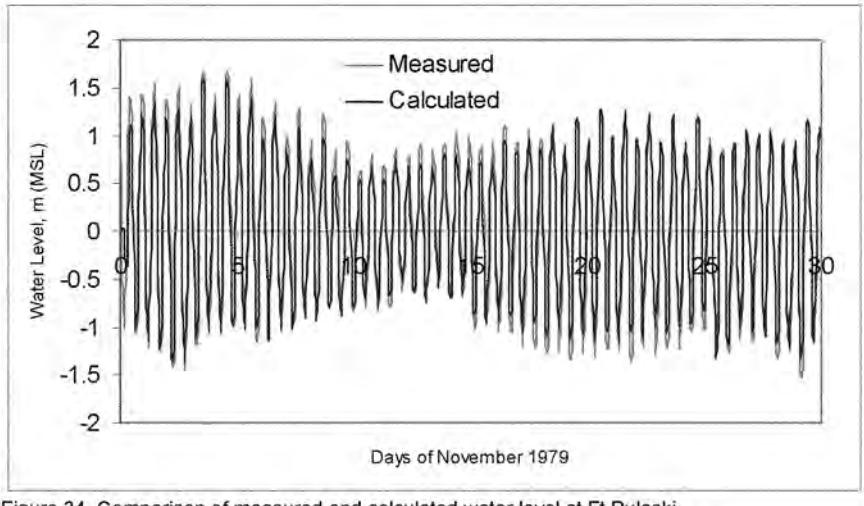


Figure 34. Comparison of measured and calculated water level at Ft Pulaski

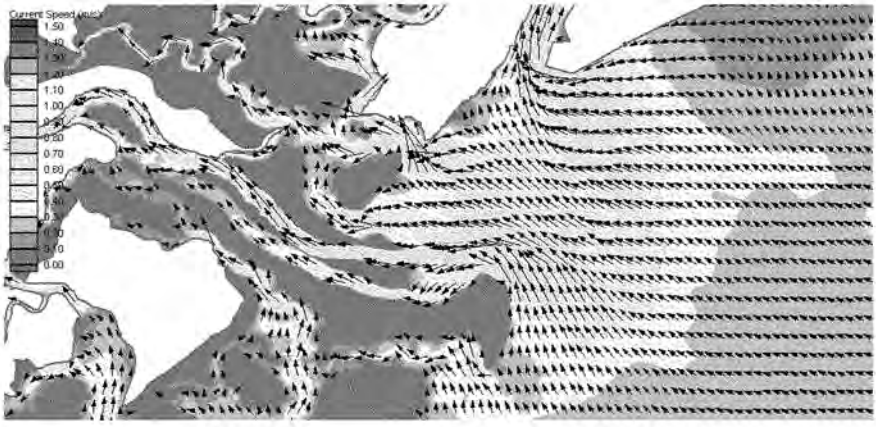


Figure 37. Circulation pattern in the study area during peak flood flow

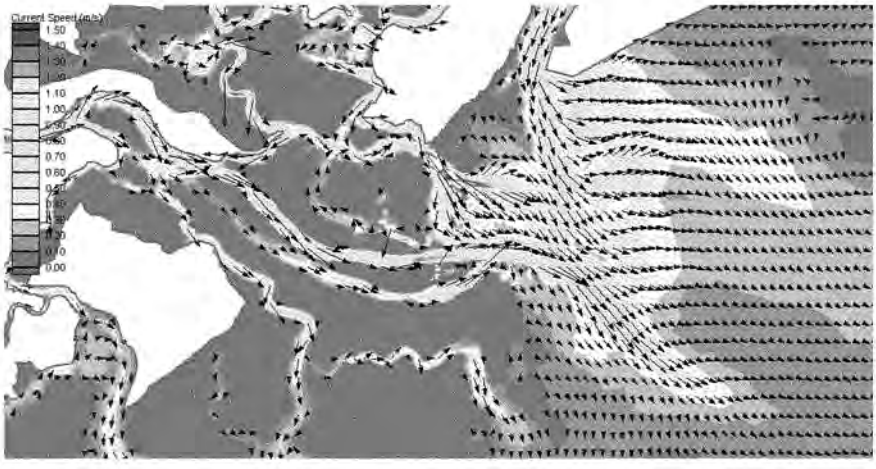


Figure 37. Circulation pattern in the study area during peak ebb flow

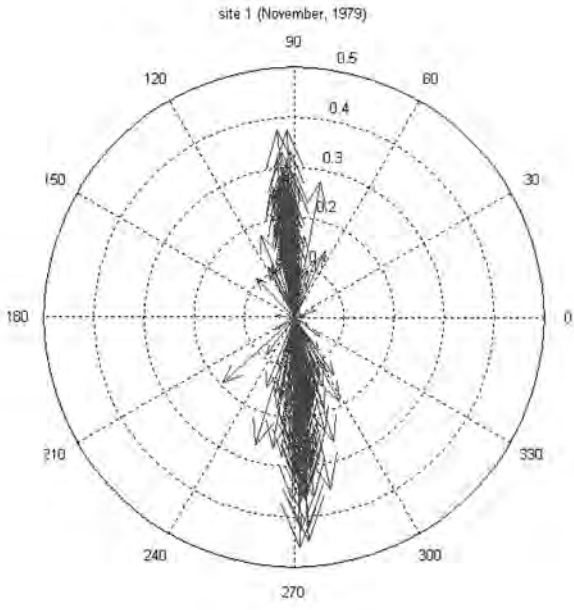


Figure 38. Current vectors at site 1 (current speed in m/s)

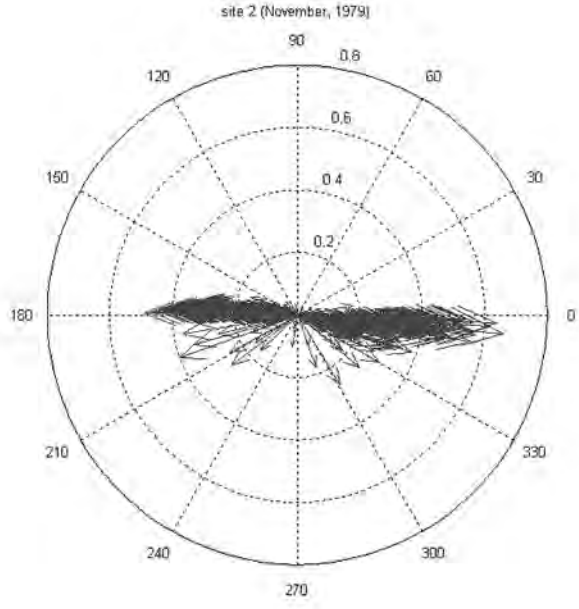


Figure 39. Current vectors at site 2 (current speed in m/s)

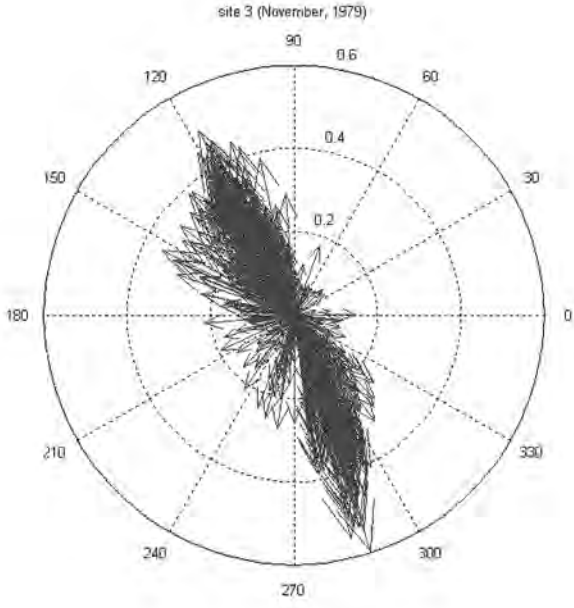


Figure 40. Current vectors at site 3 (current speed in m/s)

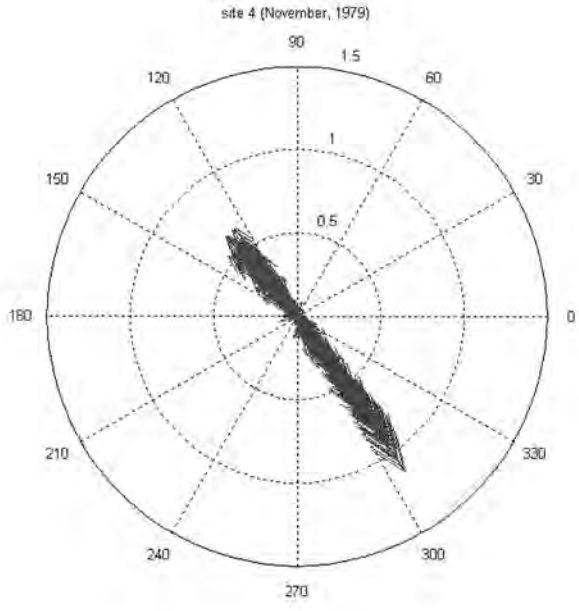


Figure 41. Current vectors at site 4 (current speed in m/s)

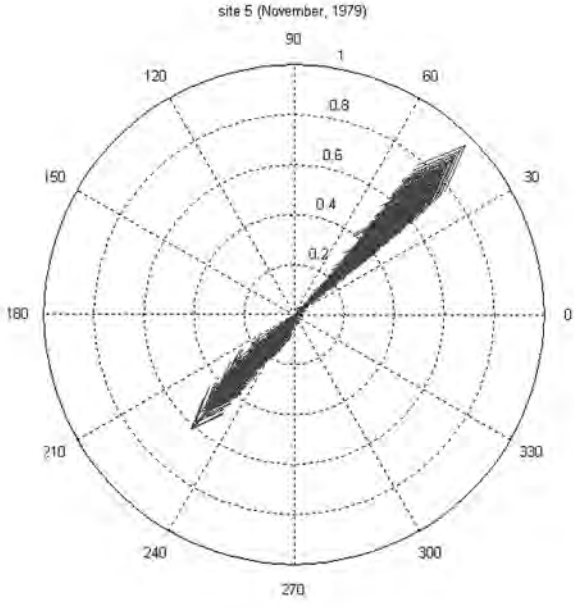


Figure 42. Current vectors at site 5 (current speed in m/s)

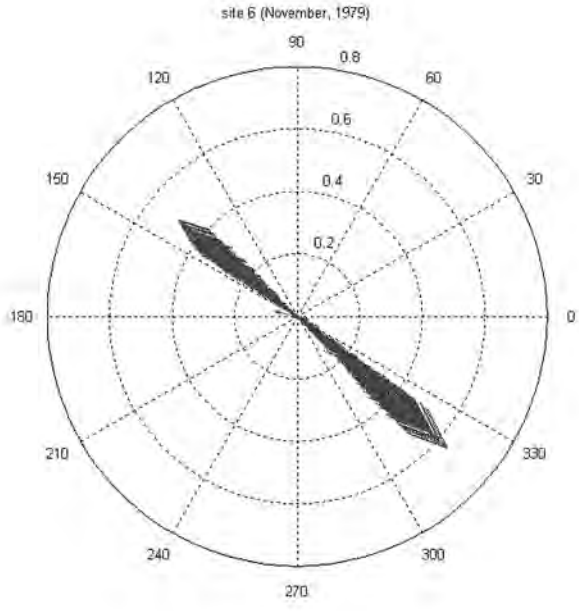


Figure 43. Current vectors at site 6 (current speed in m/s)

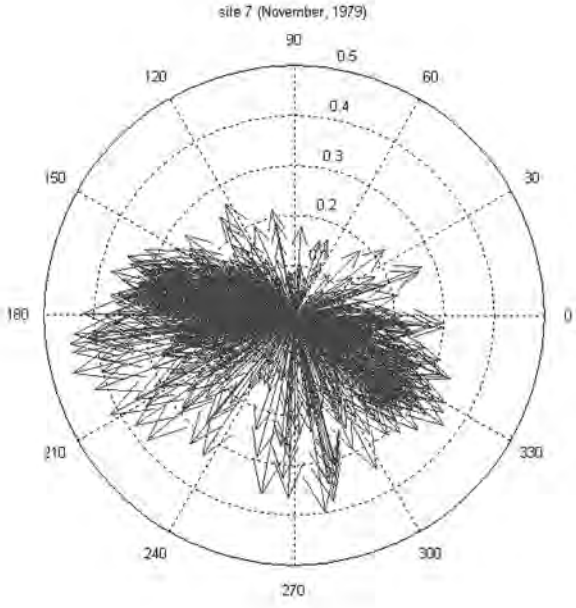


Figure 44. Current vectors at site 7 (current speed in m/s)

It can be seen from the figures that at site 1, the current is approximately parallel to the shoreline with maximum current speed is about 0.4 m/s. At site 2 the current is moving approximately parallel to the jetty with maximum speed of about 0.6 m/s. At site 3 the current is influenced by the tide (toward northeast and southwest) with maximum speed of about 0.6 m/s. Currents with magnitudes of 0.2-0.3 m/s moved toward Tybee Island. At site 4 the current is mainly influenced by the tide with maximum speed of about 1.2 m/s and with net direction toward the southeast. At site 5 the current is parallel to the shore with net direction toward the northeast and with maximum speed of about 1.0 m/s. At site 6 the current is parallel to the shore with net direction toward the southeast and with maximum speed of about 0.65 m/s. At site 7 the current direction is influenced by the tide with maximum speed of about 0.45 m/s, but shows strong tendency for current movement toward the shore (northeast).

Simulation of One-Month Operational Period

ADCIRC was run for January 1992 as the one-month operational period that represents a typical dredging window. Figure 45 shows the energy-based zero-moment wave height (Hmo) and peak period and direction during January 1992.

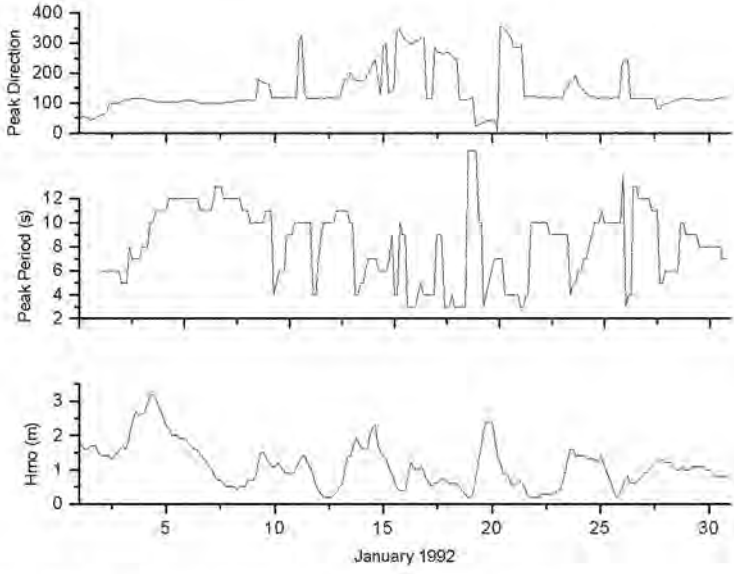


Figure 45. Wave height, period and direction during November 1979

The ADCIRC model was forced with water level, river flow and wind. Water level forcing constructed from astronomical tidal constituents at the open ocean boundary for January 1992 was obtained from the Eastcoast 2001 tidal database. Daily river flow for January 1992 is shown in figure 46. Wind speed and direction was entered to a longitude, latitude grid and interpolated in space onto the ADCIRC grid.

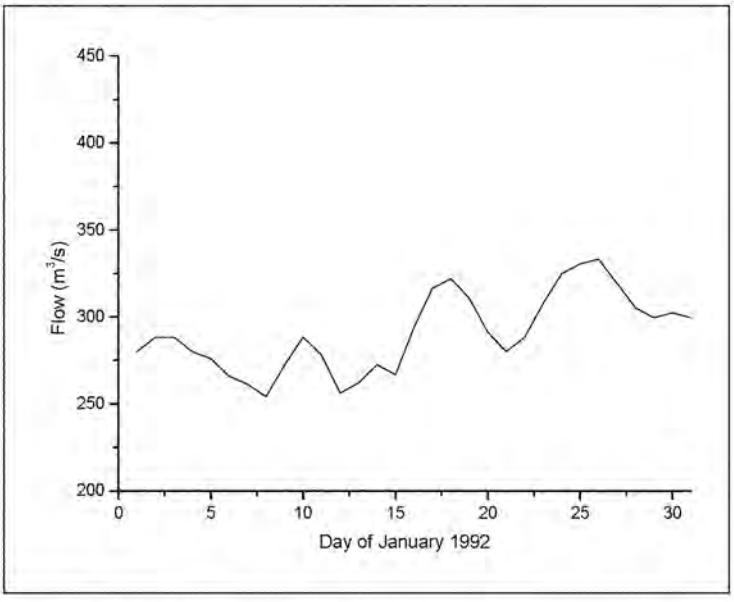


Figure 46. Daily discharge river flow for January 1992

The percent error between measured and calculated water level at Ft Pulaski was 7.

Comparison of measured and calculated water level at Ft Pulaski is shown in figure 48.

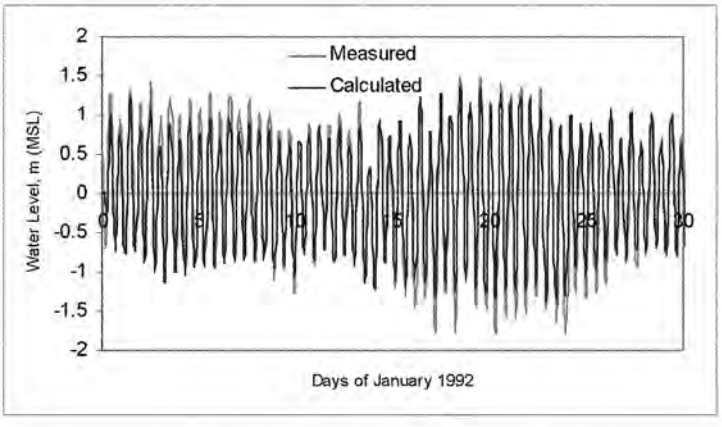


Figure 48. Comparison of measured and calculated water level at Ft Pulaski

Circulation patterns in the study area during peak flood and peak ebb flows are shown in figures 49 and 50 respectively.

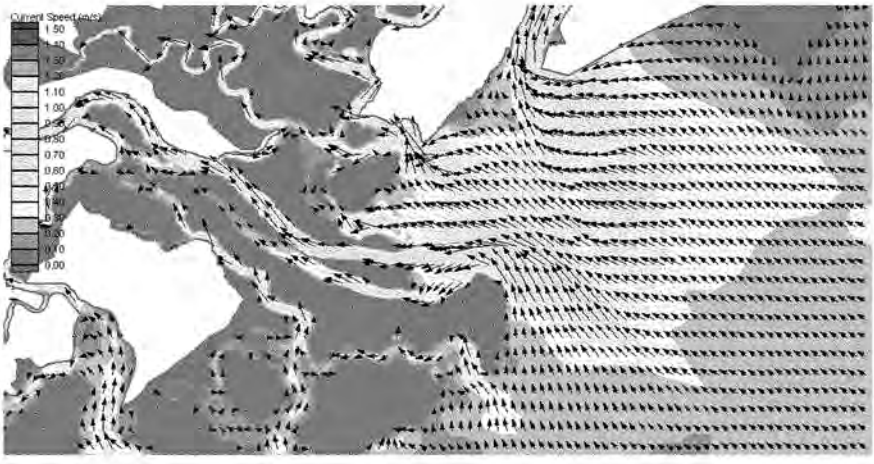


Figure 49. Circulation pattern in the study area during peak flood flow.

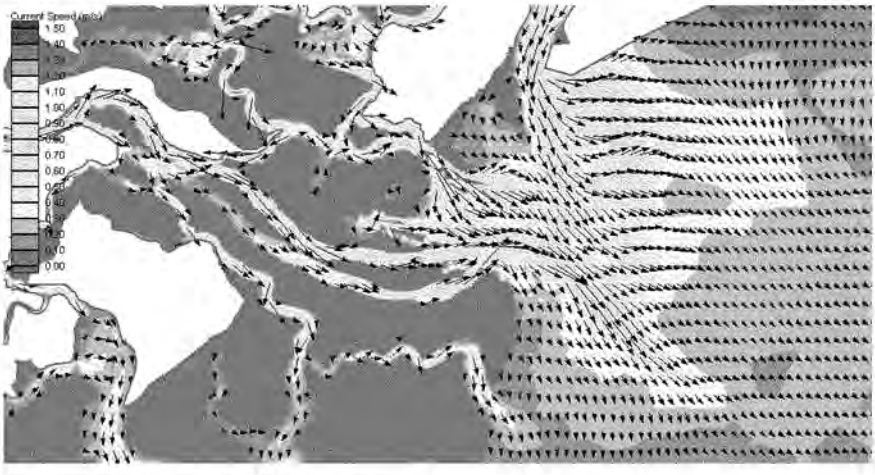


Figure 50. Circulation pattern in the study area during peak ebb flow.

Current speed and direction at the seven proposed study sites are shown in figures 51 through 57.

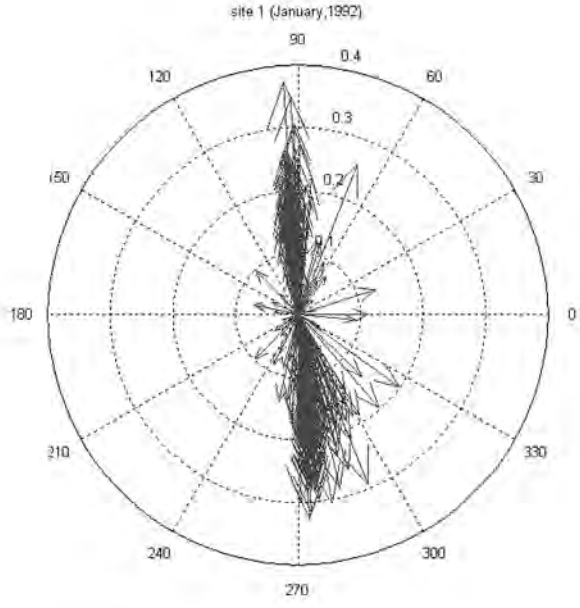


Figure 51. Current vectors at site 1 (current speed in m/s)

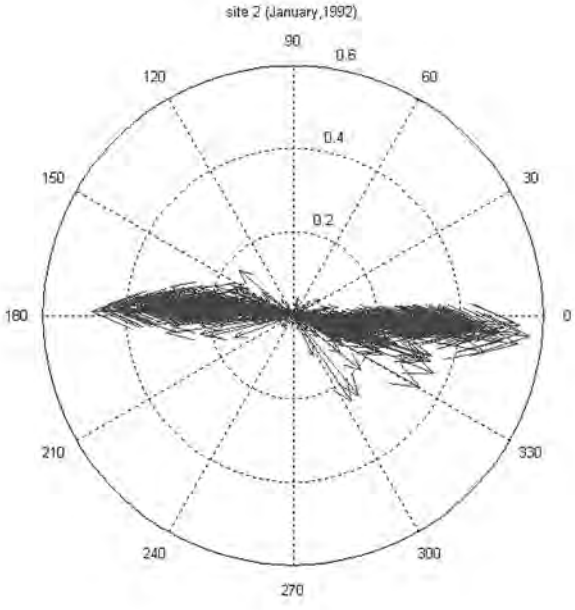


Figure 52. Current vectors at site 2 (current speed in m/s)

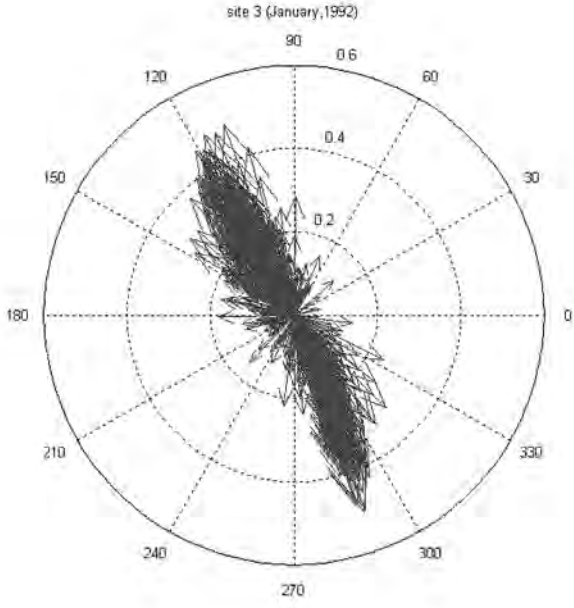


Figure 53. Current vectors at site 3 (current speed in m/s)

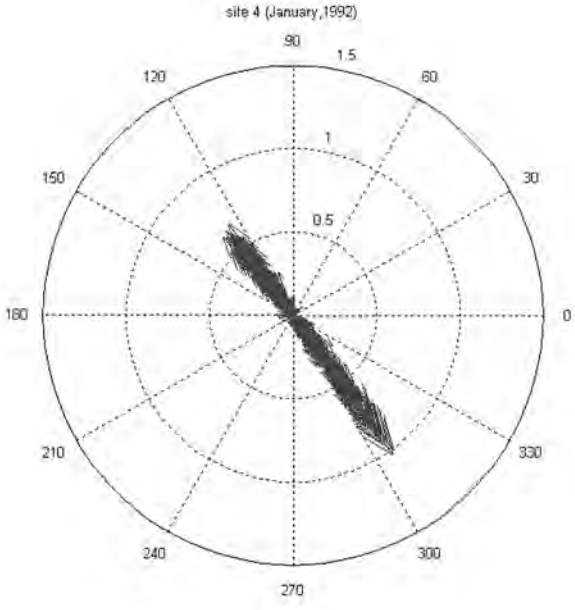


Figure 54. Current vectors at site 4 (current speed in m/s)

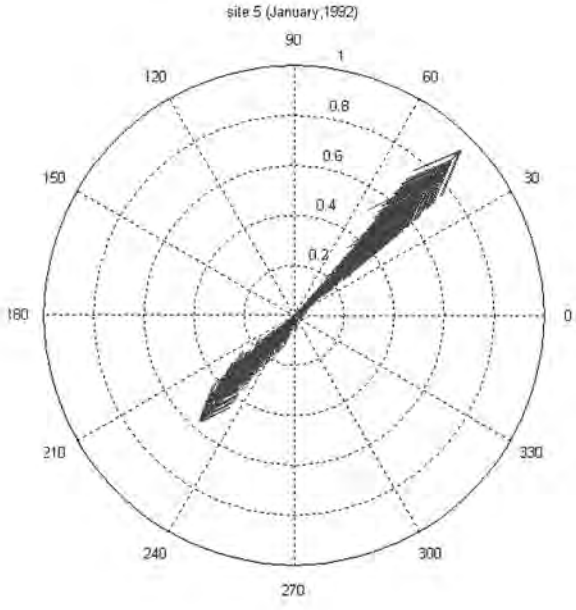


Figure 55. Current vectors at site 5 (current speed in m/s)

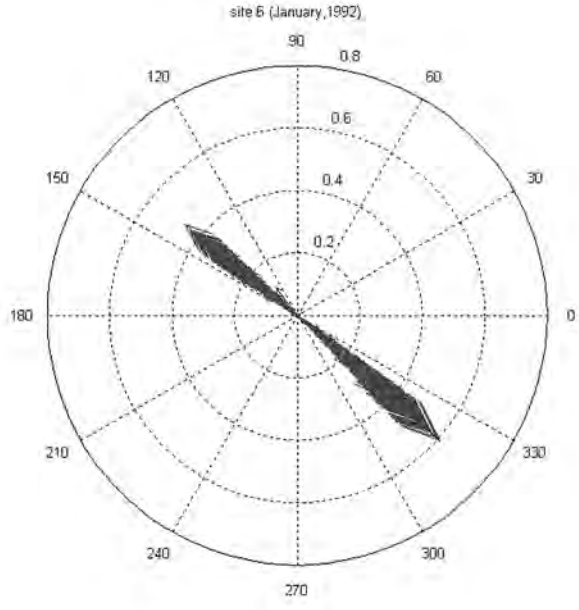


Figure 56. Current vectors at site 6 (current speed in m/s)

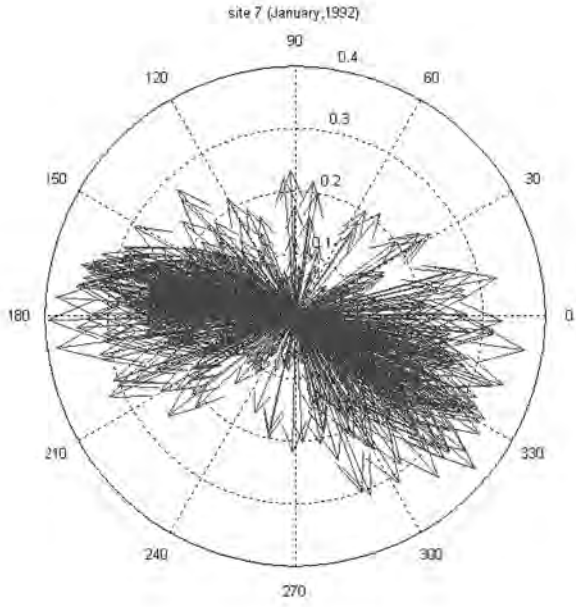


Figure 57. Current vectors at site 7 (current speed in m/s)

At site 1, the current is approximately parallel to the shoreline with maximum current speed of about 0.4 m/s. At site 2 the current is moving approximately parallel to the jetty with maximum speed of about 0.5 m/s. At site 3 the current is influenced by the tide (toward northeast and southwest) with maximum speed of about 0.5 m/s. At site 4 the current is mainly influenced by the tide with maximum speed of about 1.0 m/s and with net direction toward the southeast. At site 5 the current is parallel to the shore with net direction toward the northeast and with maximum speed of about 1.0 m/s. At site 6 the current is parallel to the shore with net direction toward the southeast and with maximum speed of about 0.6 m/s. At site 7 the current direction is influenced by the tide with maximum speed of about 0.4 m/s, but shows tendency for current movement toward the shore (northeast).

Simulation of One-Month Summer Period

ADCIRC was run for July 1999 as the one-month summer period. The ADCIRC model was forced with water level only. Water level was constructed from astronomical tidal constituents at the open ocean boundary for July 1999 obtained from the Eastcoast 2001 tidal database.

The percent error between measured and calculated water level at Ft Pulaski was 5.

Comparison of measured and calculated water level at Ft Pulaski is shown in figure 58.

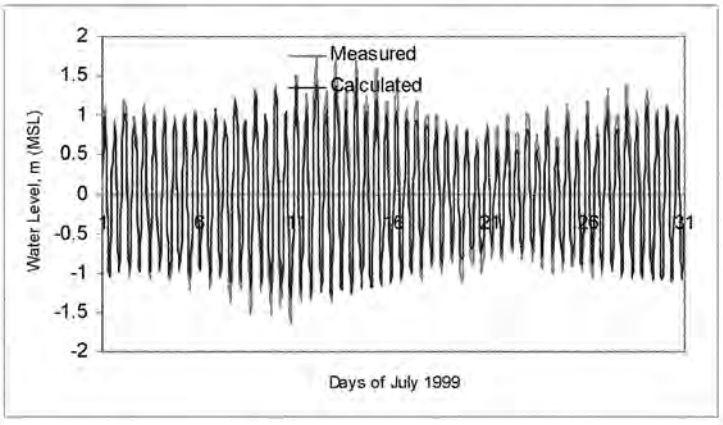


Figure 58. Comparison of measured and calculated water level at Ft Pulaski

Circulation patterns in the study area during peak flood and peak ebb flows are shown in figures 59 and 60 respectively.

Current speed and direction at the seven proposed study sites are shown in figures 61 through 67.

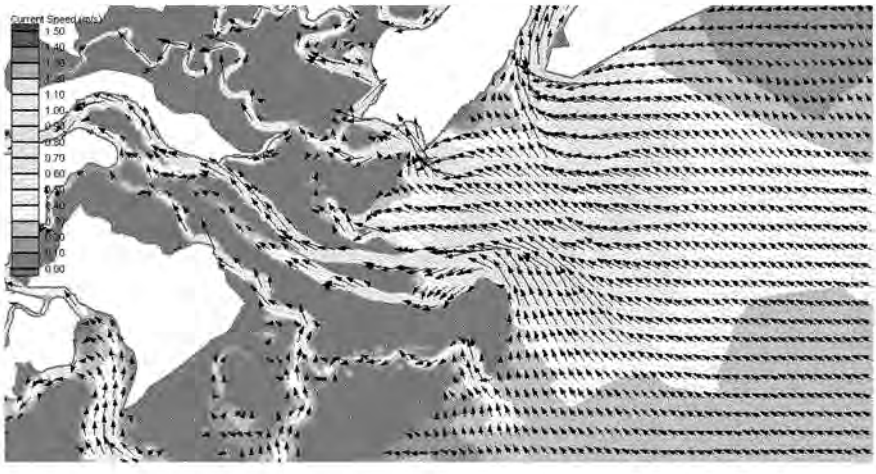


Figure 59. Circulation pattern in the study area during peak flood flow

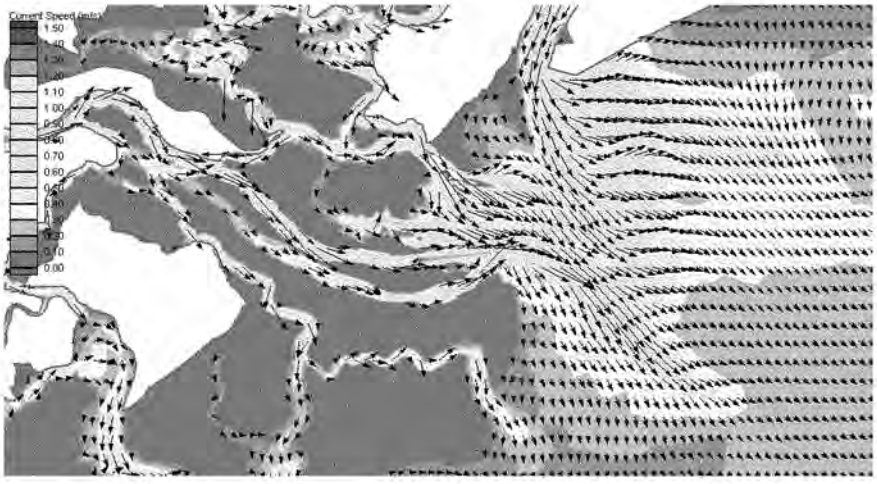


Figure 60. Circulation pattern in the study area during peak ebb flow

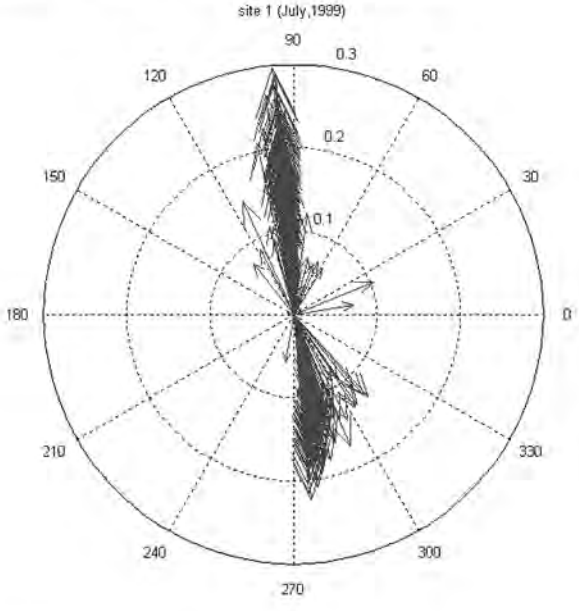


Figure 61 Current vectors at site 1 (current speed in m/s)

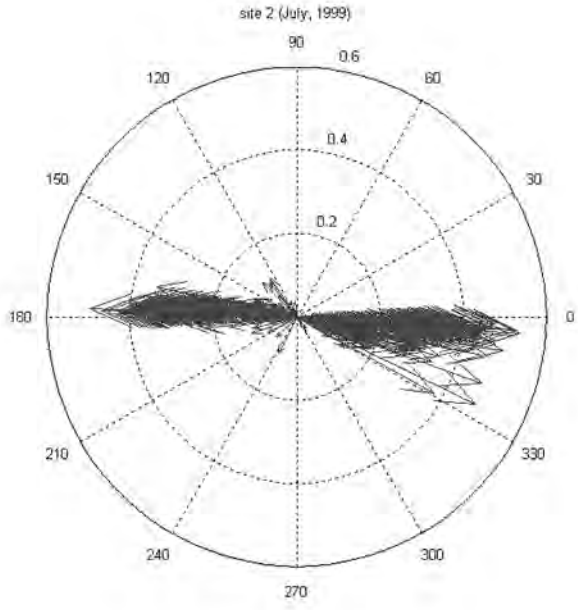


Figure 62. Current vectors at site 2 (current speed in m/s)

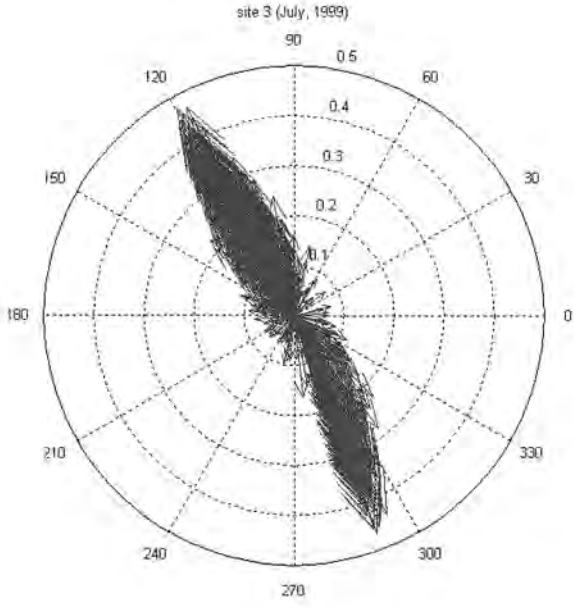


Figure 63. Current vectors at site 3 (current speed in m/s)

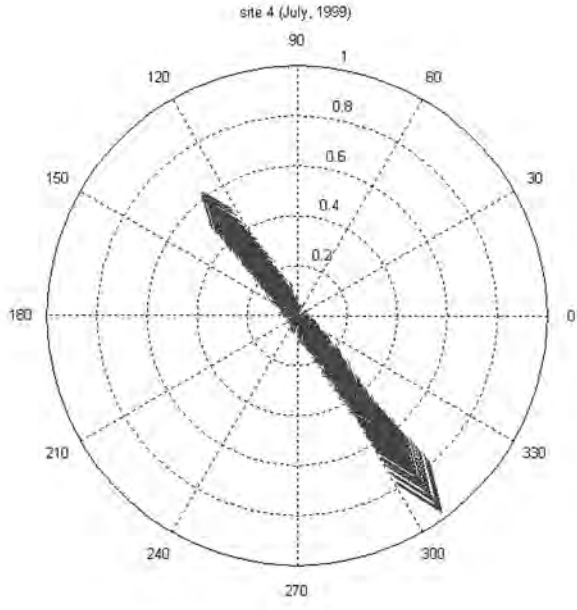


Figure 64. Current vectors at site 4 (current speed in m/s)

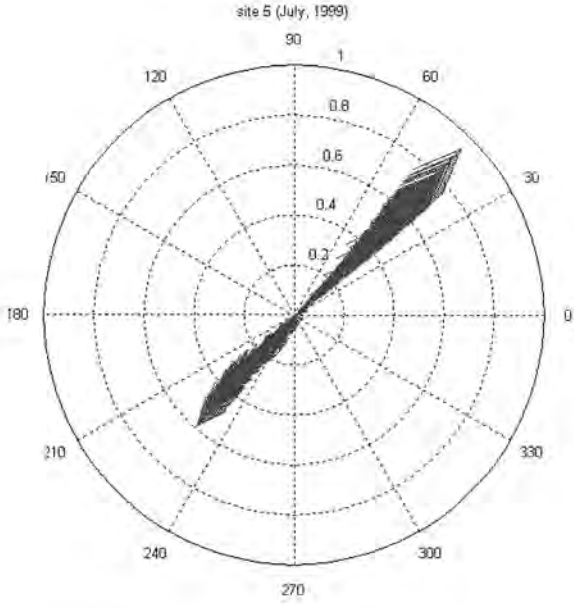


Figure 65. Current vectors at site 5 (current speed in m/s)

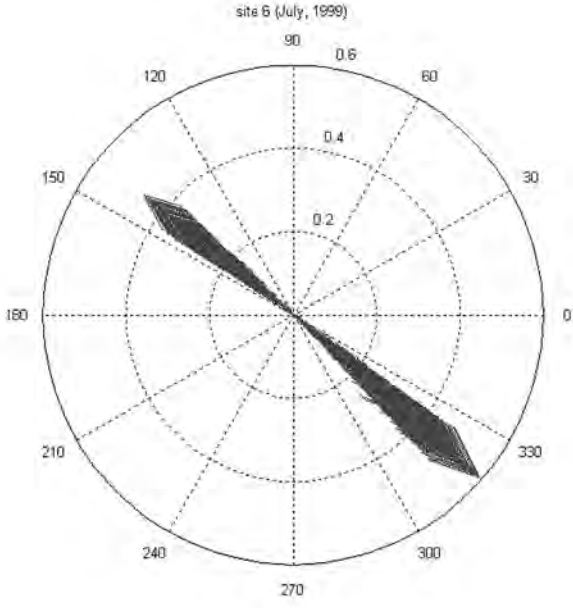


Figure 66. Current vectors at site 6 (current speed in m/s)

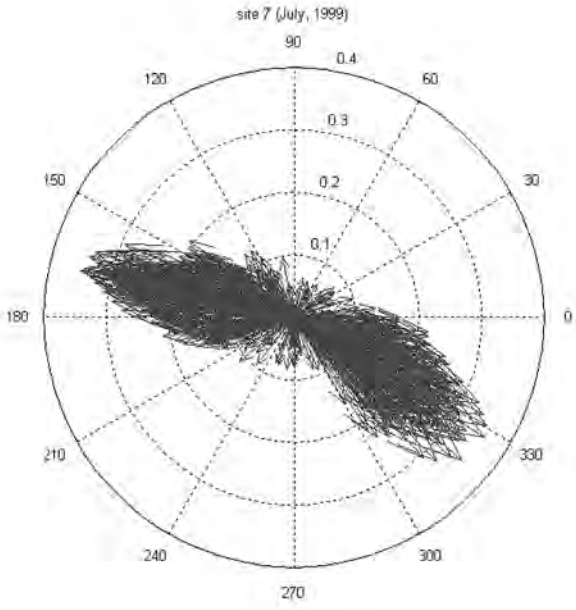


Figure 67. Current vectors at site 7 (current speed in m/s)

At site 1, the current is approximately parallel to the shoreline with maximum current speed of about 0.3 m/s. At site 2 the current is moving approximately parallel to the jetty with maximum speed of about 0.5 m/s. At site 3 the current is influenced by the tide (toward northeast and southwest) with maximum speed of about 0.5 m/s. At site 4 the current is mainly influenced by the tide with maximum speed of about 1.0 m/s and with net direction toward the southeast. At site 5 the current is parallel to the shore with net direction toward the northeast and with maximum speed of about 1.0 m/s. At site 6 the current is parallel to the shore with net direction toward the southeast and with maximum speed of about 0.6 m/s. At site 7 the current direction is mainly influenced by the tide with maximum speed of about 0.35 m/s.

Summary of ADCIRC Results

ADCIRC was calibrated for the period of December 1999. The model was used to simulate the flow during one extreme storm (Hurricane Hugo, 1989), one-month active period (November, 1979), one-month operational period (January, 1992) and one-month summer period (July, 1999).

Table 1 shows the percent error between measured and calculated water level at Ft Pulaski during the above mentioned simulation periods. Measured data was not available at Ft Pulaski during the Hurricane case and therefore the percent error was not calculated. The model shows good agreement between measured and calculated water level during all the simulations.

Table 1
Error in Calculated Water Level

Simulation	Percent Error
November 1979	5
January 1992	7
July 1999	5

Tables 2 through 8 show the maximum current speed and the predominant direction at the seven proposed study sites during each simulation period.

Table 2
Maximum Current Speed and Predominant Direction at Site 1

Simulation	Maximum Current Speed (m/s)	Predominant Direction
Hurricane Hugo	1.5	Parallel to shoreline
November 1979	0.4	Parallel to shoreline
January 1992	0.4	Parallel to shoreline
July 1999	0.3	Parallel to shoreline

Table 3
Maximum Current Speed and Predominant Direction at Site 2

Simulation	Maximum Current Speed (m/s)	Predominant Direction
Hurricane Hugo	0.8	Parallel to jetty
November 1979	0.6	Parallel to jetty
January 1992	0.5	Parallel to jetty
July 1999	0.5	Parallel to jetty

Table 4
Maximum Current Speed and Predominant Direction at Site 3

Simulation	Maximum Current Speed (m/s)	Predominant Direction
Hurricane Hugo	1.0	Influenced by the tide with strong current moving toward Tybee Island
November 1979	0.6	Influenced by the tide with current of 0.2-0.3 m/s moving toward Tybee Island
January 1992	0.5	Influenced by the tide
July 1999	0.5	Influenced by the tide

Table 5
Maximum Current Speed and Predominant Direction at Site 4

Simulation	Maximum Current Speed (m/s)	Predominant Direction
Hurricane Hugo	1.5	Influenced by the tide with net direction toward southeast
November 1979	1.2	Influenced by the tide with net direction toward southeast
January 1992	1.0	Influenced by the tide with net direction toward southeast
July 1999	1.0	Influenced by the tide with net direction toward southeast

Table 6
Maximum Current Speed and Predominant Direction at Site 5

Simulation	Maximum Current Speed (m/s)	Predominant Direction
Hurricane Hugo	1.3	Parallel to shore with net direction toward northeast
November 1979	1.0	Parallel to shore with net direction toward northeast
January 1992	1.0	Parallel to shore with net direction toward northeast
July 1999	1.0	Parallel to shore with net direction toward northeast

Table 7
Maximum Current Speed and Predominant Direction at Site 6

Simulation	Maximum Current Speed (m/s)	Predominant Direction
Hurricane Hugo	1.2	Parallel to shore with net direction toward southeast
November 1979	0.65	Parallel to shore with net direction toward southeast
January 1992	0.6	Parallel to shore with net direction toward southeast
July 1999	0.6	Parallel to shore with net direction toward southeast

Table 8
Maximum Current Speed and Predominant Direction at Site 7

Simulation	Maximum Current Speed (m/s)	Predominant Direction
Hurricane Hugo	1.5	Tidal with strong current moving toward northeast
November 1979	0.45	Tidal with strong current moving toward northeast
January 1992	0.4	Tidal with some current moving toward northeast
July 1999	0.35	Tidal

Highest current speed occurred during the hurricane case at the seven sites as expected. Lowest current speed values were observed during the calm period of July where the model was forced with water level only. The tendency for current to move toward the shore increased during the storm and the active period at sites 3 and 7.

References

Donnell, B. P., Letter, J. V., McAnally, W. H., and Roig, L. C. 1996. "User's guide for RAMA2 Version 4.3, "U S Army Engineer Waterways Experiment Station, Vicksburg, MS.

Luettich, R. A., Westerink, J. J., and Scheffner, N. W. 1992. "ADCIRC: An advanced three-dimensional circulation model for shelves, coasts, and estuaries; Report 1, Theory and methodology of ADCIRC-2DDI and DCIRC-3DL," Technical Report DRP-92-6, U.S. Army Engineer research and Development Center, Vicksburg, MS.

Militello, A. 1998. "Grid Development for Modeling Two-Dimensional Inlet Circulation," ERDC/CHL CETN IV-14, U S Army Engineer research and Development Center, Vicksburg, MS.

Militello, A. and Kraus, N. 2001. "Shinnecock Inlet, New York, site Investigation, Report 4, Evaluation of Flood and Ebb Shoal Sediment Source Alternatives for the west of Shinnecock Interim Project, New York," U S Army Corps of Engineers, Coastal Inlets Research Program.

Mukai, A. W., Westerink J. J., Luettich, R. A. 2002. "Guidelines for Using Eastcoast 2001 Database of Tidal Constituents within Western North Atlantic Ocean, Gulf of Mexico and Caribbean Sea," ERDC/CHL CETN IV-40, U S Army Engineer research and Development Center, Vicksburg, MS.

4 Sediment Transport

A primary component of the Savannah Harbor study is assessing various placement locations. Specifically of interest is Tybee Island littoral zone placement of dredged material. The goal of this effort would be to nourish the nearshore profile and the associated potential for beach nourishment. Additional issues include re-handling of dredged material placed near the channel and separation of fine from coarse material after nearshore placement. This chapter describes laboratory experiments and modeling efforts to estimate erosion and transport rates of dredged material placed in the region between Tybee Island and the ship channel. The simulations of sediment transport described in this chapter rely heavily on the estimated environmental conditions at the site, specifically the STWAVE wave simulations (Chapter 2) and the ADCIRC circulation simulations (Chapter 3) presented earlier.

This chapter is divided into five sections. The first section describes available field data on ebb shoal evolution and dredging history from the ship channel. This section includes description of laboratory experiments performed to estimate erosion rates of dredged material. These sediments are a mixture of sand, silt, and clay. Therefore, their behavior cannot be described using routines for sand transport and site-specific erosion experiments are required. The second section describes proposed placement sites for analysis developed by SAS and ERDC. The third section describes the effects of these berms on nearshore placement. GENESIS (Hansen and Kraus 1989, Gravens et al. 1992) model simulations predict longshore transport at the Tybee Island surf zone and the resulting surf zone transport changes due to nearshore mound placement. The fourth section describes sediment transport modeling from proposed berms and in the nearshore region using the GTRAN model. The first part of this section describes GTRAN simulations for possible mound configurations in the river, near the channel, and between Tybee Island and the channel. The second part describes GTRAN simulations of sediment transport patterns over the entire nearshore Tybee region. The original scope of work required simulation of operational and storm one-month periods. However, further analysis of data from the selected months indicated that they may not be representative of long-term conditions. Therefore, additional 24-year simulations of waves and tidal currents only (no wind-driven current) were added to this section. . The final section provides analysis of model results and recommendations for nearshore placement based on the historical data and modeling.

Historical Data

SAS provided ERDC data on ebb shoal evolution from 1852-present, dredging records from 1998-2001, and placement records for the existing offshore placement site. In addition, sediment grain size distributions were provided and this effort included sediment erosion analysis. These data are described in this section because of their relevance to proposed nearshore placement of dredged material.

Dredging records

SAS provided ERDC with dredging records from the base of the north jetty out to the end of the channel for the years 1998-2001. Information provided in this section is reported in English, not metric, units so it remains consistent with the SAS data files and navigation charts. Dredging volumes for these four years were divided into five sections (Figure 4-1): channel stations 0-14 (0-14,000 ft from the base of the north jetty); stations 14-20; stations 20-30; stations 30-40, and stations 40-60. Figure 4-2 provides the dredging volume from each reach for each year. Between 500,000 yd^3 and 1,200, 000 yd^3 were dredged each year. Approximately 3.4 million yd^3 was dredged during the four years, or an average of 850,000 yd^3 annually. Excluding 1998, average annual dredging was approximately 500,000 yd^3.Over 40% of the dredging during the four years was between stations 30-40. Over 1.5 million yd^3 was dredged from this section during the four years. Virtually no dredging occurred beyond station 40. The high volume of dredging in this reach is probably caused by a combination of factors, the two most dominant being longshore transport from the north and deposition of material flowing through the channel as the current velocities decrease (see Chapter 2, ADCIRC simulations). Station 0-14 channel infilling is dominated by river sediment. Stations 14-30 are a combination of river sediment and longshore transport.

Long-term analysis of dredging records performed by ATM (Applied Technology Management Inc., 2001) for the Georgia Port Authority indicated that the annual average dredging from the ebb shoal to maintain navigable depth is approximately 510, 000 yd^3. Volume of maintenance material dredged in the bar channel was large (2M yd^3) for the first year of 44 ft maintenance (1995), but averaged approximately 500,000 yd^3 between 1996 and 1998. This would indicate that the 1998-2001 record described here is similar to findings of ATM. The sediment processes influencing the first four reaches (Figure 4-2) will be described in more detail later in this chapter.

Sediment Bed

The dredged material at the Savannah site can be generally classified into two types, cohesive and non-cohesive. The cohesive bed material has erosion resistance greater than the simple self-weight of larger, non-cohesive sediments. Cohesive sediments are a mixture of both cohesive and non-cohesive particles.

Definition of cohesive particles is dependent on water and sediment properties such as chemistry and mineralogy, but a general definition that can be applied is that sand-size particles are non-cohesive, clay-size particles are cohesive, and silt-size particles may or may not be cohesive. As will be described later, whether a sediment mixture of sand/silt/clay behaves cohesive is also dependent on many factors.

Non-Cohesive Sediments. Non-cohesive, or sand, erosion is characterized by a particle-by-particle nature. Transport potential of non-cohesive sediments is a function of the mass of the particles in the bed and the applied bottom shear stresses. Most of the particles roll or move by saltation along the bottom. Only under high-energy conditions is there a significant amount of suspension. Even under high wave energy, the majority of suspended sand re-deposits over each wave cycle during the backward velocity under the trough. The mechanics of non-cohesive sediment transport results in a phenomenon called armoring. Armoring starts with the winnowing of fine-grained particles (silt and clay) out of the sediment bed and into suspension. These fine-grained particles cannot deposit because of the high-energy due to waves and are carried away by currents. This leaves a layer of sand, moving as bedload, behaving as a sheet of sand protecting the bed underneath. As wave/current energy increases, more fine sediments are winnowed from the underlying stable bed.

Cohesive Sediment. Cohesive sediment transport potential is not solely a function of particle size. Rather, the inter-particle electro-chemical forces control the behavior of transport. These forces, and thus transport rate and mechanism, is a function of many factors, including grain size distribution, bulk density, chemistry, organic content, and mineralogy. Under some conditions, electro-chemical bonds influence predominately sand beds if sufficient fine material lies between the sand particles. These fine particles behave as a cementing agent for the sand particles. Depending on mineralogy and other factors, a predominately clay bed can be much more resistant to erosion than sand. However, the mechanisms of transport between fine-grained particles and sands also differ. The fine-grained clay and silt moves as suspended load, while the sand moves as bedload or combined bedload and suspended load. The clay and silt are not in frequent contact with the bed once suspended. Therefore, they do not armor the bed like sand particles moving as sheet flow.

Sediment grain size and spatial distribution

Several data sets describing grain size distribution on the ebb shoal and in the channel have been collected in recent years. ATM (2001) provides a detailed discussion of grain size distributions over the entire ebb shoal, including the channel. All data sets indicate that the majority of material in the channel is sand. However, the study described below (and included in the ATM study) indicates that the material is far from uniform. Rather it is stratified, with layers of mud intermingled with the sand.

In 1998, Law Engineering Inc. sampled surface sediments between the jetty and the offshore terminus of the channel. Forty locations were sampled. Table 4-1 summarizes the percent sand and mean grain size for each core sample. These

samples indicate that most locations are predominately sand. These samples also indicate that little of the material would be classified as beach quality (greater than 88% sand). Placing this material at offshore disposal sites would isolate the sand fraction from the littoral system. One concept discussed in this section is that placement in the nearshore will emulate processes under a non-controlled river. Specifically, mixed material will move into and deposit in the nearshore during calm conditions. A combination of wave and tidal forces during higher energy events will winnow the fine material, which will then move offshore.

In winter 2001, shallow core samples were collected at six locations in the navigation channel. The sample locations are indicated in Figure 4-3. Approximately 50 gallons of sediment were extracted from each site. Table 4-2 summarizes the sediment grain size distributions and percentile diameters from sample slurry analysis. Figure 4-4 provides the complete distribution for each sample. These are the sediments that were used for erosion experiments described in the next section. It can be seen that the percent sand for the Law Engineer studies differ somewhat from those performed in this study. This is not unexpected for samples of channel infilling material, where the grain size distribution is a function of many time varying factors, including time history of prior hydrodynamics and river loadings. However, in general, the samples collected between station 17 and 62 will be predominately sand and therefore may be utilized in nourishing the littoral zone.

Erosion rate data

The balance of gravity forces and drag forces on individual particles governs mobilization and transport of non-cohesive sediments. With silt and clay (cohesive sediment), the interparticle forces become important to sediment bed erosion resistance, particularly for the case of well-consolidated sediments with tightly packed particles. There exists a fraction (by weight) of fine particles at which a mixed sand/silt/clay bed will behave cohesively. This fraction is variable, dependent on particle and bed conditions. There are no established relationships between the physical properties and mineralogy of cohesive sediments and sediment mobility. The erosion resistance of silt and clay is highly variable, site-specific, and typically varies with erosion of the bed below the water-sediment interface due either to stratification or increasing bulk density, which increases the interparticle forces. To address the site-specific nature of sediment mobility of the mixed sediments filling the navigation channel, a sediment erosion study was conducted. This study is required to determine the mobility of dredged material placed in the nearshore.

SEDFLUME is a false-bottom flume that allows the determination of shear-stress/erosion relationships of minimally disturbed sediment samples. Figure 4-5 presents a schematic that indicates the fundamental operating principles of SEDFLUME. A vertical core collected from the sediment bed is inserted into the false bottom of the flume and is positioned such that the sediment surface is flush with the channel bottom. A pump-and-valve system on the flume allows the operator to control the flow rate and corresponding bottom shear stress across the surface of the sediment core. This shear stress is applied for a length of time and

the sediment core is advanced such that the sediment surface remains flush with the channel bottom. The distance that the core was advanced divided by the time that the shear stress was applied indicates the erosion rate at a given level in the sediment core. As the sediment core is eroded, this procedure is repeated with a stair-stepped approach that results in erosion rates over a range of shear stresses and depths. For these experiments, an additional segment of test section was attached to the exit of SEDFLUME. This addition included bottom traps that collect sediment traveling as bedload. These bedload samples, collected after each shear stress test, permit evaluation of separation of fine from coarse sediment as the mixed sediment bed erodes. Sediment bulk property samples were collected from a comparable core consolidated in the same manner as the erosion core. Data from the erosion and bulk property cores are then used to relate sediment properties and the erosion rate data. A detailed description of the SEDFLUME study is presented in Appendix A.

Sediment samples were collected at the locations labeled in Figure 4-3. The samples were individually slurried and poured into coring tubes. Six cores were poured for each site. These cores were then permitted to consolidate. Consolidation periods were 4 days, 20 days, and 120 days. After seven days, two of the cores were removed from the refrigerator. One was eroded in SEDFLUME and shear-stress/erosion relationships were determined for each core. The other core was used to develop bulk density profiles for the sediment core. Data from the two cores were combined to develop relationships between erosion rate, shear stress, and bulk density. The final equations are of the form:

$$E = A\tau^{n}\rho^{m} \tag{4-1}$$

where A, n, and m are site-specific parameters resulting from data regression, E is the erosion rate (cm/s), τ is the shear stress (dynes/cm^2) and ρ is the sediment bed bulk density (g/cm^3). The second core is used to develop values for bulk density values at intervals below the original sediment/water interface This equation is coupled with these bulk density values within GTRAN to estimate erosion rates under specified wave-current shear stress and the change in these erosion rates with depth below the mound surface. The erosion rate data served to represent the erosion resistance and transport reduction caused by the cohesive nature of the dredged material sediment mounds.

Figure 4-6 presents the erosion-rate/bulk density relationships developed for SEDFLUME analysis of site 78s sediments. The impact of bulk density on erosion rate is seen here by the parallel lines, which relate bulk density to erosion. A 10% change in bulk density caused an order of magnitude change in erosion rate for a specified shear stress for sediments at this site. Coupled with bulk density profiles measured from the cores, sufficient data exist to define erosion of mound material as a function of surface shear stress and distance between the existing surface layer and the original surface layer. Other cohesive samples behaved the same way, although the exact relationship is site specific. Cores that behave non-cohesively do not show any relationship between bulk density and erosion rate. The erosion rate is similar at any bulk density and the parallel lines in Figure 4-6 would have near zero slope. Sediments behaved as a non-cohesive bed at locations 17 and 62 (Figure 4-3).

The bedload traps attached to SEDFLUME for these experiments indicate that separation of fine from coarse material occurs almost instantaneously with erosion of the ebb shoal channel dredged material. Table 4-3 shows example grain size distribution for the eroded core and the material collected in the bedload traps. This table also shows percent of total material eroded that was trapped. It can be seen that for material collected outside the jetties (not including site 38N), the modest fraction of fine material less than .08 mm was reduced significantly. The trapped material from the offshore sites is 4-20% less silt/clay than the original material. The percent of fine material remaining in the traps ranged from 2-21% in the traps verses 6-41% in the cores. The core at 38N (in the river) eroded as small aggregates and the grain size distribution of trap material is similar to core sediment. This indicates no separation of fine and coarse material during the erosion process.

A general guideline for beach fill (beach quality material) is 88-90% sand (*****). All tested offshore channel sediments showed a smaller percent fine material in the bedload trap than in the original core. This indicates that fine and coarse grains are separated during erosion of the mixed sediment bed. Fine material moved in suspension and coarse material as bedload. These experiments also indicated that erosion, and therefore release of fine material, will occur at moderate rates. Specifically, the bed will not experience mass failure at one time. This type of mass failure could cause turbidity plumes of unacceptable magnitude. The steady release of fines from the bed will result in modest turbidity plumes during storm events. Quantification of turbidity plumes would require a complex modeling application beyond the scope of this project. However, it should be noted that turbidity, even in nearshore regions, is elevated during storms in most East Coast locations. Sources of the sediment include nearby inlets and rivers, and offshore deposits.

Potential Sites for Nearshore Placement of Dredged Material

Early in the study, 12 potential sites for dredged material placement were identified, primarily from the perspective of economic and convenient dredged material placement. The initial placement alternatives are referred to as Berms 01-12 in Figure 4-7a. Following initial assessment of Berms 01-12 and general transport trends over the ebb shoal, Berms 13 and 14 were added to the group of alternatives. Figure 4-7b presents mean lower low water (MLLW) crest elevation, surface area of the mound footprint, and volume of material contained within the mound. The mound volume given is the maximum capacity of the mound with the given footprint, crest elevation, and existing bathymetry.

Three candidate placement locations (Berms 10-12) are considered estuarine environment. Berms 10 and 11 are long, narrow areas near the channel and represented as uniform, 1-m thick veneers of dredged material. Berm 12, near the north tip of Tybee Island was approximated as a mound with 3.0-m MLLW crest elevation placed over a natural depression in the existing bathymetry.

Two candidate placement locations (Berms 8 and 9) are located adjacent and immediately north of the north jetty. Berm 8 is a smaller but thicker placement extending 480 m west of the north jetty tip. Berm 9 covers a larger area with a smaller thickness, extending 770 m west of the north jetty tip.

Candidate placement locations in the nearshore region of Tybee Island include Berms 01 through 07 and Berms 13 and 14. Berm 01 and 02 are large berms, with capacity of 766,000 and 451,000 m^3 of dredged material, respectively. Berm 01 is located closer to shore (approximately 750-1300 m from the north Tybee shoreline) and is placed on top of the ebb shoal platform in 3-4 m ambient water depths MLLW. Berm 02, located 900-1700 m from the north Tybee shoreline is in 3-4 m ambient depths.

Berms 03 through 05 are channel-adjacent alternatives and are attractive from the perspective of low dredged material handling costs. Berms 03, 04, and 05 would contain between 237,000-412,000 m^3 of dredged material and are located in 4-7 m ambient water depths MLLW distributed along the outer reaches of the navigation channel.

Berms 06 and 07 share the same footprint, with variation only in crest elevation and capacity. These berms are located offshore of central Tybee Island in ambient depths of 4-5 m. It is assumed that a shallow draft split-hull scow or hopper dredge could potentially place material economically in this site as it is located 1800-2200 m from the navigation channel. Anticipated advantages of this placement location are the reduction of the potential for sediment rehandling, and proximity to the shoreline where sediment may feed the littoral system and benefit the Tybee Island shoreline.

Berms 13 and 14 are placed 2700-3700 m from the channel immediately offshore of central Tybee Island, adjacent to and merging with the existing transverse attachment bar. The primary difference between the two berms is the variation in footprint size and site capacity. Concerns of such nearshore placement are cost (because of the longer transport distance for a pipeline dredge) and potential negative impacts to the Tybee Island shoreline arising from wave refraction over the nearshore feature. Potential benefits include a more effective sediment source for Tybee Island.

With this wide range of alternatives for nearshore placement defined, sediment transport modeling simulations were performed to 1) evaluate the effects of nearshore berms on shoreline change, 2) assess the likelihood of dredged material re-entering in the navigation channel, and 3) determine the relative potential of dredged material serving as a source of sand to the Tybee Island littoral zone.

Effects of Nearshore Berms on Shoreline Change

The placement of dredged material in the nearshore is proposed as a potential benefit to the Tybee Island shoreline by supplying sediment to the littoral system. However, there are potentially negative impacts to shoreline change arising from wave refraction patterns produced by the nearshore berms of dredged material.

The morphological shape of Tybee Island's ocean shoreline is significantly influenced by refraction of waves over the ebb shoal present offshore. Changes in bathymetry on this ebb shoal (through dredged material placement) may introduce changes to the Tybee Island shoreline. Evaluation of this potential is addressed through application of wave refraction and shoreline change models on 9 scenarios of dredged material placement.

Wave refraction over depressions or mounds in the nearshore bathymetry may produce amplification or reduction in nearshore wave height and changes in nearshore wave direction. Mounds introduced onto shallow, relatively flat bathymetry tend to focus wave energy in a zone behind the mound with lateral lobes of lower wave energy as depicted in Figure 4-8. Figure 4-9 illustrates the simulated change in wave refraction patterns produced by the introduction of Berm 01 to the nearshore bathymetry for a single wave condition. The wave conditions for this simulation were the most frequently occurring conditions from the 20-year simulation (H_{mo} = 0.75 m, T_p = 7 sec, and wave direction from ESE). Note that wave breaking at low tide reduces wave height over and in the lee of the berm. At mid-tide, the water depth allows waves to pass over the berm, resulting in a wave focusing pattern in the lee of the berm. The modification of the nearshore wave climate as illustrated in Figure 4-9 is sufficient to modify longshore sand transport and consequently may modify trends in shoreline evolution. The trends in longshore sand transport and shoreline change resulting from changes in the nearshore wave climate will be quantified through application of a shoreline change model.

GENESIS

The GENEralized Model for SImulating Shoreline Change (GENESIS) (Hanson and Kraus, 1989) is a one-line numerical model for simulating longshore sand transport and shoreline change. The model assumes that beach profile shape is constant and all alongshore transport is produced by the action of breaking waves. (Note: The version of GENESIS applied in this study neglects tidal currents; a recently released version of the model has this capability. The ramifications of neglecting tidal currents will be addressed later.). The governing partial differential equation for shoreline change is derived from conservation of sand volume (Eq. 4-2).

$$\frac{\partial y}{\partial t} + \frac{1}{(D_B + D_C)}\left(\frac{\partial Q}{\partial x} - q\right) = 0 \qquad (4\text{-}2)$$

where,
x = longshore position,
y = shoreline position,
t = time,
D_B = berm height,
D_C = depth of closure,
Q = longshore sand transport,
q = source/sink term.
The empirical estimate for longshore sand transport, Q, is given by

$$Q = \left(H^2 C_g\right)_b \left(a_1 \sin 2\theta_{bs} - a_2 \cos\theta_{bs} \frac{\partial H}{\partial x}\right)_b \tag{4-3}$$

where,

H = wave height, m

C_g = wave group speed from linear wave theory, m/s

b = subscript denoting breaking wave condition

θ_{bs} = angle of breaking waves to the local shoreline

and nondimensional parameters a_1 and a_2 are given by

$$a_1 = \frac{K_1}{16(S-1)(1-p)(1.416)^{5/2}} \tag{4-4}$$

$$a_2 = \frac{K_2}{8(S-1)(1-p)\tan\beta(1.416)^{7/2}} \tag{4-5}$$

where

K_1 = empirical coefficient

S = specific gravity of sand

p = porosity of sand on the bed (taken as 0.4)

K_2 = empirical coefficient

$tan\ \beta$ = average bottom slope from the shoreline to depth of active transport

Additional details on the development, assumptions, and application of GENESIS are provided by Hanson and Kraus (1989) and Gravens, Kraus, and Hanson (1991).

Approach

STWAVE (Chapter 3) and GENESIS were applied to evaluate the impact of nearshore placement of dredged material on wave refraction, longshore sand transport, and shoreline change. The approach taken in this study was to apply GENESIS with no representation of structures along the Tybee shoreline. Neglecting structures in this application is justified in that the objective is to identify changes in the longshore transport and shoreline change resulting from nearshore placement of dredged material. This GENESIS application did not include contributions to longshore transport from tidal currents (which are likely important near the northern tip of Tybee Island). This model limitation is accepted, keeping in mind that the objective of this evaluation is to identify potential impacts from the nearshore placement of dredged material.

Figure 4-10 presents the positioning of the GENESIS baseline (x-axis), the nearshore reference line (where waves are given from the wave transformation model), and candidate berm locations. The grid in the figure represents the resolution of the STWAVE grid. The GENESIS baseline extends 4150 m from the north end of Tybee Island near the north terminal groin to the southern tip of the island with a shoreline resolution of 50 m.

The nearshore reference line was established in a nominal depth of 3 m at the north end of Tybee Island but transitioned into depths of 1.5 m. The nearshore reference line was placed in these relatively shallow water depths to represent the refractive effects of the ebb shoal and the dredged-material berms under evaluation. The Tybee Island beach profile is perched upon the offshore ebb shoal platform at a depth of 3 m. Depth of closure is defined as the depth at which the native sediment ceases to be influenced by the largest waves of the wave climate. The depth of closure offshore of Tybee Island is significantly deeper than 3 m, however the substantial width of the ebb shoal platform and the protection the platform offers the Tybee Island shoreline causes shoreline change at Tybee Island to be controlled more by the depth of the ebb shoal platform than the depth of closure. To represent the Tybee Island shoreline change potential, the GENESIS depth of closure was set to the 4-m platform depth and the subaerial berm height was set to 2 m. Calibration of the GENESIS model was performed to yield reasonable longshore transport rates at the north tip of Tybee Island. Little published data were found regarding the net longshore transport rates at Tybee Island. Posey and Seyle (1980) report a net volume loss between Center St. and the north terminal groin of 420,600 m^3 (550,000 yd^3) between May 1976 and March 1979. Averaged over the 43-month period, this amounts to an annual loss rate along the northern half of the island of 117,000 m^3/yr. GENESIS was calibrated to this volume loss rate by adjusting the K_1 and K_2 coefficients of Equations 4-4 and 4-5 and simulating the period between May 1976 and March 1979 and comparing annual average net transport during this period. The calibrated net transport rate at north Tybee (for the period May 1976 to March 1979) was 114,000 m^3/yr to the north. The calibrated value of K_1 used in evaluating each scenario was 0.06 and K_2 was set to the recommended value of 0.5 times the K_1 value. The coefficient K_2 Simulations with K_2 set to 2.0 times K_1 were performed for sensitivity analysis.

Twenty-year simulations of shoreline change were performed for the without berm condition and for each of the berm cases shown in Figure 4-10. The 20-year offshore wave record (1976-1995) was transformed to the nearshore reference line through wave transformation indices from the 831 STWAVE simulations characterizing the nearshore wave environment (See Chapter 3). These wave transformation simulations represent changes in wave transformation over the ebb shoal resulting from variation in wave height, wave period, wave direction, and water level. Differences in shoreline change between the no-berm scenario and those including nearshore berms were evaluated to determine the effect on the Tybee Shoreline. The wave transformation simulations assumed that the berms were a permanent feature in the bathymetry. In practice, the berms are expected to erode and disperse when placed in the active, nearshore environment. The static treatment of these features in the wave transformation and sediment transport simulations is likely to overstate the impact of the nearshore berms on shoreline change.

Analysis of Results

The 20-year average annual net longshore transport estimated by GENESIS is presented in Figure 4-11. The solid line indicates the average annual net

longshore transport rate along the shoreline and the dashed lines represent the north-bound and south-bound longshore transport rates. (Note, negative net longshore transport indicates transport to the north and positive net longshore transport indicates movement to the south.) The 20-year average net longshore transport at the north terminal groin is 87,000 m^3/yr to the north and at the south end of the island the net longshore transport is 33,000 m^3/yr to the south. Notice that between 0 and 1500 m south of the north terminal groin, the transport is nearly exclusively to the north.

The gradient in the average annual net longshore transport indicated in Figure 4-11 suggests that the entire Tybee Island shoreline is in an erosive configuration. A nodal point (or reversal) in net longshore transport direction is evident at approximately 2700 m from the GENESIS origin, corresponding to approximately 9th St. The net longshore transport gradient suggests a tendency for erosion along the entire Atlantic shoreline of Tybee Island, but the magnitude of the transport gradient (and the corresponding shoreline erosion tendency) is stronger north of the nodal point than south of the nodal point. The modeled gradient in transport suggests that the Tybee shoreline would experience average shoreline erosion rates of 3 to 7 m/yr. Average shoreline change rate between 1920 and 1972 was approximately 1 to 2 m/yr (Posey and Seyle, 1980), somewhat less than predicted by this GENESIS application. One likely explanation for the higher predicted erosion rates by GENESIS (and a point of consideration for evaluating these model results) is that the model neglects any supply of material from the offshore ebb-shoal platform. Nearshore placement of dredged material will introduce substantial quantities of sand into the littoral system that may mitigate a portion or all of the negative impacts introduced by the nearshore berms. Whether or not a nearshore mound of dredged material causes erosion of the shoreline depends on the relative magnitude of the gradients in longshore transport and the quantity of sand introduced to the littoral system.

Berm 01 located north-east of northern Tybee Island produces a relative change in shoreline position as indicated in Figure 4-12. Relative shoreline change indicates the difference in shoreline position between the with- and without-berm simulations after 20 years of simulation. Positive values of relative shoreline change indicate decreasing erosional trends and negative values indicate increasing erosional trends attributed to the dredged material mound. The solid and dashed lines in the figure indicate the range of valid solutions resulting from varying the coefficient K_2. The dotted lines indicate the envelope of relative shoreline change over the 20-year simulation. The sheltering effect of Berm01 on the waves at the northern tip of Tybee Island results in a reduction in erosion rate from the north terminal groin to approximately 1000 m south of the groin. The reduction in erosion rate amounts to a relative shoreline change of 8 to 25 m over the 20-year simulation. Refraction patterns further to the south result in a slight increase in erosional trend amounting to approximately 0 to -3 m of relative shoreline change over the 20-year simulation. The positioning of Berm 01 is such that longshore transport (and that by tidal currents) will not carry material along the northern Tybee shoreline and will not likely feed the Tybee littoral system.

DRAFT

Berm 02, positioned just offshore of Berm 01, produces (Figure 4-13) a smaller accretional trend at the north end of Tybee Island, but produces a larger zone of erosional tendency with a maximum of 3 to 5 m of relative shoreline change over the 20-year simulation. As with Berm 01, Berm 02 is not regarded as a promising location for feeding of littoral material to Tybee Island.

Berms 03 through 05 are located in deeper water depths and further from the shoreline and consequently produced only slight changes in longshore transport and relative shoreline change. The maximum relative shoreline change produced by these scenarios is approximately 3 m of accretional tendency and 2 m of erosional tendency. Placement of material in these regions is not expected to measurably impact the Tybee shoreline.

Berm 06 is positioned offshore of central Tybee Island and produces relative shoreline change indicated in Figure 4-13a. Moderate erosional tendencies are found near central Tybee Island with adjacent lobes of moderate accretional tendency. Berm 07 is placed at the same location as Berm 06, but with higher crest elevation. The relative shoreline response to Berm 07 is indicated in Figure 4 –13b. A mixed erosional/accretional trend is indicated, with moderate to small magnitude. Erosional and accretional trends do not exceed 5 m over the 20-year period. Placement of dredge material at Berms 06 and 07 is not expected to introduce significant changes in the present shoreline change rate.

Berm 13 is positioned just offshore of central Tybee Island and adjacent to the existing shore-attached transverse bar. The wave refraction patterns produced by this modification to the ebb shoal reduce the erosion potential in the central portion of the island, but increase the erosional potential to the southern third of the island (Figure 4-14). The maximum increase in erosion potential after 20 years is approximately 6-8 m along the southern third of the island. Recall that these results neglect the additional sediment introduced to the littoral system through cross-shore transport processes.

Berm 14 is positioned just offshore of central Tybee Island, and is essentially a larger version of Berm 13, extending further offshore and to the north of the existing shore-attached, transverse bar. Being larger and extending further offshore, Berm 14 produces a greater signature in the relative shoreline change as seen in Figure 4-15. Maximum reduction in erosion trends between 25 to 30 m over 20 years is centered about the shoreline 1600 m south of the north jetty (3rd St.). Two zones of increased erosional tendency are estimated at the north and south ends of the island: a 700-m wide zone at the northern tip and a 1400-m wide zone at the southern tip, with a maximum erosional tendency of –10 m over 20-year simulation. Again, these model simulations neglect the effect of a large quantity of sand available for feeding the littoral system.

Sand released from dredged material placed at Berms 13 and 14 will be in a zone of predominantly north-bound longshore sediment transport (refer back to Figure 4-11). Although most of the sand released from the Berm 13/14 position is expected to be transported north, the placement location is in a region where longshore transport is also directed to the south. Therefore, benefits to the shoreline through littoral feeding are expected both north and south of Berms 13 and 14.

Sediment Transport from Dredged Material Placement Sites

In addition to the assessment of shoreline change effects from the nearshore placement of dredged material, sediment transport at the placement sites was evaluated. The two primary issues addressed through sediment transport modeling at the placement site are 1) dredged material re-entering and depositing in the navigation channel and 2) dredged material as a source of material to the Tybee Island littoral system. The following section will describe the development and application of a numerical sediment erosion model, GTRAN (Jensen et al, 2002), to estimate sediment transport in the nearshore. The model results will then be presented and reviewed to address the channel infilling and littoral feeding issues.

Nearshore Sediment Transport Model

To estimate the transport of dredged sediment placed in the nearshore, predictive techniques must be applied with available knowledge of the environmental conditions and sediment properties. The sediment transport model GTRAN was supplied a blend of field and modeled data to predict mound erosion and transport pathways in the Tybee nearshore region. GTRAN includes effects of wave and current on transport of non-cohesive sediment. Although the sediment transport represented in the model is purely non-cohesive, a cohesive sediment bed algorithm is included which represents site-specific erosion resistance from the Sedflume erosion data. Wave conditions and tidal and wind-generated circulation are provided to GTRAN through the external models STWAVE and ADCIRC. Sediment properties for the dredged material mounds were determined from the sediment sampling and laboratory erosion rate experiments described earlier. From input wave, hydrodynamic, and sediment bed conditions, GTRAN calculates sediment transport through a collection of sediment transport methods. A detailed description of the GTRAN sediment transport methods, including sediment transport equations, is provided in Appendix 4B.

In order to numerically estimate sediment transport, certain simplifying assumptions and representations of the natural processes must be developed. Making such approximations is standard practice in the field of numerical modeling and is not unique to sediment transport models. The following discussion of the approximations developed for estimating transport rates will be limited to general statements and descriptions of the approximations applied.

Wave-Generated Current and Transport.

ADCIRC simulations include currents from tidal, wind, and river discharge and do not include currents generated by wave action. The presence of surface waves in the nearshore region produces stresses and near-boundary effects that were not represented in the ADCIRC hydrodynamics. Wave-generated currents

(longshore currents and undertow) and asymmetry in the wave orbital motions are a significant or dominant factor in nearshore hydrodynamics at many sites and must be considered in nearshore transport studies. This section will address the treatment of wave-induced hydrodynamics included in this study and the implications of neglecting certain components of the hydrodynamic forcing on model results.

Longshore Current. Longshore transport is defined as the quantity of nearshore sediment transport generated along the coast by the effects of breaking waves and the associated longshore currents. At Savannah, the shore parallel tidal and wind-driven currents augment this transport. The distinction between transport in the nearshore region and offshore (deep water) region is primarily in the transport processes of the two regions. In offshore transport, waves produce additional bottom shear stresses and increase turbulence that suspends sediment near the bottom. Surface waves contribute little to transport direction. Ocean circulation currents transport the suspended sediment (and sediment near the bed). In the most general terms, the waves act as a stirring mechanism, and the currents transport the sediment. In the case of nearshore transport, breaking waves also impart an increased shear stress and turbulence on the bottom sediments. In addition, breaking waves exert a stress that generates longshore currents and transport along with tidal and wind-driven currents. Wave-generated longshore currents are difficult to estimate over straight beaches, and become quite complex and non-linearly coupled with the tidal and wind-generated circulation. Because of these complexities, wave-generated longshore current and transport are not represented in the GTRAN sediment transport calculations.

The impact of the missing longshore transport can be qualitatively evaluated through assessment of longshore transport estimated by GENESIS. The GENESIS simulations described above indicate a northerly net longshore transport direction north of central Tybee Island. The longshore transport estimated by GENESIS at the north terminal groin is 84,000 m^3/yr north-directed. These same GENESIS simulations indicated south-directed transport south of the attachment bar. These longshore transport rates are due to the wave-generated component not included in GTRAN and neglect the effects of tidal and wind-generated currents on longshore transport. Later analysis in this chapter will discuss the implications of these rates on GTRAN predictions.

Undertow. In addition to longshore currents, waves generate an offshore-directed current or 'undertow' to balance the shoreward mass flux that occurs above wave troughs. Undertow is a primary factor in offshore sediment transport during storms (Miller et al. 1999, Smith and Miller, in review). Undertow exists in the lower water column, influencing the sediment bed and is therefore a strong mechanism for offshore sediment transport during large wave events.

A simple estimation of undertow derived through mass balance was implemented in the GTRAN simulations. The undertow estimate (called stokes velocity), U_{Stokes} as described Nielsen (1992) is:

$$U_{stokes} = \frac{-gH^2}{8cD} \tag{4-6}$$

where,

g = gravitational acceleration
H = wave height
c = wave celerity
D = water depth

Wave Asymmetry. Wave asymmetry is the imbalance of forward (onshore) and backward (offshore) components of the bottom orbital velocities resulting from the non-linear behavior of surface waves in shallow water. Wave asymmetry becomes a mechanism for shoreward sediment transport primarily during milder wave conditions (when undertow is small). In deep water, waves have a sinusoidal form and generate equal backward and forward bottom velocities. As the waves approach shallow water, wave crests become short and steep, while the troughs become long and flat. Near the bottom, orbital velocities include short-bursts of fast, forward velocity under the steep wave crest and slow, longer duration backward velocity under the trough. These forward bursts generally move more sand than the longer-duration, lower-magnitude offshore velocities. The transport methods in GTRAN include the effect of wave asymmetry on transport.

Transport and Erosion of Simulated Mounds

Twelve possible dredged material mound placement sites were assessed in the initial phase of this study. Nine of these sites, with an assumed maximum crest elevation are mapped in Figure 4-16. Two locations are riverine, long narrow areas near the channel (these do not have crest elevations, but rather are 1 m thick placements). Two locations are north of the north jetty at the entrance channel. One location is in the south channel. Seven locations are near Tybee Island, five close to the channel and two mid-way between the channel and island. In addition to wave orbital velocities, tidal currents, and wind driven currents; the coastal sites are exposed to the effects of breaking storm waves, asymmetric wave motion in shallow water, and wave generated longshore currents. As previously stated, of these three coastal conditions, only wave asymmetry is accounted for in the mound sediment transport simulations.

The GTRAN model, described above and in Appendix 4B was used for the nearshore mound simulations. GTRAN is a point model which does not account for incoming sediment transport, i.e. it is a gross transport and not net transport model. However, of interest in the mound simulations is net transport magnitude and direction, which is more representative of mound migration. To address this interest, GTRAN was applied at the mound crest and at the base of the mound in the direction of current. The difference of sediment transport at the base (assumed to be entering the mound configuration) and sediment transport at the crest (assumed to represent material exiting the mound configuration) was used to develop net transport direction and magnitude from the mound.

It is unlikely that any of these sites would be completely filled in one dredging cycle. Dredging practice would call for minimizing pipeline pumping or barge transport. Therefore, several sites would be used in any given year. To assess this situation, various mound configuration and orientation combinations

were modeled at each site. Three mound orientations were simulated for each configuration (Figure 4-17). Mound configurations were 75x250 m, 150x150 m, and 250x250 m. Each configuration's mound crest elevation was set at the maximum condition shown in Figure 4-16. Dimensions and orientation were chosen such that the mounds remained completely within the proposed locations outlined in Figure 4-17. In addition, mound location within each site was varied within the larger sites. Figure 4-18 provides mound crest and base locations processed in the GTRAN model for mounds at sites 1-7. Each berm site includes 1-3 mound locations. Multiple locations were considered necessary at some berm sites because hydrodynamic and wave conditions vary significantly over the site.

The periods of simulation were January 1992 and November 1979, the operational period and two-year return period, respectively. Multiple mound configuration and sediment type simulations were performed. The patterns of transport, however, were similar at a site because the initial mound crest elevation at any designated site was constant for all simulations (Figure 4-17). As an example, the range of crest erosion for 75x250 m mounds at each location is provided in Table 4-4 This table includes results for multiple initial sediment conditions from the Sedflume results, and three mound orientations (Figure 4-16). It can be seen from this table that all mounds in the nearshore are dispersive during the winter months. The amount of mound erosion is highly sensitive to mound orientation. Mounds perpendicular to main current direction experienced more erosion. The amount of erosion is not sensitive to initial sediment type because typically there is an armored sheet flow layer of sand atop the cohesive base. Table 4-4 can be used to provide a relative comparison of the different locations. Clearly, the mound at site 5 will experience the most erosion. This is due to a combination of strong tidal currents and high wave energy. Wave energy at sites 1-3 is much less than at site 5 because a significant amount of breaking occurs on the shoals seaward of these locations. Site 5 has much less protection. Similarly, it can be seen that erosion at site 1 and 2 is very sensitive to location. Again, this is due to the complex shoals and channel that change rapidly at these sites.

Figure 4-18 shows transport rose plots for an example offshore mound at berm locations 1, 5, and 7 for the active month (November 1979). Each rose plot was constructed by summing the GTRAN sediment transport directed into bins with 15-degree resolution. The area of each wedge represents the sum of the hourly transport in each bin. Each wedge protrudes from the GTRAN calculation point in the direction of transport. It can be seen from the rose plots in Figure 4-18 that the directions of transport from berms 1 and 5, which are near the channel, are almost exclusively in the direction of tidal currents, i.e. the direction of the channel. This indicates that there is a strong possibility that sediment from these berms will re-enter the channel. Large amounts of sediment moving on the channel slope would be biased toward moving down-slope into the channel. The small components of onshore transport indicated in the along-channel sites suggests that placement of dredged material at berms 1 through 5 would have negligible impact on beach or littoral zone nourishment. Placement at these locations would result in significant re-handling of the material.

Transport at berms 6 and 7 (Figure 4-18), which are further from the channel, is dominated by shore-parallel components of the hydrodynamics. In addition, transport at these berms includes a modest component toward shore (due to wave asymmetry). Under most storm conditions, undertow would counteract wave asymmetry, but undertow will not impact the mound crest. It should be noted that although material moving off the mound has a toward-shore bias, once a sand particle leaves the mound, it will be exposed to undertow and may start moving offshore. However, the general trend of mound migration is longshore spreading with a slight onshore bias during the time when the mound remains an identifiable feature. Berms 6 and 7 will be dominated by shore-parallel transport. It is expected that most of the transport will be predominately parallel to shore because of the strong shore parallel tidal currents on the Tybee Island coast. The mound would be dissipated long before it attaches with the beach. This modest onshore bias is important for nearshore placement because it indicates that some sediment will migrate toward the beach. Although the mound will spread out during winter months, and there is an offshore bias to non-mound storm transport, this will reverse during summer periods and winter non-storm periods. Low energy onshore movement can be seen from the typical winter and summer beach profiles. Summer (and other non-storm periods) will move this material toward shore. This is a gradual process and the benefit of nearshore placement will provide a new sediment source for onshore migrations. These processes will be discussed further in the next section.

Although berms 6 and 7 would provide sand for littoral zone nourishment, the main impact will be on south Tybee, not the north Tybee area of concern. Once material leaves the mound in the north direction, it will become part of the attachment bar of the ebb shoal. As will be demonstrated in the next section, material moving onto the south side of the ebb shoal does not benefit north Tybee. The next section reviews sediment pathways for the entire region between Tybee and the channel.

Besides the nearshore locations, five river or jetty placement sites were also assessed (Figure 4-17). Three of these were existing depressions that would be filled (Berms 08, 09, and 12). The remaining two sites (Berms 10 and 11) are placement of material along the north side of the channel off of Jones Island. These locations would not be significantly affected by wave action. Therefore GTRAN simulations included current only. Material type input for the riverine placement sites came from SEDFLUME sample 38N, the only riverine sample collected. 38N consolidated material eroded as a combination of individual particles and aggregates (see Appendix A). The aggregates move as bedload and are sensitive to slope.

As described in Chapter 2, riverine hydrodynamics are strongly influenced by tidal current, with an ebb bias from river flow contributions. This can be seen for the near-channel placement site transport rose plot (Figure 4-19) which has both ebb and flood components, but a larger ebb component. There is little detectable transport in the cross-channel direction. However, the point simulations assumed a flat-crested mound. The channel slopes would influence material that moves as bedload off of the mound. This may introduce much of the aggregate erosion back into the channel due to the steep side slopes.

Approximately 50% of the material erodes as individual particles in suspension. The majority of this material will be transported out of the river before re-deposition or will deposit in the low-energy near-bank areas.

The ADCIRC simulations were two-dimensional and therefore do not represent the vertical stratification in tidal estuaries. However, the direction of transport is clearly biased toward ebb flow. The proposed mound locations are in 1-4 m water depth and therefore would be influenced more by the fresh-water surface flow than the ocean water tidal currents in the channel. Therefore, if the hydrodynamic modeling were three-dimensional, the transport direction ebb bias at these placement sites may be greater than indicated in these GTRAN simulations.

Berm 12 is on the northwest side of Tybee Island in a natural depression at the mouth of the south channel. The transport pattern is clear and unidirectional (Figure 4-19). Material moves toward the northeast. This is in the direction of the shoal forming off of the north tip of Tybee Island. This shoal is believed to be a source for channel infilling. Material placed at Berm 12 will erode at a high rate. The depression at this location is due to shoaling on the north side of the south channel, which diverts flow to the south, producing higher shear stresses and sediment transport to the south side of the channel. High currents at this depression are one of the reasons it has not filled in. It is claimed by some (Eric Olsen, personal communication), that this depression is a remnant of a previous channel. Therefore, the depression may not be a scour hole, but the high currents at the site does not permit deposition or infilling.

The Berm 08 and 09 site, on the north side of the north jetty, is also positioned over an active channel with depths up to 4.5 m. Transport from this site is tide dominated with a strong offshore bias. The channel probably exists due to the high velocities in this area from tidal drainage of the marshes around Daufuskie Island. It should be assumed that material placed at this site would disperse and move offshore from the site. Some of the coarser material will likely move into the navigation channel.

General Trends in Nearshore Transport

The mound erosion study described in the previous section, centered on consideration of specific pre-defined sites, was the main transport analysis defined in the original scope of work. However, the results of this analysis indicated a need to understand transport direction and magnitude throughout the nearshore region. This is specifically required to assess optimum placement of dredged material to benefit the beach and nearshore profiles. Berms at sites 1-5 in the original study will have very little impact on nearshore nourishment. Most of the material will move parallel to the channel, with strong indications that the material will re-enter the channel. These locations (1through 5) were originally selected for assessment because of the low-cost of pipeline or barge placement. Sites 6and 7 were selected because light-loaded barges could place material there. Assessment of sites 6 and 7 indicated that material placed further from the channel has more potential for littoral zone nourishment and less potential for rehandling. Therefore, a second phase was added to the sediment transport study.

This phase uses the recently developed GTRAN model applied over an array of points in the nearshore region to assess sediment pathways and aid in placement site selection that will most benefit the beach with minimal sediment rehandling.

Figure 4-20 shows a distribution of points selected for GTRAN simulations of general transport over the ebb shoal. Ambient bathymetry (no mounds) was used for transport simulations at these points and undertow was included. The following analyses and discussions are intended to estimate dominant sediment transport processes and sediment pathways for material placed in the nearshore region and are not intended to simulate erosion from a mound.

Winter conditions. GTRAN transport simulations were performed for two winter months of varying wave conditions: the operational (January 1992) and storm (November 1979) months. Figure 21a-f provides time-history of waves, currents, and transport at GTRAN points 60, 70, 75, 80, 83, and 90 (Figure 4-20) for November 1979. These time series can be utilized to assess relative activity at various locations. The transport magnitude variation is an order of magnitude, with greatest transport rates near the channel (Figure 4-21d-f) and more modest near the coast of Tybee Island (Figure 4-21a-c). In addition, the majority of transport over the month is during the two wave/wind-driven current events centered on November 3 and November 25. These time series demonstrate the episodic nature of sediment transport.

Relative to offshore placement, transport in most of the nearshore region is significant due in part to the strong tidal currents. Figure 22 provides time history of waves, currents and transport at the present offshore disposal site. It can be seen that transport in the nearshore regions is several times greater than at the present disposal site. Therefore, while dredged material remains in place at the offshore disposal site for long durations, this is not expected to occur at nearshore placement sites.

The net transport direction and relative magnitude at each node in the fine mesh are provided for the operational (Figure 4-23) and storm (Figure 4-24) periods. Rose plots of transport magnitude and direction are provided in Figure 4-25 for the storm month. The remainder of this sub-section will describe the results in these two figures and their implications for nearshore transport of dredged material.

Review of transport (Figure 4-23) at points 32-48 (from Figure 4-20) reveals that net transport is seaward along the navigation channel. These locations are also where the greatest magnitude of transport occurs. This is due to the strong tidal currents that dominate transport in this area. The offshore bias of transport shown in the rose plots is due to the addition of river flow to the tidal currents and stronger ebb currents for purely tidal conditions. This figure also indicates a gradient in transport magnitude suggesting a depositional zone in the channel. This depositional zone corresponds to the location of increased dredging volume between Stations 30 and 40 shown in Figure 4-2. It should be noted that transport magnitude and direction on the outer edge of the ebb shoal (around channel stations 40-45) may not be accurate because wave-generated longshore currents not included in the GTRAN simulations may be significant here, particularly during storms with wave direction from the northeast.

DRAFT

Net transport vectors in the nearshore region of north Tybee Island generally indicate north-directed net transport with some offshore component. The offshore component is expected during a storm month when undertow is strongest. The rose plots indicate that there are periods of onshore transport even during this stormy month. The shoreward transport components (Figures 4-25 and 4-27) are greatest in 5-10 ft water depth and then decrease in the surf zone (<5 ft water depth). The decrease is due to the increased impact of undertow and decreased wave height (wave breaking) in the surf zone. . Sediment transport north of the ebb shoal is in the tidal current directions, with a bias toward the north direction (flood cycle). This net north-direction of transport for both the January 1992 and November 1979 periods provides some explanation for migration of the ebb shoal to the south over the past decades. The attachment bar is located at a nodal point in net transport during these two periods. North of the attachment bar, sediment moves northward. While the south directed transport indicated in the rose plots will nourish the ebb shoal, the north directed component erodes the ebb shoal. Since the north directed component is slightly larger, the net effect will be net sediment movement from the attachment bar of the ebb shoal toward the north (Figure 4-24). This does not, however, imply that the ebb shoal is disappearing. There are other sources of sediment to the attachment bar, which will be described later. It does, however, indicate that the ebb shoal will move south as offshore and southerly sources nourish the shoal. It should be emphasized that these are one-month simulations. Other months may be different. This is the reason that the 24-year wave simulation described in Chapter 3 were applied in the GTRAN model, as will be described later in this section.

Net transport on the attachment bar of the ebb shoal during the active and operational periods is generally offshore. This is due to the effect of strong undertow during winter storms. Less wave energy and weaker tidal currents exist over the nearshore portion of the attachment bar compared to the nearshore region to the north of the attachment bar. Consequently, transport magnitudes are smaller for locations close to shore on the attachment bar (points 8-10) than for similar locations north of the bar (points 3-6)..

Locations south of the attachment bar indicate a net offshore and southward transport during both the operational and active months. The net southward transport is stronger during the active month because of wind-generated southerly currents during the first week in the period. The net southerly direction coupled with the net northerly direction on the north side of the attachment bar does not necessarily imply risk to the bar stability. Both of the active and operational months included strong northerly winds. In addition, the time series transport data (Figure 4-21) indicate that transport during different periods of the month will be in different directions, including strong northerly and northeast components south of the attachment bar. These transport periods would feed the bar.

Long-Term Simulations. Net transport direction vectors and rose-plots for the 24-year wave hindcast are provided in Figures 4-26 and 4-27, respectively. It should be noted that wind-generated currents are not included in these simulations. Wind generated currents included in the ADCIRC one-month

simulations are not computationally feasible for the 24-year wave hindcast period. Therefore, ADCIRC 30-day tidal cycle simulations were repeated to provide currents for the 24-year simulation. Comparison of one-month sediment transport simulations for tide-only and tide-plus-wind forcing indicate that wind forcing may contribute significantly to transport magnitude and net transport direction in the nearshore regions, particularly for areas further removed from the Savannah River entrance channel. The 24-year wave hindcast was originally performed for GENESIS simulations. Application to GTRAN is representative of low-wind conditions where wind-generated currents are negligible, but wave conditions represent the actual 24-year hindcast.

Long-term transport directions and relative magnitudes are similar to those for the one-month simulations except on and south of the attachment bar. Without the strong, south-directed, wind-generated currents experienced in the one-month simulations, nearshore currents south of the attachment bar are dominated by tidal flow from Savannah River. Therefore, there is an indicated net northerly transport direction (flood flow bias) for most locations south of the attachment bar. The November 1979 and January 1992 simulations indicated a net south-directed transport in this area. This indicates that low-wind conditions will favor transport towards the attachment bar from the south while high-wind conditions from the northeast will favor net transport off the south edge of the attachment bar. In addition, there is a noticeably stronger north-directed component to transport over the ebb shoal attachment bar. Long-term hydrodynamic simulations including wind forcing would assist in estimating the overall impact of wind-generated currents in the Tybee nearshore region. However, this effort is beyond the scope of this study.

Uncertainty in Transport Estimates

Uncertainty in the sediment transport estimates is difficult to quantify, site-specific, and would require significant field data. This is particularly true for estimating erosion volumes from mounds. These erosion estimates can, however, be used to compare various placement locations and options, as has been described in this chapter. The sediment pathways on the fine grid are logical, given what is known about morphologic evolution, wave/current patterns, and dredging volumes in the area. Therefore, relative magnitude and direction of transport are relevant and can be used for assessing the benefit of various placement options. However, treatment of undertow and wave asymmetry has significant influence on transport direction and present understanding limits predictive capabilities over complex bathymetry. In addition, longshore currents are not treated in these estimates. This process will also influence longshore transport, especially during storms.

Recommendations

Recommendations on nearshore placement of dredged material from the Savannah River Navigation channel are developed from knowledge of sediment

transport processes near inlets and model simulations. Key issues addressed include 1) the effects of nearshore berms of dredged material on wave refraction and consequently on shoreline change at Tybee Island, 2) the likelihood that dredged material will re-enter the navigation channel and increase maintenance dredging volumes, and 3) the potential of nearshore-placed dredged material to provide sand to the littoral system of Tybee Island.

The recommended location for nearshore placement of dredged material is adjacent to the transverse, shore-attached bar just offshore of central Tybee Island (Berms 13 and 14). The dominant transport direction from these berms will be north, with some material moving shoreward, especially during low-wave conditions. This process will enhance the normal shoreline accretion experienced during mild conditions. Net movement will be offshore during storm conditions. However, even during these periods, this material will benefit and nourish the littoral system, thus reducing shoreline erosion. Any nearshore placement at north Tybee will result in some material eventually moving to the shoal north of the island. Some of this material will re-enter the channel. The likelihood of significant increases in maintenance dredging for nearshore placement along central Tybee Island is less than other alternatives for nourishing the north Tybee littoral system. Berms 13 and 14 are the furthest locations from the north shoal and channel that will still provide littoral and beach nourishment to north Tybee. Adverse impacts to the shoreline (as predicted by GENESIS) are small relative to the present rate of shoreline change and are likely to be offset by the addition of sand to the Tybee Island littoral system.

Berms 06 and 07 are other promising locations for nearshore placement of dredged material. Model predictions made assuming that the mound relief eliminates undertow indicate an onshore bias of the migrating mound. Berm migration is dominated by tidal current direction, but the onshore bias in direction is the important factor. Placement at these locations will reduce shoreline erosion because the health of the beach is directly tied to the sediment quantity in the littoral zone. The transport roses at these mound locations initially created the interest in 2-3 m water depth placements, eventually leading to the development of Berms 13 and 14.

Placement of dredged material adjacent to the channel (Berms 03 through 05) will likely result in significant quantities of dredged material re-entering the channel and increasing maintenance dredging volumes. Transport patterns over the ebb shoal indicate that although some of this material could re-enter the littoral system along the outer margin of the ebb shoal, little of this material would directly benefit the Tybee Island littoral system.

Dredged material placed on the ebb shoal platform offshore of the northern portion of Tybee Island (Berms 01 and 02) provide some benefit to northern Tybee Island in the form of wave sheltering, but material transported from these locations is likely to re-enter the channel and increase maintenance dredging volumes. As much of the transport from these locations is directed toward the channel and then offshore, relatively little of the dredged material is expected to directly benefit the Tybee Island littoral system.

Placement of material in Berm 12 at the northeast end of Tybee Island is not recommended. Sediment transport from this site is unidirectional towards the shoals off north Tybee, which are suspected to contribute significantly to channel infilling at that location. Little lasting benefit to the ocean or river-facing shorelines is expected from dredged material placement at this location.

Dredged material placement at Berms 08 and 09 is not recommended for similar reasons as Berm 12. The placement zone is in an active channel fed by salt marsh backing Daufuskie Island and Turtle Island. Dredged material placed here would likely be eroded from the placement zone and transported into the navigation channel.

Material placed in shallow water near the river banks (Berms 10 and 11) will move in a net seaward direction. Some of the material will likely re-enter the channel. However, the majority of suspended material will either deposit in low energy nearshore regions or move offshore via the channel.

Summary and Conclusions

Regional considerations of sediment management have expanded traditional viewpoints of dredged material handling to include nearshore placement of dredged material containing significant fractions of sand. The focus of this study was to identify favorable locations for nearshore placement of dredged material. Issues considered in the study include 1) the effects of nearshore berms of dredged material on wave refraction and consequently on shoreline change at Tybee Island, 2) the likelihood that dredged material will re-enter the navigation channel and increase maintenance dredging volumes, and 3) the potential of nearshore-placed dredged material to provide sand to the littoral system of Tybee Island.

Shoreline Change.

Effects of nearshore berms of dredged material on wave refraction, longshore transport, and shoreline change were assessed through application of the shoreline change model, GENESIS. Nine nearshore berm scenarios were represented on the ambient bathymetry. Wave transformation simulations representing the long-term wave climate were preformed over the ambient bathymetry and each of the dredged material berm scenarios. The resulting nearshore wave climate was then passed to GENESIS to simulate changes in the shoreline change response of Tybee Island. Berms placed in deeper water and further from the shoreline produced little change in shoreline change trends. Berms placed closer to or immediately offshore produced moderate changes in the shoreline evolution trends. Berms 01 and 02, offshore of the northern tip of Tybee Island resulted in a decreased erosional trend at the northern tip of the island, but increased the erosional trend along the central portion of the shoreline. Berms 13 and 14, placed adjacent to the transverse bar attached to the central island shoreline produced a reduction in erosion rates along the central third of the island and relatively weak erosional trends on the northern and southern

thirds of the island. The influence of sediment supply to the littoral zone and the influence of tidal currents were neglected in the GENESIS simulations.

Maintenance Dredging Requirements.

A point sediment transport model for combined wave and current environments was applied to estimate transport and erosion of nearshore-placed dredged material mounds. One issue of concern is an increase in maintenance dredging requirements resulting from the nearshore placement of dredged material. One conclusion from the sediment transport simulations is that placement of dredged material in the nearshore will likely lead to some increase in maintenance dredging requirements over placement of material in the offshore disposal site. However, not all nearshore placement sites were equal in the likelihood of significant increases in maintenance dredging volumes. Simulated transport over the ebb shoal indicates that a significant portion of dredged material placed adjacent to the offshore channel, adjacent to the north jetty, and at the northeastern tip of Tybee Island is likely to re-enter the channel. Dredged material placed offshore of central Tybee Island is least likely to produce significant quantities of channel infilling.

Littoral Feeding

The point sediment model was also used to assess the potential for benefits to the Tybee Island shoreline through feeding of sand to the littoral system. The balance of undertow and wave asymmetry have been shown to play a strong role in shoreward sediment transport. By placing dredged material in shallow water, the stronger influence of wave asymmetry allows sand to be transported toward shore. Sediment transport simulations at the offshore disposal site indicate that significantly lower transport rates occur there compared to the more energetic nearshore environment. Nearshore sediment transport simulations indicate that placement of dredged material near the central Tybee Island shoreline adjacent to the present transverse, shore-attached bar is most likely to introduce sand to the littoral system and provide a benefit to the north Tybee shoreline. Trends in nearshore transport over the ebb shoal suggest that dredged material placed in deeper water near the navigation channel will either be transported back to the channel, or will re-enter the littoral system along the margins of the ebb shoal, providing little direct benefit to the Tybee shoreline. Transport offshore of the northern tip of Tybee Island is predominantly directed to the north from both tidal and longshore transport influences. This predominant direction of transport is likely to transport dredged material there back to the channel instead of benefiting the Tybee Island littoral system.

Recommendations

The recommended location for nearshore placement of dredged material is adjacent to the transverse, shore-attached bar just offshore of central Tybee Island. The impacts to the shoreline at this location are similar to those of other

DRAFT

extreme-nearshore placement options, but these impacts are likely to be offset by the potential of sand to be transported shoreward to benefit the littoral system. Figure 28 presents a schematic of the mechanisms delivering sediment from the nearshore placement zone to the beach at north Tybee Island. The large arrow indicates the dominant transport direction, and the smaller arrows indicate the onshore component that will benefit the beach. The figure is not to suggest that the material will not disperse in other directions under the complex forcing at this site. This location has the least potential for increasing maintenance dredging while providing benefit to Tybee Island.

References

Gravens, M.B., Kraus, N.C., and Hanson, H. 1991. "GENESIS: Generalized Model for Simulating Shoreline Change, Report 2, Workbook and System User's Manual," Technical Report CERC-89-19, Coastal Engineering Research Center, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

Hanson, H. and Kraus, N.C. 1989. "GENESIS: Generalized Model for Simulating Shoreline Change, Report 2, Workbook and System User's Manual," Technical Report CERC-89-19, Coastal Engineering Research Center, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

Jensen, R., Scheffner, N., Smith, S.J., Webb, D., and Ebersole, B.A. 2002. Engineering studies in support of Delong Mountain Terminal project. Technical Report ERDC/CHL TR-02-26. US Army Engineer Research and Development Center, Vicksburg, MS.

Madsen, O.S., and Wikramanayake, P.N., 1991. Simple models for turbulent wave-current bottom boundary layer flow. Contract Report DRP-91-1, U.S. Army Engineer Waterway Experiment Station, Vicksburg, MS, USA.

Meyer-Peter, E., and Müller, R., 1948. Formulas for bed-load transport. Second International Association of Hydraulic Engineering and Research (IAHR) Congress, Stockholm, Sweden. IAHR, Delft, Netherlands.

Nielsen, P., 1992. *Coastal Bottom Boundary Layers and Sediment Transport.* World Scientific Publishing, Singapore, Advanced Series on Ocean Engineering, vol. 4.

Posey, F.H. and Seyle, F.W. 1980. Unpredicted rapid erosion, Tybee Island, Georgia. Proceedings of the Symposium on Coastal and Ocean Management. 1869-1882.

Soulsby, R.L., 1997. *Dynamics of marine sands.* Thomas Telford, London.

Taylor, J.R. 1997. *An introduction to error analysis.* 2nd ed., University Science Books, Sausolito, CA.

Van Rijn, L.C., 1984. Sediment Transport: part I: bedload transport; part ii: suspended load transport: part iii: bed forms and alluvial roughness, *Journal of Hydraulic Engineering* 110(10): 1431-1456; 110(11): 1613-1641, 110(12): 1733-1754.

Vincent, C.E. and Green, M.O., 1990. Field measurements of the suspended sand concentration profiles and fluxes and of the resupsension coefficient over a rippled bed. Journal of Geophysical Research, 95(C7): 11591-11601.

Wikramanayake, P.N., and Madsen, O.S., 1994a. Calculation of suspended sediment transport by combined wave-current flows. Contract Report DRP-94-7, U.S. Army Engineer Waterway Experiment Station, Vicksburg, MS, USA.

Wikramanayake, P.N., and Madsen, O.S., 1994b. Calculation of movable bed friction factors. Contract Report DRP-94-5, U.S. Army Engineer Waterway Experiment Station, Vicksburg, MS, USA.

Station	Location (N=North S=South C=Center)	% Sand	d_{50} (mm)	Observations
16	S	59.7	0.684	Fine sand and shale
17	S	33.9	0.231	Medium sand, mud rip-ups
18	S	55.4	2.630	Coarse sand, gravel, shale
33	N	72.4	0.212	Medium sand and black high water mud
33	C	73.2	0.277	Medium sand and mud rip-ups
33	S	71.8	0.386	Medium sand and black high water mud
34	C	77.4	0.260	Medium sand and mud rip-ups
36	N	66.3	0.165	Medium sand with minor mud
40	S	74.0	0.157	Fine sand
42	N	62.7	0.150	Olive mud, rip-ups, minor sand and shale
42	C	68.8	0.292	Medium sand and shell with mud rip-ups
44	S	74.5	0.195	Find sand and shell
45	S	48.1	0.115	Black mud under fine thick sand
49	S	78.3	0.495	Medium sand and shell with mud rip-ups
50	N	74.3	0.426	Medium sand and shell on top of muddy sand
51	N	73.6	0.198	Find, muddy sand
51	C	79.9	0.639	Coarse, slightly muddy sand
51	S	79.4	0.192	Fine sand on top of olive high water mud
52	S	50.0	0.185	Find sand on top of sandy mud
53	N	62.3	0.207	Black high water mud with 1 inch sand on top
54	S	40.6	0.153	Dark olive high water mud with 1 inch fine sand on top
55	S	54.6	0.135	Dark gray high water mud with 1 inch fine sand on top
55	N	61.4	0.109	Tan high-water mud
56	N	47.6	0.121	Black high water mud with 1 inch sand on top
56	S	55.9	0.123	Black high water mud with 1 inch sand on top
57	S	37.5	0.105	Dark gray high water mud with 1 inch fine sand on top
58	N	57.5	0.115	Dark gray high water mud with 1 inch fine sand on top
59	N	64.2	0.115	Dark gray high water mud with 1 inch fine sand on top
59	C	66.6	0.119	Dark gray high water mud with 1 inch fine sand on top
59	S	52.6	0.112	Dark gray high water mud with 1 inch fine sand on top
60	S	67.1	0.111	Dark gray high water mud with 1 inch fine sand on top
61	N	47.3	0.108	Dark gray high water mud with 1 inch fine sand on top
61	S	65.1	0.110	Dark gray high water mud with 1 inch fine sand on top
61	N	47.3	0.108	Dark gray high water mud with 1 inch fine sand on top
62	N	67.8	0.110	Very dark sand and dark gray mud, separate layers
62	S	55.5	0.110	Dark gray high water mud with 1 inch fine sand layer on top
63	S	45.4	0.110	Dark gray high water mud with 1 inch fine sand on top
63	N	52.7	0.117	Dark gray high water mud with 1 inch fine sand layer on top
63	S	45.4	0.110	Dark gray high water mud with 1 inch fine sand layer on top
66	S	67.1	0.112	Tan high-water mud
66	N	70.5	0.106	Tan high-water mud

Table 4-1: Law Engineering bar channel sediment samples

	38n	17s	33s	52s	62s	78s
Percent < 4 micron	8.9	1.5	1	2.7	2.5	7
Percent < 20 micron	23.1	4.8	2.5	10.3	6.1	20.5
Percent < 80 micron	47.7	14.3	8.2	35.9	23	50.7
Percent < 400 micron	96.3	63.2	55.7	98.4	100	99.1
D10 (micron)	5	52	96	20	45	7
D50 (micron)	90	290	350	115	120	80
D90 (micron)	280	1000	850	270	200	205

Table 4-2 Sedflume sediment sample grain size distributions

DRAFT

Site	Bedload (%)	Mean Particle Size Trap (mm)	Mean Particle Size Core (mm)	Silt Component Trap (%)	Silt Component Core (%)
38N	70	0.136	0.136	37	40
17S	62	1.226	0.51	3.1	11
33S	65	0.868	0.584	1.8	6
52S	40	0.205	0.144	23	27
62S	20	0.19	0.147	1.8	14
78S	50	0.2	0.112	21	41

Table 4-3: Mean particle size and silt component of eroded and bedload samples

Location (berm/point)	1/92 Erosion (min/max) (cm)	11/79 Erosion (min/max) (cm)
01-7481	14-42	27-47
01-7482	17-38	27-48
01-7483	13-31	25-26
02-7587	23-37	31-39
02-7588	21-39	15-27
02-7589	14-32	22-85
03-7593	16-45	14-54
03-7594	12-28	14-75
04-7597	9-28	8-26
05-7599	25-68	67-92
06-7601	5-26	26-71
06-7602	13-51	27-58
07-7601	15-41	38-58
07-7602	17-33	35-40

Table 4-4. Mound crest erosion range (cm).

FIGURES

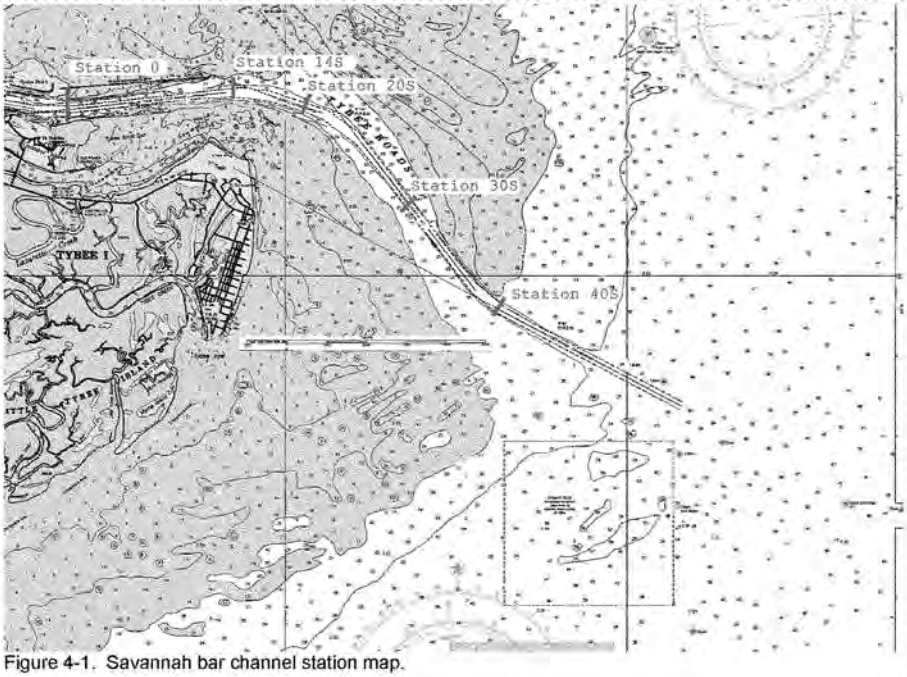


Figure 4-1. Savannah bar channel station map.

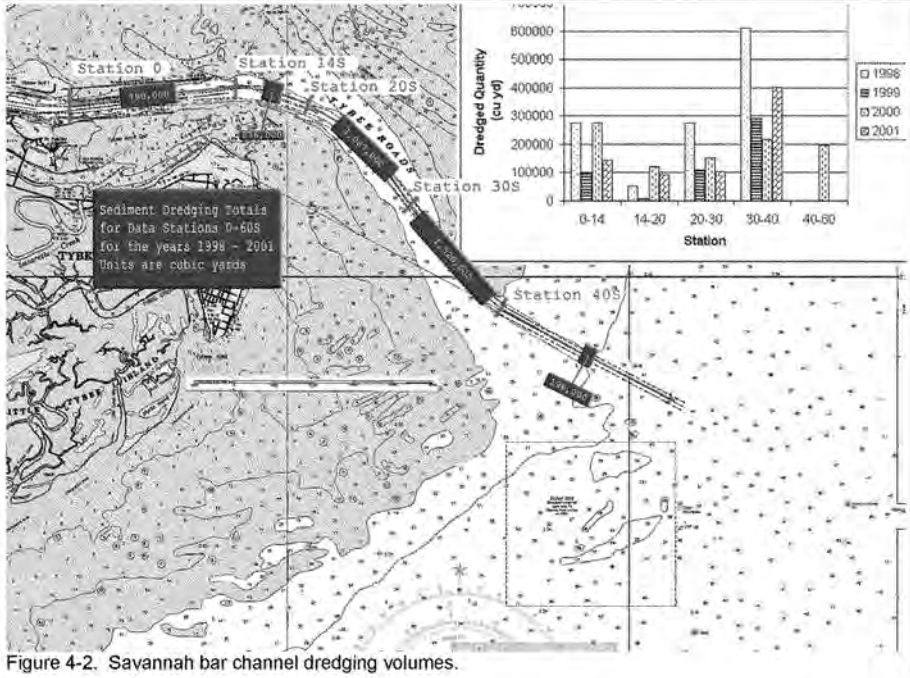


Figure 4-2. Savannah bar channel dredging volumes.

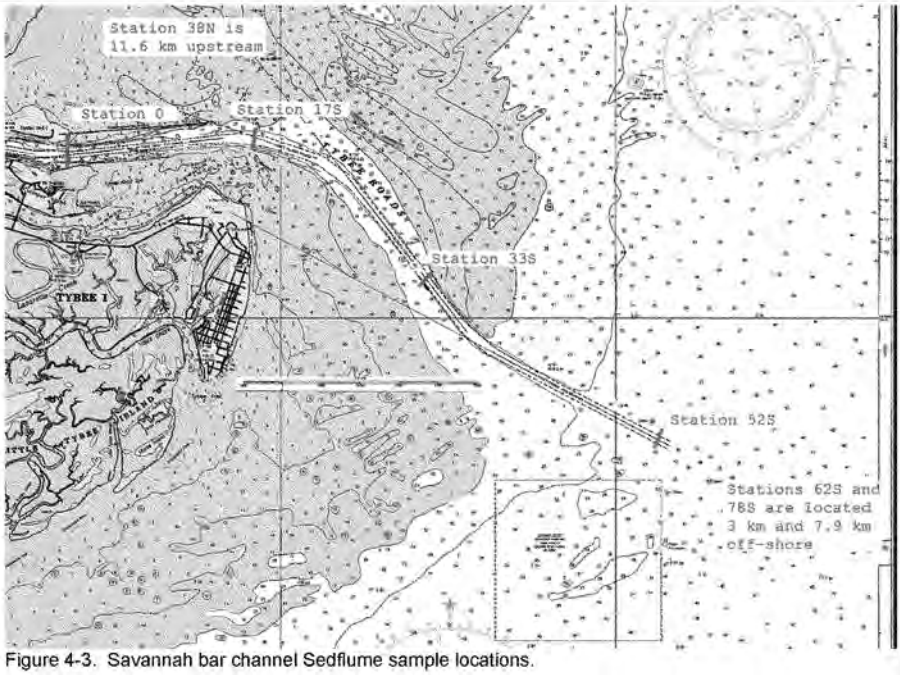


Figure 4-3. Savannah bar channel Sedflume sample locations.

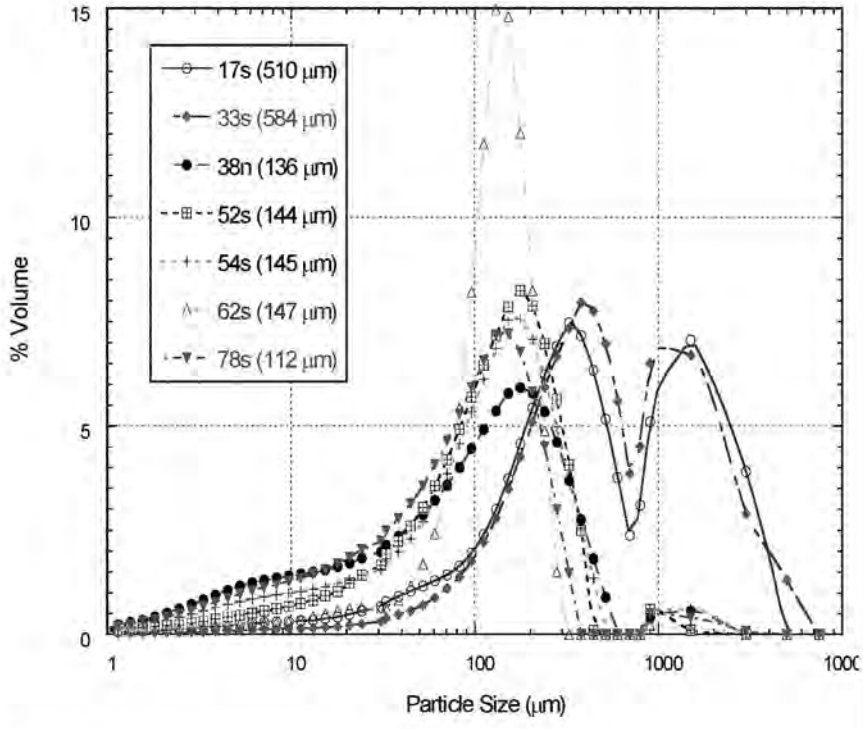


Figure 4-4. Particle size volume distribution for six Sedflume sample sites.

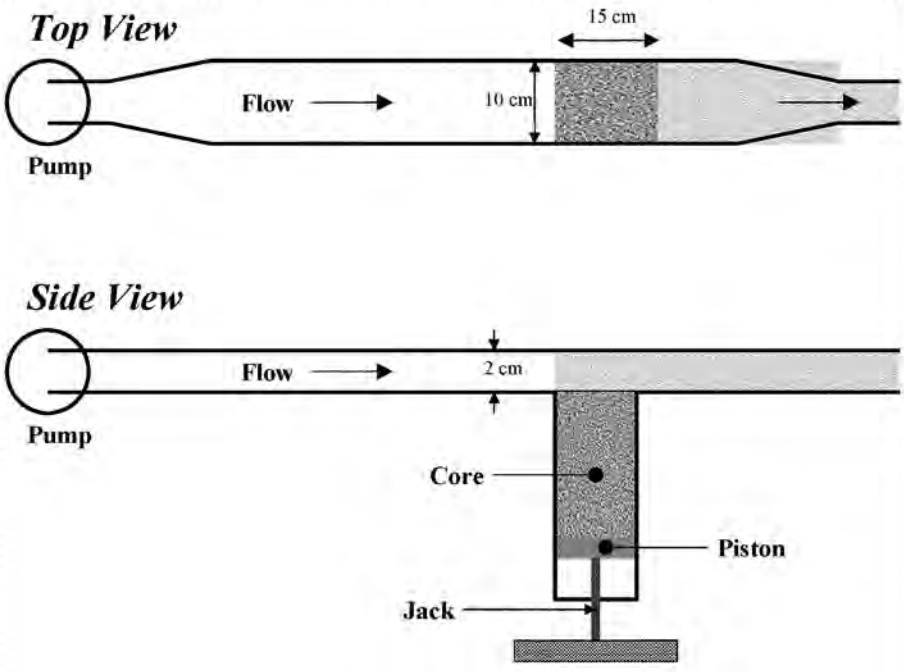


Figure 4-5. Schematic of Sedflume.

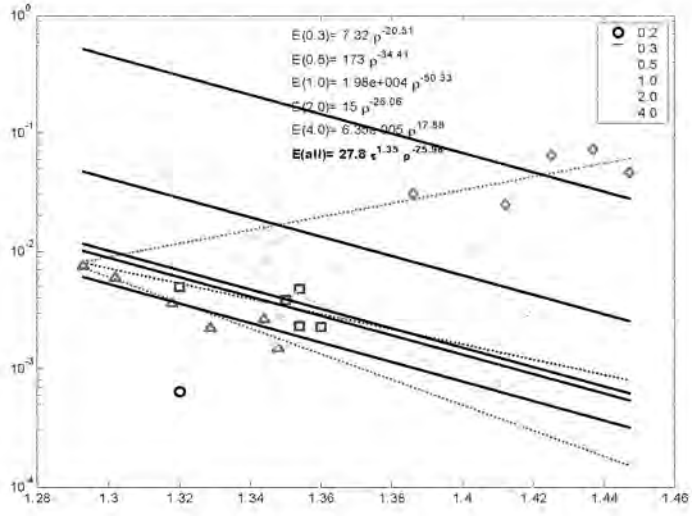


Figure 4-6. Erosion data and equation at Site 78S.

DRAFT

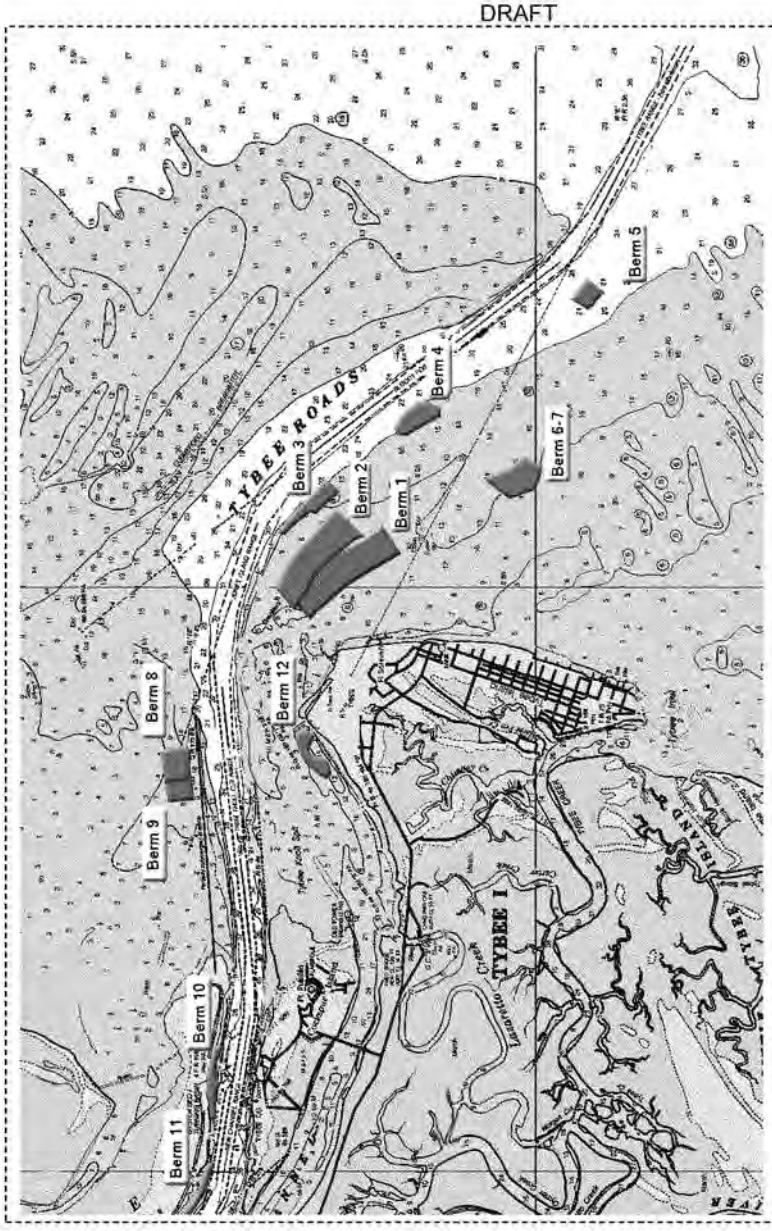


Figure 4-7a. Original mound locations analyzed.

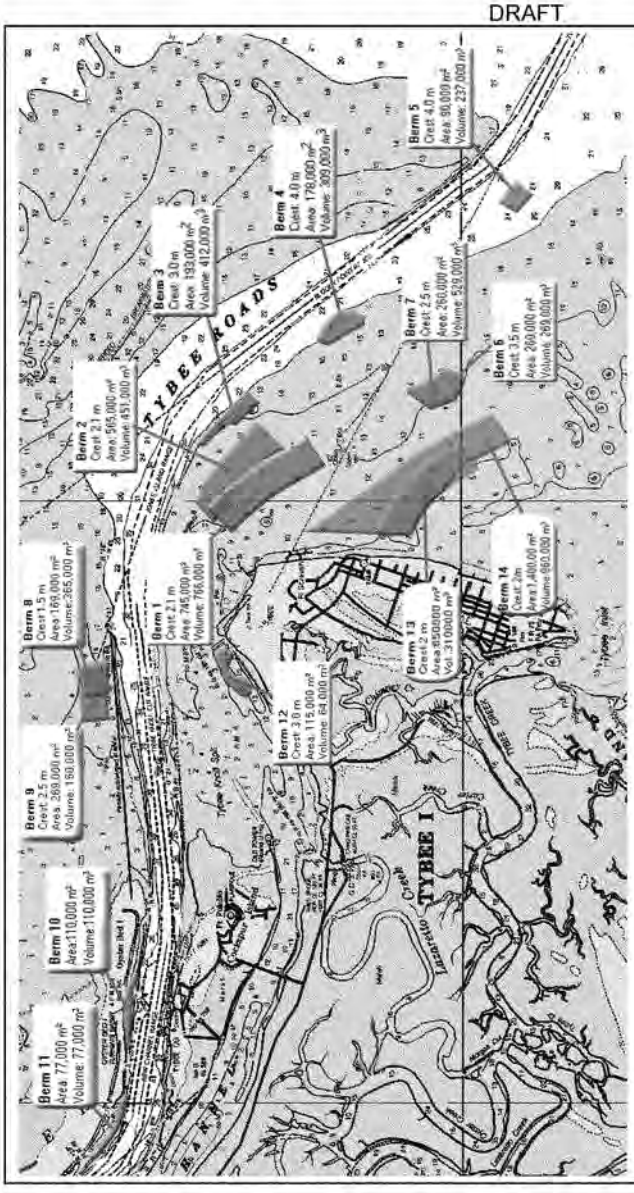


Figure 4-7b. Mound water depth (MLW), area, and maximum capacity.

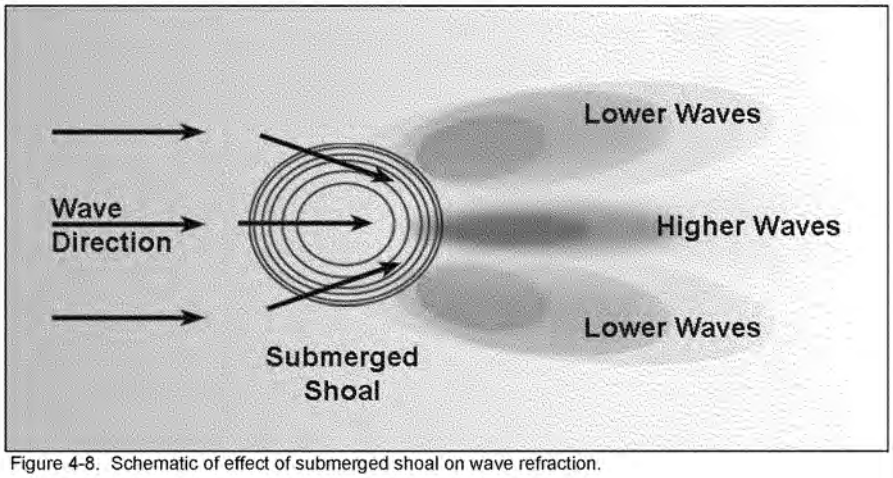


Figure 4-8. Schematic of effect of submerged shoal on wave refraction.

DRAFT

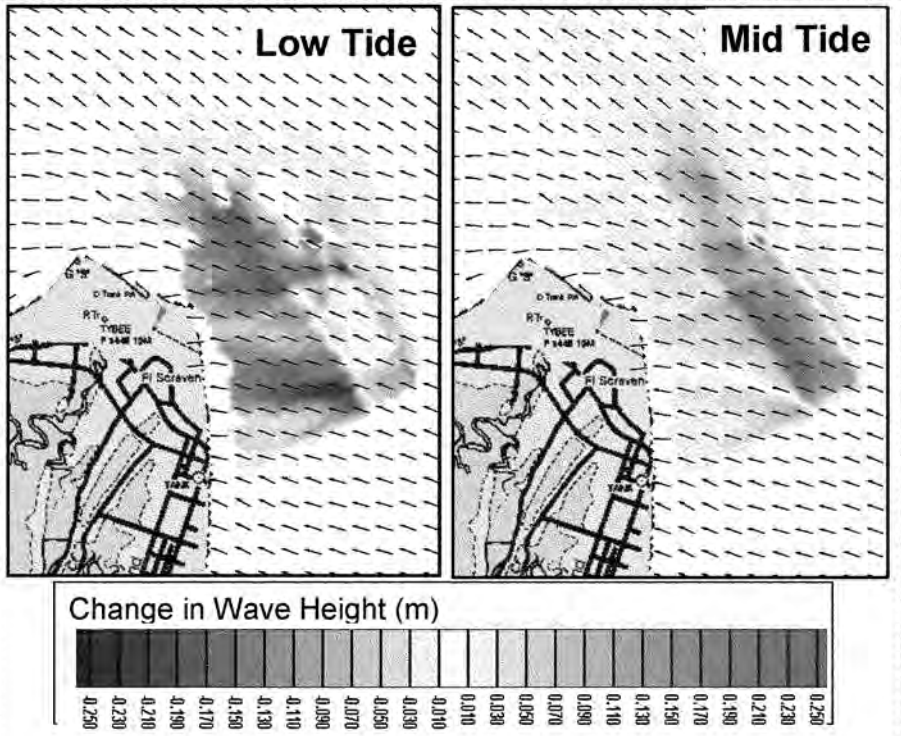


Figure 4-9. Change in wave transformation over Berm 01 at low- and mid-tide. Offshore wave conditions: H_{mo} = 0.75 m, T_p = 7 sec, wave direction: from ESE.

DRAFT

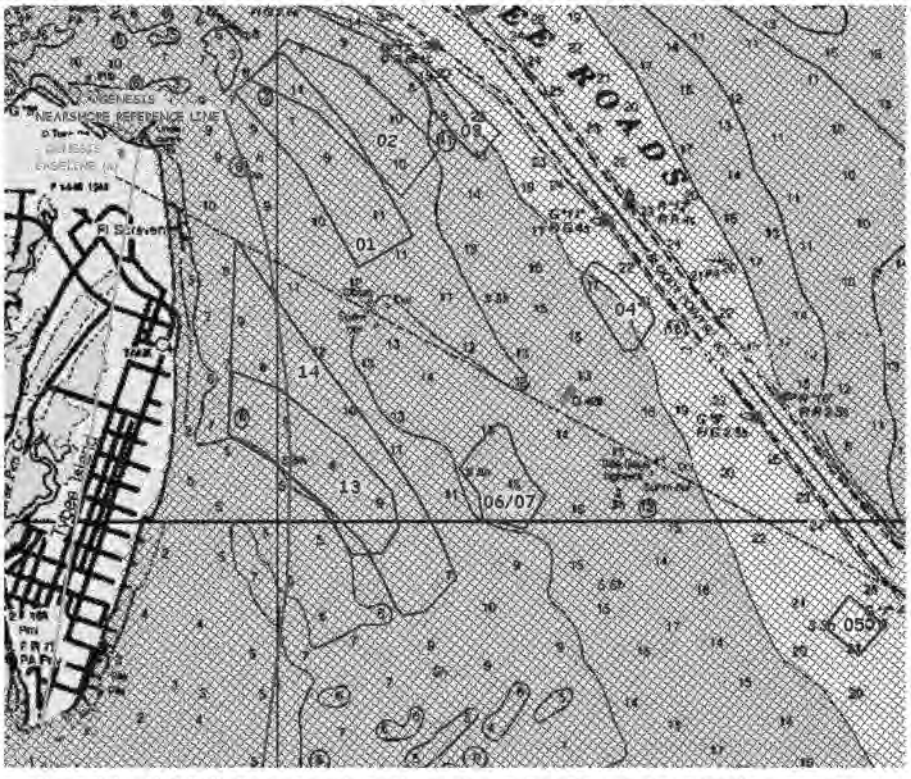


Figure 4-10. GENESIS domain, nearshore reference line, and candidate configurations for nearshore placement berms.

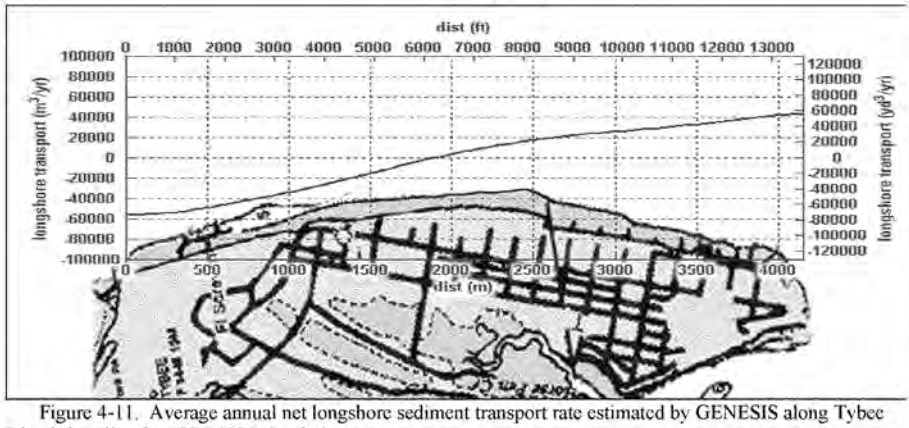


Figure 4-11. Average annual net longshore sediment transport rate estimated by GENESIS along Tybee Island shoreline for 1976-1995 simulation.

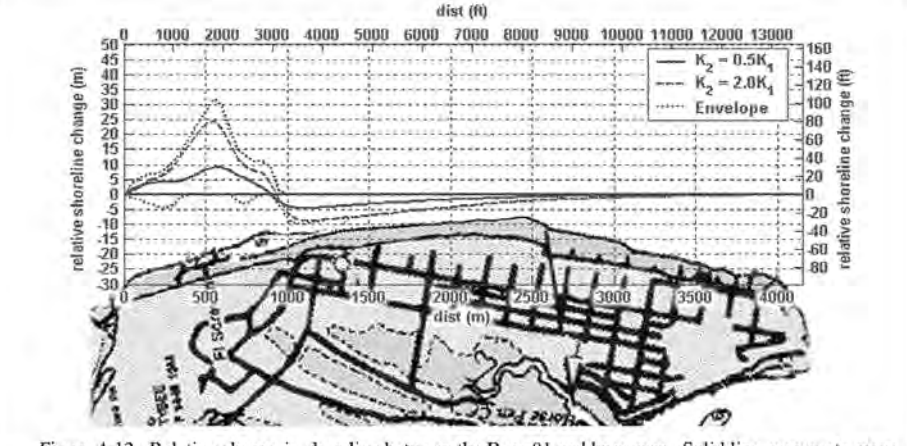


Figure 4-12. Relative change in shoreline between the Berm01 and base case. Solid line represents range in solutions within the uncertainty in the value of K_2. Dotted line indicates range of relative shoreline change over the 20-year simulation.

DRAFT

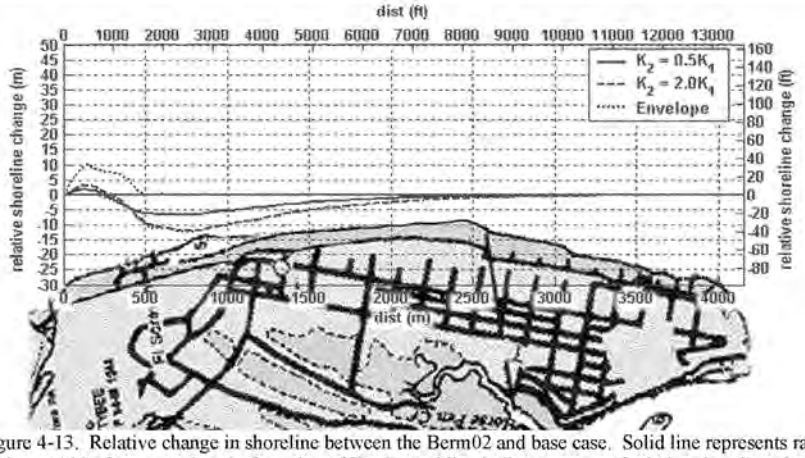


Figure 4-13. Relative change in shoreline between the Berm02 and base case. Solid line represents range in solutions within the uncertainty in the value of K_2. Dotted line indicates range of relative shoreline change over the 20-year simulation.

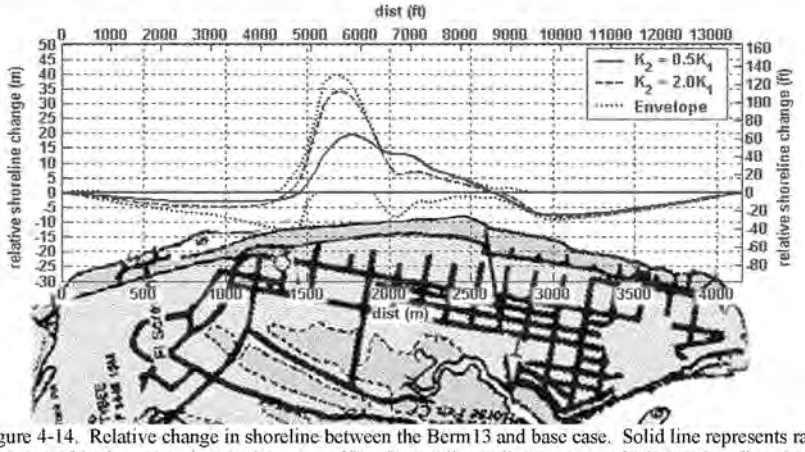


Figure 4-14. Relative change in shoreline between the Berm13 and base case. Solid line represents range in solutions within the uncertainty in the value of K_2. Dotted line indicates range of relative shoreline change over the 20-year simulation.

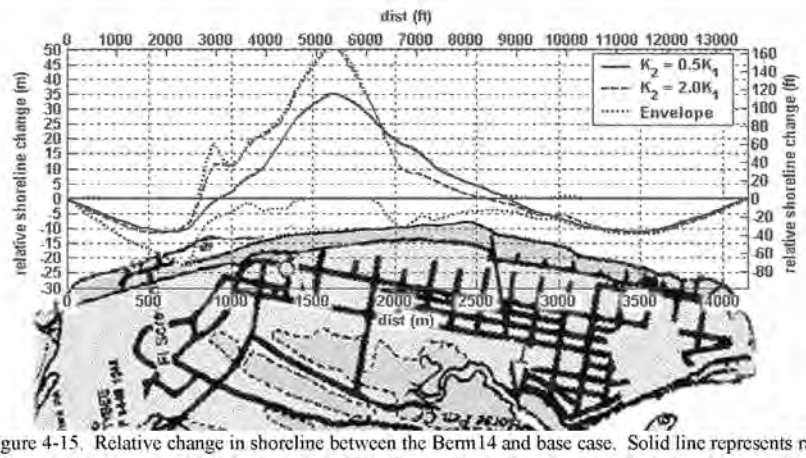


Figure 4-15. Relative change in shoreline between the Berm14 and base case. Solid line represents range in solutions within the uncertainty in the value of K_2. Dotted line indicates range of relative shoreline change over the 20-year simulation.

DRAFT

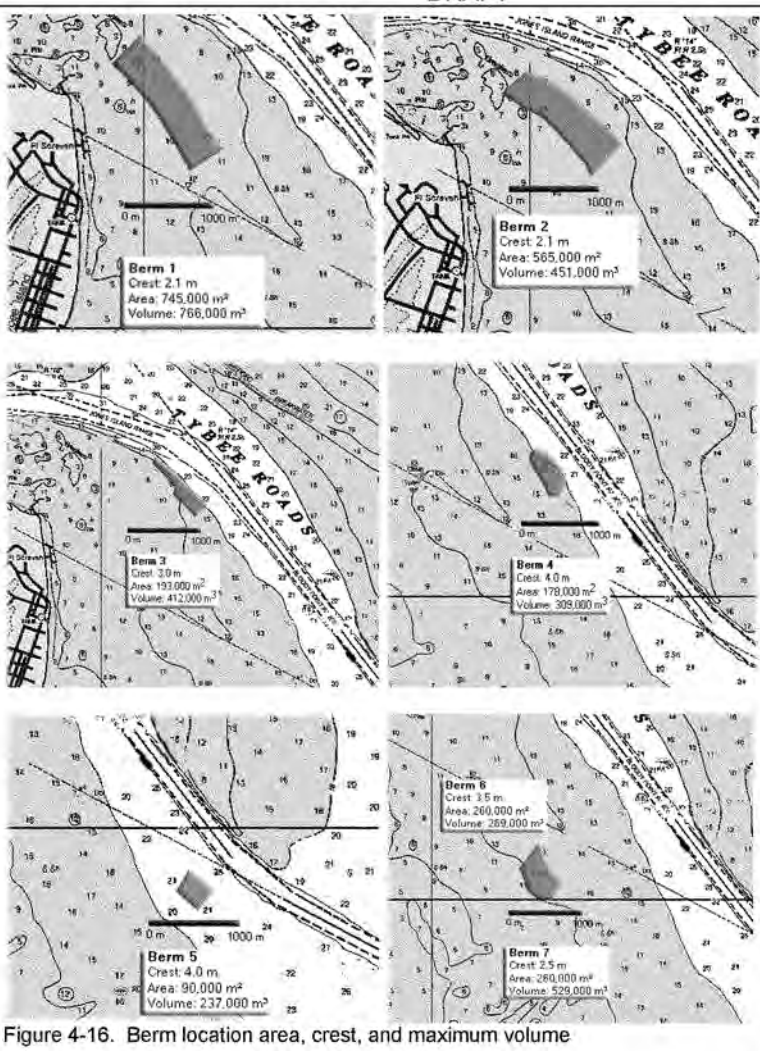


Figure 4-16. Berm location area, crest, and maximum volume

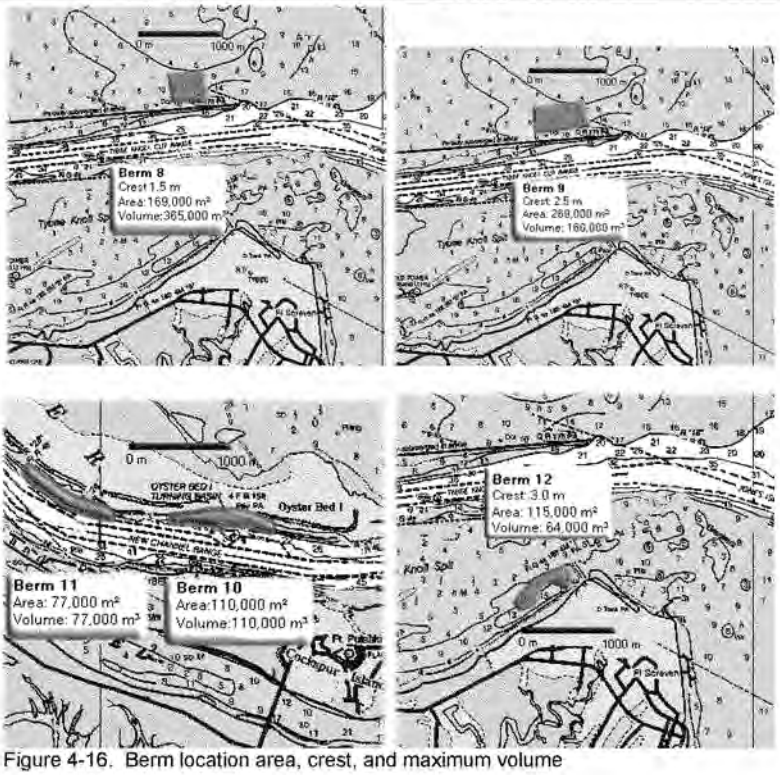


Figure 4-16. Berm location area, crest, and maximum volume

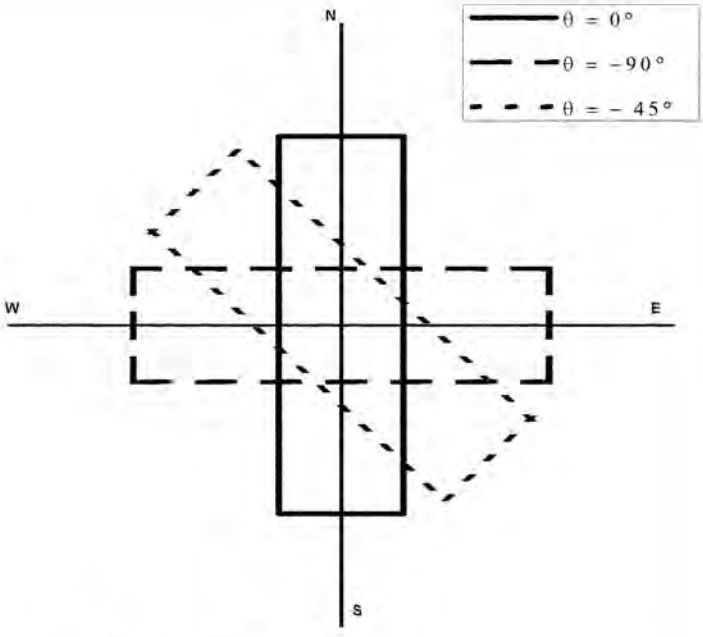


Figure 4-17. Mound orientations

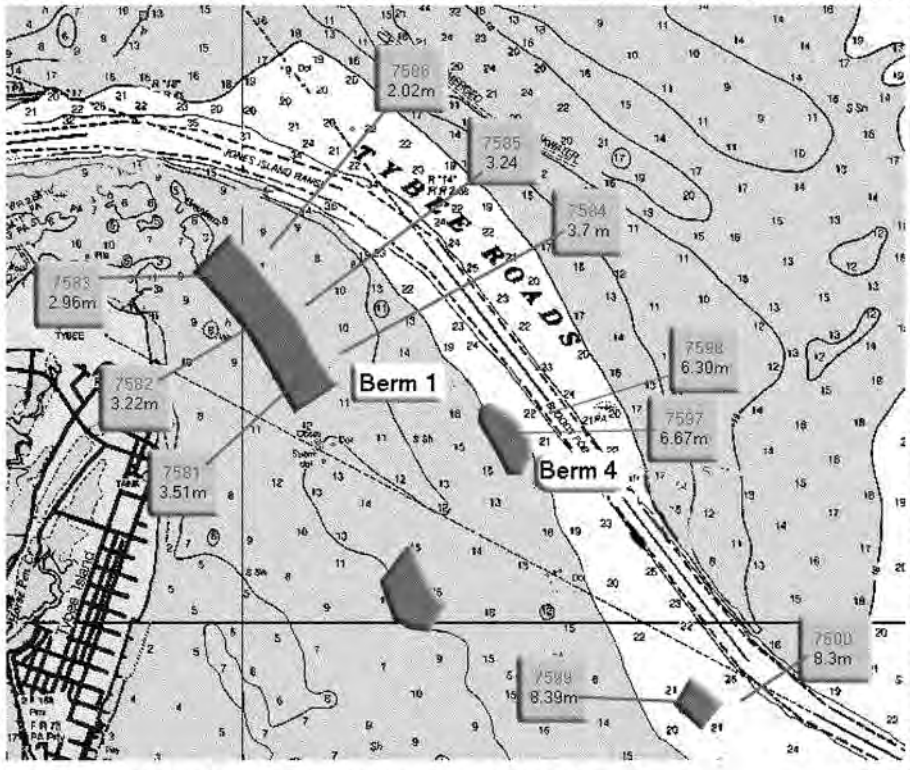


Figure 4-18. Locations for GTRAN erosion calculation: mounds 1,4,5.

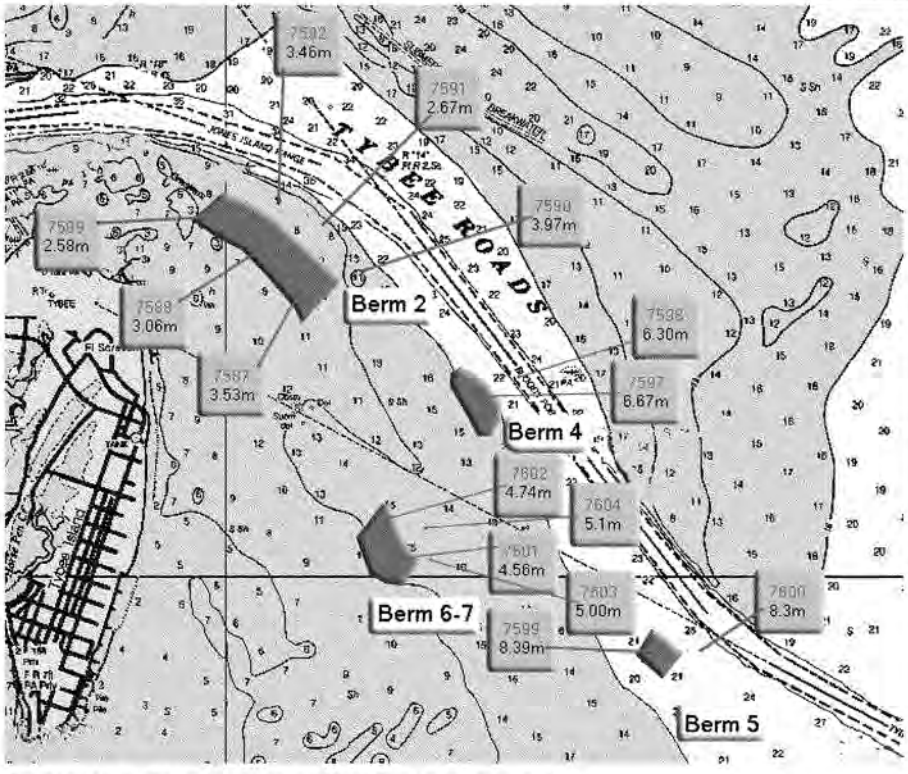


Figure 4-18. Locations for GTRAN erosion calculation: mounds 2,4-7.

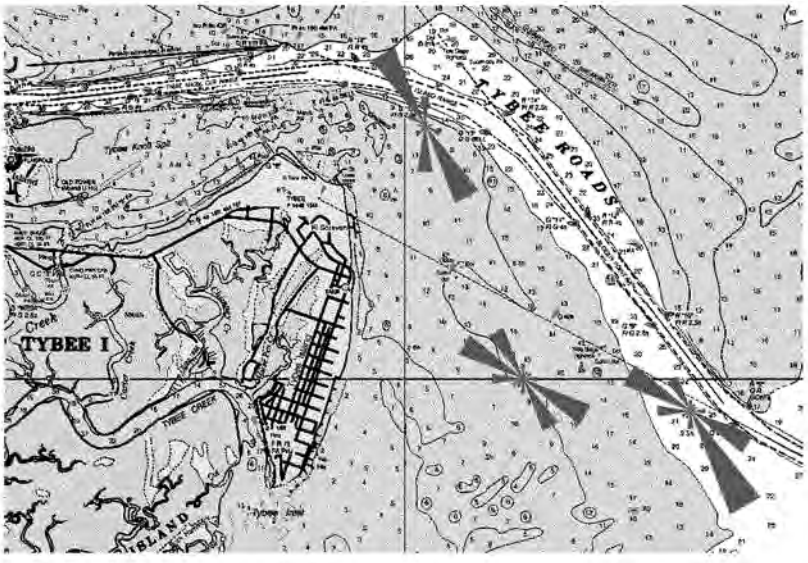


Figure 4-18. Sample rose plot of erosion magnitude and direction at berms 1,5,7

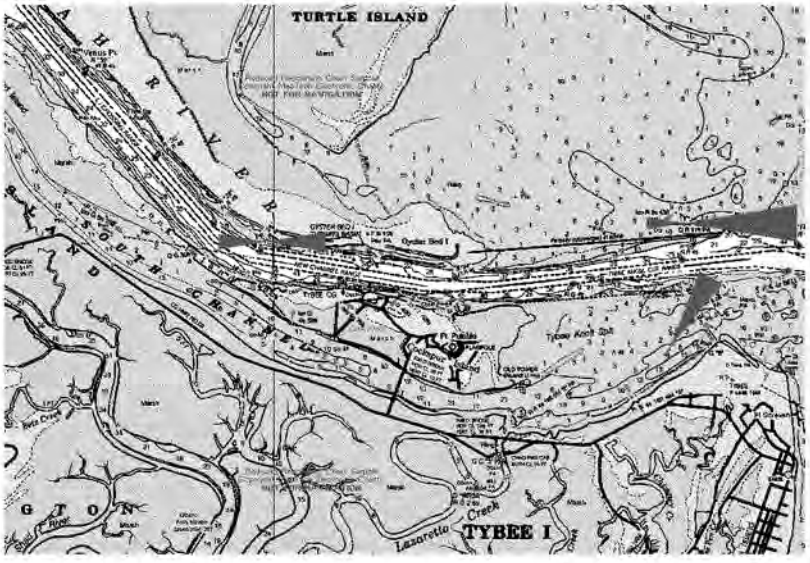


Figure 4-19. Sample rose plot of erosion magnitude and direction at berms 8, 10, 12

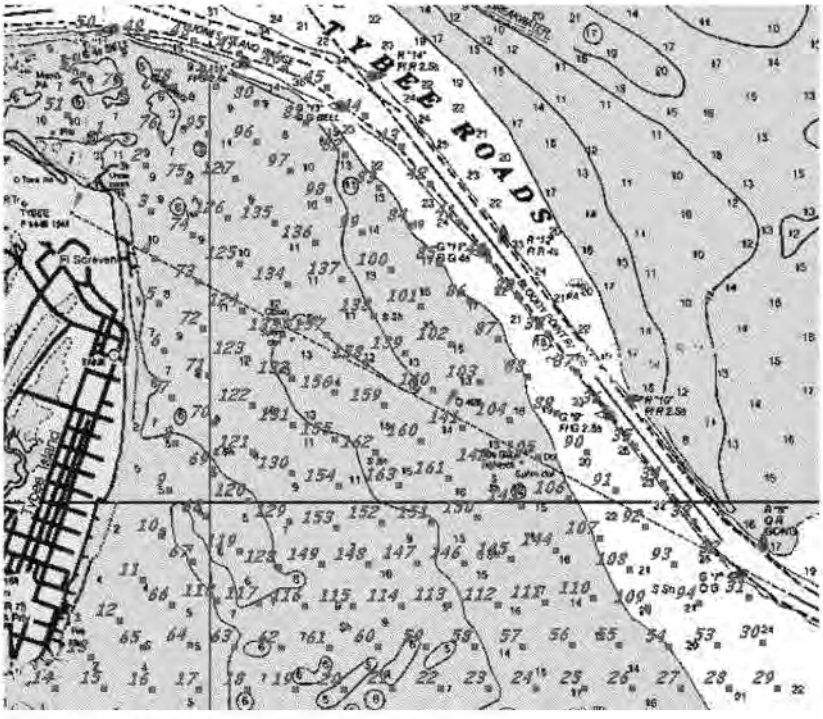


Figure 4-20. Distribution of GTRAN calculation points.

DRAFT

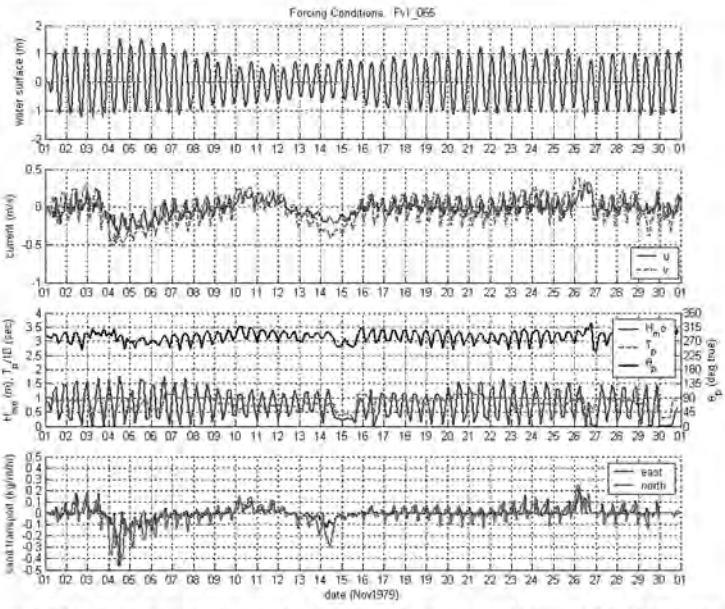


Figure 4-21a Time-series of water level, current, waves, and transport for November 1979 at Point 65 (Figure 4-20)

DRAFT

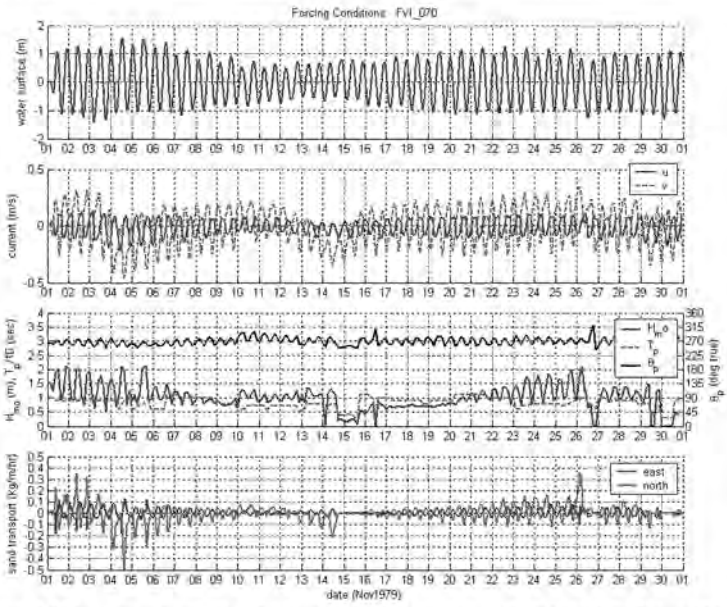


Figure 4-21b Time-series of water level, current, waves, and transport for November 1979 at Point 70 (Figure 4-20)

DRAFT

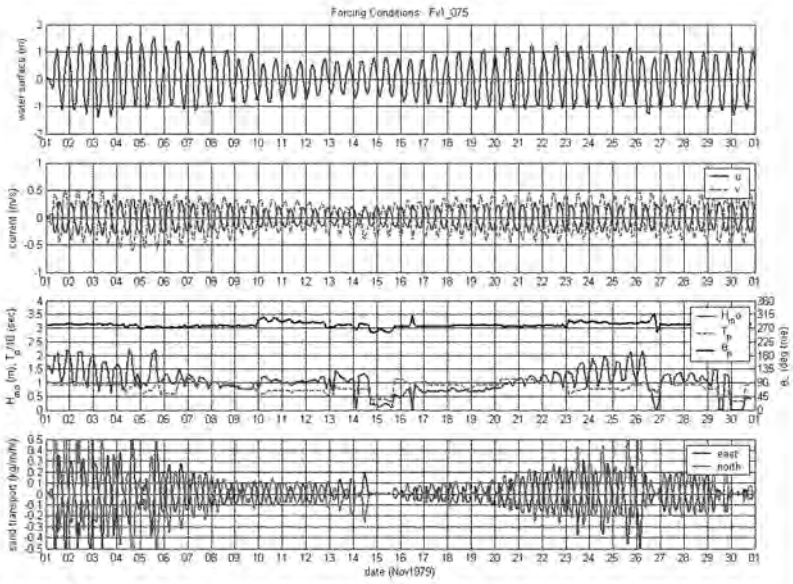


Figure 4-21c Time-series of water level, current, waves, and transport for November 1979 at Point 75 (Figure 4-20)

DRAFT

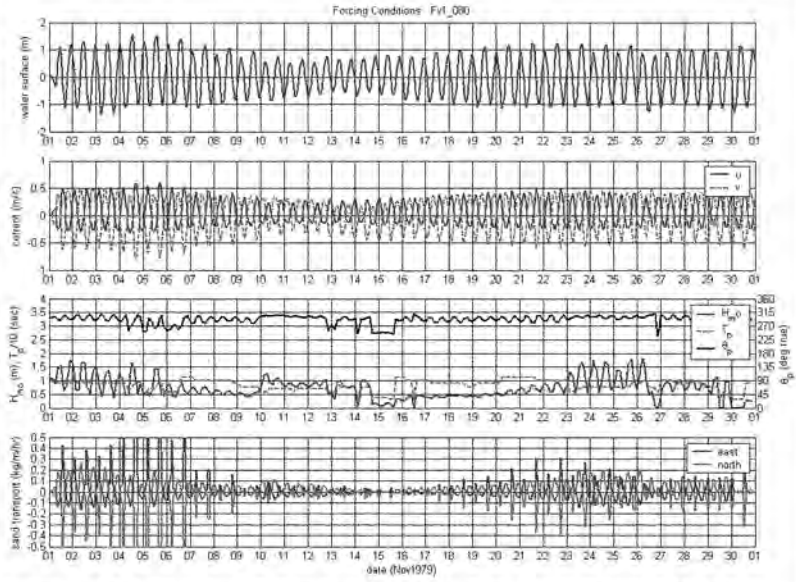


Figure 4-21d Time-series of water level, current, waves, and transport for November 1979 at Point 80 (Figure 4-20)

DRAFT

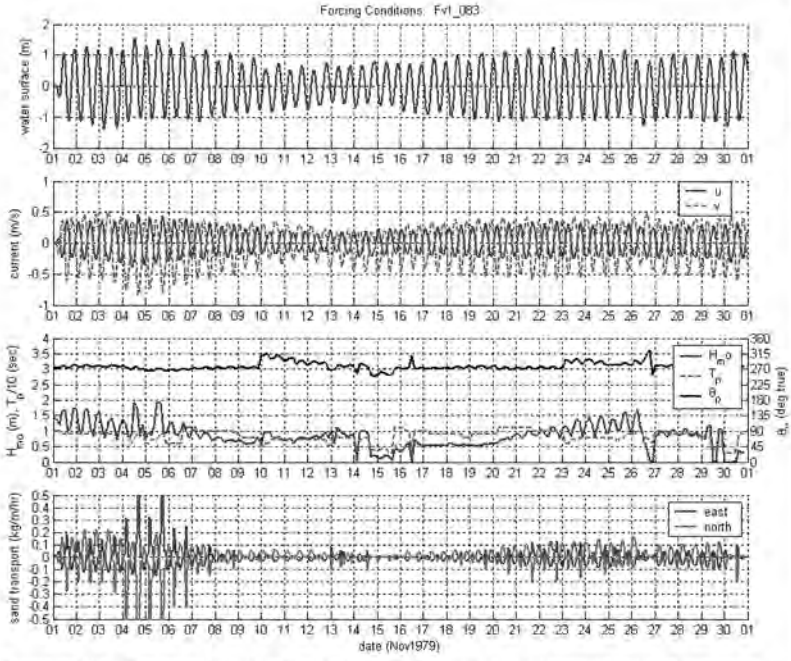


Figure 4-21e Time-series of water level, current, waves, and transport for November 1979 at Point 83 (Figure 4-20)

DRAFT

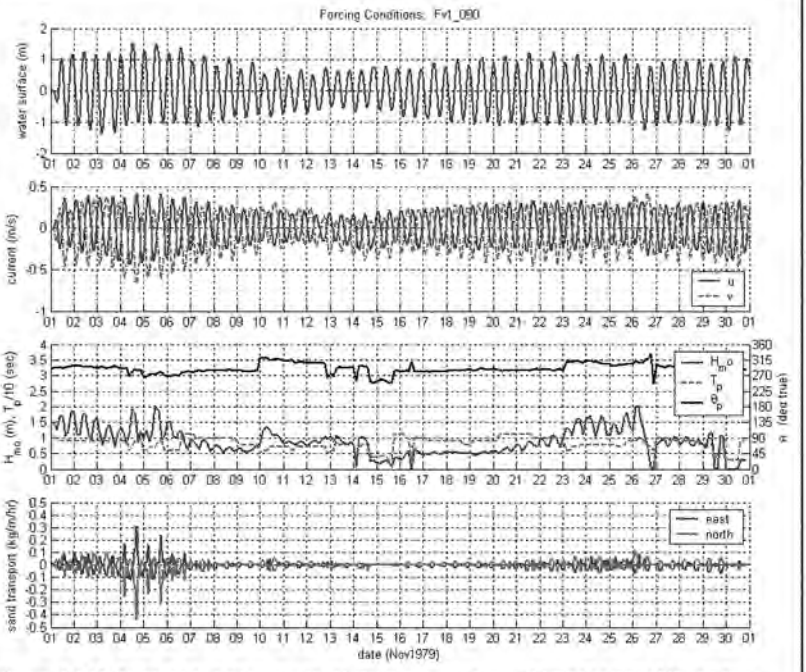


Figure 4-21f Time-series of water level, current, waves, and transport for November 1979 at Point 90 (Figure 4-20)

DRAFT

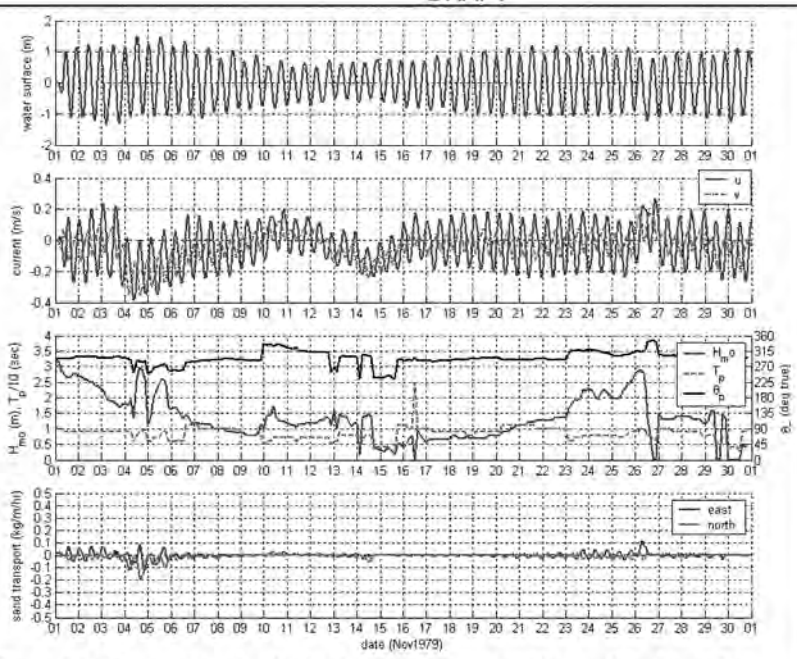


Figure 4-22 Time-series of water level, current, waves, and transport for November 1979 at existing offshore disposal site.

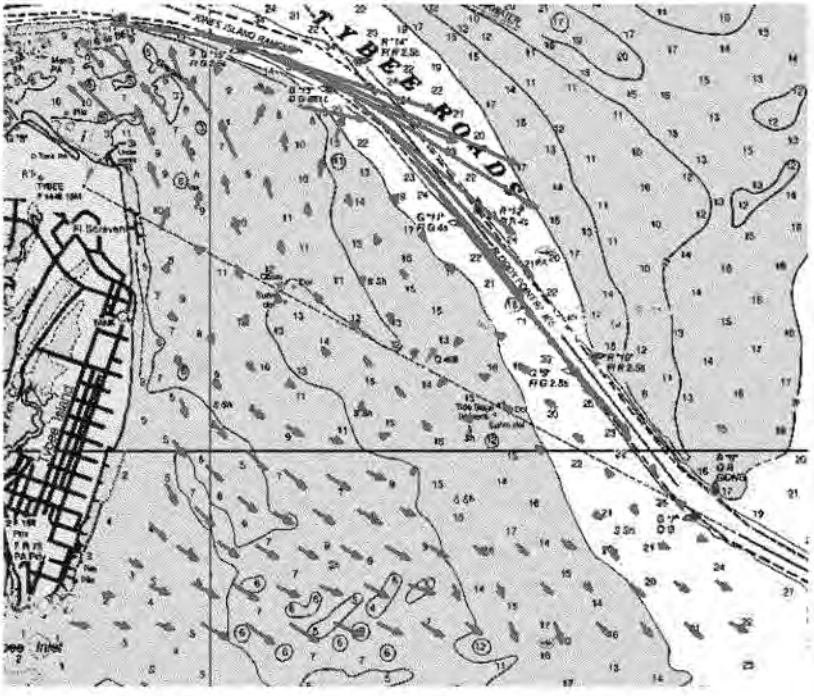


Figure 4-23. Net transport vectors for operational month (January 1992).

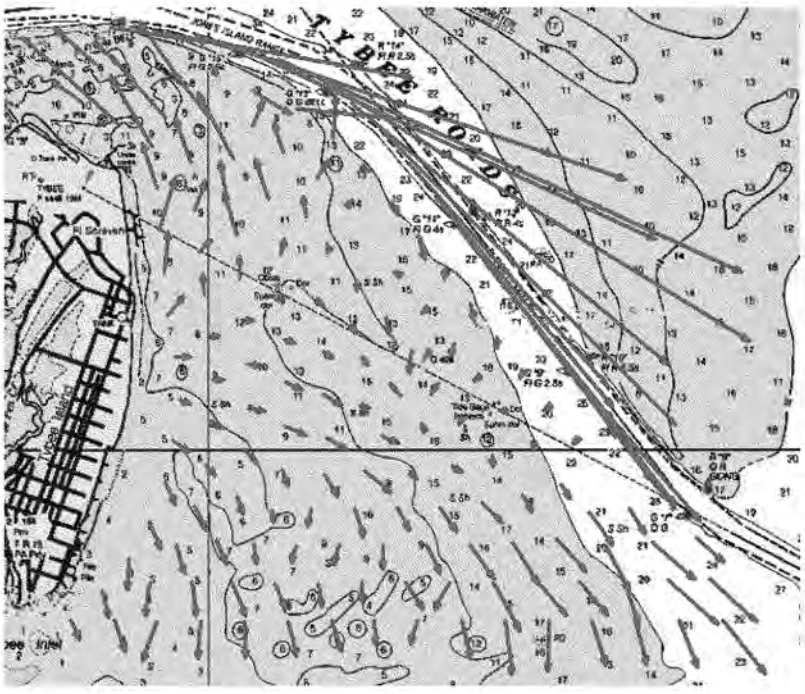


Figure 4-24. Net transport vectors for storm month (November 1979)

DRAFT

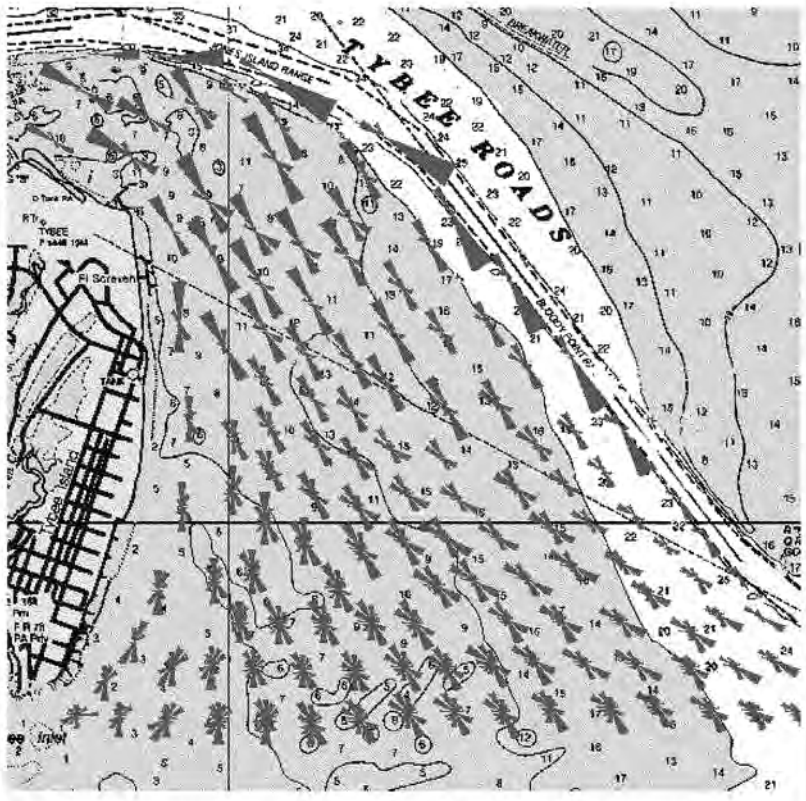


Figure 4-25 Transport roses at selected points for storm month (November 1979)

DRAFT

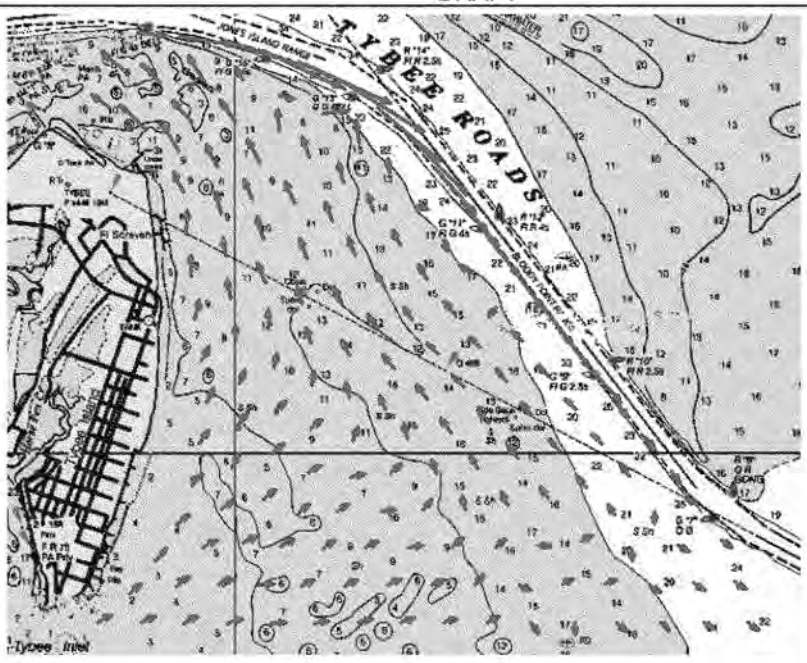


Figure 4-26. Net transport vectors for 24-year simulation (1976-1999). Note: not to same scale as presented in Figures 21 and 22.

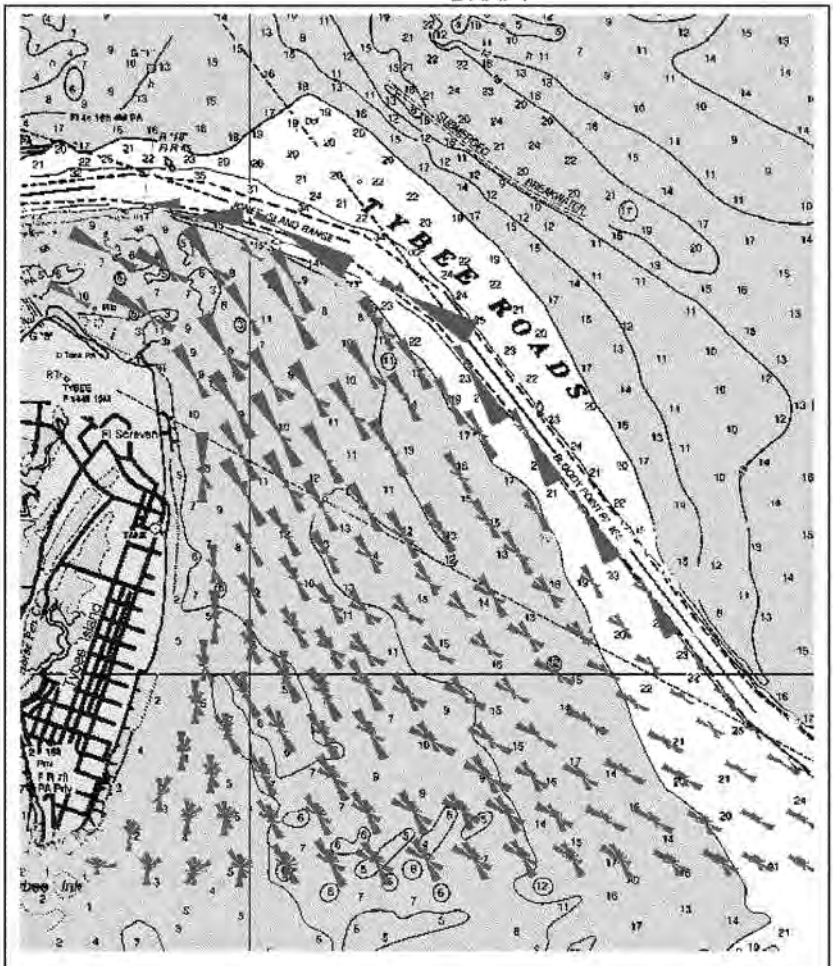


Figure 4-27. Transport rose at selected points for 24-year simulation (1976-1999).

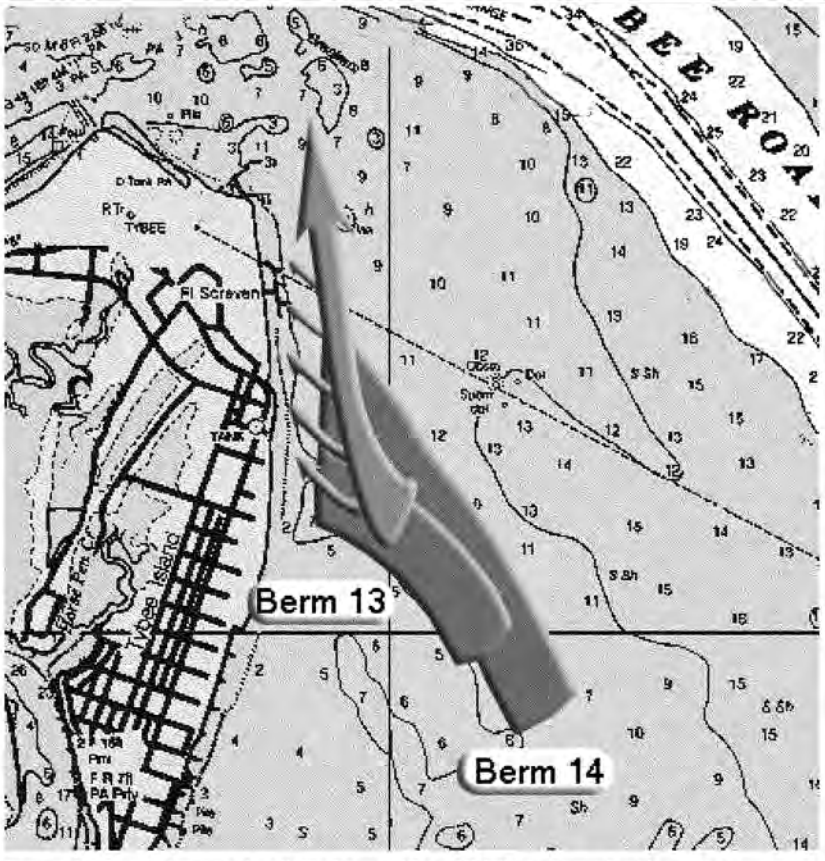


Figure 4-28. Net transport path for berms 13 and 14 (large arrow) with onshore transport component (small arrows). Note: other secondary transport directions are not included.

5 Sediment Suspension and Deposition During Dredging and Placement Operations

Plumes of suspended sediment generated during dredging and placement operations are of potential concern on the aquatic environment. Consequently, estimates of suspended sediment entrainment and transport during the dredging and placement operations are required to assess the potential impact to the environment. Chapter 5 describes model applications and analysis addressing sediment suspension, transport, and deposition during dredging and nearshore placement operations at the Savannah River entrance channel and adjacent waters. Two primary issues are 1) whether unsuitable levels of suspended sediment are present in the water column or suspended sediment in the water column or 2) do fines placed in suspension settle out in the nearshore zone. This chapter does not address the biological effects or risk to the environment, but presents suspended sediment concentrations from which those assessments may be made.

SSFATE Model and Input

The SSFATE (Suspended Sediment FATE) model was recently developed under the Dredging Operations and Environmental Research (DOER) Program of the US Army Corps of Engineers to address concerns related to sediment resuspension by the dredging process. The model is designed to predict spatial and temporal variations in suspended solids and re-deposition of dredged material. The model was originally intended for use in assessing environmental windows, but SSFATE is used for multiple purposes where dredge-generated turbidity is a concern. Model output includes three-dimensional temporal and spatial distribution of sediment concentration in the water column and thickness of deposition on the sea floor.

At the core of SSFATE is a computational, particle-based (Lagrangian) transport model with random-walk dispersion and settlement of material suspended during the dredging process. An integral component of the modeling system is the specification of the sediment source strength and the vertical distribution of the suspended material. Sediment sources in SSFATE represent the introduction of sediment into the water column as the result of a cutterhead dredge, a hopper dredge, or a clamshell dredge. The user specifies the source strength and the vertical distribution of the material released to the water column. This capability can be used to adapt the model input to simulate a wide range of dredging scenarios.

Model modifications

As a result of the complex hydrodynamics at the Savannah River Entrance and the surrounding coastal areas, limitations were encountered in the SSFATE model framework. In the

original SSFATE model, hydrodynamic and sediment transport simulations were performed on a rectangular grid. Data from a hydrodynamic model were imported and interpolated onto each cell in the rectangular SSFATE grid, or applied at specified points (for example, from current data measured in the field) and subsequently interpolated by the model to cover the entire grid. The rectangular grid was considered unacceptable for the Savannah application, where issues included both nearshore turbidity and far field concentrations in a complex estuarine/coastal ebb shoal environment for a wide area containing numerous dredging and placement locations. The original SSFATE model permits a maximum grid size of 100x100. The uniform, rectangular cell size is user specified. Adequate resolution of the complex nearshore/river areas in the Savannah River entrance required a small cell size, which coupled with the grid dimension limit, only allowed a small domain to be examined. Much of the suspended sediment in the fast-flowing Savannah River and ebb shoal channel exits this small grid domain within hours after release, long before most material is deposited. A larger domain requires larger grid cell size, thus resulting in lack of resolution in some areas of special interest such as the channel, nearshore regions, and near the jetties.

To address these model limitations, SSFATE was modified for application at Savannah to operate on an unstructured mesh with unlimited number of cells and variable, non-rectangular cell dimensions. In addition, SSFATE was modified to import the mesh, bathymetry, current time series, and water elevation time series directly from the ADCIRC simulations described in Chapter 3. Therefore, SSFATE transport simulations now include the same fine-scale resolution of river, coastal, and marsh areas as ADCIRC simulations. Cell spacing is as small as 30 m within the river and in the ebb shoal channel. Maximum resolution on the SSFATE grid is in the river and channel, where cell size is approximately 30x30 m. Vertical resolution is 2 m, resulting in approximately 6 vertical cells in the channel and less in nearshore regions. While permitting more flexibility in application, the new capabilities have two negative consequences. First, the computational requirements for unstructured grid SSFATE simulations are significantly increased. Savannah SSFATE simulations performed on the rectangular grid require approximately 1 hour to simulate 8 days. This same simulation now requires approximately 36 hours of computation time. The output files in the unstructured grid are also more cumbersome to manage (extract data and process results). The total number of simulations was reduced from original plans due to the increased CPU and processing requirements. The tradeoff between number of runs and grid resolution (simulation accuracy) is acceptable. The scenarios simulated provide substantial and adequate insight into dredge-generated total suspended solids (TSS) produced during dredging and placement operations at the Savannah River entrance.

Model input

SSFATE permits the user to specify local bathymetry, hydrodynamic conditions, dredging location, dredging processes and rates, and dredged material properties. Therefore, there are a large number of possible scenarios that can be simulated. Input variables used in the Savannah application of SSFATE are listed in Table 5-1. Dredging locations considered in SSFATE simulations are shown in Figure 5-1. User-specified input for each of the variables that are listed in Table 5-1 are described below.

Hydrodynamic conditions. As previously stated, the hydrodynamic conditions are imported directly from ADCIRC. All SSFATE simulations utilized the January 1992 operational period that was simulated using ADCIRC. Each simulation lasted for 8 or10 days, which included 4 or 5 days of dredging followed by 4-5 days of tracking plume movement and deposition. The simulation start date was always set to 12:00 PM on January 5. The SSFATE model treats sediment transport by current only, and therefore does not include the effects of wave-induced

nearshore currents or the impact of waves on the probability of deposition. In addition, the ADCIRC simulations did not include wave-generated longshore current in the simulations.

Dredging locations. The user specifies locations on the grid where dredging is simulated. These points represent initial source locations, i.e., locations where dredged material is released in SSFATE. Dredging simulations are specified either as a point source (all material released at the same location) or a line source (released evenly over a line of specified length and direction starting at the specified point). Four locations were selected for the Savannah River entrance simulations. These points, shown in Figure 5-1, include two locations in the river, one just seaward of the jetty, and one in the channel offshore of Tybee Island.

Dredging processes and rates. Savannah River entrance channel dredging utilizes both cutterhead and hopper dredges. SSFATE simulates either of these dredging processes. Hopper dredging was assumed for most offshore simulations (C and D in Figure 5-1), while riverine simulations (points A and B) exclusively used cutterhead dredging (Table 5-1). The user-specified production rates for these simulations were 500, 1000, and 2000 m^3/hr (Table 5-1). Loss rate for sediments during the dredging operation and distribution of this loss in the water column are also user-specified. Loss rates were set to 1, 3, or 5 percent, which correspond well with recent, yet unpublished, data based on monitoring at a dredge (John Land, personal communication; Donnie Hayes, personal communication). The majority of the sediment was assumed to be lost in the lower 25 percent of the water column. The user also specifies if the material is released at a single point over the entire dredging simulation or uniformly distributed along a line through the channel. River simulations (cutterhead) were designated as point sources. Simulations at Location C and D, offshore, (Figure 5-1) included both line and point sources.

Dredged material properties. The user specifies the fractions of the dredged material that are clumps, coarse sand, fine sand, silt, and clay. No clumps were assumed for Savannah simulations. This assumption is conservative in that it will overestimate far field TSS and deposition. Clumps would settle predominately immediately below the dredging source point. Fractions of sand, silt and clay were developed from the sediment samples used for Sedflume analysis and described in Chapter 4 (Table 4-2). All river location simulations used properties of sediment designated as 38N (Table 5-1). This material has the highest fine sediment fraction of all the locations that were sampled and analyzed. Sediments designated 17S and 33S (Table 5-1) were considered typical of sandy material dredged from the outer portion of the channel. Both of these sediment distributions was used for offshore SSFATE simulations.

SSFATE Simulations and Results

It should be noted here that the results of suspended sediment concentration calculations must be analyzed in perspective with the natural or background suspended solids concentrations in the river and nearshore. Because much of the suspended material in the river is fine-grained, both suspended solids and turbidity can be relatively high. In lieu of data from this region, it can be estimated that surface concentration would be approximately 5-10 mg/L in the river during non-storm periods and typically less than 1 mg/L concentration of fine-grained sediment in the Tybee nearshore region. The Savannah River concentration profile is generally highly stratified (Charles Dickerson, personal communication). Concentrations near the bottom in the channel are generally highest, because much of the sediment in this river moves in a near-bottom nephloid layer (Charles Dickerson, personal communication). SSFATE estimates concentration at 2-m vertical increments in the water column, and estimates are considered to be an average over this vertical increment. In addition, concentrations are averaged over the one-hour output interval of SSFATE. It should be noted that in most rivers, sediment concentrations often exceed 50-100 mg/L for several days during storm events. There is often a corresponding intrusion of fine material into the nearshore surf zone during storms (based on inspection of data acquired at the

CHL Field Research Facility in Duck, NC). However, high bottom shear stresses do not permit deposition of these fines near the beach and the material deposits offshore during the waning stages of the storm. Stratification is generally found only in the channel. Outside the channel (the area of most concern in these simulations), the water column concentrations are predominantly uniform with depth.

Location A

All dredging simulations at this river location assume a point-source discharge from a cutterhead dredge. Simulations were performed assuming 12% clay, 40% silt, 37% fine sand and 11% coarse sand. These values correspond to the Sedflume sediment sample extracted at location 38N. Production (m^3/hr) /loss rates (%) combinations simulated were: 500/1 (ex, 500 m^3/hr and 1% loss rate), 500/5, 1000/1, 2000/1, and 2000/5 (see Table 5-1). The 2000/5 combination is a worst-case scenario, from the perspective of introducing sediment into the water column, i.e., maximum production rate and maximum loss rate. Vertical dispersion is user specified and was set to 0.0001 m^2/sec, as recommended in the SSFATE users manual (Applied Science Associates, 2001). The 500/5 and 2000/5 simulations were re-run with vertical dispersion increased to 0.001 m^2/sec, and order of magnitude increase, to determine the sensitivity of results to this user input. Horizontal dispersion is calculated in the model and is a function of hydrodynamic conditions. There is no method for the user to modify horizontal dispersion in SSFATE. The simulation duration spanned 5 days of dredging and 5 days post-dredging.

Location B

Location B is also in the river, but closer to the mouth than Location A. Only two simulations were performed at this location because it was determined after these simulations that deposition and TSS patterns were similar to those calculated at Location A. The two simulations assumed a cutterhead dredge and point sources; with grain size distribution identical to those at Location A. Production/loss rates for the two simulations were 1000/3 and 2000/5.

Location C

Location C is just offshore of the north jetty and north of Tybee Island. Both cutterhead and hopper dredges were simulated. All hopper dredge simulations considered line sources approximately 1 km in length, originating at Location C. In addition, three cutterhead point sources and one line source were simulated. Hopper simulations assumed production/loss rates of 2000/1 and 2000/5. Cutterhead production/loss rates were 2000/1, 2000/3, and 2000/5. Sediment grain size distribution was based on Sedflume sample 17S, which was 3% clay, 8% silt, 70% fine sand, and 19% coarse sand.

Location D

Location D is east of the north end of Tybee Island. Two line source hopper dredge simulations and two point source cutterhead simulations were performed. Line sources were approximately 1 km long. Production/loss rates for the hopper dredge and cutterhead simulations were 2000/1 and 2000/3. Sediment was characterized as that from Sedflume sample 33S, which was 1% clay, 5% silt, 74% fine sand and 20% coarse sand.

Suspended Sediment

Due to strong tidal currents, dredging in the Savannah Harbor entrance channel produces a long, narrow plume that maintains its shape during the dredging period and moves upstream and downstream with the tidal current. Swift tidal currents rapidly spread the material released during dredging. This is seen in all SSFATE Savannah dredging scenarios. A large, relatively low concentration plume typifies high-current environments. Concentrations in low-current, low-convection regions (not typical of Savannah) can be much higher. Typical of the computed dredged material plumes associated with dredging at the bar channel, some shore-ward intrusion of fines occurred during flood tide, but the concentrations remain low (generally less than 1 mg/L) and are rapidly moved offshore during the ebb cycle. Some material enters the nearshore region, but virtually no sediment enters the surf zone at Tybee. None of the material, which moves into the nearshore region, deposits there due to the high shear stresses (even with wave-induced stresses neglected). The majority of the material remains near the channel, indicating the system is dominated by convective transport.

The convection-dominated transport is demonstrated in this paragraph. See Table 5-1 for specifics of the simulations that are discussed here. Calculated TSS time histories for simulation PACCAAA, the worst-case scenario (2000 m^3/hr production rate, 5% loss rate, increased vertical dispersion, 38N sediment), are provided in Figures 5-2a through 5-2e for Location A. Figure 5-2a shows depth-averaged TSS at the source, i.e. at the dredge. The concentration varies over several orders of magnitude during the dredging operation. Highest concentrations are observed during slack tide when velocities are low. Low concentrations are seen during maximum ebb and flood currents, when the high velocities rapidly move the material away from the source. The slack tide maximum concentrations also vary, depending on the effects of other conditions such as wind-driven currents and elevation changes at the river mouth. Maximum concentration at any cell at the source is approximately 600 mg/L. Concentrations over 100 mg/L last for two hours or less. Figures 5-2b and 5-2c show the time-series of average water column concentrations 50 m and 100 m from the source, respectively, in a direction perpendicular to the channel, heading toward the right (south) bank. It can be seen from these graphs that TSS concentration drops off rapidly with increasing cross-channel distance from the source. A depth-averaged concentration maximum of 320 mg/L is predicted at 50 m, and at 100 m from the source the maximum is about 110 mg/L. Figures 5-2d and 5-2e depict depth- averaged water column concentration time series at distances of 500 m and 2500 m in the down-channel direction from the source, respectively. These concentrations are higher than those calculated in the cross-channel direction due to high convective transport of sediment in the along-channel direction. Time variation in TSS is generally due to fluctuation in tidal velocities. These figures also demonstrate the rapid decrease in concentration away from the source. Similar time histories occurred upstream of the dredge, but with slightly lower concentrations in this ebb-dominated tidal environment. In addition, the TSS in Figures 5-2a-e indicate that dredging-induced increases in TSS are negligible within 12 to 24 hours after dredging operations cease on Day 10.5. Time- and depth-averaged concentrations at various cross-channel locations are provided in Table 5-2. From this table, it can be seen that concentration drops off rapidly from the source. At 100 m from the barge at Location A for the greatest loss rate, the concentration average is 5 mg/L.

TSS variation in the water column is also estimated using SSFATE. Generally, the highest water column concentrations were near the bottom. Surface TSS concentrations were lower than the depth-averaged values. As an example, time-varying, near-bottom concentration 500 m down-channel for simulation PACCAAA is provided in Figure 5-3. This can be compared to the depth-averaged concentration 500 m down-channel in Figure 5-2d. Concentrations near the bottom are generally a factor of 5 to 10 higher than depth-averaged values in high-concentration areas where

the sediment load is still stratified. The factor decreases as concentration decreases and distance from the disposal site increases.

Simulated plume concentrations at Location B are similar to those at Location A. Plume concentration from dredging at Location C and D are generally lower than those at Location A and B. This is due to the smaller fraction of fine sediment at the offshore dredging locations. Sand particles released during the dredging process quickly deposit near the dredge. Fine sediment does not deposit due to the lower settling speed and lower critical stress for deposition. Simulation PBCCAA, at Location B, and PCCCBA, at Location C, both reflect cutterhead dredging with 2000/5 production/loss rates (the worst case scenario). Table 5-2 indicates that the concentrations at Location C are significantly less due to the lower fine sediment content in the dredged material at this location. The concentrations away from the source are a factor of 2-4 lower for operations at Location C compared to Location B. This may be due in part to differences in hydrodynamic conditions, but is due predominately to the reduced fine fraction at Location C.

Water quality, habitat risk analysis, and turbidity analysis generally require that TSS remain below a certain level for a specified duration at various distances from the dredging location. Figures 5-4a-c quantify the percent of time TSS remain above various concentration levels during the period of dredging, for various dredging source term/location combinations. These values are for the largest dredging rate/loss rate combinations in Table 5-1. Figure 5-4a is for simulation PACCAA. It can be seen, for example, that depth- averaged water column concentration at a cross-shore distance of 50 m from the source (xs_50 in the figure legend) remains above 10 mg/L for approximately 28% of the 4-day dredging duration. Similarly, depth-averaged water column concentration in the 30x30 m cell around the dredge remains above 100 mg/L for approximately 6% of the 4-day dredging period. Comparison of Figure 5-4a to Figure 5-4c, which is at Location C, indicates the lower concentrations produced by dredging on the ebb shoal, where the fraction of fine sediment is much lower than at Location A or B.

The TSS at the source should be evaluated relative to the ambient concentrations in the river. This comparison, if data were available, would likely indicate that increased TSS from the dredging operation is lower than that experienced during natural events in the river (Chuck Dickerson, personal communication). In addition, storm-induced TSS in the river and nearshore remains high for several days. The dredge-induced TSS is highly variable (as seen in Figure 5-2) and concentrations above typical storm levels last for only a few hours at any one location.

The order-of-magnitude level of temporal variability in concentration between high and low values is in large part due to the strong tidal currents. The same suspended particle may cross a specified river cross section several times with the changing tidal currents. However, in this ebb-dominant channel region, most suspended material has moved permanently past Location A approximately two days after dredging ceases. It should be noted that increasing vertical dispersion by an order of magnitude beyond the SSFATE default value (simulation PACCAA vs. PACCAAA) did not significantly change the maximum near-bottom or near-surface concentration maxima or depth-averaged values.

For dredging in the coastal region, suspended solids concentrations are lower due to the reduced fraction of fine sediment and greater cross-channel dispersion. This cross-channel dispersion rapidly reduces concentration. Figures 5-5a to 5-5f show time series of depth-averaged concentration at the source, 50 m cross-channel, 100 m cross-channel, and 500 m cross-channel, 500 m down-channel, and 2500 m down-channel, for simulation PCCCBA at Location C (2000/5 production/loss rate, which is the worst case scenario). TSS concentrations associated with dredging at Location C are significantly less than those at corresponding distances from dredging at Location A. At a cross-channel position of 100 m from the dredging source, maximum depth-

averaged concentration is less than 11 mg/L and the time-averaged concentration over the dredging period was 0.5 mg/L (maximum near-bottom concentration remains below 50 mg/L). At 500 m cross-channel from the dredging location, maximum depth-averaged concentration was less than 5 mg/L; maximum near-bottom concentrations remain below 25 mg/L. The time- and depth-averaged water column concentration over the entire dredging cycle 500 m cross-channel from the source was 0.07 mg/L. Similar patterns of concentration were observed at location D, but maximum and average concentration values were even slightly lower than at Location C, due to the smaller fraction of fine material.

Deposition of suspended sediments

Another area of concern during dredging operations is deposition of material released during the dredging operation. This deposition can impact benthic communities near the channel. SSFATE estimates the deposition of material suspended during the dredging process (deposition of ambient sediments is neglected). The deposition thickness output is provided to quantify deposition away from the source. It is important to note that deposition computations right at the source are probably unrealistic because SSFATE assumes the dredge remains stationary for four days in point model simulations. The along-channel deposition patterns for simulation PBCCAA (Location B, 2000/5 production/loss rate) are shown in Figure 5-6. As expected, the greatest deposit thickness is immediately below the dredge and in the channel near the dredge. However, deposition quickly drops off away from this line, particularly in the cross-channel direction. Light blue and dark blue colors indicate less than 0.5 mm deposition thickness outside the channel. The deposited layer outside the channel is almost all silt and clay particles. These sediments are similar to ambient material outside the channel within the river.

Deposit thickness after four days of dredging for Location C (simulation PCCCBA) is provided in Figure 5-7 (missing this figure). Deposit thickness outside the channel for this simulation is less than at Location B. There are two reasons for this. First, dredging at Location B includes less fine sediment. Sand generally deposits in the channel soon after release from the dredge. Fine material is the only material that remains in suspension long enough to exit the channel. Second, high shear stress outside the channel on the ebb shoal does not permit fine material to deposit. This material will remain in suspension for longer periods of time until it is transported to lower-shear stress regions (offshore) where deposition is possible. Table 5-3 provides cross-channel bottom deposit thickness for several SSFATE simulations covering all four locations shown in Figure 5-1. The pattern described above is clear. Deposit thickness outside the channel (250-500 m in the cross-channel direction) is less than 0.06 cm for all conditions and is insufficient to significantly impact benthic communities. Deposition within the channel of several cm is expected as part of the dredging process.

D-CORMIX Model

The Continuous Dredge Cornell Mixing Zone Model (D-CORMIX) is a program for the analysis, prediction, and design of aqueous, dense-sediment-laden, pipeline discharges into coastal water bodies, with emphasis on the geometry and dilution characteristics of the initial mixing zone, and for evaluating compliance with regulatory requirements. D-CORMIX was developed as an extension to the CORMIX family of models for representing discharges and mixing zones of buoyant plumes (Donneker and Jirka, 1991). D-CORMIX gives water column predictions of suspended sediment concentrations. Predictions of bottom fluid mud movement, which is an important aspect of pipeline placement, are not included in this model. D-CORMIX was applied to both riverine and nearshore pipeline placement of dredged material at the Savannah River entrance channel to determine extent and density of the resulting plume. Initially, use of the PDFATE model was planned to examine the spread of fluid mud. However, testing

with PDFATE determined that this model is not applicable to high-sand-content mixtures found in the Savannah River entrance channel. No model or method available was considered to be an appropriate replacement for predicting bottom flow (fluid mud) movement of the types of mixed sand/silt/clay dredged material from the Savannah River entrance that were sampled.

D-CORMIX is a simplified, idealized, screening level model that is designed to simulate a highly complex process. Unlike SSFATE, D-CORMIX does not account for complex bathymetric or hydrodynamic variation. Input includes two zones, or model domains, one nearshore and one offshore. Each zone has a specified width, bottom slope, and time-invariant velocity. Zone 1 starts at the shoreline and requires a minimum 1-degree bottom slope and user defined domain width. Therefore, even relatively flat regions must be simulated using this modest slope. Zone 2 also requires a minimum 1-degree slope, begins at the deep-water end of Zone 1, and has an infinite width. The user also specifies sediment properties for the pipeline disposal including initial concentration, flux rate or velocity, fraction of various sediment classes, and pore water properties. User-specified pipeline characteristics include dimensions, orientation, and location. Since the bathymetry and velocity are highly idealized, the model does not apply to a specific location within the domain, but rather D-CORMIX is applied in a general manner with representative bathymetry/velocity conditions for the nearshore and river regions.

Two bathymetric conditions were simulated. The first was defined as the river condition, which included a 2-degree nearshore slope followed by a 5-degree slope in Zone 2. Zone 1 was 140-m wide. This bathymetry was designed to reflect the nearshore region and channel slope near river reach 38N. Pipeline placement was simulated at the divide between the zones, in 4.9-m water depth. The second bathymetry was assumed to reflect placement offshore of north Tybee Island. Zone 1 had a 1-degree slope and extended for 200 m. Zone 2 had a 2-degree slope. Placement was also at the boundary between zones, in 3.5-m water depth. Placement would not actually occur only 200 m from shore, but this distance was used so that a 1-degree slope would reflect the water depth at the placement location, 3.5 m, which does accurately reflect water depths for proposed nearshore placements. Table 5-4 shows the various river and north Tybee placement scenarios simulated using D-CORMIX. Variables included sediment type (chosen from various Sedflume sample analyses), discharge rate, and flow velocity. (Specifically define each of the parameters defined in the table.) The number of possible runs is quite extensive given the list of variables. The simulations listed in Table 5-4 provide sample results since exact specifications for dredging rates and dredge types are not yet determined.

Table 5-5 shows the gaussian half-width (BH) and centerline concentration (C) for each of the sample runs listed in Table 5-4. D-CORMIX assumes a gaussian distribution for the plume concentration. The centerline concentration is the highest concentration in the plume at the specified distance from the source. The concentration, C, at any cross-plume location from the centerline is estimated by:

$$C = C_{centerline} e^{-(x/BH)^2}$$

where $C_{centerline}$ is the centerline concentration, BH is the gaussian half width, and x is the cross-plume distance. The gaussian half width, BH, is one-half the plume width that includes 68% of the mass in the plume at the specified distance downstream from the source. Concentration at the edges of the gaussian half width is equal to 0.6* $C_{centerline}$. Ninety-five percent of the suspended sediment mass is contained within two gaussian half-widths from the plume centerline. The concentration at the edges of this plume width is 0.4* $C_{centerline}$. Gaussian distribution of concentration within a plume is often utilized in environmental plume modeling. Figure 5-8 provides an example of how the suspended sediment concentrations would typically appear. Table 5-5 indicates that concentration drops off rapidly for pipeline placements of predominately sandy material (run tyb62s), while clays remain in suspension for silty/clay sediments (riverine

simulations). Centerline concentration for the riverine runs was 0.04 to 0.13 g/l (40-130 mg/L) for the riverine simulations. For sediments with higher sand content dredged offshore of Tybee, concentrations at 2 km from the source were 0-0.06 g/l (0-60 mg/L).

Centerline concentration of sand, silt and clay fractions (as a function of distance downstream from the pipeline) for three of the riverine simulations (riv10d, riv10h, and riv10j) is provided in Figure 5-9a-c. It can be seen that the only material with significant concentration remaining in suspension at distances greater than 500 m from the source is the clay material. Fine silt generally drops below 10 mg/L between 500-1000 m from the source. Figure 5-8c shows the concentration for simulation Riv10j, which is the 'worst-case' simulation. The dredging rate was set at 2000 m^3/hr in this simulation and the channel velocity was 0.5 m/s. This condition will carry the most material downstream, as shown in Table 5-5. Centerline concentration at 2 km from the source was approximately 130 mg/L. Figures 5-10a-c show gaussian half-width associated with the plume for the same river simulations. Similarly, Figures 5-11a-c show centerline concentration as a function of distance from the source for three Tybee offshore simulations (tyb25cms, tyb35cms, and tyb45cms). These figures indicate that centerline concentration decreases with increasing velocity because of increased mixing of the pipeline effluent with clean water.

One important factor missing in the Tybee nearshore simulations is wave action. Waves will act to dissipate the plume more rapidly. D-CORMIX does not include wave effects. Therefore, concentrations can be assumed to be lower than calculated in these simulations. In addition, the plume would probably be larger due to wave effects. It is not presently possible to quantify the effects of wave action in D-CORMIX, or in any other post-processing of results. Plume gaussian half-width is provided in Figure 5-12a-c for the same three Tybee nearshore simulations. These figures indicate that plume width decreases with increasing velocity.

Summary and Conclusions

Plumes of suspended sediment generated during dredging and placement operations are of potential concern to the aquatic environment. Consequently, estimates of suspended sediment entrainment and transport during the dredging and placement operations are required to assess the potential impact on the environment. Chapter 5 describes model applications and analysis addressing sediment suspension, transport, and deposition during dredging and nearshore placement operations at the Savannah River entrance channel and adjacent waters. Two primary issues are 1) whether unsuitable levels of suspended sediment are present in the water column or 2) do fines placed in suspension deposit in the nearshore zone. This chapter does not address the biological effects or risk to the environment, but presents suspended sediment concentrations from which those assessments may be made.

Two numerical models of dredged material resuspension and transport were applied to address the effects of suspended sediments at the dredge and the pipeline outfall. SSFATE was applied to quantify sediment suspension from the dredge, transport of the suspended sediment from the dredging site, and deposition of the suspended material. D-CORMIX was applied to quantify sediment entrainment and transport at the pipeline outfall.

Resuspension from dredging operations

Higher concentrations of resuspended sediments were predicted at riverine dredging sites, primarily attributed to the higher silt/clay content in the dredged sediments. Dredging in the coastal region (seaward of the Savannah River entrance) produced lower TSS concentrations because of the higher sand content, which more quickly settles out of suspension. SSFATE predicted that the resuspended dredged material was quickly advected in a net seaward direction

by the ebb-dominant tidal currents. Peak TSS concentrations from the resuspension plume were observed to coincide with near-slack currents. Suspended sediment concentrations also generally drop to negligible levels within 12-24 hours after cessation of dredging operations. Accumulation of resuspended dredged material ranged up to several centimeters within the navigation channel (as expected) and amounted to sub-millimeter thickness outside the navigation channel. Only small quantities of fine sediments were observed to pass within the nearshore region of the Atlantic shoreline of Tybee Island and suspended fine-grained sediments were not deposited in the nearshore because of the relatively large tidal-current-generated shear stresses in this region. The influence of waves on suspended material in the nearshore was not simulated. Agitation by waves would further prevent the deposition of fine-grained suspended sediments in the nearshore.

Resuspension from pipeline disposal

As experience would suggest, significantly higher suspended sediment concentrations are produced at pipeline outfalls than for resuspension at the dredging site. Plumes from pipeline outfalls are expected to be transported primarily in the direction of the tidal currents, with some lateral mixing. Sand and coarse silts were observed in the model simulations to settle out of suspension fairly close to the discharge location, while fine silts and clays remained in suspension to be transported further distances from the discharge point. Fine silts were found to settle out of suspension between 500-1000 m from the discharge point, and the clay fraction remained in concentrations of approximately 100 mg/L at a distance of 2000 m from the discharge point.

References

Doneker, R.L., and G.H. Jirka. 1991. An Expert System for Hydrodynamic Mixing Zone Analysis of Conventional and Toxic Submerged Single Port Discharges (CORMIX 1). EPA 600/3-90/012. DeFrees Hydraulics Laboratory, School of Civil and Environmental Engineering, Cornell University, Ithaca, NY (Prepared for US EPA Office of Research and Development).

Table 5-1: SSFATE simulations

Filename	Dredge Type	Line or Point Source	Location	Dredging Rate (m^3/hr)	Percent Loss	Dredged Sediment	Start Date	Dredging (Days)	Model Simulation (Days)	Vertical Dispersion (m^2/s)
PAAAAA	Cutterhead	Point	A	500	1%	38N	5th Jan 92	5	10	0.001
PAACAA	Cutterhead	Point	A	500	5%	38N	5th Jan 92	5	10	0.001
PAACAAA	Cutterhead	Point	A	500	5%	38N	5th Jan 92	5	10	0.0001
PABAAA	Cutterhead	Point	A	1000	1%	38N	5th Jan 92	5	10	0.001
PACAAA	Cutterhead	Point	A	2000	1%	38N	5th Jan 92	5	10	0.001
PACCAA	Cutterhead	Point	A	2000	5%	38N	5th Jan 92	5	10	0.001
PACCAAA	Cutterhead	Point	A	2000	5%	38N	5th Jan 92	5	10	0.0001
PBBBAA	Cutterhead	Point	B	1000	3%	38N	5th Jan 92	4	8	0.001
PBCCAA	Cutterhead	Point	B	2000	5%	38N	5th Jan 92	4	8	0.001
PCCABA	Cutterhead	Point	C	2000	1%	17S	5th Jan 92	4	8	0.001
PCCCBA	Cutterhead	Point	C	2000	5%	17S	5th Jan 92	4	8	0.001
PDCACA	Cutterhead	Point	D	2000	1%	33S	5th Jan 92	4	8	0.001
PDCBCA	Cutterhead	Point	D	2000	3%	33S	5th Jan 92	4	8	0.001
LCCABA	Hopper	Line	C	2000	1%	17S	5th Jan 92	4	8	0.001
LCCCBA	Hopper	Line	C	2000	5%	17S	5th Jan 92	4	8	0.001
LCCCBAA	Hopper	Line	C	2000	5%	17S	5th Jan 92	4	8	0.0001
LCCCBA-B	Cutterhead	Line	C	2000	5%	17S	5th Jan 92	4	8	0.001
LDCACA	Hopper	Line	D	2000	1%	33S	5th Jan 92	4	8	0.001
LDCBCA	Hopper	Line	D	2000	3%	33S	5th Jan 92	4	8	0.001

	PACCAA	PBCCAA	PCCCBA
Source	25	29	12
50-m	12	6.9	1.6
100-m	5	1.7	0.5
500-m	NA	NA	0.07

Table 5-2: Time-averaged, depth-integrated concentrations (mg/l) at various cross-channel locations during 2000 m^3/hr dredging rate, 5% loss rate simulations

Run	-500 m (cm)	-250 m (cm)	-100 m (cm)	-50 m (cm)	Source (cm)	50 m (cm)	100 m (cm)	250 m (cm)	500 m (cm)
LCCABA	5.16E-07	3.03E-04	1.71E-02	6.71E-01	2.13E+01	2.28E+00	1.30E-01	8.99E-06	0.00E+00
LCCCBA	1.56E-03	5.87E-05	1.52E-01	4.28E+00	1.14E+02	9.66E+00	5.55E-01	2.20E-06	0.00E+00
LDCACA	9.26E-04	1.77E-03	6.91E-01	7.06E+00	1.03E+01	6.59E+00	3.86E-01	4.02E-03	9.75E-06
PACAAA	NA	NA	1.24E+00	2.60E+01	4.90E+01	7.98E+00	7.98E+00	NA	NA
PAAAAA	NA	NA	2.46E-01	6.46E+00	1.20E+01	1.87E+00	1.87E+00	NA	NA
PBBBAA	NA	NA	1.18E-01	5.01E+00	1.11E+02	7.07E+00	5.34E-02	NA	NA
PBCCAA	NA	NA	3.56E-01	1.71E+01	3.85E+02	2.12E+01	2.46E-01	NA	NA
PCCCBA	3.14E-05	5.08E-03	7.38E-02	3.16E+01	7.37E+02	4.33E+01	6.90E-01	3.39E-04	1.09E-04
PDCACA	1.78E-05	3.69E-03	1.46E+00	2.13E+01	1.07E+02	1.83E+01	2.24E+00	9.02E-04	1.32E-03

Table 5-3: Deposition at various cross-channel locations from the source

Table 5-4: Sample D-CORMIX simulations

FILE	Sediment	slope1	slope2	u1	u2	ybreak	zbreak	slurry	slurry	C total	C sand	C csilt	C fsilt	C clay
Name	Type	(degrees)	(degrees)	(m/s)	(m/s)	(m)	(m)	flux m3/hr	flux m3/s	(g/l)	(g/l)	(g/l)	(g/l)	(g/l)
riv10c	38N	2	5	0.1	0.15	140	4.89	1000	0.28	240	120	64.8	33.6	21.6
riv10d	38N	2	5	0.2	0.25	140	4.89	1000	0.28	240	120	64.8	33.6	21.6
riv10f	38N	2	5	0.2	0.25	140	4.89	500	0.14	240	120	64.8	33.6	21.6
riv10g	38N	2	5	0.3	0.4	140	4.89	500	0.14	240	120	64.8	33.6	21.6
riv10h	38N	2	5	0.4	0.5	140	4.89	1000	0.28	240	120	64.8	33.6	21.6
riv10i	38N	2	5	0.4	0.5	140	4.89	500	0.14	240	120	64.8	33.6	21.6
riv10j	38N	2	5	0.4	0.5	140	4.89	2000	0.56	240	120	64.8	33.6	21.6
tyb25cms	38N	1	2	0.25	0.35	200	3.49	1000	0.28	240	120	64.8	33.6	21.6
tyb35cms	17s	1	2	0.35	0.35	200	3.49	1000	0.28	240	144	48	36	12
tyb45cms	17s	1	2	0.45	0.45	200	3.49	1000	0.28	240	144	48	36	12
tyb62s	62s	1	2	0.14	0.1	200	3.49	1080	0.3	240	199.2	27.84	7.92	5.04
tyb78s	78s	1	2	0.14	0.1	200	3.49	1080	0.3	240	117.6	69.6	38.4	14.4

FILE	100m	100m	500m	500m	1000m	1000m	2000m	2000m
Name	C (g/l)	BH (m)	C (g/l)	BH (m)	C (g/l)	BH (m)	C (g/l)	BH (m)
riv10c	1.98	140	0.71	249	0.26	347	0.05	517
riv10d	1.83	78	0.59	171	0.28	261	0.09	427
riv10f	1.62	33	0.35	98	0.08	167	0.03	313
riv10g	1.07	46	0.28	118	0.13	196	0.05	348
riv10h	1.41	47	0.39	122	0.18	200	0.07	354
riv10i	1.11	35	0.22	99	0.1	181	0.04	330
riv10j	1.95	60	0.63	146	0.3	229	0.13	385
tyb25cms	3.75	51	0.67	111	0.22	159	0.04	246
tyb35cms	3.3	37	0.49	84	0.14	129	0.03	207
tyb45cms	3.1	30	0.36	71	0.09	112	0.02	181
tyb62s	0.3	146	0.03	192	0.01	284		
tyb78s	2	168	0.2	235	0.11	358	0.06	554

Table 5-5: Centerline concentration and plume gaussian half width at 100, 500, 1000, and 2000 m from pipeline dredging source

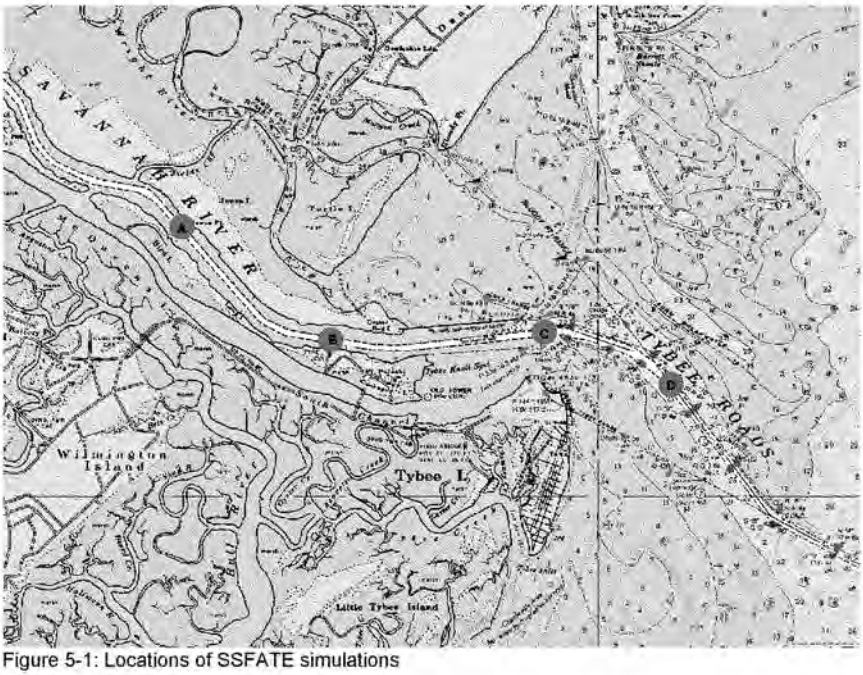


Figure 5-1: Locations of SSFATE simulations

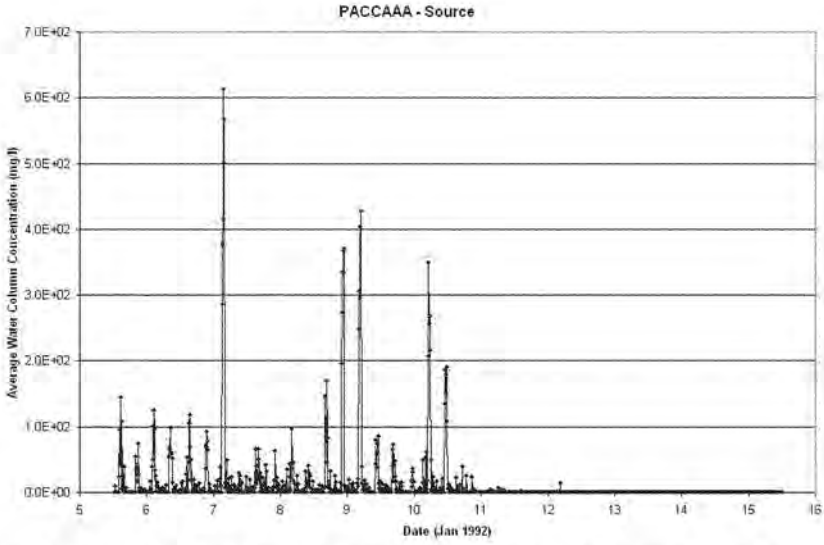


Figure 5-2a: SSFATE simulation PACCAAA, depth-averaged time-series concentration at the source

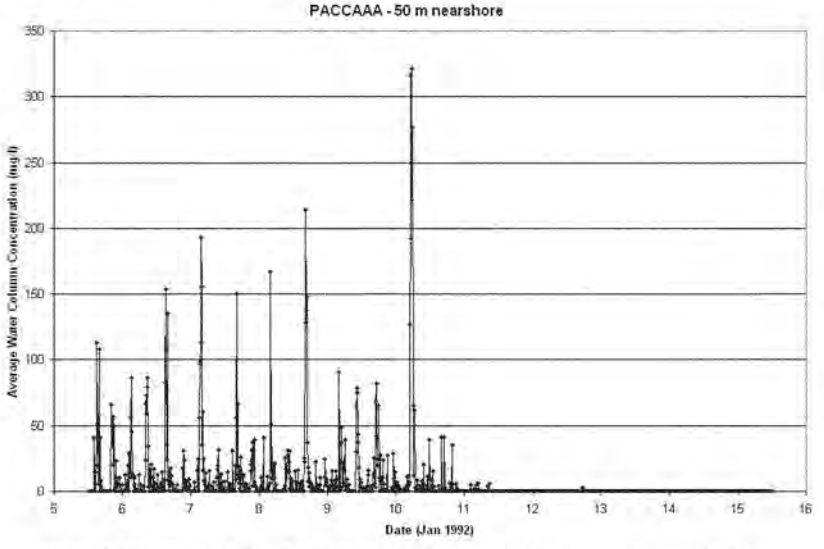


Figure 5-2b: SSFATE simulation PACCAAA, depth-averaged time-series concentration 50 m cross-channel from the source

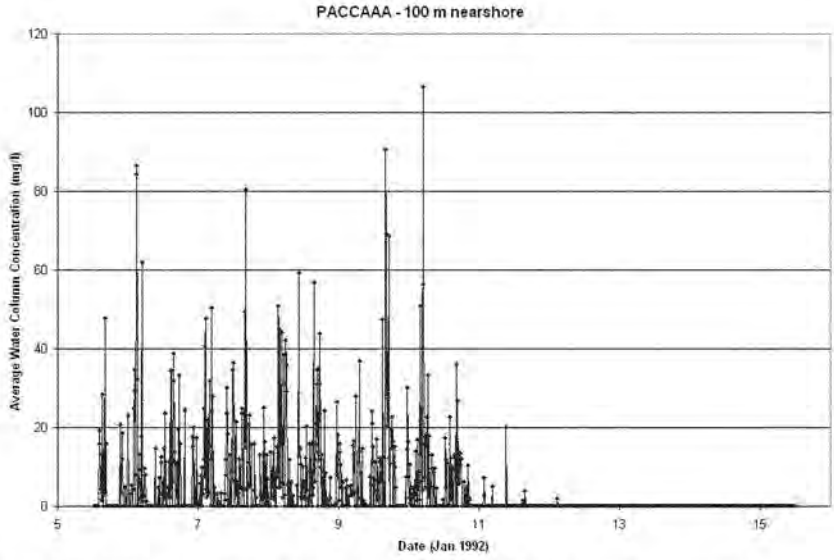


Figure 5-2c: SSFATE simulation PACCAAA, depth-averaged time-series concentration 100 m cross-channel from the source

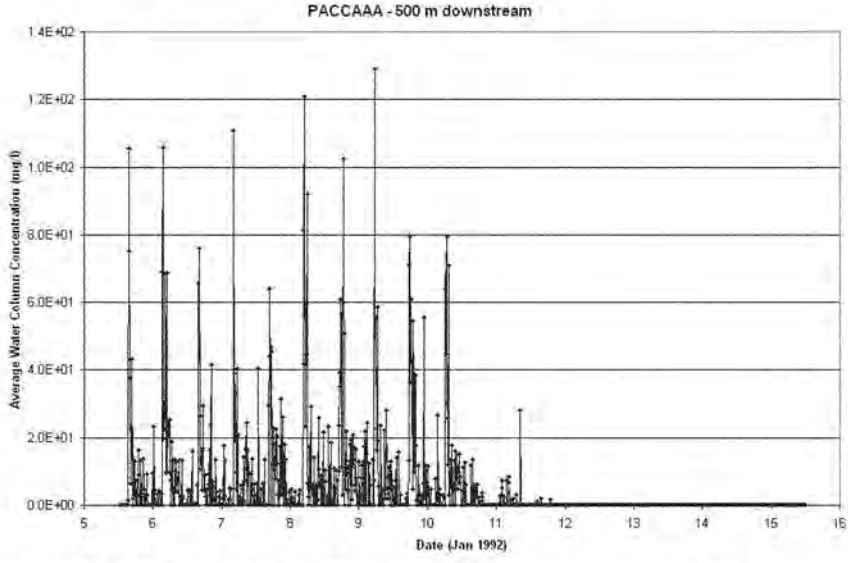


Figure 5-2d: SSFATE simulation PACCAAA, depth-averaged time-series concentration 500 m down-channel from the source

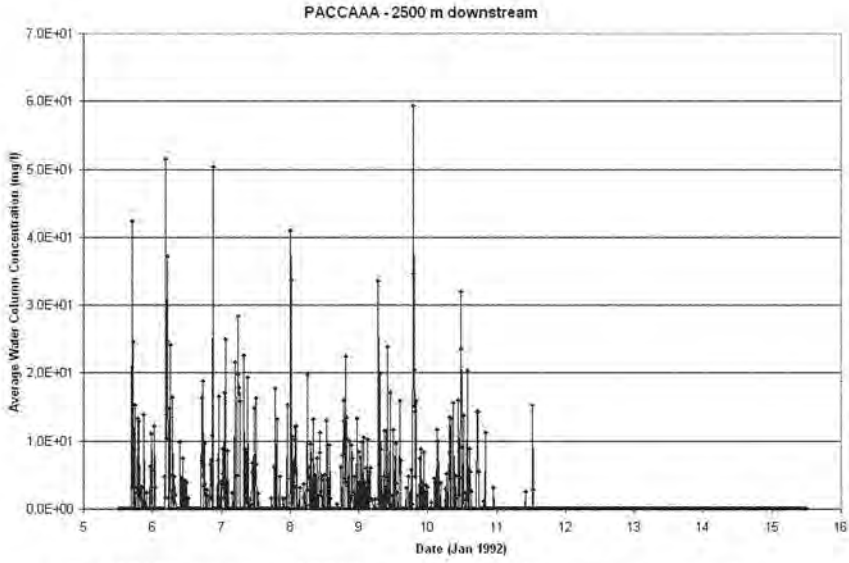


Figure 5-2e: SSFATE simulation PACCAAA, depth-averaged time-series concentration 2500 m down-channel from the source

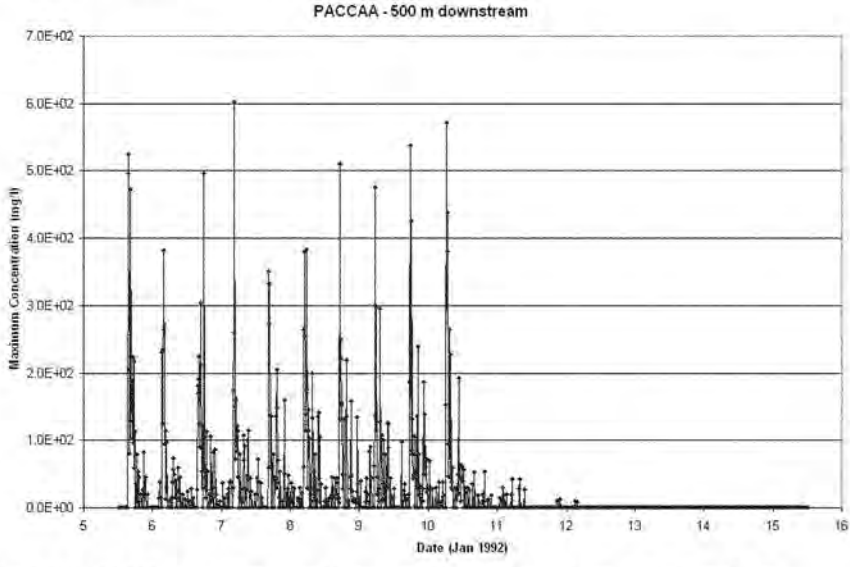


Figure 5-3: SSFATE simulation PACCAAA, near-bottom time-series concentration 500 m down-channel from the source

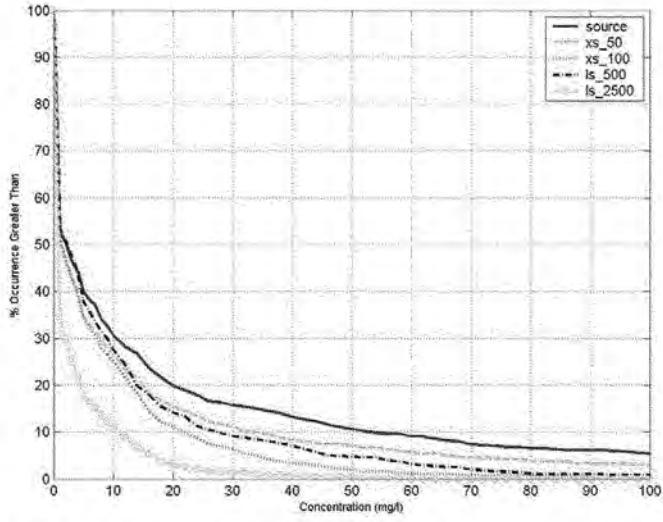


Figure 5-4a: Percent occurrence greater than specified depth-averaged concentration for simulation PACCAA

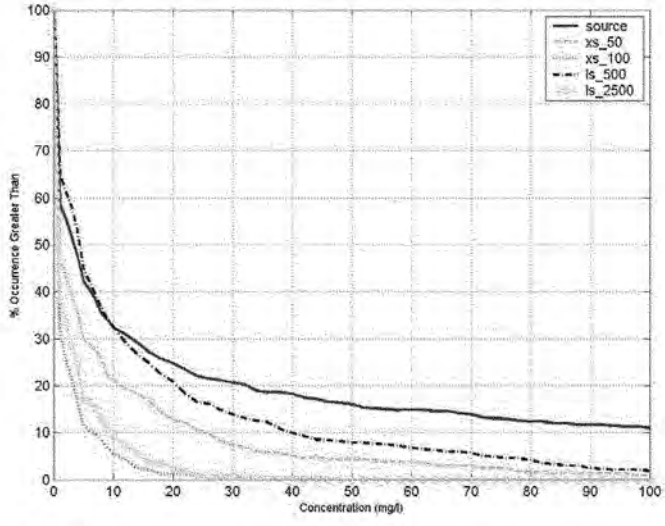


Figure 5-4b: Percent occurrence greater than specified depth-averaged concentration for simulation PBCCAA

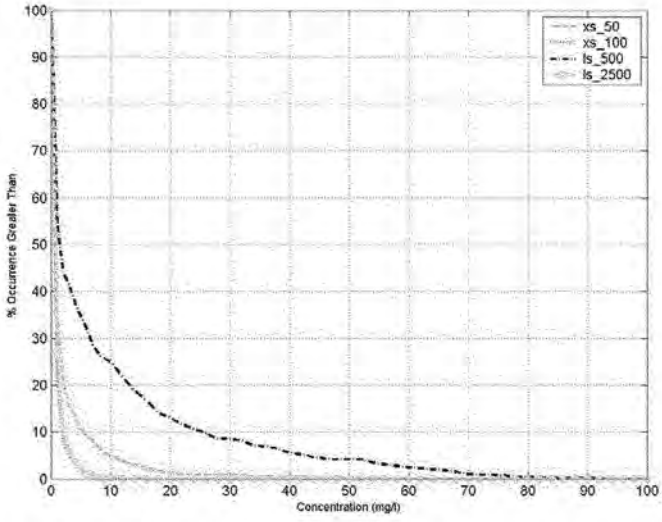


Figure 5-4c: Percent occurrence greater than specified depth-averaged concentration for simulation PCCCAA

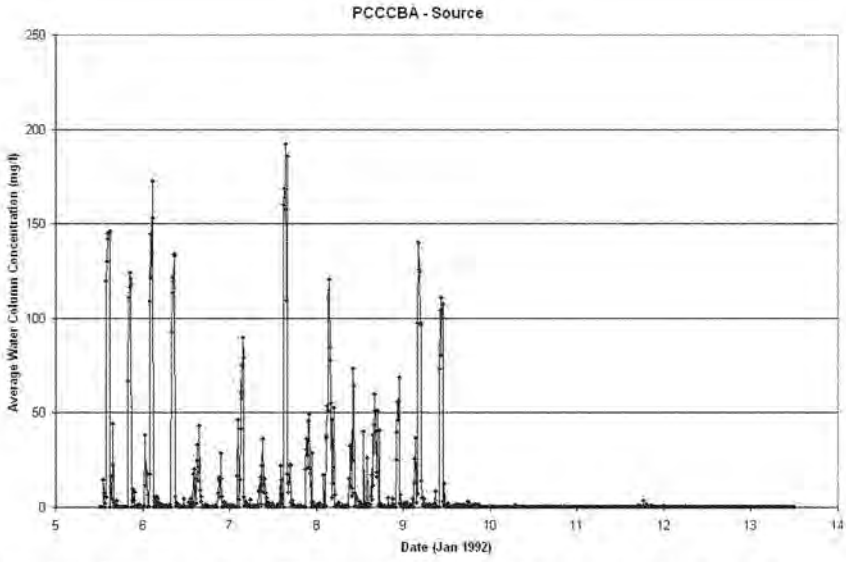


Figure 5-5a: SSFATE simulation PCCCAA, depth-averaged time-series concentration at the source

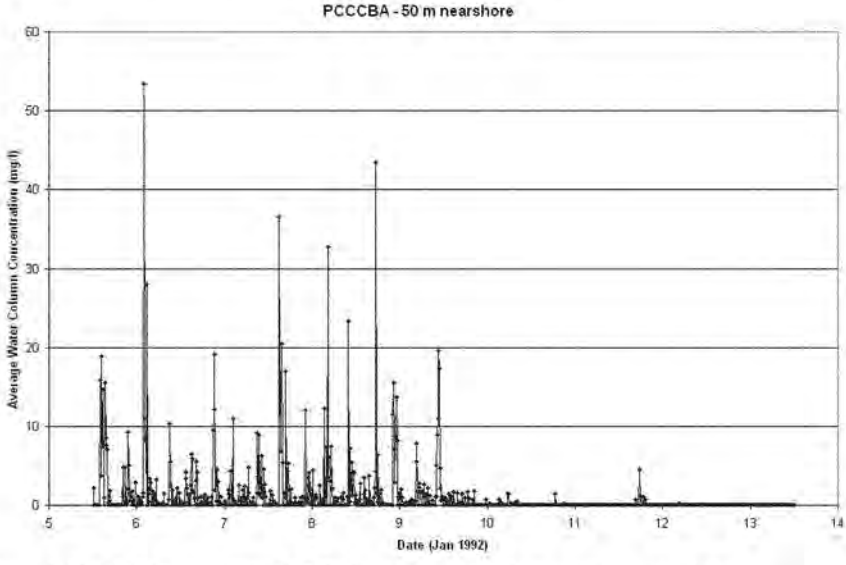


Figure 5-5b: SSFATE simulation PCCCAA, depth-averaged time-series concentration 50m toward shore from the source

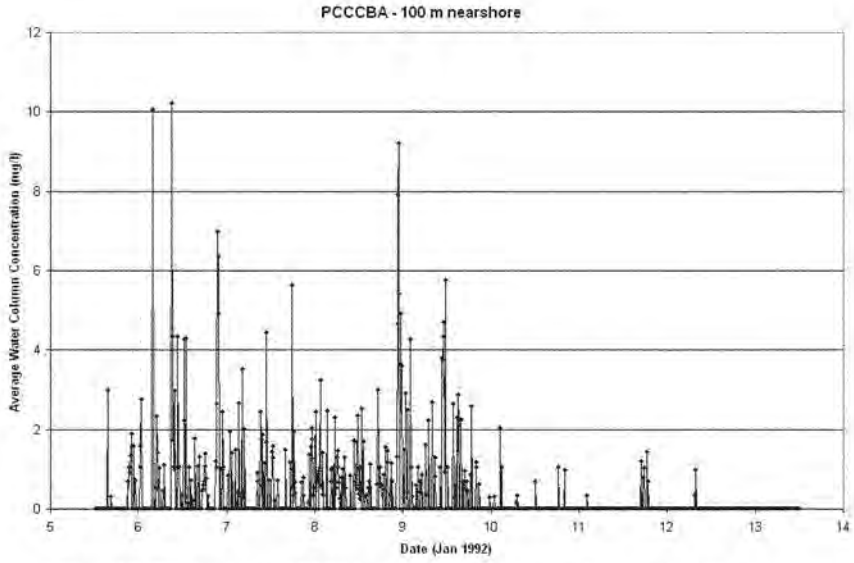


Figure 5-5c: SSFATE simulation PCCCAA, depth-averaged time-series concentration 100m toward shore from the source

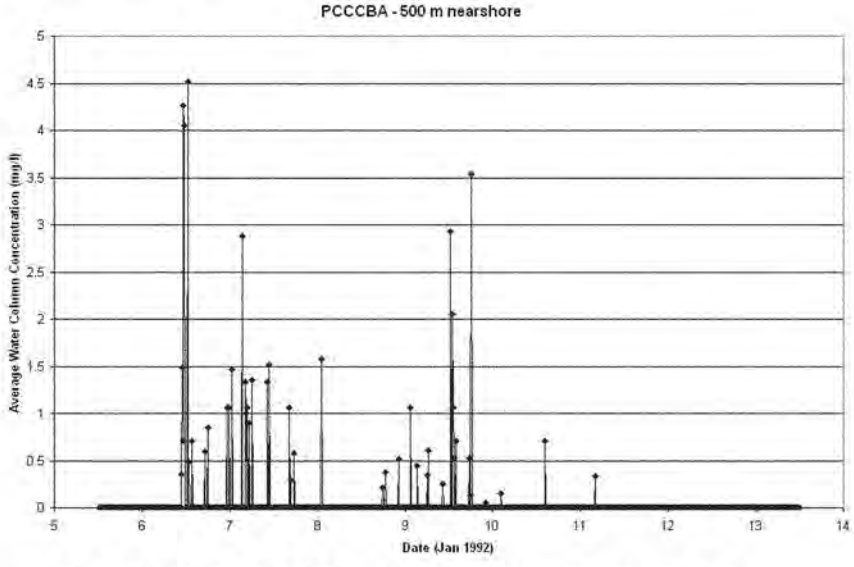


Figure 5-5d: SSFATE simulation PCCCAA, depth-averaged time-series concentration 500m toward shore from the source

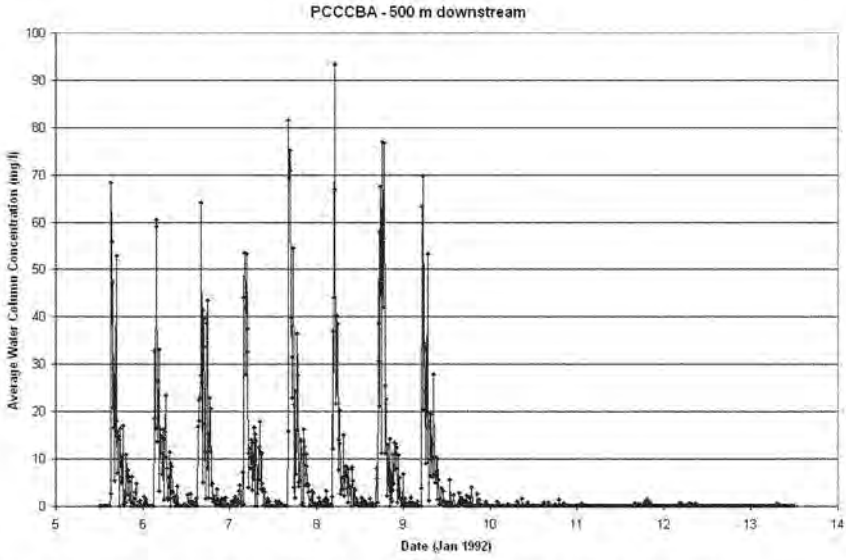


Figure 5-5e: SSFATE simulation PCCCAA, depth-averaged time-series concentration 500 m down-channel from the source

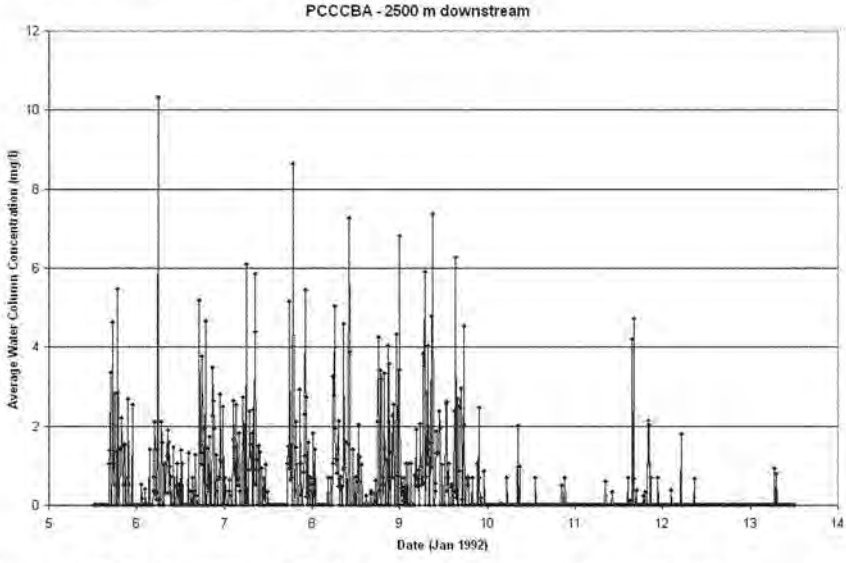


Figure 5-5f: SSFATE simulation PCCCAA, depth-averaged time-series concentration 2500m down-channel from the source

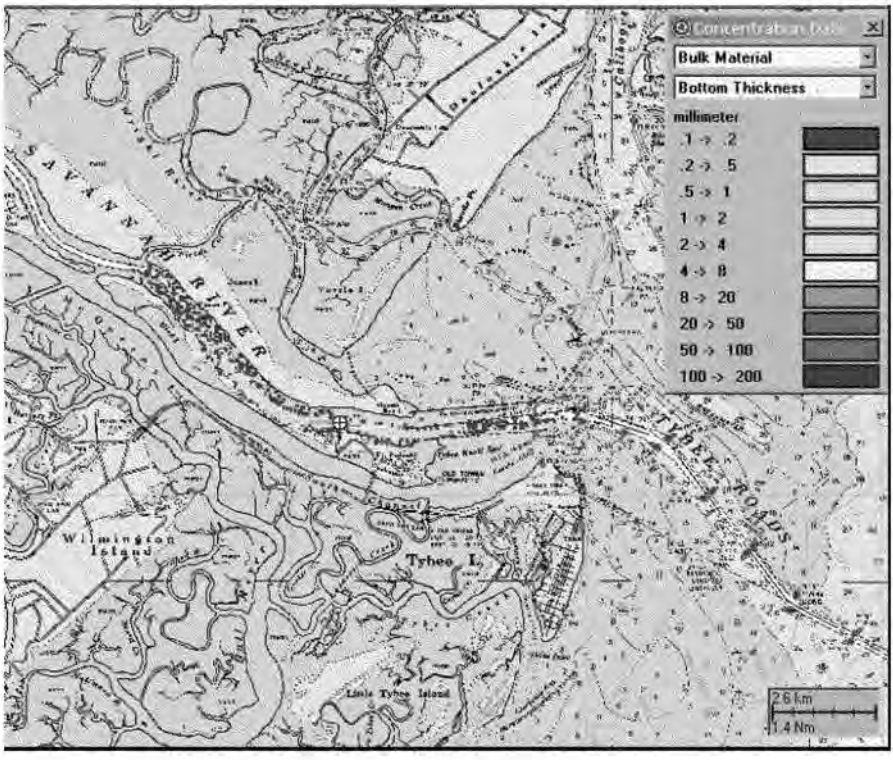


Figure 5-6: Bottom deposition after 4 days of dredging, simulation PBCCAA

<< Figure missing >>

Figure 5-7 Bottom deposition after 4 days of dredging, simulation PCCCBA

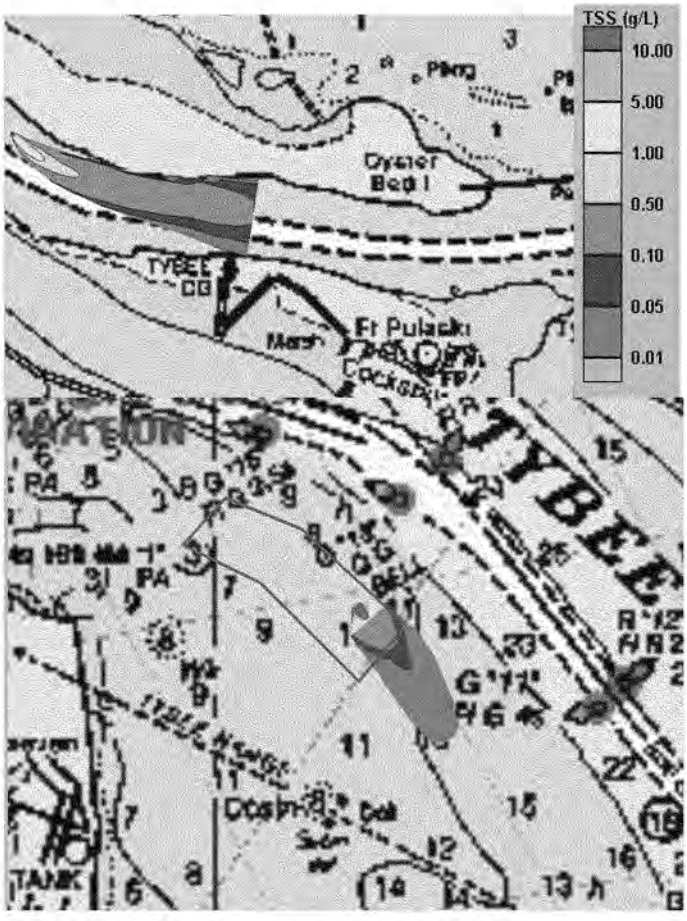


Figure 5-8: Pipeline placement: river plume at 40 cm/s velocity (upper panel); and offshore plume at 14 cm/s velocity (lower panel)

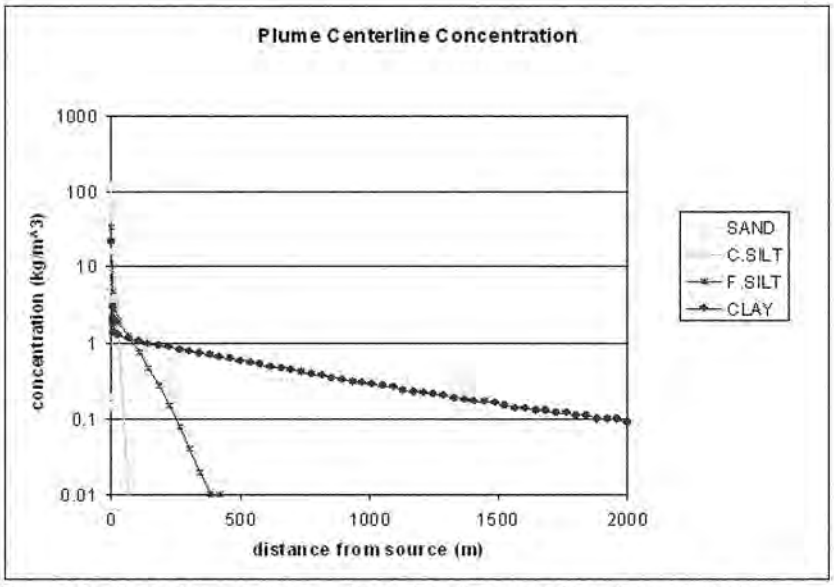


Figure 5-9a: Centerline concentration of sand, fine silt, coarse silt, and clay, simulation riv10d

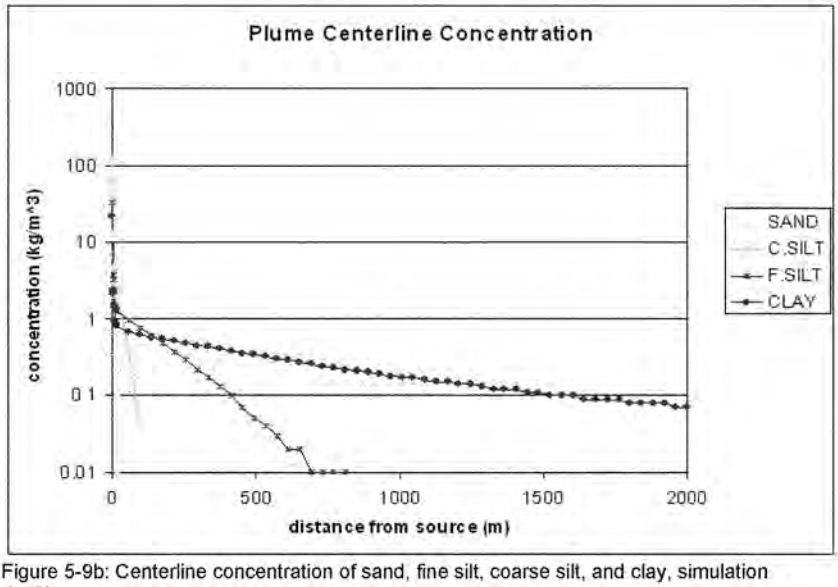


Figure 5-9b: Centerline concentration of sand, fine silt, coarse silt, and clay, simulation riv10h

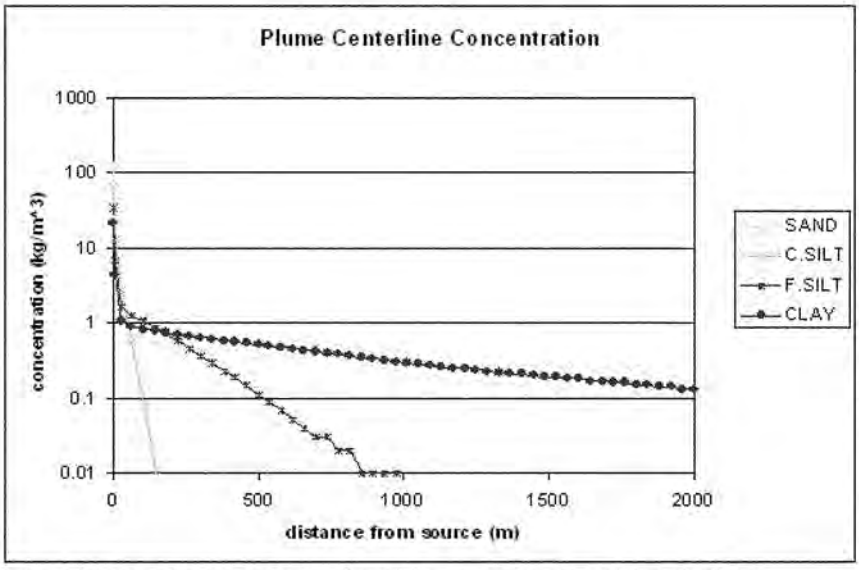


Figure 5-9c: Centerline concentration of sand, fine silt, coarse silt, and clay, simulation riv10j

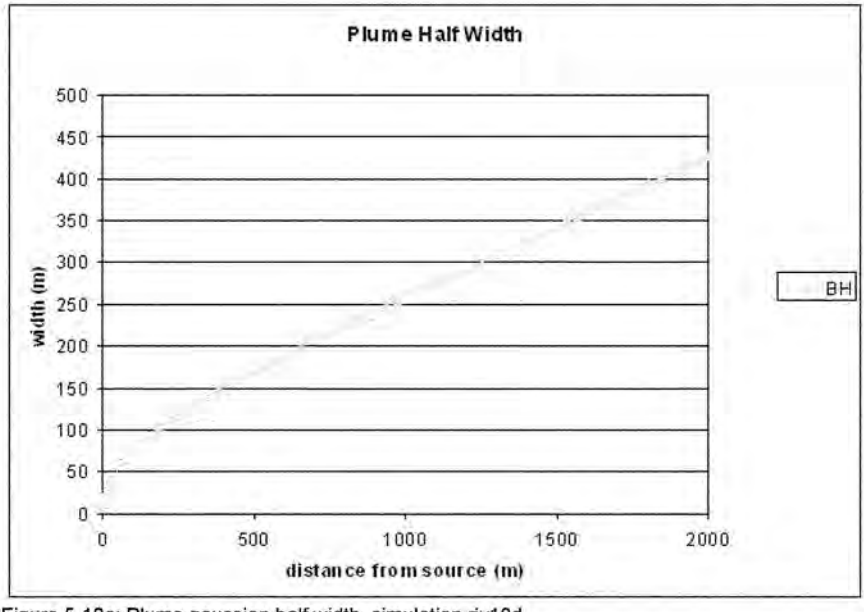


Figure 5-10a: Plume gaussian half width, simulation riv10d

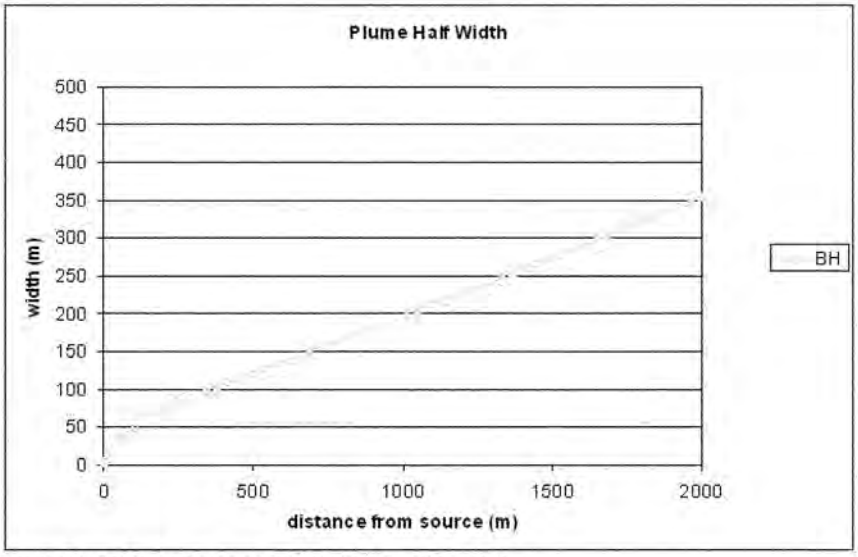


Figure 5-10b: Plume gaussian half width, simulation riv10h

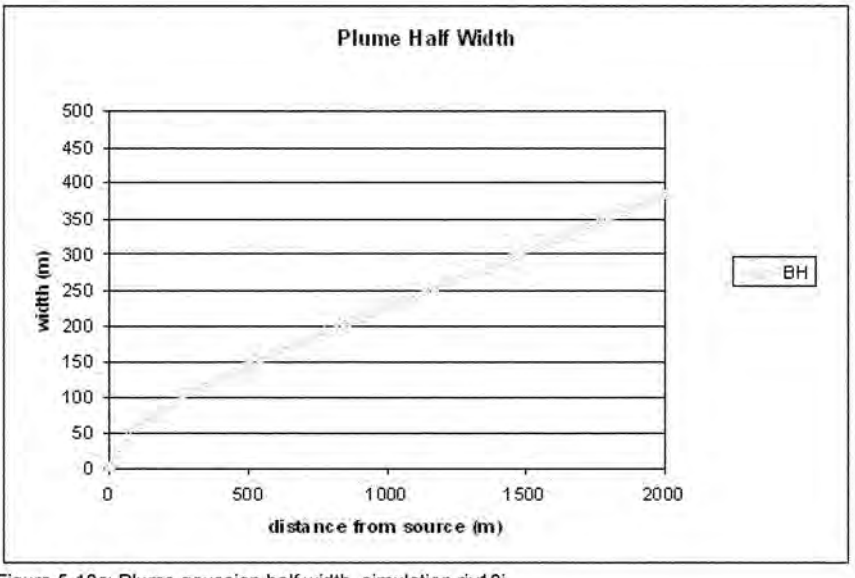


Figure 5-10c: Plume gaussian half width, simulation riv10j

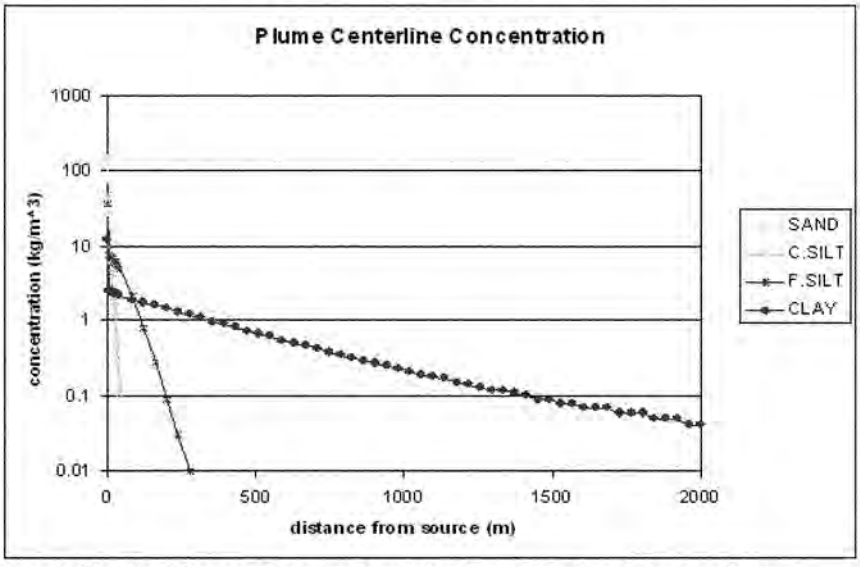


Figure 5-11a: Centerline concentration of sand, fine silt, coarse silt, and clay, simulation tyb25cms

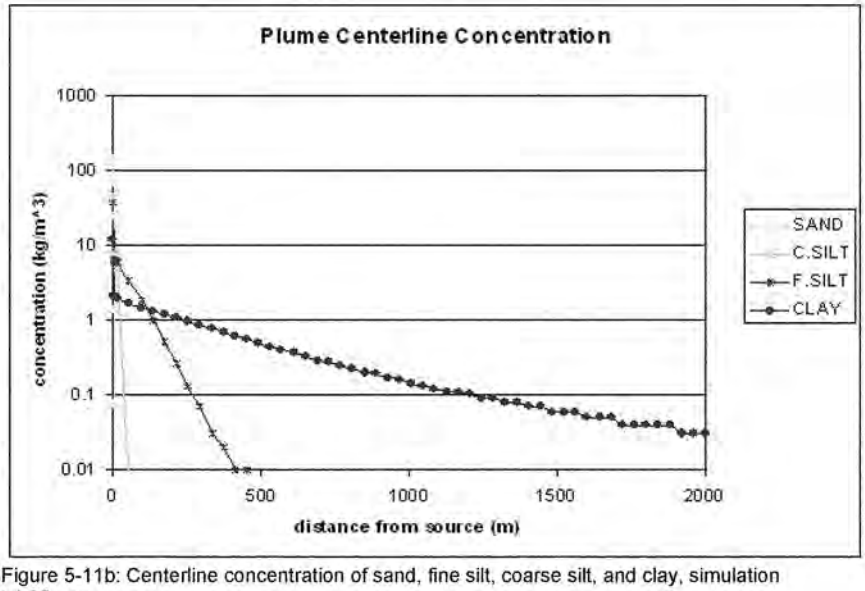


Figure 5-11b: Centerline concentration of sand, fine silt, coarse silt, and clay, simulation tyb35cms

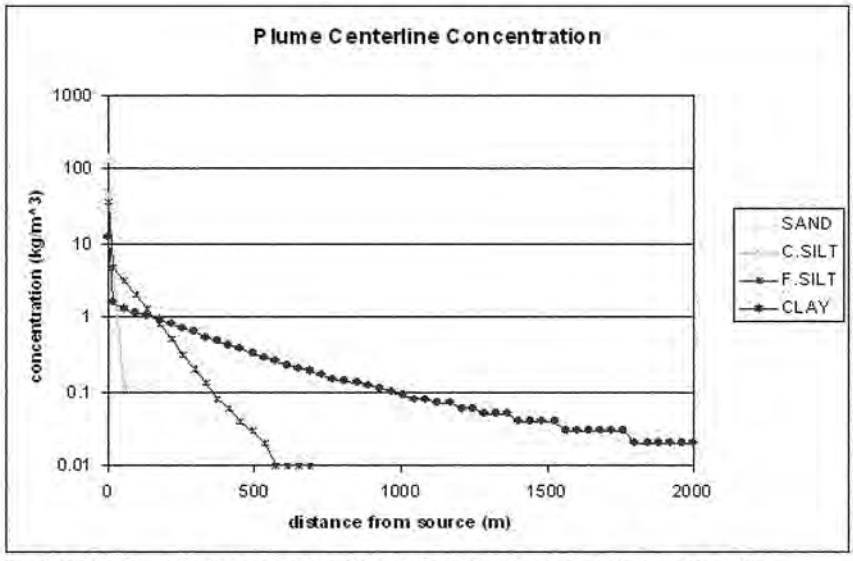


Figure 5-11c: Centerline concentration of sand, fine silt, coarse silt, and clay, simulation tyb45cms

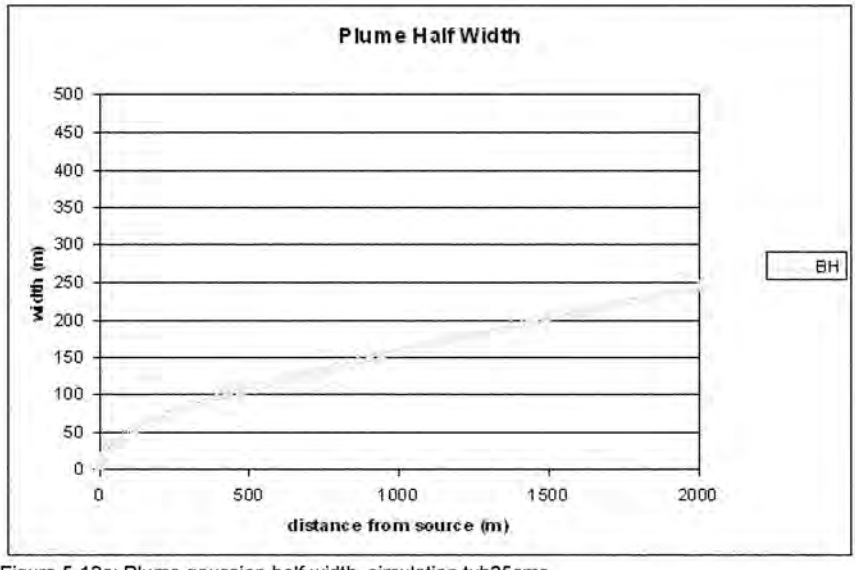


Figure 5-12a: Plume gaussian half-width, simulation tyb25cms

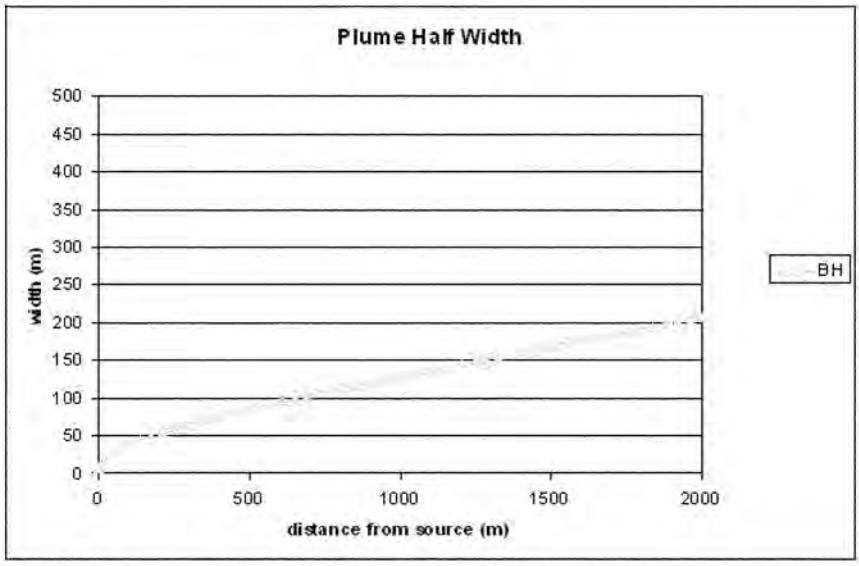


Figure 5-12b: Plume gaussian half-width, simulation tyb35cms

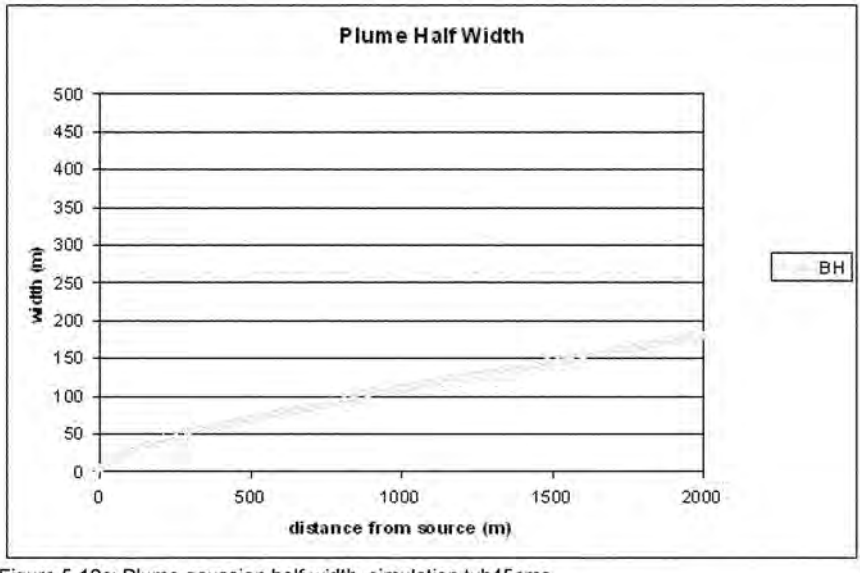


Figure 5-12c: Plume gaussian half-width, simulation tyb45cms

6 Summary and Conclusions

At the request of SAS, the U.S. Army Engineering Research and Development Center, Coastal and Hydraulics Laboratory (CHL) conducted studies that involved use of numerical models to characterize water level, current, and wave conditions in areas being considered for nearshore placement; and using the models, identified sediment pathways around the Savannah Harbor Entrance Channel and the surrounding ebb shoal. Specifically, CHL was tasked with preparing recommendations for nearshore placement of dredged material. Of specific interest is nearshore placement that maximizes benefit to the littoral system and the beaches along Tybee Island. Concerns with nearshore placement include increased nearshore turbidity during and after placement, movement of the dredged material back into the navigation channel, and influence of a nearshore berm on adjacent shorelines. The conclusions of this study will assist SAS in developing a Dredged Material Management Plan (DMMP) for the Savannah Harbor and River Federal Navigation channel and will assist the district in developing methods for utilizing dredged material beneficially within the context of a Regional Sediment Management (RSM) plan for the Savannah River/north Georgia coastline.

Study Objectives

The primary objectives of this study are:

1. Develop, calibrate, and apply a fine-grid hydrodynamic model of the Savannah River Entrance Channel and the surrounding ebb shoal and coast.
2. Develop and apply a fine-grid wave model to simulate transformation of offshore waves over the entire ebb shoal.
3. Simulate dredged material mound movement in the nearshore and lower river regions
4. Develop methods for assessing sediment pathways in the region between Tybee Island and the channel
5. Predict magnitude of turbidity during the dredging and placement operations
6. Provide guidance and recommendations for nearshore placement for feeding sand to the littoral system and beach, while minimizing re-handling (dredged material re-entering the channel), and minimizing any adverse impact on adjacent shorelines

Study Approach

Meetings between ERDC and SAS staff were used to develop project goals and an initial scope of work (SOW) covering areas of interest to the district. The original SOW included study of offshore placement sites and a few nearshore mound locations. As the study progressed, goals were modified to meet evolving questions and the focus was placed on nearshore placement for maintaining dredged material in the littoral zone/beach area.

Current and wave conditions expected during placement operations, i.e., typical non-storm wave and tidal conditions, and active high-energy (storm) periods are critical for dredged-material locations being considered for placement. Therefore, as part of this project, SAS requested a comprehensive review and modeling of current and wave conditions across the ebb shoal as well as current conditions in the river and around the jetties. In addition, sediment properties of the dredged material must be assessed for transport predictions. The dredged material is a mixture of sand, silt, and clay. Some of these mixed sediments will behave as non-cohesive sand, but some material will display cohesive properties. Erosion, transport and dispersion properties of cohesive material depends on multiple factors, including grain size distribution, mineralogy, pore water chemistry, organic content, bulk density, and other factors. Although these bulk properties are easily assessed, there are no theoretically valid methods available to accurately quantify sediment transport processes based on the sediment properties for mixed cohesive sediments. Therefore, a second part of this study was laboratory testing of sediments collected on site to quantify the erodability and transport characteristics of the dredged material (expected maintenance material). The third part of this study was assessing placement options for maintaining the material in the littoral system. The final part addresses turbidity due to dredging and placement operations.

The remainder of this section briefly describes each of the study components.

a. ADCIRC modeling of tidal circulation, wind-driven currents, and storm surge. The ADvanced CIRCulation (ADCIRC) model (Luettich et al, 1992) was used to generate tidal currents, wind driven currents and storm surges needed for the for the sediment transport and wave models. ADCIRC is a two-dimensional, depth-integrated, finite element, ocean circulation model that has been proven to accurately simulate tidal and storm conditions in near-shore regions. ADCIRC-predicted velocities and water levels were used to develop storm and non-storm hydrodynamic conditions in the river and on the ebb shoal. The ADCIRC modeling effort is described in Chapter 2. The accuracy of the model was evaluated using available tidal data at Fort Pulaski, in Tybee Creek, and offshore. In addition, current data provided by ATM, which were collected using an Acoustic Doppler Current Profiler (ADCP) (ENSR, 1999) were used to evaluate the model.

b. STWAVE modeling of wave transformation over the ebb shoal. Databases exist for offshore wave conditions near Savannah (Brooks and Brandon, 1995), produced by the U.S. Army Corps of Engineers Wave Information Studies (WIS). These data reflect conditions well offshore of Tybee Island, in deeper water, and do not accurately reflect conditions in shallower water. Also, wave transformation over a complex channel/ebb shoal region

cannot be predicted using simple refraction and shoaling equations because the bottom bathymetry is so irregular. Therefore, the STWAVE model was applied over the entire ebb shoal to predict wave refraction and shoaling, and to characterize wave conditions at the potential nearshore placement sites and along Tybee Island. The offshore WIS wave data were used to define the offshore boundary conditions needed as input by STWAVE. A two-step STWAVE modeling approach was adopted, using nested grids, in light of the wide shelf seaward of the ebb shoal and the complexity of the bathymetry. The STWAVE model was also used, along with the GENESIS shoreline change model, to investigate the potential impacts of a nearshore berm on local wave transformation, longshore sand transport processes, and shoreline change.

c. Sediment properties analysis. Historical data available from dredging records and previous studies were used to estimate grain size distributions, dredging volumes, and ebb shoal evolution. These data provide significant information on the ebb shoal and channel processes which can be used as input to transport models and to verify transport model results. As stated previously, site-specific cohesive sediment erosion tests were required to understand critical stresses for initiation of transport and transport rates of mixed dredged material. These experiments involved applying an erosion-testing flume, SEDFLUME (McNeil et al, 1996), to examine erodability of dredged material collected from various stretches of the channel. The erosion data are then used to develop site-specific erosion algorithms that are incorporated into the sediment transport models. The algorithms define sediment erosion rates as a function of bulk density, shear stress, and depth of burial. Algorithms were developed for each stretch of channel, for which sediments were acquired and tested.

d. Modeling of mound erosion and sediment pathways. The GTRAN model was used to simulate mound erosion at each proposed nearshore and riverine mound during storm and normal hydrodynamic conditions. The cohesive sediment erosion algorithms were incorporated into GTRAN and erosion from various mound configurations was simulated. In addition, a mesh of points was established between the channel and Tybee Island. Sand erosion magnitude and direction time series were developed at each point to assist in determining sediment pathways. This provided needed information for assessment of various nearshore placement locations. Hydrodynamic and wave time series required to estimate transport were developed from ADCIRC and STWAVE simulations.

e. Modeling of dispersion of material during dredging and placement operations. A significant amount of fine material is stripped from the sediment/water mixture during dredging and placement. This material is free to move through the water column. Transport of material released during the dredging process was modeled using the SSFATE model (Clarke ****). Various dredging methods, sediment types, dredging rates, and loss rates were simulated to provide a comprehensive understanding of sediment plume concentration and migration. In addition, the D-CORMIX model was used to predict loss of sediment during a pipeline placement operation. Placement is especially a concern in the nearshore where released sediment could migrate toward the beach.

Nearshore Placement of Dredged Material

Optimal location(s) of nearshore placement of dredged material is strongly dependent upon an understanding of coastal processes near the Savannah River Entrance and the Tybee Island littoral zone. Understanding of sediment transport patterns near the channel and ebb shoal gained from sediment transport modeling is presented followed by discussion of how the transport patterns influence selection of nearshore placement sites.

Channel and Ebb Shoal Sediment Transport Patterns

The modeling studies have revealed certain aspects of the coastal processes in and around the Savannah River Entrance, which provide valuable insight regarding the optimal location for nearshore placement. It is worthwhile to review some of these modeling results.

Sediment pathways at the entrance are influenced by many factors, which interact in a complex manner. These factors include: the relative strength of ebb and flood tidal currents, locally; spatial variability in the relative current strength throughout the entrance region, which is controlled by bathymetry and topography; local wave conditions which are dictated by many factors including incident deepwater conditions, tide stage, and bathymetry which influences refraction, shoaling, and wave asymmetry; and wave generated currents. For example, at a particular location, given the same wave conditions, ebb currents that are relatively stronger than flood currents will tend to produce ebb-directed sediment transport. The jetties and channel act to concentrate the ebb tidal jet, and influence the balance between ebb and flood flows at the entrance

Point sediment modeling results indicate that the navigation channel and areas in close proximity to it are dominated by sediment transport in the ebb direction (seaward). Ebb current speeds in the channel are greater than flood current speeds (the ebb jet is a little more concentrated), and this appears to create the ebb dominance in and near the channel. Model results for the computational points that were considered in the analysis (see Figure 6-1) indicate that in the channel section just to the north of Tybee Island, there is a pattern of increasing ebb-dominant transport. This gradient, increasing ebb-directed transport in the seaward direction, suggests an erosive pattern. This erosion tendency is consistent with the relatively low dredging requirement associated with the section of channel between stations 14S and 20S shown in Figure 6-2. Point model results in Figure 6-1 also indicate that there is a strong gradient in the ebb-dominant transport where the channel takes a more northwest/southeast orientation in the Tybee Roads area, but here the gradient is characterized by decreasing transport. This gradient suggests a tendency for sediment accretion; and, the region where the simulated gradient is strongest matches well with the outer portion of the channel that has experienced the highest shoaling rates, from stations 20S to 40S in Figure 6-2. Also, model results indicate a location well out in the channel where the ebb-directed transport decreases dramatically, indicating a zone where tidal current strengths have diminished to the point that sediment is less easily transported. Here, the transport gradient decreases too. This region corresponds to the location where the ebb bar, on the north side of the channel, impinges on the channel and where the ebb bar is shallowest. It appears that most of the sand-sized sediment carried

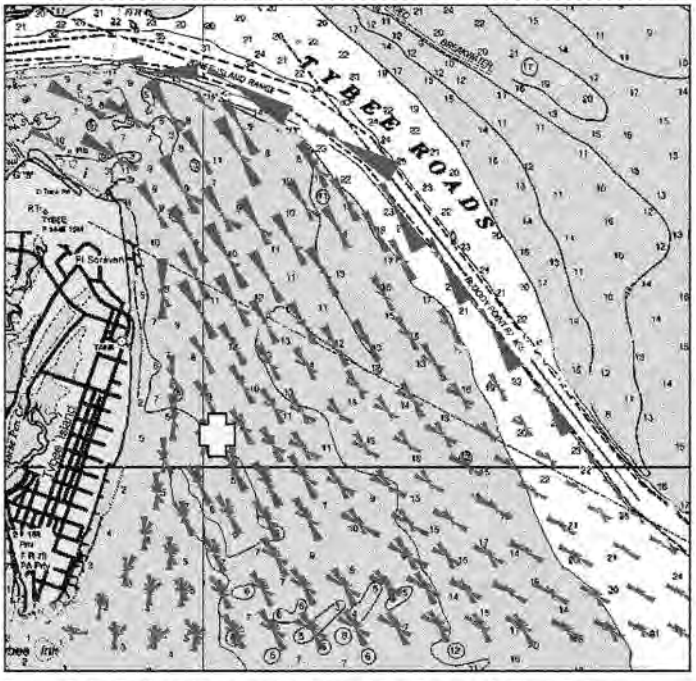


Figure 6-1. Sediment transport pattern at the Savannah River Entrance

out the channel is deposited in this vicinity, and landward of station 40S. Seaward of this point, dredging requirements are much smaller, which is also consistent with transport gradients evident in the model results.

The transport pattern to the south of the navigation channel, on the shallow tidal flats which are just offshore of the northern half of Tybee Island, is quite different according to the model results. Here, model results indicate a flood-dominant transport pattern. This different pattern, opposite of that computed in the channel region, is attributed to shallow water effects on the waves and the relative balance between flood and ebb tides on the tidal flats. Model results also suggest what seems to be an increasing gradient in flood-directed transport just offshore of north Tybee Island (evident in some of the calculation results; but less clear in others), in the region extending from the middle of the island to the north end of the island. An increasing gradient of flood-dominant transport would suggest an area of erosion. The tendency for erosion in this area is consistent with the recent historic pattern of tidal flat deflation identified by ATM in their analysis of bathymetric changes in this region of the ebb shoal. The presence of extensive shallow shoals off the northern end of Tybee Island, between Tybee Island and the navigation channel, are also consistent with the model-generated flood-dominant transport pattern. Model results suggest that the tidal flats off north Tybee are the probable sources for the sediment that is now resident in the shoals north of the island. Model results and evidence from

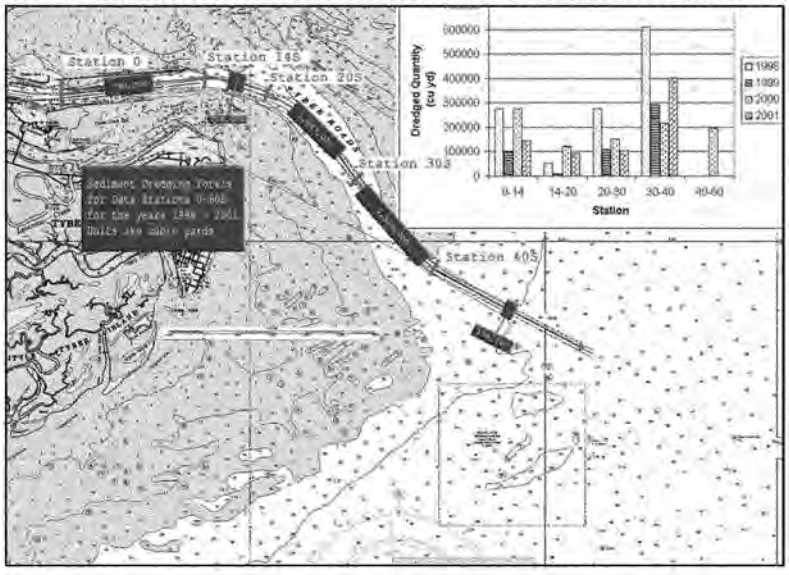


Figure 6-2. Recent pattern of channel maintenance dredging (length of the dark bars in the various channel sections indicate the magnitude of volume dredged)

sediment samples also suggest that if sand from these extensive flats and shoals is entering the navigation channel, it may be transported seaward and then deposited in the outer portions of the channel, in addition to sand being transported to the south along the outer ebb bar. Characteristics of these sediment transport patterns were a key factor in selecting an optimal location for nearshore placement.

Optimal Location for Nearshore Placement

Regional considerations of sediment management have expanded traditional viewpoints of dredged material handling to include nearshore placement of dredged material containing significant fractions of sand. The focus of this study was to identify favorable locations for nearshore placement of dredged material. Issues considered in the study include 1) the potential of nearshore-placed dredged material to provide sand to the littoral system of Tybee Island, 2) the likelihood that dredged material will re-enter the navigation channel and increase maintenance dredging volumes, and 3) the effects of nearshore berms of dredged material on wave refraction and consequently on shoreline change at Tybee Island.

Littoral Feeding Along North Tybee Island. The point sediment model results were used to assess the potential for benefits to the Tybee Island shoreline through feeding of sand to the littoral system. The balance of undertow and wave asymmetry were shown to play a strong role in shoreward sediment

transport. By placing dredged material in shallow water, the stronger influence of wave asymmetry allows sand to be transported toward shore. Sediment transport simulations at the offshore disposal site indicate that significantly lower transport rates occur there compared to the more energetic nearshore environment. Nearshore sediment transport simulations indicate that placement of dredged material near the central Tybee Island shoreline adjacent to the present transverse, shore-attached bar is most likely to introduce sand to the littoral system and provide the most benefit to the north Tybee shoreline. Trends in nearshore transport over the ebb shoal suggest that dredged material placed in deeper water near the navigation channel will either be transported back to the channel, or will re-enter the littoral system along the margins of the ebb shoal, providing little direct benefit to the north Tybee shoreline but possibly providing a benefit to south Tybee over the longer term. Transport offshore of the northern tip of Tybee Island is predominantly directed to the north due to both tidal and longshore transport influences. This predominant direction of transport is likely to produce little to no direct benefit to north Tybee, for material placed north of Tybee Island. Material placed here may simply re-enter the channel.

Maintenance Dredging Requirements. One issue of concern is an increase in maintenance dredging requirements resulting from the nearshore placement of dredged material. One conclusion from the sediment transport simulations is that placement of dredged material in the nearshore will likely lead to some increase in maintenance dredging requirements compared to placement of material in the offshore disposal site. But, placement offshore removes it from the littoral system, which is not desirable. Not all nearshore placement sites were equal in the likelihood of significant increases in maintenance dredging volumes. Simulated transport over the ebb shoal indicates that a significant portion of dredged material placed adjacent to the offshore channel, adjacent to the north jetty, and at the northeastern tip of Tybee Island is likely to re-enter the channel. Dredged material placed offshore of central Tybee Island is least likely to produce significant quantities of channel infilling. Model results suggest that material placed here will eventually work its way northward, eventually ending up in the shoals at the north end of Tybee Island, and possibly then entering the navigation channel. But during the northward movement, benefits to Tybee Island are likely to be maximized.

Impacts on Shoreline Change. Effects of nearshore berms of dredged material on wave refraction, longshore transport, and shoreline change were assessed through application of a shoreline change model, GENESIS. Nine nearshore berm scenarios were represented on the ambient bathymetry. Wave transformation simulations representing the long-term wave climate were preformed over the ambient bathymetry and each of the dredged material berm scenarios. The resulting nearshore wave climate was then passed to GENESIS to simulate changes in the shoreline change response of Tybee Island. Berms placed in deeper water and further from the shoreline produced little change in shoreline change trends. Berms placed closer to or immediately offshore produced moderate changes in the shoreline evolution trends. Berms 01 and 02, offshore of the northern tip of Tybee Island resulted in a decreased erosional trend at the northern tip of the island, but increased the erosional trend along the central portion of the shoreline. Berms 13 and 14, placed adjacent to the transverse bar attached to the central island shoreline produced a reduction in

erosion rates along the central third of the island and relatively weak erosional trends on the northern and southern thirds of the island. The influence of the sediment supply to the littoral zone and the influence of tidal currents were neglected in the GENESIS simulations. Because the positive influence of a sediment source to the beach system was not considered, negative impacts of berm placement on adjacent shoreline changes are likely overstated, particularly along north Tybee which is expected to benefit from placement of the dredged material. The beaches on the southern half of the island are reasonably healthy. Any negative impact on the beaches on south Tybee could be offset during the course of renourishment of the federal shore protection project on Tybee Island, or through alteration of the nearshore berm placement practice, i.e., periodically placing dredged material to the south side of the transverse bar off central Tybee, where model results suggest it will move to the south.

Recommendations. The recommended location for nearshore placement of dredged material is adjacent to the transverse, shore-attached bar just offshore of central Tybee Island (yellow cross shown Figure 6-1). Details of berms proposed for this location are provided in Chapter 4. The impacts to the shoreline by berms placed at this location are similar to those of other extreme-nearshore placement options, but these impacts are likely to be offset by the potential of sand to be transported shoreward to benefit the littoral system. This location has the least potential for increasing maintenance dredging while providing benefit to Tybee Island.

Impacts of Dredging and Placement Operations

Plumes of suspended sediment generated during dredging and placement operations are of potential concern to the aquatic environment. Consequently, estimates of suspended sediment entrainment and transport during the dredging and placement operations are required to assess the potential impact on the environment. Chapter 5 describes model applications and analysis addressing sediment suspension, transport, and deposition during dredging and nearshore placement operations at the Savannah River entrance channel and adjacent waters. Two primary issues are 1) whether unsuitable levels of suspended sediment are present in the water column or 2) do fines placed in suspension deposit in the nearshore zone. This chapter does not address the biological effects or risk to the environment, but presents suspended sediment concentrations from which those assessments may be made.

Two numerical models of dredged material resuspension and transport were applied to address the effects of suspended sediments at the dredge and the pipeline outfall. SSFATE was applied to quantify sediment suspension from the dredge, transport of the suspended sediment from the dredging site, and deposition of the suspended material. D-CORMIX was applied to quantify sediment entrainment and transport at the pipeline outfall.

Resuspension from dredging operations

Higher concentrations of resuspended sediments were predicted at riverine dredging sites, primarily attributed to the higher silt/clay content in the dredged sediments. Dredging in the coastal region (seaward of the Savannah River entrance) produced lower TSS concentrations because of the higher sand content,

which more quickly settles out of suspension. SSFATE predicted that the resuspended dredged material was quickly advected in a net seaward direction by the ebb-dominant tidal currents. Peak TSS concentrations from the resuspension plume were observed to coincide with near-slack currents. Suspended sediment concentrations also generally drop to negligible levels within 12-24 hours after cessation of dredging operations. Accumulation of resuspended dredged material ranged up to several centimeters within the navigation channel (as expected) and amounted to sub-millimeter thickness outside the navigation channel. Only small quantities of fine sediments were observed to pass within the nearshore region of the Atlantic shoreline of Tybee Island and suspended fine-grained sediments were not deposited in the nearshore because of the relatively large tidal-current-generated shear stresses in this region. The influence of waves on suspended material in the nearshore was not simulated. Agitation by waves would further prevent the deposition of fine-grained suspended sediments in the nearshore.

Resuspension from pipeline disposal

As experience would suggest, significantly higher suspended sediment concentrations are produced at pipeline outfalls than for resuspension at the dredging site. Plumes from pipeline outfalls are expected to be transported primarily in the direction of the tidal currents, with some lateral mixing. Sand and coarse silts were observed in the model simulations to settle out of suspension fairly close to the discharge location, while fine silts and clays remained in suspension to be transported further distances from the discharge point. Fine silts were found to settle out of suspension between 500-1000 m from the discharge point, and the clay fraction remained in concentrations of approximately 100 mg/L at a distance of 2000 m from the discharge point.

APPENDIX A: SEDFLUME/ASSET Flume Analysis

Description of ASSET Flume

The ASSET flume is a straight flume that has a test section with an open bottom through which a rectangular or circular cross-section coring tube containing sediment can be inserted (Figure A-1). Downstream of the test section is a bedload trap used to capture eroded sediment that rolls or moves by saltation along the bottom of the flume channel. The flume used in these experiments is a modified version of Sedflume, developed by researchers at the University of California at Santa Barbara (McNeil et al, 1996). The difference between the two flumes is the bedload trap section, which permits separation of suspended load and bed load in the ASSET flume. The main components of the flume are the coring tube; the test section; an inlet section for uniform, fully developed, turbulent flow; a bedload trap section, a flow exit section; a water storage tank; and a pump to force water through the system. The coring tube, test section, inlet section, bedload trap section, and exit section are made of clear polycarbonate so that the sediment-water interactions can be observed. The coring tubes, which are up to 80 cm in length, are 10 cm diameter.

Water is pumped through the system from a storage tank into a 5 cm diameter pipe, and then through a flow converter into the rectangular duct (Figure A-1). The duct is 2.5 cm in height, 10 cm in width, and 120 cm in length; it connects to the 15 cm long test section and 1 m long bedload trap section, which have the same cross-sectional area. The flow converter changes the shape of the cross-section from circular to the rectangular duct shape while maintaining a constant cross-sectional area. A three-way valve regulates the flow so that part of the flow goes into the duct while the remainder returns to the water source (tank or river). In addition, there is a small valve in the duct immediately downstream from the test section that is opened at higher flow rates to keep the pressure in the duct and over the test section at atmospheric conditions.

At the start of each test, the coring tube is filled with the reconstructed sediment core that was permitted to consolidate prior to erosion testing. Three consolidation times we used for each sediment type tested. Consolidation time and it's variation are important because bulk density, which changes with time for

cohesive sediments, is one of the key factors in cohesive sediment erosion potential. The procedure for preparing the reconstructed core sediments in the laboratory will be described later. The coring tube and the sediment it contains are then inserted into the bottom of the test section. The flume operator moves the sediment upward using the plunger, which is inside the coring tube and is connected to a jack (Figure A.2). The jack is driven by motor, which is regulated with a switch. By this means, the sediment surface is raised and made level with the bottom of the test and inlet sections. The speed of the jack movement can be controlled at a variable rate in measurable increments as small as 0.5 mm.

Water is forced through the duct and the test section over the surface of the sediments. The shear produced by this flow, if great enough, causes the sediments to erode. As the sediments in the core erode, the core surface is moved upwards by the operator as necessary so that the sediment-water interface remains level with the bottom of the test and inlet sections. The erosion rate is recorded as the upward movement of the sediments in the coring tube over time. Duration of each erosion test for a specified shear stress is dependent on the rate of erosion and generally is between 0.5 and 10 minutes.

Hydrodynamics

Fully developed turbulent flow exists in the test section for the flow rates of interest. Turbulent flow through pipes has been studied extensively, and empirical functions have been developed which relate the mean flow rate to the wall shear stress. In general, flow in circular cross-section pipes has been investigated. However, the relations developed for flow through circular pipes can be extended to non-circular cross-sections by means of a shape factor. An implicit formula relating the wall shear stress to the mean flow in a pipe of arbitrary cross-section can be obtained from Prandtl's Universal Law of Friction (Schlichting, 1979). For a pipe with a smooth surface, this formula is

$$\frac{1}{\sqrt{\lambda}} = 2.0\log\left[\frac{UD\sqrt{\lambda}}{\nu}\right] - 0.8 \qquad \text{(A.1)}$$

where U is the mean flow speed, ν is the kinematic viscosity, λ is the friction factor, and D is the hydraulic diameter defined as the ratio of four times the cross-sectional area to the wetted perimeter. For a pipe with a rectangular cross-section, or duct, the hydraulic diameter is

$$D = 2hw/(h + w) \qquad \text{(A.2)}$$

where w is the duct width and h is the duct height. The friction factor is defined by

$$\lambda = \frac{8\tau}{\rho U^2} \qquad \text{(A.3)}$$

where ρ is the density of water and τ is the wall shear stress. Inserting Eqs. (2.2) and (2.3) into Eq. (2.1) then gives the wall shear stress τ as an implicit function of the mean flow speed U.

For shear stresses in the range of 0.1 to 10.0 N/m^2, the Reynolds numbers, UD/v, are on the order of 10^4 to 10^5. These values for Reynolds numbers are sufficient for turbulent flow to exist for the stresses of interest in this study. For flow in a circular pipe, turbulent flow theory suggests that the transition from laminar to turbulent flow occurs within 25 to 40 diameters from the entrance to the pipe. Since the hydraulic diameter of the duct pipe is 4 cm, this suggests an entry length of 100 to 160 cm. The length of the duct leading to the test section is 120 cm and is preceded by a 20 cm flow converter and several meters of inlet pipe. These arguments along with direct observations indicate that the flow is fully turbulent in the test section.

Core Collection and Preparation

Approximately 50 gallons of sediment were collected from each of seven sites in the Savannah ship channel (Figure A-3). The sediment for each site was slurried immediately prior to creating cores for Sedflume analysis. This is done to assure that the sediments are well mixed and will be of similar grain size distribution.

Pouring the slurried sediment from each site into coring tubes created the sediment cores tested in Sedflume. This process was repeated for each of the six Sedflume analysis sites. Cores were consolidated for periods of 4, 20, and 120 days. The variation in consolidation times permits erosion analysis over a wide range of bulk density conditions. At the end of each consolidation period, two cores were extracted. One was used for bulk property analysis (including bulk density) and the other for Sedflume erosion analysis.

Measurements of Sediment Erosion Rates

The procedure for measuring the erosion rates of the sediments as a function of shear stress and depth is described in this section. The sediment cores were obtained as described above and then moved upward into the test section until the sediment surface was even with the bottom of the test section. A measurement was made of the depth to the bottom of the sediment in the core. The flume was then run at a specific flow rate corresponding to a particular shear stress. Erosion rates are estimated by measuring the remaining core length at different time intervals, taking the plunger height difference between each successive measurement, and dividing by the time interval.

In order to measure erosion rates at several different shear stresses using only one core, the following procedure was used. Starting at a low shear stress, the flume was run sequentially at higher shear stresses with each succeeding shear stress being twice the previous one. Generally about three shear stresses were run sequentially. Each shear stress was run until at least 0.5 mm but no more than 2 cm was eroded. The minimum 5 mm is required to obtain sufficient sample for bedload analysis The time interval was recorded for each run with a stopwatch and the bedload traps emptied and effluent saved for later analysis. The flow was then increased to the next shear stress, and so on until the highest shear stress was run. This cycle was repeated until all of the sediment had eroded from the core. If after two cycles a particular shear stress showed a rate of erosion less than 10^{-4}

cm/s, it was dropped from the cycle; if after many cycles the erosion rates decreased significantly, a higher shear stress was included in the cycle. A lower shear stress was sometimes re-introduced to the cycle if it became apparent that a more easily erodible layer was exposed. In general, erosion tests for each cycle were chosen from 1, 2.5, 5, 10, 20, and 40 dynes/cm^2. Sedflume can generate shear stress as great as 100 dynes/cm^2, but high values were not needed for these sediments

The previously described laboratory cores were developed so bulk properties other than bulk density, which affect erosion could be held constant and erosion rates could be related to bulk density. These data can then be fit to equations describing erosion as a function of bulk density and shear stress only. The equations are then used to develop algorithms for predictive models of sediment transport. Generally, with the other bulk properties held constant, erosion rates decrease exponentially as bulk density increases (Jepsen et al 1997a and 1997b; Roberts et al 1998) for natural sediments. In general, the data can be approximated by an equation of the form

$$E = A\tau^n \rho^m \qquad (A.4)$$

where E is the erosion rate (cm/s), τ is the shear stress (dynes/cm^2), ρ is the bulk density (g/cm^3), and n, m, and A are constants. The constants are shown in Table *** for the composite sediment from each site. For each shear stress, the erosion rate as a function of bulk density is shown as a straight line, which demonstrates that the above equation represents the data quite well and also that the erosion rate is a unique function of shear stress and bulk density. This relationship (with different constants) has been shown to successfully describe several other natural sediments (Jepsen et al, 1997a and 1997b; Jepsen et al 1998).

Measurements of Critical Shear Stress for Erosion

The value for critical shear stress, τ_c is determined directly from the erosion rate equation developed from the laboratory SEDflume results, equation 2.4, which, after rearranging becomes

$$\tau_c = \left(\frac{E}{A}\right)^{1/n} \rho^{-m/n} \qquad (A.5)$$

where E, the erosion rate is defined here as E=1x10^{-4} and the constants A, n, and m are determined from the erosion experiments. Smaller values of E can also be used to define critical shear stress to develop a sensitivity analysis. For this study, sensitivity testing is performed by analyzing critical shear stress based on a minimum erosion rate of 1x10^{-5} cm/s. This value of E is significantly less than is measurable using SEDflume and corresponds to an erosion rate of 1 mm every 150 minutes.

Measurements of Sediment Bulk Properties

Bulk properties of the sediment and water in the core influence erosion rate. Cores were consolidated in water from the site of collection. One of the main

factors influencing erosion is bulk density. For each sediment, a core that was consolidated in the same conditions as the Sedflume core was analyzed for bulk density. In addition, several samples were analyzed for grain size distribution.

Bulk density measurements

In order to determine the bulk density of the sediments at a particular depth and consolidation time, the weight of the sediment analysis samples, including the cup, were measured immediately after extraction from the core. Weight of the cup (tare weight) was measured and recorded prior to sample extraction. Wet weight of the sample was calculated by subtracting tare weight from the weight of the sample. The samples were then dried in the oven at approximately 75°C for 2 days and weighed again. The dry weight of the sample was calculated as the tare weight subtracted from the weight after drying. The water content W is then given

$$W = \left(\frac{m_w - m_d}{m_w} \right) \tag{A.6}$$

where m_w and m_d are the wet and dry weights respectively. A volume of sediment, V, consists of both solid particles and water, and can be written as

$$V = V_s + V_w \tag{A.7}$$

where V_s is the volume of solid particles and V_w is the volume of water. If the sediment particles and water have density ρ_s and ρ_w respectively, the water content of the sediment can be written as

$$W = \frac{\rho_w V_w}{\rho V} \tag{A.8}$$

where ρ is the bulk density of the sediment sample. A mass balance of the volume of sediment gives

$$\rho V = \rho_s V_s + \rho_w V_w \tag{A.9}$$

By combining Eqs. (2.5), (2.6), and (2.7), an explicit expression can be determined for the bulk density of the sediment sample, ρ, as a function of the water content, W, and the densities of the sediment particles and water. This equation is

$$\rho = \frac{\rho_s \rho_w}{\rho_w + (\rho_s - \rho_w) W} \tag{A.10}$$

For the purpose of these calculations, it was assumed that $\rho_s = 2.6$ gm/cm^3 and $\rho_w = 1.0$ gm/cm^3.

Particle size distribution measurements

A Coulter LS Series100 was used to measure the size distributions of particles for each of the Sedflume sites. The LS100 measures particles from 0.4μm to 900 μm in size. The particle size for the material is measured by placing a small portion of the sample in the fluid module. The fluid module is a chamber that is

filled with water and is sonicated to break up the particles for measurement. Once the sample has been placed in the fluid module, the sample is pumped and recirculated through the system past the optical module. The optical module is a rigid frame containing the light sources, lenses, detectors and printed circuit cards. The optical module uses a spatial filter assembly containing a laser diode and laser beam collimator. The diffraction detector assembly contains a custom photodector array that is used for the measurement of the particle size. From these measurements, the distribution of grain sizes at each erosion analysis site is provided.

Analysis of bedload samples

After each shear stress erosion measurement, the bedload traps were evacuated before beginning the next erosion experiment. The evacuated water with sediment generally amounted to approximately 1 liter. The samples were labeled, and sediment allowed to settle for 24 hours. A pipette was then used to remove water overlying the deposited sediment. After removal of most of the water, the sediment samples were oven dried as described in the previous section. The dried sediments were weighed and a grain size distribution measured using the Coulter LS particle sizer described above.

Each bedload sample corresponded to a specific erosion test in the Sedflume for which a depth of erosion of the core was measured. The surface area of the core is known and the bulk density was measured from the duplicate core. These three parameters were used to calculate the mass of sediment eroded. This calculation, along with the measured mass of bedload provided the fractions moving in suspension and on the bed.

Results

Six sites were chosen for analysis from the river and bar channels at Savannah. Sediment sites were selected to attempt to collect samples that would behave cohesive and would be from a broad range of locations in the channel. The six sites are shown in Figure A-3. Site selection was based in part on grain size distributions collected from the bar channel in 2000 by Law Engineering (Table ***). Sites were chosen to represent various areas in the bar and river channel. In addition, samples were not collected in areas that were defined as sandy. The transport processes for sand are well known and Sedflume is not required for sand transport analysis. However, grain size distribution in the channel is temporally changing and Sedflume samples grain size distribution did not generally match those from the Law Engineering data set.

Two of the sites selected, 17S and 62S, were non-cohesive. A relatively constant bulk density characterized these sites in both consolidation time and depth from the surface. In addition, erosion rates did not vary with the small span of bulk density variation. The grain size distributions of these two sites demonstrate very little fine material (Figure A-4). Table A-1 provides the median and other relevant grain sizes in the distribution plotted in Figure A-4.

The other sites behaved as cohesive sediment. Erosion rate generally decreased with increasing bulk density. Table A-2 provides the equations and coefficients to Equation A-4 for each of the four cohesive sediments. Plots of bulk density verses shear stress for each of the four cohesive sediment samples are provided in Figure A-5a-d. The colored lines are the slopes for each of the corresponding shear stresses. The black lines are the slopes for each shear stress for all data. Greater values of m indicate increased sensitivity to bulk density. All of the cohesive samples from Savannah can be classified as moderately cohesive. The value of parameter m is often 40 or greater for strongly cohesive sediments. Outlying points that do not fit the trend are expected. These could be due to gas bubbles, an oxidized layer, or other aberrations in what is assumed to be a well mixed sediment. Sometimes this can lead to positive slopes in the bulk density/erosion relationship (see τ=4.0 in Figure A-5c), but this generally happens only when all bulk density points are near each other and only a few data points exist for the given shear stress. Despite these anomalies, the inverse relationship trend between bulk density and erosion is clear.

Plots of bulk density verses depth for the six sites are presented in Figure A-6. The consolidation with time between 4 and 120 days is seen. For the four cohesive sites, these plots indicate that the sediment bed becomes more consolidated and thus harder to erode as it ages. In addition, these plots indicate that the sediment becomes more consolidated with depth below the surface. This indicates that the sediment surface is more easily eroded than deeper layers. The two non-cohesive sites (17S and 62S) show a relatively vertical profile with depth when consolidated (except for the surficial layer, which is often a layer of fine sediment). The vertical profile is indicative of non-cohesive sediments, which generally do not have bulk density variation when consolidated There are other factors, such as thixotropic effects and increasing organic content that will also increase the erosion resistance, but bulk density has been determined to be one of the most important factors (Roberts et al, 1998). Also, the increase in bulk density with depth below the surface for most samples is seen in Figure A-6. This indicates that the bed will become more difficult to erode with depth below the original sediment surface. This is an important feature of cohesive sediment beds. Many previous experiments have been only on the surficial layer of sediment. Estimated erosion rates will be excessive if the mound is assumed homogeneous and surficial sediment erosion rates are applied throughout the mound.

The decrease in erosion with depth is also important when considering turbidity generated by release of fines from the bed. Generally, a plume will be created at the beginning of a storm, but the plume will decrease greatly as the storm progresses. This is due, in part, to the significantly decreased erosion rates of sediments below the surficial layer. Time histories of suspended solids concentrations during storms have demonstrated this trend. A model cannot match these time history data if it assumes a homogeneous erosion rate with depth (for example, see Gailani et al, 1991).

Bedload trap analysis indicated that material from the bar channel separated after erosion (Table A-3). The material collected from the bedload traps was

coarser than the core sediments. Therefore, the fine material was moving in suspension while the sand fraction moved as bedload. Figure *** shows the separation 1 m downstream from the core by providing grain size distribution for both the trap and core sediments. The 'tail' of fines in the original core (sediment smaller than 80 μm) is almost completely missing from the trap grain size distribution. Other river sediments showed similar distribution change. Site 38N, in the river, included a higher percent fines than the bar channel. This material eroded as aggregates and individual particles. The aggregates moved as bedload and were collected in the bedload trap. These aggregates had the same composition as the core and therefore there is little difference in median grain size between core and bedload trap (Table A-3).

The coefficients in Table A-2 were used as input to the cohesive portion of the GTRAN model as described in Chapter 4. These data permitted testing of mound erosion using various sediment types that may be placed in the nearshore. The bedload trap data were used to validate the hypothesis that mixed silt/sand placed in the nearshore will quickly separate. Fine-grained sediment not associated with aggregates will not deposit in the higher energy nearshore. It will eventually disperse and move, then deposit, offshore.

References

Gailani, J., C.K. Ziegler, and W. Lick, 1991. Transport of Suspended Solids in the Lower Fox River. Vol. 17, No. 4, pp. 479-494.

Jepsen, R., J. Roberts, and W. Lick, 1997a. Effects of Bulk Density on Sediment Erosion Rates, *Water, Air, and Soil Pollution*. Vol. 99, pp. 21-31.

Jepsen, R., J. Roberts, and W. Lick, 1997b. Long Beach Harbor Sediment Study, Report Submitted to U.S. Army Corps of Engineers, DACW09-97-M-0068

Jepsen, R., Roberts, J., W. Lick, Gotthard, D., and Trombino, C, 1998. New York Harbor Sediment Study, Report Submitted to the U.S. Army Corps of Engineers, New York District.

McNeil, J., C. Taylor, and W. Lick, 1996. Measurements of the Erosion of Undisturbed Bottom Sediments with Depth, *Journal of Hydraulic Engineering*. Vol. 122, No. 6, pp. 316-324.

Roberts, J., Jepsen, R., Gotthard, D., and Lick, W. 1998. Effects of Particle Size and Bulk Density on Erosion of Quartz Particles. *Journal of Hydraulic Engineering*. Vol. 124, No. 12, pp. 1261-1267.

Schlichting, H., 1979. *Boundary-Layer Theory*. Seventh ed, McGraw-Hill.

	38n	17s	33s	52s	62s	78s
Percent < 4 micron	8.9	1.5	1	2.7	2.5	7
Percent < 20 micron	23.1	4.8	2.5	10.3	6.1	20.5
Percent < 80 micron	47.7	14.3	8.2	35.9	23	50.7
Percent < 400 micron	96.3	63.2	55.7	98.4	100	99.1
D10 (micron)	5	52	96	20	45	7
D50 (micron)	90	290	350	115	120	80
D90 (micron)	280	1000	850	270	200	205

Table A-1 Sedflume sediment sample grain size distributions

Site	A	n	m
38N	9.3	2.07	-28.3
33S	5140	2.45	-27.7
54S	88.7	2.75	-40.1
78S	27.8	1.35	-26.0

Table A-2: Site-Specific coefficients and exponents for four cohesive sites

Site	Bedload	Mean Particle Size		Silt Component	
		Trap	Core	Trap	Core
	(%)	(mm)	(mm)	(%)	(%)
38N	70	0.136	0.136	37	40
17S	62	1.226	0.51	3.1	11
33S	65	0.868	0.584	1.8	6
52S	40	0.205	0.144	23	27
62S	20	0.19	0.147	1.8	14
78S	50	0.2	0.112	21	41

Table A-3: Example from one Sedflume erosion test: Percent bedload erosion, mean particle size in core and bedload trap, percent silt in core and bedload trap

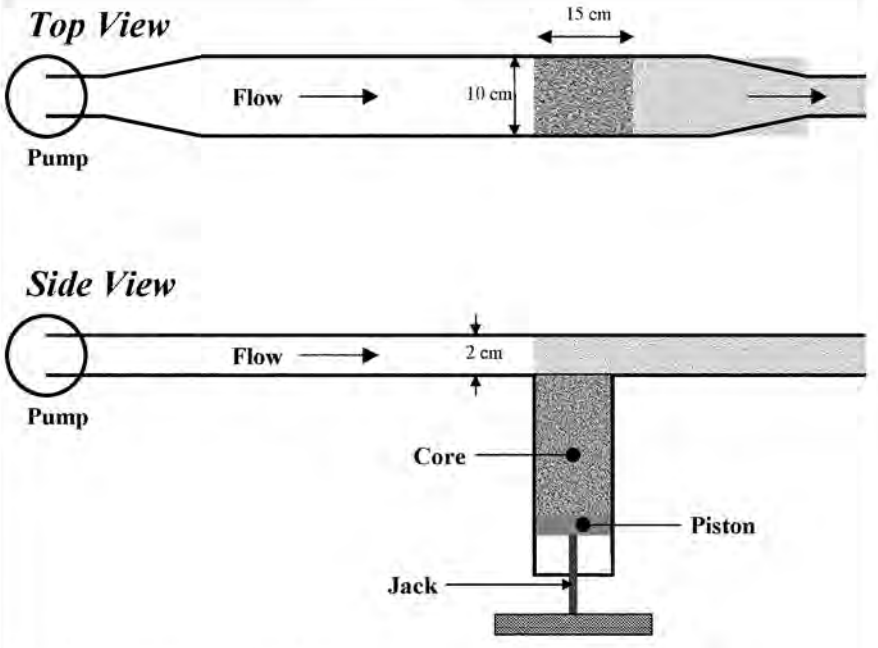


Figure 2.1: Schematic of Sedflume device

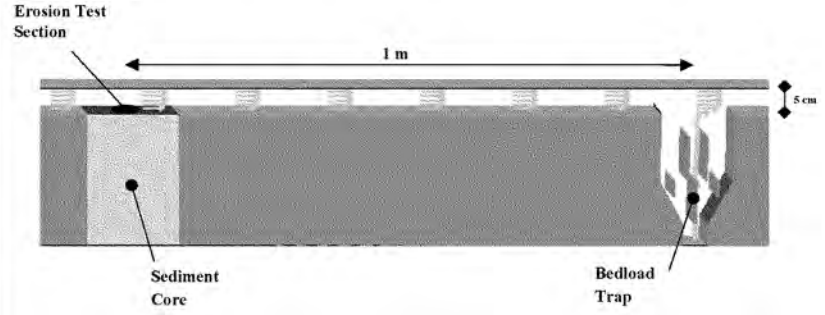


Figure 2.1: Schematic of ASSET flume, modified Sedflume

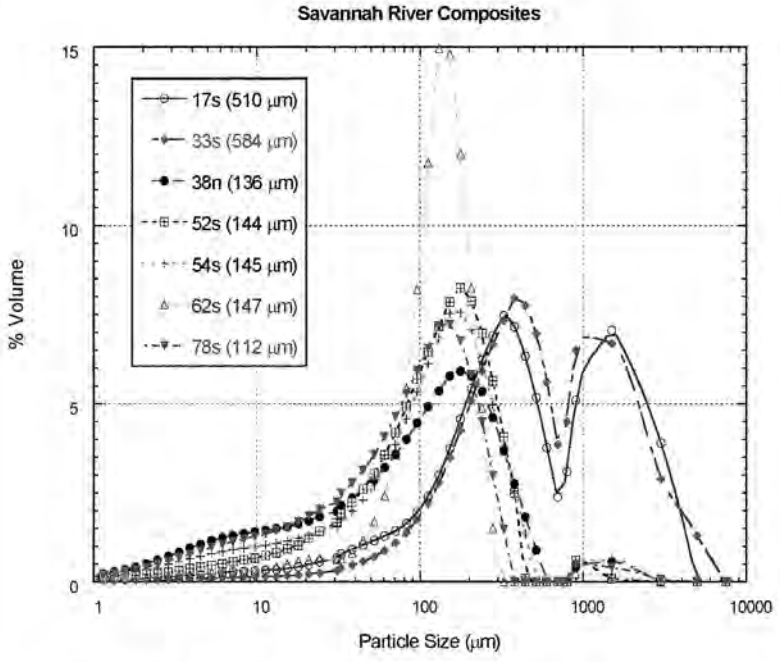


Figure A-4: Grain size distribution at six Sedlume analysis sites

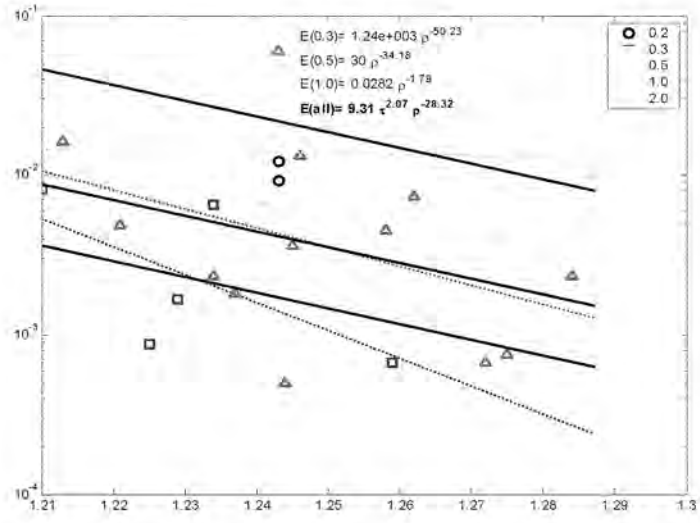


Figure A-5a: Erosion data for Site 38N

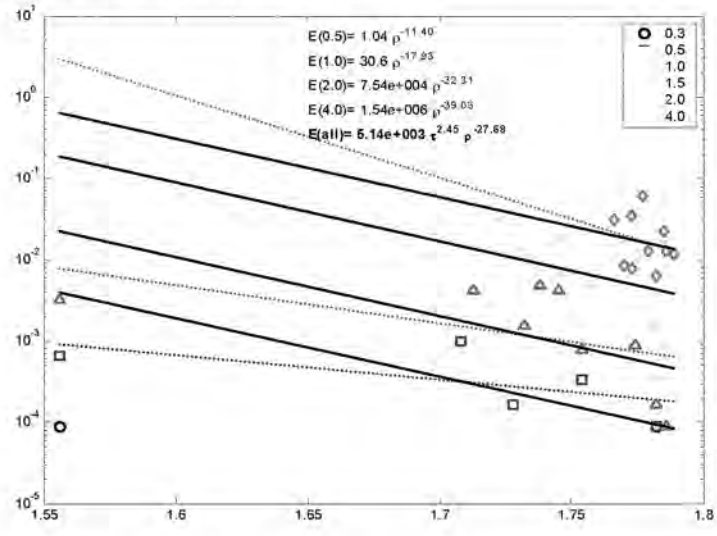


Figure A-5b: Erosion data for Site 33S

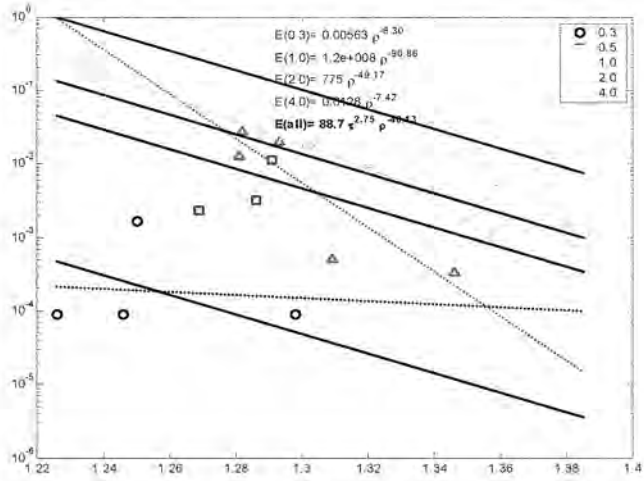


Figure A-5c: Erosion data for Site 52S

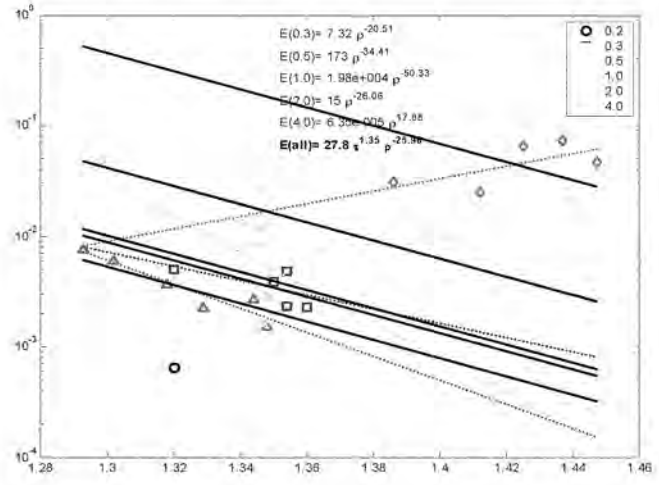


Figure A-5d: Erosion data for Site 78S

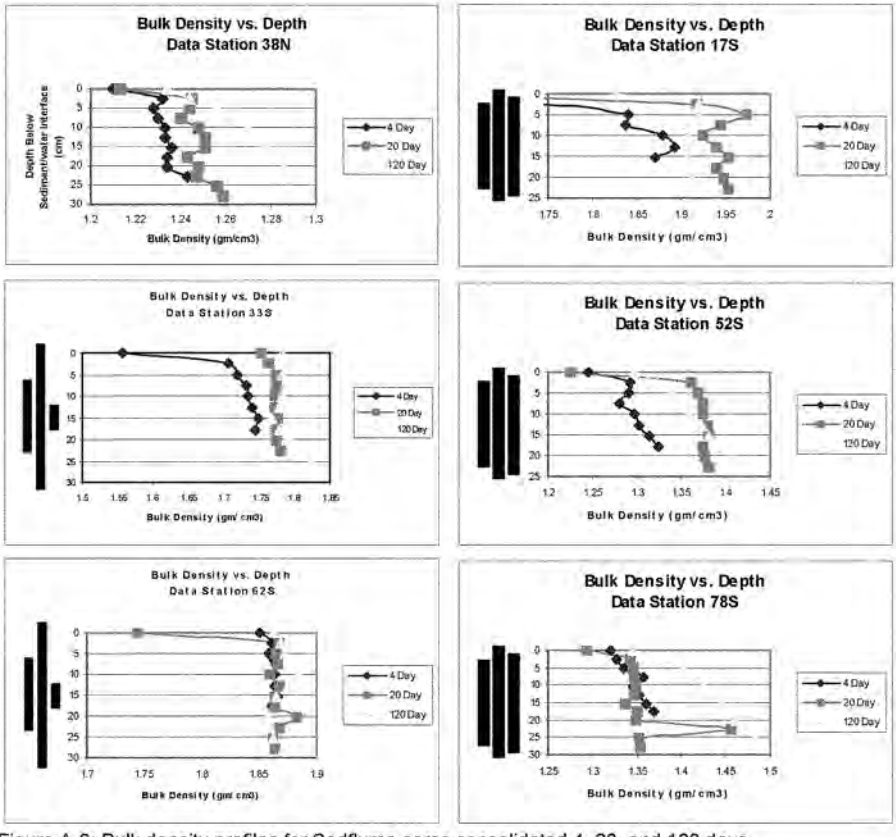


Figure A-6: Bulk density profiles for Sedflume cores consolidated 4, 20, and 120 days

FOR CONTINUATION OF HOUSE DOCUMENT 112-153

SAVANNAH HARBOR EXPANSION PROJECT
CHATMAN CO., GEORGIA & JASPER CO., S. CAROLINA:
FINAL GENERAL RE-EVALUATION REPORT AND
ENVIRONMENTAL IMPACT STATEMENT

SEE PART 4