FINAL REPORT

OF THE SCIENTIFIC PEER REVIEW PANEL ON THE DATA AND METHODOLOGIES SUPPORTING THE PROPOSED MFLS FOR THE LOWER SUWANNEE RIVER INCLUDING FANNING AND MANATEE SPRINGS

Prepared for

SUWANNEE RIVER WATER MANAGEMENT DISTRICT
9225 CR 49
Live Oak, Florida 32060

Prepared under Contract 03/04-137
By

HSW Engineering Peer Review Panel
Scott Emery, Ph. D.
Ken Watson, Ph. D.
Mike Dennis, Ph.D.
Mark Luther, Ph.D.

October 17, 2005

Department of Water Resources
WR03/04-06

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INTRODUCTION

The Minimum Flows and Levels (MFL) Program within the State of Florida is based on the requirements of Chapter 373.042 Florida Statutes. This statute requires that either a Water Management District (WMD) or the Department of Environmental Protection (DEP) establish minimum flows for surface watercourses and minimum levels for groundwaters and surface waters. The statutory description of a minimum flow is "the limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area" (Ch. 373.042 (1)(a), F.S.).

The statute provides additional guidance to the WMDs and DEP on how to establish MFLs, including how they may be calculated, using the "best information available," to reflect "seasonal variations," when appropriate. Protection of non-consumptive uses also are to be considered as part of the process, but the decision on whether to provide for protection of non-consumptive uses is to be made by the Governing Board of the WMD or the DEP (Ch. 373.042 (1) (b), F.S.).

WMDs are to develop priority lists of water courses and water bodies for which to establish MFLs and the proposed schedules to do so. These lists are to be updated yearly and sent to DEP for review and approval. In developing these lists, the WMDs are to examine the importance of the watercourse or water body to the State or region and the potential for significant harm to the water resources or ecology. Beginning in 2003, each priority list and schedule must include all first magnitude springs (Ch. 373.042 (2), F.S.). For such springs within the Suwannee River Water Management District (SRWMD), the District may choose not to establish MFLs on first magnitude springs provided the District submits a report to DEP containing evidence demonstrating that such first magnitude springs are not currently experiencing adverse impacts from withdrawals and are not anticipated to experience adverse impacts during the next 20 years.

In 1994 the Governing Board of the SRWMD initiated the effort to develop MFLs for the Lower Suwannee River, including the estuarine portion of the river. As the MFLs were being developed, it became clear that two historic first magnitude springs (Fanning and Manatee Spring), which also are on the District's MFL list, play an important role in the MFLs of the River. Therefore, it was decided to set the three sets of MFLs simultaneously.

The District enlisted a team of technical consultants to complete the development of the proposed MFLs, pursuant to the direction and guidance provided within the Florida Statutes (summarized in the preceding paragraphs). The District enlisted a separate team of technical experts to undertake a voluntary peer review of the methodologies used in the determination of an MFL for MBS. The Peer Review Panel for the Lower Suwannee consists of Dr. Scott Emery, Dr. Mark Luther, Dr. Mike Dennis and Dr. Ken Watson. Resumes of the qualifications of these four technical experts are provided in Appendix A at the end of this Peer Review Report.

The District provided the Peer Review Panel with a set of general review constraints, a specific set of charges, and a specific set of limitations defining what the Peer Review Panel was to consider in its review, summarized as follows.

General Review Conditions

1. *The selection of the Lower Suwannee River and associated springs as water bodies for which minimum flows and/or levels are to be initially set is a given.*

2. *The determination of the baseline from which "significant harm" is to be considered a given.*

3. *The definition of what constitutes "significant harm" to the water resources or ecology of the area is considered a policy decision.*

Specific Charge to the Peer Review Panel for TASK 1

Determine whether the methods used for establishing the minimum flows are scientifically reasonable.

Specific Charge to the Peer Review Panel for TASK 1(a)

Review the data and information that supports the method and the proposed minimum flows, as appropriate.

Specific Limitations and Assumptions to be made by the Peer Review Panel for TASK 1(a)

1. *It is to be assumed the data and information used were properly collected.*

2. *It is to be assumed that reasonable quality assurance assessments were performed on the data and information.*

3. *It is to be assumed that the exclusion of available data from analyses supporting the development of the minimum flows was justified.*

4. *It is to be assumed that the data used for the development of the minimum flows was the best information available.*

5. *The Peer Review Panel is not expected to provide independent review of standard procedures used as part of institutional programs that have been established for the purpose of collecting data, such as the USGS and District hydrologic monitoring networks.*

Specific Charge to the Peer Review Panel for TASK 1(b)

Review the technical assumptions inherent in the methodology and determine whether

1. *the assumptions are clearly stated, reasonable and consistent with the best information available; and*

2. *the assumptions were eliminated to the extent possible, based on available information.*

Specific Charge to the Peer Review Panel for TASK 1(c)

Review the procedures and analyses used in developing quantitative measures and determine qualitatively whether

1. *the procedures and analyses were appropriate and reasonable, based upon the best information available;*
2. *the procedures and analyses incorporate appropriate factors;*
3. *the procedures and analyses were correctly applied;*
4. *limitations and imprecision in the information were reasonably handled;*
5. *the procedures and analyses are repeatable; and*
6. *conclusions based on the procedures and analyses are supported by the data.*

Specific Charge to the Peer Review Panel for TASK 2

If the proposed method is not scientifically reasonable, the Peer Review Panel shall

1. *list and describe scientific deficiencies;*
2. *determine if the identified deficiencies can be remedied and, if so, provide suggested remedies; and*
3. *if the identified deficiencies cannot be remedied, then, if possible, identify one or more alternative methods that are scientifically reasonable, based on published literature, to the extent feasible.*

TIMETABLE

The Peer Review Panel Received a draft document titled: "DRAFT TECHNICAL REPORT MFL ESTABLISHMENT FOR LOWER SUWANNEE RIVER & ESTUARY, FANNING & MANATEE SPRINGS Suwannee River Water Management District, by Water Resource Associates, Inc.," on August 15, 2005. That report included five sections and approximately 271 pages describing the approach taken to recommend proposed MFLs. The appendices contain an additional 100 pages of supporting information. On August 23, 2005, the Team requested backup literature that was referenced in the draft report, and a field trip to the Suwannee River was taken on September 8, 2005.

The Peer Review Panel was given a deadline to have a draft of its Peer Review Report to the District by September 16, 2005. This was accomplished on schedule by e-mail, with a Draft Peer Review Report (Appendix B) that provided SRWMD multiple questions about the methods and procedures, different suggestions for text and figure clarification, along with an assessment of the extent to which the report being reviewed had succeeded in developing scientifically valid methods and procedures.

The Panel separated its questions, comments, and suggestions into two different categories:

1. Primary Comments/Issues: Items that represent data methodological or procedural flaws that might invalidate the proposed MFL; and

2. Secondary Comments/Issues: Items that could improve the report but would not invalidate the proposed MFL.

The Panel received responses to our original draft comments on September 30, 2005. Most of our comments were addressed by simple explanation and often accompanied by proposed text changes that provided a correction or a clarification (see Appendix B). In a few instances it was pointed out to the review Panel that our comments were outside of our scope and more related to District policy. Therefore, in the Peer Review Summary we have focused only on remaining issues related to data and analysis. We have included our draft comments and the Districts responses as Appendix B of this document to provide a complete record of the review process.

On October 11, 2005, Drs Scott Emery and Ken Watson of the Review Panel attended the SRWMD Board meeting and Dr. Emery provided a summary of our peer review. The presentation is provided as Appendix C.

PEER REVIEW SUMMARY

The following Table 1 provides a summary of our comments related specifically to our charge; namely the evaluation of the data and techniques used in the development of the MFLs. The original comments provided to the District and District responses are included as Appendix B. While the panel had numerous comments and suggestions both in the following table and in the draft comments provided in Appendix B, none of the questions or comments invalidates the proposed MFLs.

Another primary comment made on the draft report involved providing MFLs for the two springs for the entire year. MFLs were proposed only for the five cold season months and only for the protection of the Manatee thermal refuge. It is our understanding that MFLs will be proposed in the final report for the remainder of the year and will be set at 90 percent of the historic median flow. This MFL is a policy decision and not based on any technical analysis that the Panel reviewed.

Table 1. Final Summary Peer Review Comments for the Lower Suwannee River, Fanning Springs, and Manatee Springs

Lower Suwannee		Score	Comments
1.	Review the data and information that supports the method and the proposed minimum flows, as appropriate. The Panel assumes the following:		
a.	the data and information used were properly collected.	N/A	While not directly part of our review, procedures used for collecting data used in the development of MFLs were adequately documented and qualified when necessary.
b.	reasonable quality assurance assessments were performed on the data and information.	N/A	While not directly part of our review, reasonable quality assurance assessments were adequately documented in the MFL report.
c.	the exclusion of available data from analyses supporting the development of the minimum flows was justified.	N/A	While not directly part of our review, the exclusion of data was questioned by the review committee and, following clarification, the exclusion of data was justified.
d.	the data used for the development of the minimum flows was the best information available.	N/A	While not directly part of our charge, the Panel agrees that the information used in the development of the proposed MFLs are the best available.
e.	The Peer Review Panel is not expected to provide independent review of standard procedures used as part of institutional programs that have been established for the purpose of collecting data, such as the USGS and District hydrologic monitoring networks.	N/A	Standard procedures were not reviewed or critiqued.
2.	Review the technical assumptions inherent in the methodology and determine whether		
a.	The assumptions are clearly stated, reasonable and consistent with best information available	***	The panel agrees that, in general, the assumptions were clearly stated, reasonable and consistent with best available information
b.	Assumptions were eliminated to the extent possible, based on available information	***	The panel agrees that assumptions, in general, were eliminated to the extent possible, based on best available information.
3.	Review the procedures and analyses used in the developing quantitative measures and determine qualitatively whether		
a.	the procedures and analyses were appropriate and reasonable, based on the best available information	***	The panel agrees that the procedures and analyses were appropriate and reasonable. This includes the regression procedures used for record extension, graphical and analytical procedures used for filtering data, modeling procedures for characterizing river stage (i.e., HEC-RAS)

			and CE-QUAL-W2 for thermal regime modeling, and the salinity regression models.
b.	the procedures and analyses incorporate appropriate factors	**	1. The Panel agrees that SAV is an important component of the ecological system in the Lower Suwannee and is deserved of protection. At 27.1 acres of SAV it would be more accurate to describe SAV as an important component rather than a "major" component of the system. The report should more clearly emphasize the maintenance of a salinity regime that ensures protection of SAV and other important components.
c.	the procedures and analyses were correctly applied.	***	The panel agrees that the procedures and analyses were correctly applied.
d.	Limitations and imprecision in the information were reasonably handled.	**	The panel agrees that limitations and imprecision in the information were reasonable handled. The panel requested additional clarification on regression procedures used and this clarification should be added to the text.
e.	The procedures and analyses are repeatable.	***	The panel agrees that the procedures and analyses are repeatable.
f.	Conclusions based on the procedures and analyses are supported by the data.	**	The panel agrees that the conclusions based on the procedures and analyses are supported by the data. However, the panel also stated that a dynamic model rather than statistical models would be preferable and would provide more confidence in the salinity relationships.
4.	If the proposed method is not scientifically reasonable, the Peer Review Panel shall		
a.	List and describe scientific deficiencies.	N/A	N/A
b.	Determine if the identified deficiencies can be remedied and, if so, provide suggested remedies.	N/A	N/A
c.	If the identified deficiencies cannot be remedied, then, if possible, identify one or more alternative methods that are scientifically reasonable, based on published literature, to the extent feasible.	N/A	N/A

Key:

*** The statement is substantially supported; sufficient information provided and/or Panel finds no significant deficiencies.

** The statement is partially supported; questions about information or analyses exist, but the questions or requested clarification do not invalidate the determination of appropriate MFLs, and can be answered or supported by additional data in the future.

* The statement is not substantially supported; insufficient information provided and/or Panel has found significant deficiencies.

N/A Not Applicable

Table 1. Final Summary Peer Review Comments for the Lower Suwannee River, Fanning Springs, and Manatee Springs (Continued)

Fanning Spring			Score	Comments
1.	Review the data and information that supports the method and the proposed minimum flows, as appropriate. The Panel assumes the following:			
	a.	the data and information used were properly collected.	N/A	While not directly part of our review, procedures used for collecting data used in the development of MFLs were adequately documented and qualified when necessary.
	b.	reasonable quality assurance assessments were performed on the data and information.	N/A	While not directly part of our review, reasonable quality assurance assessments were adequately documented in the MFL report.
	c.	the exclusion of available data from analyses supporting the development of the minimum flows was justified.	N/A	The panel agrees that the procedures and analyses were correctly applied.
	d.	the data used for the development of the minimum flows was the best information available.	N/A	While not directly part of our charge, the Panel agrees that the information used in the development of the proposed MFLs are the best available.
	e.	The Peer Review Panel is not expected to provide independent review of standard procedures used as part of institutional programs that have been established for the purpose of collecting data, such as the USGS and District hydrologic monitoring networks.	N/A	Standard procedures were not reviewed or critiqued.
2.	Review the technical assumptions inherent in the methodology and determine whether			
	a.	The assumptions are clearly stated, reasonable and consistent with best information available	***	The panel agrees that, in general, the assumptions were clearly stated, reasonable and consistent with best available information
	c.	Assumptions were eliminated to the extent possible, based on available information.	***	The panel agrees that assumptions, in general, were eliminated to the extent possible, based on best available information
3.	Review the procedures and analyses used in the developing quantitative measures and determine qualitatively whether			
	a.	the procedures and analyses were appropriate and reasonable, based on the best available information	**	The panel agrees that the procedures and analyses were appropriate and reasonable. This includes the regression procedures used for record extension, graphical and analytical procedures used for filtering data, modeling procedures for characterizing river stage (i.e., HEC-RAS) and CE-QUAL-W2 for thermal regime

			modeling, and the salinity regression models. However, if the value being protected at Fanning Spring is thermal refuge, then it appears that a minimum flow in addition to a minimum stage is warranted.
	b. the procedures and analyses incorporate appropriate factors	***	The Panel agrees that procedures and analysis incorporate appropriate factors.
	c. the procedures and analyses were correctly applied.	***	The Panel agrees that procedures and analysis were correctly applied.
	d. Limitations and imprecision in the information were reasonably handled.	***	The panel agrees that limitations and imprecision in the information were reasonable handled.
	e. The procedures and analyses are repeatable.	***	The panel agrees that the procedures and analyses are repeatable.
	f. Conclusions based on the procedures and analyses are supported by the data.	***	The panel agrees that the conclusions based on the procedures and analyses are supported by the data.
4.	If the proposed method is not scientifically reasonable, the Peer Review Panel shall		
	a. List and describe scientific deficiencies.	N/A	N/A
	b. Determine if the identified deficiencies can be remedied and, if so, provide suggested remedies.	N/A	N/A
	c. If the identified deficiencies cannot be remedied, then, if possible, identify one or more alternative methods that are scientifically reasonable, based on published literature, to the extent feasible.	N/A	N/A

Key:

*** The statement is substantially supported; sufficient information provided and/or Panel finds no significant deficiencies.

** The statement is partially supported; questions about information or analyses exist, but the questions or requested clarification do not invalidate the determination of appropriate MFLs, and can be answered or supported by additional data in the future.

* The statement is not substantially supported; insufficient information provided and/or Panel has found significant deficiencies.

N/A Not Applicable

Table 1. Final Summary Peer Review Comments for the
Lower Suwannee River, Fanning Springs, and Manatee Springs
(Continued)

Manatee Spring		Score	Comments
1.	Review the data and information that supports the method and the proposed minimum flows, as appropriate. The Panel assumes the following:		
a.	the data and information used were properly collected.	N/A	While not directly part of our review, procedures used for collecting data used in the development of MFLs were adequately documented and qualified when necessary.
b.	reasonable quality assurance assessments were performed on the data and information.	N/A	While not directly part of our review, reasonable quality assurance assessments were adequately documented in the MFL report. The report correctly identifies quality issues related to the Manatee Spring discharge data.
c.	the exclusion of available data from analyses supporting the development of the minimum flows was justified.	N/A	While not directly part of our review, the exclusion of data was questioned by the review committee and, following clarification, the exclusion of data was justified. However, we are concerned that the exclusion of data, particularly in reference to the Manatee Springs discharge data throws into some doubt the validity of the remaining data. It is recommended that the District verify the discharge relationships developed in the report as additional data become available.
d.	the data used for the development of the minimum flows was the best information available.	N/A	While not directly part of our charge, the Panel agrees that the information used in the development of the proposed MFLs are the best available.
e.	The Peer Review Panel is not expected to provide independent review of standard procedures used as part of institutional programs that have been established for the purpose of collecting data, such as the USGS and District hydrologic monitoring networks.	N/A	Standard procedures were not reviewed or critiqued.
2.	Review the technical assumptions inherent in the methodology and determine whether		
a.	The assumptions are clearly stated, reasonable and consistent with best information available	***	The panel agrees that, in general, the assumptions were clearly stated, reasonable and consistent with best available information
d.	Assumptions were eliminated to the extent possible, based on available information.	***	The panel agrees that assumptions, in general, were eliminated to the extent possible, based on best available

		information
3. Review the procedures and analyses used in the developing quantitative measures and determine qualitatively whether		
a. the procedures and analyses were appropriate and reasonable, based on the best available information	***	The panel agrees that the procedures and analyses were appropriate and reasonable. This includes the regression procedures used for record extension, graphical and analytical procedures used for filtering data, modeling procedures for characterizing river stage (i.e., HEC-RAS) and CE-QUAL-W2 for thermal regime modeling, and the salinity regression models.
b. the procedures and analyses incorporate appropriate factors	**	1. The regression analysis for Manatee Spring flow incorporates Fanning Spring discharge and stage at Wilcox, which may be problematic. It has previously been established that Fanning Spring discharge is associated with Wilcox stage so the consequences of using two correlated variables as explanatory variables should be explained. Also the concordant relationship between Manatee Spring flow and Wilcox stage does not seem appropriate given the description of the interaction of river stage with spring discharge, and probably results from the association between the two "independent" variables (i.e., Fanning discharge and Wilcox stage). Multi-collinearity has other consequences such as unstable slope coefficients.
c. the procedures and analyses were correctly applied.	**	The Panel questioned the implementation (not the use) of CE-QUAL-W2 for modeling the thermal regime of the Manatee Spring run, particularly the use of the buoy data in model calibration. The buoys appeared to be outside the model domain. Additional clarification in the text would be helpful.
d. Limitations and imprecision in the information were reasonably handled.	**	The panel agrees that limitations and imprecision in the information were reasonable handled. However, the Manatee Spring discharge data, in particular, remains troublesome.
e. The procedures and analyses are repeatable.	**	Because of the multi-collinearity issue mentioned in 3c above, additional new data may result in changes to the statistical model. However, as an interpolation tool the panel agrees that the model will produce reasonable results.

	f. Conclusions based on the procedures and analyses are supported by the data.	**	The panel agrees that the conclusions based on the procedures and analyses are supported by the data.
4.	If the proposed method is not scientifically reasonable, the Peer Review Panel shall		
	a. List and describe scientific deficiencies.	1. ** 2. **	1. The calibration/application of CE-QUAL-W2 2. The regression model used for record extension of the Manatee Spring data set
	b. Determine if the identified deficiencies can be remedied and, if so, provide suggested remedies.	1. ** 2. **	1. The panel remains concerned with the parameters used in the record extension equation for Manatee Spring. It remains at least questionable whether two parameters that are presumably highly correlated should be used as independent variables in a regression model. There are appropriate statistical tools available to test for this correlation but this was essentially done for the Fanning Spring model. However, as an interpolation tool the model probably will produce reasonable results. 2. Provide the calibration information for CE-QUAL-W@ or additional clarification
	c. If the identified deficiencies cannot be remedied, then, if possible, identify one or more alternative methods that are scientifically reasonable, based on published literature, to the extent feasible.	**	The panel agrees that the reported concerns have or can be addressed using existing data. However, the Manatee Spring data in particular are problematic. The reasons for this should be investigated so that additional reliable data can be collected.

Key:
*** The statement is substantially supported; sufficient information provided and/or Panel finds no significant deficiencies.
** The statement is partially supported; questions about information or analyses exist, but the questions or requested clarification do not invalidate the determination of appropriate MFLs, and can be answered or supported by additional data in the future.
* The statement is not substantially supported; insufficient information provided and/or Panel has found significant deficiencies.
N/A Not Applicable

APPENDIX A

RESUMES

CURRICULUM VITA

Mark Edward Luther

(revised December 1, 2003)

Date of Birth:	January 20, 1954
Social Security Number:	246-92-5429
Initial Date of USF Employment:	August 8, 1990
Present Rank:	Associate Professor
College:	Marine Science

Education

Institution	Field of Study	Degree	Date
University of North Carolina at Chapel Hill	Mathematics and Physics	A.B.	1976
University of North Carolina at Chapel Hill	Physical Oceanography	M.S.	1980
University of North Carolina at Chapel Hill	Physical Oceanography	Ph.D.	1982

Professional Background

1990-Present	Associate Professor, College of Marine Science, University of South Florida
1985-Present	Associate in the Supercomputer Computations Research Institute, The Florida State University
1987-Present	Associate in the Geophysical Fluid Dynamics Institute, The Florida State University
1986-1990	Research Associate, Mesoscale Air-Sea Interaction Group, The Florida State University
1984-1986	Postdoctoral Fellow, Mesoscale Air-Sea Interaction Group, The Florida State University
1982-1984	Postdoctoral Research Associate, Mesoscale Air-Sea Interaction Group, The Florida State University
1977 (summer)	Research Technician, Department of Marine Science and Engineering, North Carolina State University
1976-1982	Graduate Research Assistant, Curriculum in Marine Sciences, University of North Carolina at Chapel Hill

Areas of Specialization

Numerical modeling of ocean dynamics; dynamics of western boundary currents; coastal and estuarine dynamics; equatorial dynamics; climate variability; real-time oceanographic observing-modeling systems.

Awards

Control Data Corporation PACER (Program for Advanced Computing in Engineering and Research) Fellow, 1984-1986.

Professional Organizations, Offices, and Service Activities

Member of:
- American Association for the Advancement of Science
- American Geophysical Union
- American Meteorological Society
- The Oceanography Society
- The Estuarine Research Federation

U.S. Global Ocean Observing System (GOOS) Steering Committee, Member, 2002-2005

National Research Council US National Committee for the International Union of Geodesy and Geophysics, Member, 1996-2004.

US National Delegate to the International Association for the Physical Sciences of the Ocean, General Assembly, 1999, 2003.

National Oceanic and Atmospheric Administration Working Group on Coastal Ocean Data Quality Assurance, Member, 1997-1998.

National Aeronautics and Space Administration Sea-viewing Wide Field-of-view Sensor (SeaWiFS) Science Team, Member, 1992-1997.

National Science Foundation Division of Ocean Sciences Review Panels, 1993, 1994, 1995, 1997, 1999.

World Climate Research Programme-International Oceanographic Commission Indian Ocean Climate Studies Panel, Member, 1989-1998.

World Ocean Circulation Experiment Indian Ocean Scientific Steering Committee, Member, 1993-1998

Managing Editor, *HydroWire, An On-Line Newsletter for the Aquatic Sciences*, 1996-2000 (sponsored by the American Geophysical Union, The Oceanography Society, the American Society for Limnology and Oceanography, and the Estuarine Research Federation)

American Geophysical Union Ocean Sciences Section Executive Committee, Public Information Officer, 1996-2000.

American Geophysical Union Information Technology Committee, 1998-2000.

American Geophysical Union Regional Advisory Committee for United States and Canada, Member, 1991-1995.

American Geophysical Union Ocean Sciences Section Secretary, 1994-1996.

American Geophysical Union Western Pacific Geophysics Meeting Program Committee, Ocean Sciences Section Program Chairman, 1991-1994.

American Geophysical Union Fall Meeting Program Committee, Ocean Sciences Section Program Chairman, 1994-1995.

American Geophysical Union Spring Meeting Program Committee, Ocean Sciences Section Program Chairman, 1994-1996.

Estuarine Research Federation 2001 Conference Steering Committee, Chairman, 1997-2001.

Estuarine Research Federation Initiative in Biocomplexity and Climate Change Steering Committee, Member, 2001-present.

U.S. Global Ocean Observing System (GOOS) Planning Workshop Steering Committee, Member, 2001-present.

American Society for Limnology and Oceanography/The Oceanography Society Ocean Research Conference, Program Committee Member, 2002-2004.

The Oceanography Society Program Committee, 1993-1995.

The Oceanography Society Meeting Local Organizing Committee, Member, 1991.

Pinellas County Schools Center for Advanced Technology Advisory Board, Member, 1994-1998.
Greater Tampa Bay Marine Advisory Council, Member, 1993-present.
Tampa Bay Physical Oceanographic Real-Time System (GTBMAC-PORTS, Inc.) Chief Operating Officer, 1995-present.
Tampa Bay Regional Planning Council Agency on Bay Management, Member, 1996-present.
Tampa Bay National Estuary Program Technical Advisory Committee, Member, 1991-present.
Tampa Bay Harbor Safety Committee Technical Subcommittee, Member, 1997-present.
The Pier Aquarium Board of Directors, Member, 2001-present.
Committee to Review the Outer Continental Shelf Environmental Studies Program, National Research Council, External Reviewer, Seattle, 1987.
NATO Advanced Study Institute on Physical Oceanographic Modelling, Banyuls-sur-Mer, France, Lecturer, 1985.
Indo/U.S. Science and Technology Initiative Planning Conference for Monsoon Oceanography, Bangalore, India, Member, U.S. Delegation, 1984.
University of South Florida Faculty Senate, Member, 2001-2004.
University of South Florida College of Arts and Sciences Tenure and Promotion Committee, Member, 1998-2000.
University of South Florida College of Arts and Sciences Faculty Advisory Council, Member, 1993-1995.
University of South Florida College of Arts and Sciences Computing Advisory Committee, Member, 1991-1995.
University of South Florida College of Marine Science Information Technology (formerly Computer) Committee, Member, 1990-present; Chair, 1992-present.
University of South Florida College of Marine Science Long Range Planning Committee, Member, 1997-present.
University of South Florida Department of Marine Science Faculty Evaluation Committee, Member, 1993; Chair, 1996.
University of South Florida Department of Marine Science Curriculum Committee, Co-chair, 1991-1994.
University of South Florida Department of Marine Science New Building Committee, Member, 1990-1991.
University of South Florida Department of Marine Science Personnel Committee, Member, 1990-1995.
University of South Florida Department of Marine Science Student Recruiting Committee, Member, 1990-1995.
University of South Florida Department of Marine Science Technical Support Positions Search Committee, Chair, 1994-1995, 1997-1998.
University of South Florida Dean of the Graduate School Search Committee, Member, 1993-1994.
University of South Florida Department of Geography Faculty Search Committee, Member, 1993-1994.
Florida State University Supercomputer Users' Executive Committee, Member, 1985-1990.
Florida State University Campus Networking Committee, Member, 1989-1990.
Florida State University Supercomputer Computations Research Institute Local Systems Operation Policy Committee, Member, 1988-1990.
Reviewer:
The Journal of Physical Oceanography
The Journal of Geophysical Research
The Journal of Marine Research
The Journal of the Oceanographical Society of Japan
Deep-Sea Research
Dynamics of Atmospheres and Oceans
Estuaries
Oceanologica Acta

Oceanography
Paleoceanography
Progress in Oceanography
Marine Technology Society Journal
Geological Society of London, Proceedings
Qatar University Science Buletin
Nonlinear World
CRC Press
The National Science Foundation
The National Oceanic and Atmospheric Administration
The National Aeronautics and Space Administration
The U.S. Department of State
The State of Louisianna Board of Regents

Cruise Experience

R/V Eastward	Bahamas	Winter 1977
M/V Albatross III	Cape Hatteras	Summer 1977
R/V Endeavour	South Atlantic Bight	Spring 1978
R/V John DeWolfe	Cape Hatteras	Summer 1978
R/V Endeavour	South Atlantic Bight	Fall 1978
R/V Endeavour	South Atlantic Bight	Winter 1979
R/V Endeavour	South Atlantic Bight	Spring 1979
R/V Researcher	South Atlantic Bight	Fall 1981

Students Supervised

Mark S. Vincent, Ph.D., 2002 (with Mark Ross)

Nancy J. Schmidt, Ph.D., 2001

David C. Burwell, Ph.D., 2001

Haiying Zhang, M. S., 2000

Dawn Olson, M. S., 1998

Zaihua Ji, Ph. D., 1997

Danielle M. Bartolacci, M. S., 1996

M. Grey Valenti, M. S., 1995

Lynn A. Leonard, Ph. D., 1994 (with A. C. Hine)

Alex H. Meng, M. S., 1985 (with James J. O'Brien)

Raymond C. Simmons, M. S., 1987 (with James J. O'Brien)

Karen E. Woodberry, M. S., 1988 (with James J. O'Brien)

Tommy G. Jensen, Ph. D., 1989 (with James J. O'Brien)

James T. Potemra, M. S., 1990 (with James J. O'Brien)

Pedro Tsai, M. S., 1990 (with James J. O'Brien)

Publications - Book Reviews

Luther, M. E., 1991. Dynamics of the Coupled Ocean and Atmosphere, edited by H. Charnock and S. Philander. *Bull. Am. Meteor. Soc., 72,* 250-251.

Publications - Chapters in Books and Symposia

Luther, M. E., 1982. Spatially unstable waves in the Gulf Stream over the Carolina continental slope. *Workshop on Gulf Stream Structure and Variability, Proceedings,* University of North Carolina at Chapel Hill, 394 pp.

Luther, M. E., and J. J. O'Brien, 1984. Indian Ocean modelling at FSU. *Proceedings of a Workshop on Oceanography of the Indian Ocean,* F. Schott, ed., RSMAS, University of Miami, pp. 3.1-3.6

Luther, M. E., 1986. Advanced methods for steady problems - Direct elliptic solvers. *Advanced Physical Oceanographic Numerical Modelling,* Ch. 3b, James J. O'Brien, ed., D. Reidel, Dordrecht, Holland, 608 pp.

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Schmidt, N. J., J. L. Chapin, and M. E. Luther, 1995. On-line access to oceanographic and meteorological data from Florida's west coast and the Caribbean. Presented at the 1995 meeting of The Oceanography Society, Newport, RI, April 18, 1995.

Vincent, M., B. Galperin, and M. Luther, 1995. Development and application of a real-time three-dimensional hydrodynamic model of Tampa Bay, Florida. Presented at the Coastal Zone '95 Conference, Tampa, FL, July 17-22, 1995.

Luther, M. E., Z. Ji, H Liu, M. G. Valenti, and D. M. Bartolacci, 1995. Real-time ocean modelling and data transmission in support of shipboard research in the Arabian Sea. *Trans. Amer. Geophys. Union, 76,* no 46(suppl), p. F294. Presented at the AGU 1995 Fall Meeting, Dec. 12, 1995, San Francisco, CA.

Schmidt, N. J., J. L. Chapin, and M. E. Luther, 1995. Real-time oceanographic and meteorological data from Florida's west coast and the Caribbean. *Trans. Amer. Geophys. Union, 76,* no 46(suppl), p. F295. Presented at the AGU 1995 Fall Meeting, Dec. 12, 1995, San Francisco, CA.

Schmidt, N. J., M. S. Vincent, and M. E. Luther, 1996. Oil spill modeling in Tampa Bay, Florida: An integrated approach. *Trans. Amer. Geophys. Union, 77,* no 17(suppl), p. S154. Presented at the AGU 1996 Spring Meeting, May 21, 1996, Baltimore, MD.

Luther, M. E., M. A. Haines, and Z. Ji, 1996. Pathways of cross-equatorial fluxes in an Indian Ocean circulation model. *Trans. Amer. Geophys. Union, 77,* no 46(suppl), p. F392. Presented at the AGU 1996 Fall Meeting, Dec. 16, 1996, San Francisco, CA.

Ji, Z., M. E. Luther, and M. A. Haines, 1996. Cross-equatorial heat fluxes in an Indian Ocean circulation model. *Trans. Amer. Geophys. Union, 77,* no 46(suppl), p. F391. Presented at the AGU 1996 Fall Meeting, Dec. 16, 1996, San Francisco, CA.

Haines, M. A., M. E. Luther, and Z. Ji, 1996. Surface boundary conditions for CFC-11 in an Indian Ocean circulation model. *Trans. Amer. Geophys. Union, 77,* no 46(suppl), p. F392. Presented at the AGU 1996 Fall Meeting, Dec. 16, 1996, San Francisco, CA.

Luther, M. E., N. Schmidt, and D. Burwell, 1997. The Tampa Bay Physical Oceanographic Real-Time System (PORTS). *Trans. Amer. Geophys. Union, 78,* no 17(suppl), p. S120. Presented at the AGU 1997 Spring Meeting, May 30, 1997, Baltimore, MD.

Luther, M. E., N. Schmidt, and D. Burwell, 1997. The Tampa Bay Physical Oceanographic Real-Time System (PORTS). Presented at the Estuarine Research Federation 1997 Meeting, October 16, 1997, Providence, RI.

Schmidt, N., M. E. Luther, M. Vincent. B. Galperin, and D. Burwell, 1997. An Integrated End-to-End Marine Contaminant Management System for Tampa Bay. Presented at the Estuarine Research Federation 1997 Meeting, October 14, 1997, Providence, RI.

Presentations

Luther, M. E., and J. J. O'Brien, 1983. Modelling of the seasonal circulation in the Arabian Basin. Invited paper presented at the Mabahiss/John Murray International Symposium on Marine Science of the North-West Indian Ocean and Adjacent Waters, Alexandria, Egypt, 3-7 September, 1983.

Luther, M. E., 1991. Equatorial waves in the Indian Ocean in models and observations. Equatorial Theoretical Panel Meeting Abstracts, Univ. Rhode Island, July 1991.

Luther, M. E., 1991. Indian Ocean Modelling activities related to WOCE. WOCE/WHP Indian Ocean Expedition Planning Meeting, Univ. Miami, November 12-15, 1991.

Luther, M. E., 1992. Modelling the variability of upwelling in the Arabian Sea. Presented at the Bedford Institute of Oceanography, April 14, 1992, Dartmouth, Nova Scotia.

Luther, M. E., 1992. Dynamics of upwelling in the Arabian Sea. Presented at the Global Ecosystems Dynamics Experiment (GLOBEC) Arabian Sea Expedition Planning Meeting, June 16, 1992, Denver, CO.

Luther, M. E., 1992. Coupled Physical-Biological Models. Invited presentation at the Workshop on Variation in the Marine Environment and Ecosystem Around the Hawaiian Archipelago, East-West Center, University of Hawaii, Honolulu, Hawaii, December 3-4, 1992.

Luther, M. E., 1992. Dynamics of the Northern Indian Ocean, invited presentation at the Seventh Session of the SCOR-IOC Indian Ocean Climate Studies Panel, Bangalore, India, August 24-28, 1992.

Luther, M. E., 1992. Upwelling in the Arabian Sea, invited presentation at the Indian Ocean Marine Affairs Cooperation (IOMAC) International Scientific Workshop on Marine Scientific Cooperation in the Indian Ocean, Colombo, Sri Lanka, October 18-25, 1992.

Luther, M. E., 1992. Modelling the Circulation of the Indian Ocean. Invited presentation at the meeting of the WOCE Working Group on Numerical Modelling, Rutgers University, October 5-6, 1992.

Luther, M. E., Z. Ji, and K. Chen, 1993. Near real-time modelling of the Indian Ocean wind-driven circulation. Invited presentation at The Oceanography Society Meeting, Seattle, WA, April 12-16, 1993.

Luther, M. E., 1993. Coupled Physical-Biological Models of the Indian Ocean/Arabian Sea. Presented at the First SeaWiFS Science Team Meeting, Annapolis, MD, January 21, 1993.

Luther, M. E., 1993. Modelling the Circulation of the Indian Ocean. Invited presentation at the University of Hawaii, Honolulu, Hawaii, March 30, 1993.

Luther, M. E., 1993. Seasonal variability in the Indian Ocean and the WOCE Hydrographic Program. Presented at a meeting of the WOCE Indian Ocean Science Steering Committee, La Jolla, CA, August 2-5, 1993.

Luther, M. E., 1993. Ocean Modelling and Remote Sensing. Presented at the monthly meeting of the ACM/SIGGRAPH Tampa Bay Chapter, St. Petersburg, FL, September 8, 1993.

Luther, M. E., 1993. Modelling the variability of upwelling in the Arabian Sea. Invited presentation at the Office of Naval Research, Arabian Sea Expedition Program Managers Meeting, October 25, 1993.

Luther, M. E., 1993. Indian Ocean circulation and the global climate system. Invited presentation in the Department of Marine Science, Eckerd College, October 27, 1993.

Luther, M. E., 1994. Modelling the Indian Ocean Circulation. Lecture presented at Scripps Institution of Oceanography, Univ. of California at San Diego, La Jolla, CA, April 22, 1994.

Luther, M. E., 1994. Interannual variability in the wind-driven circulation of the Indian Ocean. Invited presentation at the World Climate Research Programme Workshop on Monsoon Predictability, Trieste, Italy, May 13, 1994.

Luther, M. E., 1994. Activities of the World Ocean Circulation Experiment (WOCE) and the Joint Global Ocean Flux Study (JGOFS) in the Indian Ocean. Invited presentation at the Eighth Session of the SCOR-IOC Indian Ocean Climate Studies Panel, Triete, Italy, May 16-17, 1994.

Luther, M. E., 1994. Modelling and remote sensing of ocean circulation. Invited lecture at the Ocean University of Qingdao, Qingdao, China, August 1, 1994.

Luther, M. E., 1995. Real-Time monitoring and modelling of Ocean Processes. Invited lecture at the NOAA National Ocean Service, August 11, 1995.

Luther, M. E., 1996. Indian Ocean Circulation and Climate Variability. Invited lecture in the Dept. of Oceanography, Texas A&M Univ., Oct. 7, 1996.

Luther, M. E., 1996. The Tampa Bay Physical Oceanographic Real-Time System. Invited lecture in the Dept. of Marine Science, Stony Brook University, Oct. 16, 1996.

Luther, M. E., and M. A. Haines, 1998. The West Florida Coastal Ocean Monitoring and Prediction System (COMPS). 12th annual Governors Hurricane Conference, Tampa, FL, June 1-5, 1998.

Luther, M. E., 1998. Seasonal to interannual variability in the heat budget of the Indian Ocean. Invited presentation at A Workshop on the Variability of the Asian-Australian Monsoon, July 29-31, 1998, St Michaels, MD.

Luther, M. E., 1998. Real-time physical oceanographic monitoring and modeling in West Florida. Invited lecture at Eckerd College, October 14, 1998.

Luther, M. E., D. Burwell, M. Haines, N. Schmidt, M. Vincent, R. Weisberg, and H. Yang, 1998. Real-time physical oceanographic monitoring in West Florida. Invited presentation at the Marine Technology Society Ocean Community Conference '98, Baltimore, MD, November 19, 1998.

Luther, M. E., 1999. The West Florida Coastal Ocean Monitoring and Prediction System (COMPS). presented at the 13th Annual Governor's Hurricane Conference, June 7-11, 1999, Tampa, Florida.

Luther, M. E., D. Burwell, M. Haines, N. Schmidt, M. Vincent, R. Weisberg and H. Yang. The coastal ocean monitoring and prediction system for west Florida. presented at the International Union of Geodessey and Geophysics XXII General Assembly, Birmingham, UK, 19-30 July 1999.

Luther, M. E., D. Burwell, M. Haines, N. Schmidt, M. Vincent, R. Weisberg and H. Yang. Real-Time Physcial Oceangoraphic Monitoring in Tampa Bay and the West Florida Coastal Ocean, Estuarine Research Federation '99, September 25-30, 1999, New Orleans, LA.

Vincent, M., D. Burwell, M. Luther, and B. Galperin, 1999. The Tampa Bay nowcast-forecast system. presented at the 6th International Conference on Estuarine and Coastal Modeling, New Orleans, LA, November 3-5, 1999, by M. Vincent.

Burwell, D., M. Vincent, M. Luther, and B. Galperin, 1999. Modeling of estuarine residence times. presented at the 6th International Conference on Estuarine and Coastal Modeling, New Orleans, LA, November 3-5, 1999, by D. Burwell.

Luther, M. E., R. H. Weisberg, and C. R. Merz, 2000. The coastal ocean monitoring and prediction system for west Florida. presented at the American Meteorological Society Annual Conference, Long Beach, CA, 9-14 January, 2000.

Zhang, H., M.E. Luther, D.M. Legler, S.D. Meyers and R. He. High frequency wind forcing from NSCAT in a model of the Indian Ocean circulation. Presented at the 2000 Ocean Sciences Meeting, American Society of Limnology and Oceanography, American Geophysical Union, San Antonio, Texas, January 24-28, 2000.

Soloviev, A., M. E. Luther, and R. H. Weisberg, 2000. Response of the Coastal Ocean to Hurricanes Floyd and Irene at the South Florida Ocean Measurement Center. Presented at the American Meteorological Society Conference, Ft. Lauderdale, FL, May 31, 2000.

Schmidt, N, E.K. Lipp, M.E. Luther and J.B. Rose. Exploring the combined impacts of NAO and ENSO on Florida's climate and coastal water quality. Presented at the Chapman Conference, The North Atlantic oscillation, University of Vigo (Ourense Campus) Ourense, Galicia, Spain, November 28 - December 1, 2000.

Luther, M. E., R. H. Weisberg, and A. V. Soloviev, 2001. Energetic supertidal oscillations with ~10-hr period off southeast Florida. Presented at The Oceanography Society Conference, Miami, Apr. 2, 2001.

Luther, M. E., M. S. Vincent, D. C. Burwell, and B. Galperin, 2001. Numerical modeling of proposed fresh water withdrawals and desalination concentrate discharges in Tampa Bay, Florida. Presented at the 16th Biennial Conference of the Estuarine Research Federation, St. Pete Beach, FL, Nov. 8, 2001.

Schmidt, N., and M. E. Luther, 2001. ENSO impacts on salinity in Tampa Bay, Florida. Presented at the 16th Biennial Conference of the Estuarine Research Federation, St. Pete Beach, FL, Nov. 7, 2001.

Luther, M. E., 2002. Impacts of fresh water diversions and concentrate discharge from a seawater desalination facility on water quality in Tampa Bay, Florida. Presented at the American Meteorological Society Third Symposium on Environmental Applications, Orlando, FL, Jan. 15, 2002.

Schmidt, N., and M. E. Luther, 2002. ENSO Impacts on Fresh Water Input and Salinity in Tampa Bay, Florida. Presented at the 2002 Ocean Sciences Meeting, Honolulu, HI, Feb. 14, 2002.

Luther, M. E., R. H. Weisberg, and A. Soloviev, 2002. Internal Tides on the Shelf off Southeast Florida. Presented at the 2002 Ocean Sciences Meeting, Honolulu, HI, Feb. 13, 2002.

Peebles, E. B., and M. E. Luther, 2002. Spawning and Habitat Responses of the Bay Anchovy *Anchoa mitchilli* to ENSO-related Variation in Inflows to Florida Estuaries. Presented at the 2002 Ocean Sciences Meeting, Honolulu, HI, Feb. 14, 2002.

Meyers, S. D., and M. E. Luther; Simulations of Altered Freshwater Flow Into Tampa Bay and Impact on Salinity; Presented at the American Geophysical Union Fall Meeting, San Francisco, CA, Dec. 2002

Gilbert, S. A., S. Meyers, and M. Luther; Wind-Driven Waves in Tampa Bay, Florida. Presented at the American Geophysical Union Fall Meeting, San Francisco, CA, Dec. 2002

Luther, M. E., S. D. Meyers, S. A. Gilbert, V. Subramanian, and M. E. Hansen, 2003. An Integrated Observing and Modeling System for Tampa Bay, Florida. Presented at the EPA Conference on Emerging Technologies, Tools, and Techniques To Manage Our Coasts in the 21st Century, January 27-31, 2003.

Luther, M. E., S. D. Meyers, S. A. Gilbert, V. Subramanian, L. M. Wetzell, M. S. Vincent, and D. C. Burwell, 2003. An Integrated Observing and Modeling System for Tampa Bay, Florida. Presented at The Oceanography Society Conference, New Orleans, LA, June 2003.

Luther, M. E., S. D. Meyers, S. A. Gilbert, V. Subramanian, L. M. Wetzell, M. S. Vincent, and D. C. Burwell, 2003. An Integrated Observing and Modeling System for Tampa Bay, Florida. Presented at the International Union of Geodesey and Geophysics, Sapporo, Japan, July 2003.

Computer-Produced Motion Pictures

Spatially unstable waves in the Gulf Stream, 4 min., 1982, 16mm color film.

A model of the Indian Ocean forced by FGGE winds, 6 min., 1985, 16mm color film.

Interannual Variability in the Somali Current 1954-1976, 55 min., 1987, 16mm color film.

Numerous videotapes on aspects of Indian Ocean circulation.

Grants and Contracts Awarded

"Mixed Layer Parameterizations in Models of the Indian Ocean Circulation," M. E. Luther, Principal Investigator. Institute for Naval Oceanography; $64,773; May 1, 1991 to March 31, 1992.

"Modelling of Tidal Propagation in Rivers Using Data Assimilation," M. E. Luther, Principal Investigator. Florida Department of Natural Resources; $10,000; May 1, 1991 to January 15, 1992.

"Mixed Layer Parameterizations in Models of the Indian Ocean Circulation," M. E. Luther, Principal Investigator. Office of Naval Research; $121,623; January 1, 1992 to December 31, 1993.

"Modelling Primary Production in the Arabian Sea," M. E. Luther, Principal Investigator. National Science Foundation; $259,569; December 15, 1992 to December 14, 1995.

"Incorporation of SeaWiFS Data into Coupled Physical/Biological Models of the Arabian Sea," M. E. Luther, Principal Investigator, John C. Brock, Co-Investigator. National Aeronautics and Space Administration; $550,438; April 1, 1993 to September 30, 1997.

"Upwelling and Mixed-Layer Dynamics in the Arabian Sea," M. E. Luther, Principal Investigator. Office of Naval Research; $601,525; January 1, 1994 to September 30, 1998.

"Modelling chemical tracer distribution in the Indian Ocean," M. E. Luther, Principal Investigator, R. A. Fine, Co-Investigator. National Science Foundation; $323,357; January 1, 1994 to June 30, 1997.

"Satellite Data Products for Florida Waters on CD-ROM," M. E. Luther, Principal Investigator. Florida Department of Environmental Protection; $30,700; June 9, 1993 to February 21, 1994.

"Tampa Bay PORTS Cooperative Agreement," M. E. Luther, Principal Investigator. Greater Tampa Bay Marine Advisory Council-PORTS, Inc.; $207,453 (as of 11/24/2002); March 7, 1994 to March 6, 2004.

"Support of research activities of a Marine Engineering Institute at the University of South Florida," M. E. Luther, Co-Principal Investigator (among many others); Office of Naval Research; $2,000,000 ($85,816 for Luther's portion); June 1, 1994 to May 31, 1996.

"Biophysical interactions in the surface layer of the equatorial Pacific Ocean," M. E. Luther, Principal Investigator. National Aeronautics and Space Administration; $22,000; 9-1-94 to 8-31-95.

"The design of a modeling strategy for Florida Bay," Boris Galperin, Principal Investigator, M. E. Luther, M. A. Haines, and A. F. Blumberg, Co-Investigators. U.S. Dept. of the Interior/Everglades National Park; $41,070; 8-30-94 to 8-29-95.

"A study to determine the use of satellite imagery in mapping the discolored water phenomena occurring in Florida Bay," M. E. Luther, Principal Investigator. Florida Department of Environmental Protection; $15,000; February 15 to October 31, 1995.

"The Northeastern Gulf of Mexico Circulation Modeling Study," Y. Hsueh (FSU), Principal Investigator, R. Weisberg, USF Co-Principal Investigator, M. Luther, Co-Investigator; Minerals Management Service; $753,156 total USF sub-contract; October 1, 1995 to March 31, 2000.

"Development of an Integrated End-to-End Marine Contaminant Management System," M. E. Luther, Principal Investigator, B. Galperin, E. VanVleet, N. Schmidt, M. Vincent, and C. Friel, Co-Investigators; Environmental Protection Agency; $588,777; October 1, 1996 to March 31, 2000.

"Regional Assessments and Applications for Effects of Seasonal-to-Interannual Climate Variability," M. E. Luther, Principal Investigator; National Oceanic and Atmospheric Administration, through a subcontract with the Univ. of Miami; $30,000; January 1, 1997 to December 31, 1997.

"Observations and Modeling of the West Florida Shelf Circulation," R. H. Weisberg, Principal Investigator, M. E. Luther, Co-Principal Investigator; Office of Naval Research; $2,971,084; October 1, 1997 to July 31, 2003.

"A Real-Time Oceanographic Data System for Florida," P. R. Betzer, M. E. Luther, and R. H. Weisberg, Co-Principal Investigators; Florida Department of Environmental Protection; $400,000; October 29, 1997 to September 30, 1998.

"Characterization of Changes in Salinity and Tidal Residual Circulation in Tampa Bay due to Desalination Concentrate Discharge," M. E. Luther, Principal Investigator; S & W Water, LLC; $110,000; October 29, 1999 to December 31, 2000.

"A Real-Time Oceanographic Data System for Florida." Funded $300,000 for 5.3 positions for Coastal Ocean Modeling and Prediction Systems (COMPS). P. R. Betzer, M. E. Luther, and R. H. Weisberg, Co-Principal Investigators. (Annually recurring E&G funds).

"I-4 Corridor funding for the Coastal Ocean Modeling and Prediction System (COMPS)." Funded $ 69,276.00 for engineer position and $ 78,520.50 for expenses. P. R. Betzer, M. E. Luther, and R. H. Weisberg, Co-Principal Investigators. (Annually recurring E&G funds).

"Real-time monitoring in Brooker Creek Preserve," M. Luther, Principal Investigator; Pinellas County; $39,450; April 1, 2000 to September 30, 2000.

" Salinity and Residence Time in McKay Bay in the USF College of Marine Science Three-Dimensional Hydrodynamic Circulation Model of Tampa Bay." M. E. Luther, Principal Investigator; Southwest Florida Water Management District; $69,943.00; 06/01/01 to 06/30/02. (one person-month)

"Coupling of a Wave Model and Water Quality Model with the USF 3-Dimensional Hydrodynamic Circulation Model for Tampa Bay." M. E. Luther, Principal Investigator; US Geological Survey; $40,000; 06/01/01 to 06/30/03.

"Air-water turbulent flux measurements in Tampa Bay." M. E. Luther, Principal Investigator; Florida Department of Environmental Protection; $113,699; January 1, 2002 to June 30, 2003. (one person-month)

"The Alliance For Coastal Technologies (ACT):Partnership Activities at the University of South Florida." M. E. Luther, Principal Investigator; National Oceanic and Atmospheric Administration through subcontract with the Univ. of Maryland; $650,000; May 1, 2002 to April 30, 2004. (two person-months)

"An autonomous genosensor for environmental water quality." J. Paul, PI; M. Luther, Co-Pi (with others); National Science Foundation; $1.29M; 10/01/02 to 9/30/06 (one person-month).

"The Southeast Atlantic Coastal Ocean Observing System (SEA-COOS)." H. Seim, PI, M. Luther, Co-PI (with others); Office of Naval Research; $3.7M; 10/1/02 to 9/30/03. (one person-month)

"To Establish a Regional Node for the National Virtual Ocean Data System (NVODS) at the University of South Florida College of Marine Science;" Subcontract #: S030021; Texas A&M Research Foundation; PI-Mark Luther; 10/01/2002 to 08/31/2003; $19,834

"Coordinated Regional Benefit Studies of Coastal Ocean Observing Systems;" ONR subcontract through Woods Hole Oceanographic Institution; PI - K. Weiand, COBA, Co-PI - M. Luther, D. Colie; 9/15/02-7/31/04; $49,939.

Consultant Services

Oceaneering, Inc., 1994 (assisted with prediction of Indian Ocean currents for salvage of a downed Navy jet off the coast of Somalia)

Greater Tampa Bay Marine Advisory Council - PORTS, Inc., 1995-present (provide management services for the Tampa Bay Physical Oceanographic Real-Time System)

Post, Buckley, Schuh, and Jernigan, Inc., 1998-present (provided simulations of salinity and circulation changes in Tampa Bay from proposed water supply projects; assist in design and implementation of a comprehensive hydro-biological monitoring plan for permitted water supply projects)

Tampa Bay Water, a Regional Water Supply Authority, 1998-present (provide expert testimony on the effects of water supply projects on the Tampa Bay estuary)

Nova Southeastern University, 1998-present (provide coordination of design and implementation of a real-time environmental observing array for the South Florida Ocean Measurement Center)

ENSR, 1999-2000 (evaluated environmental effects of a proposed natural gas pipeline to be built through Tampa Bay)

Conrod Associates, 2000-2001 (provide field instrumentation for real-time monitoring of the Brooker Creek Preserve, Pinellas County)

Marine Desalination Systems, LLC, 2001-present (provide analyses of oceanographic data for the Tampa Bay region)

Taiwan National Center for Ocean Research, 2001 (provide optical instrumentation for calibration of satellite remote sensing of ocean color)

Woods Hole Group, 2001 (provide installation and retrieval of oceanographic instrumentation in Tampa Bay, Florida)

S and W Water, LLC, 2001 (provided expert testimony in permit hearing for Big Bend desalination facility)

Carnival Cruise Lines, 2002 (provided analyses of oceanographic data in support of legal proceedings)

KEN W. WATSON, Ph.D.
President/Principal Hydrologist

EDUCATION / CREDENTIALS

B.S. Soil Science, University of Florida, 1977
M.S. Soil Physics, University of Kentucky, 1979
Ph.D. Soil Physics, University of Kentucky, 1983

Continuing Education

University of South Florida

Hydrology of Islands/Coasts, 1988
Florida and Island Hydrology, 2000
Analytical and Semi-analytical Models, 1992
Mathematics of Flow Nets and Analytic Elements, 1994

Risk Assessment (American Petroleum Institute)
Risk Analysis
Stochastic Methods in Risk Analysis
Visual ModFlow
Basins

PROFESSIONAL AFFILIATIONS

Certified and registered Professional Hydrologist – Groundwater
American Institute of Hydrology
National Groundwater Association
American Water Resources Association

FIELDS OF SPECIALIZATION

- Hydrologic and solute transport modeling in porous and fractured media (analytical and numerical)
- Hydrologic, hydraulic and hydrodynamic modeling of surface waters
- Mixing zone modeling
- Surface water quality and permitting
- Total Maximum Daily Loads
- Statistics and stochastic modeling
- Investigation of groundwater, surface water, soil and sediment and contamination
- Investigation of remedial alternatives
- Human health and ecological risk assessments
- Groundwater and surface water hydrology
- Minimum Flows and Levels
- Water conservation
- Irrigation and drainage system design
- Saturated and unsaturated hydraulic conductivity determinations
- Wetland investigations
- Expert Witness

EXPERIENCE SUMMARY

As a Principal Hydrologist at HSW (1988 to present), Dr. Watson is the officer in charge of water resources investigations, surface water modeling studies, groundwater studies, hydrologic and solute transport modeling projects and human health risk assessments, contamination assessments/corrective actions of industrial facilities, and numerous underground storage tank projects. He is also involved in specific investigations dealing with establishing minimum flows and levels in water bodies in west-central Florida for the Southwest, St. Johns River and Suwannee River Water Management Districts. Dr. Watson is continually called upon to provide quantitative expertise with respect to groundwater, surface water and unsaturated zone hydrology, and the transport of contaminants in surface and-subsurface waters, and has qualified as an expert in administrative hearings in the fields of groundwater modeling and applied mathematics. As president of HSW, he is in charge of corporate technical development.

After receiving his Ph.D., Dr. Watson held a Research Associate position (1983 – 1986) with Oak Ridge National Laboratories (ORNL). Under sponsorship of the Office of Health and Environmental Research and the University of Tennessee, Dr. Watson participated in studies of the transport rates of trace contaminants from shallow land waste disposal sites, biodegradation of TCE, solidification techniques, geostatistics and various review committees dealing with hazardous waste disposal.

Dr. Watson also spent 16 months (1979 – 1980) at the U.S. Department of Agriculture research station in Beltsville, Maryland, where he investigated the transport of nitrogen in the vadose zone. Measurement techniques were developed for sampling in the vadose zone, and models to describe
transport in the vadose zone were investigated.

Before co-founding HSW Environmental Consultants, Inc. (HSW), Dr. Watson was a senior consultant with the firm of Geraghty & Miller, Inc. (G&M) in Tampa, Florida, where he was manager of numerous projects and assisted the professional staff in several G&M offices on numerical modeling studies (1986 – 1988). Projects involved the assessment and remediation of contaminated soil and groundwater, the implementation of complex numerical modeling codes to predict the transport and recovery rates of contaminants, and provision of expert testimony related to modeling efforts. As manager of the computer department at G&M's Tampa office, an in-depth knowledge of verified numerical modeling codes (e.g., MODFLOW, MOC, MT3D, ATD123) also was required.

Dr. Watson has compared various modeling strategies for determining solute travel times to water supply wells, and developed stochastic modeling techniques for water flow and solute transport problems. He has applied complex numerical transport models to hazardous waste areas; developed solution sampling techniques for unsaturated soil systems; developed field measurement techniques and instrumentation for unsaturated hydraulic conductivity determinations; investigated modeling techniques for biodegradation of TCE; and designed a spray irrigation system for the removal of VOCs.

From 1986-present, Dr. Watson has been involved in numerous projects where travel times, recovery rates, capture zones, mixing zones, and other quantitative analyses of dynamic processes are required. He investigated the transport of sulfate from a gypsum stack in central Florida; calculated the travel time of a solvent plume from an industrial landfill in central Florida to a nearby public water supply wellfield; performed a capture zone analysis for public supply wells in Hillsborough County, Florida; and conducted numerical and statistical modeling studies of public water supply wellfields, saltwater intrusion, and contaminant migration. He is well versed in the most recent versions of modeling codes (groundwater - MODFLOW, MODPATH, MT3DMS, WinFLOW, and WinTRAN; surface water BASINS, XP-SWMM, HEC-RAS, CE-QUAL, and CORMIX; and the statistical packages SPSS and SAS) and has written specialty codes for hydrologic and statistical evaluations. He has also performed numerous human health risk evaluations and reviewed ecological risk assessments. He currently manages very diverse projects that include contamination assessment and remediation of DNAPL sites at the Kennedy Space Center, underground storage tank sites, human health risk assessments, water conservation in agriculture, and groundwater and surface water modeling tasks.

Dr. Watson recently prepared a detailed drainage model for TECO's Big Bend Facility using XP-SWMM. This model was used because of its ability to model surface water conveyance and pumping systems, which was necessary because of the blending of process and surface waters at the facility. He currently manages and plays key technical roles in several water resource projects involving minimum flows and levels in surface water bodies located in the SWFWMD, SJRWMD, and SWRWMD. For SWFWMD, he is performing a variety of statistical analysis and modeling tasks to assist with establishing MFLs in estuarine systems. For the SRWMD, Dr. Watson is part of and manages a Peer review team for MFLs in rivers in that District. This includes peer review of the surface water models used for setting MFLs (e.g., hspf and HEC-RAS).

PROJECT EXPERIENCE

Modeling & Solute Transport

- Performed a detailed drainage and hydraulic conveyance model of Tampa Electric's Big Bend plant using SWMM.

- Evaluated MFLs set on the St. Johns River using extreme value frequency analysis techniques.

- Currently managing and on a peer review team evaluating MFLs in the SRWMD, including the appropriate use of hydrologic, hydraulic, and hydrodynamic models (e.g., hspf (BASINS), and HEC-RAS)

- Performed Residence time modeling for estuarine systems in support of minimum flows and levels on the Alafia River in west central Florida.

- Project officer and lead modeler for water resource evaluation of the Belleair Wellfield. Developed a pumping optimization model and performed trend analysis and water level and water quality data.

- Served as project officer and lead modeler for modeling of selected hydrogeologic settings in Pinellas County, Florida for siting of a reverse osmosis water treatment facility.

- Compared various modeling strategies for determining solute travel times to water supply wells.

- Developed stochastic modeling techniques for water flow and solute transport problems.

- Applied complex numerical transport models to hazardous waste areas.

- Investigated modeling techniques for biodegradation of TCE.

- Investigated potential salt-water encroachment in the Northwest Hillsborough County area and developed a conceptual model of the transition zone in that region of the county.

Contamination Assessment & Remediation

- Project manager and project officer for numerous contamination assessment and remediation investigations for solid waste management units at the Kennedy Space Center that include the contaminants: chlorinated VOCs including DNAPL, petroleum compounds, PCBs, PAHs, and metals.

- Serving as project officer for the preparation of annual reports for several wellfields operated by Tampa Bay Water. Work included statistical evaluation of groundwater level and water quality trends.

- Principal investigator for 1.5 million dollar cleanup of chlorinated solvent site at facility in Orlando, Florida

- Served as project manager on various contamination assessments for hydrocarbon and inorganic contamination at service stations, industrial complexes, and military bases.

- Served as project manager for an Alternative Concentration Level demonstration.

Risk Assessment

- Lead scientist for numerous human health risk assessments for sites at the Kennedy Space Center and other industrial clients.

Statistical Analysis

- Performed statistical evaluations of pumping and other stresses on water levels in and around the Cross Bar Ranch Wellfield.

- Performed a variety of descriptive, parametric, and non-parametric analyses procedures to evaluate water level and water quality trends as well as the relationships between water level changes and environmental stresses.

- Performed trend analysis and regression analysis of water flow and level data for several rivers in west central Florida in support of establishing minimum flows and levels for these water bodies.

- Performing frequency and duration analyses for flow and levels on the Saint Johns River in support of establishing minimum flows and levels on a section of that river.

- Provided peer review to the EPA for establishing statistical procedures for determining cleanup of RCRA facilities.

Expert Testimony

- Provided expert testimony on the G-I Aquifer Wellhead Protection Rule. Qualified as an expert in groundwater flow modeling and applied mathematics.

Water Resources, Wellfield Siting, Development & Management

- Project officer for water resource evaluation of the Belleair Wellfield. Developed a pumping optimization model and performed trend analysis and water level and water quality data.

- Served as project officer on a wellhead protection program for Hillsborough County, Florida.

- Evaluated potential water savings alternatives in agriculture for the SWFWMD.

- Project manager for hydrologic studies and annual wellfield reports for the Tampa Bay Water from 1990 – current.

- Manage peer review team and perform peer review related to the establishment of MFLs on surface rivers for the SRWMD.

- Evaluated proposed MFLs for the St Johns River against 10 water resource values foe SJRWMD.

Engineering Design

- Designed spray irrigation system for the removal of VOCs.

- Provided conceptual and quantitative design of various remediation systems including pump and treat, air sparge, soil vapor extraction, exfiltration galleries, and bioremediation.

Other Relevant Experience

- Developed a solution sampling technique for unsaturated soil systems.

- Developed field measurement techniques and instrumentation for unsaturated hydraulic conductivity determinations.

- Simulated the transport of sulfate from a gypsum stack cooling pond.

- Simulated the transport of VOCs from several landfill sites to a municipal wellfield.

- Served as project officer for the preparation of the annual Groundwater Quality Assessment Reports for the Department of Energy's Y-12 Plant in Oak Ridge, Tennessee.

- Involved with unsaturated zone studies of wetlands that involved the installation and use of piezometers.

SELECTED PUBLICATIONS AND PRESENTATIONS

Radcliff, D., T. Hayden, K.W. Watson, P. Cowley, and R.E. Phillips. 1980. Simulation of soil water within the root zone of a corn crop. Agronomy Journal 72: p. 19-24.

Southworth, G.R., K.W. Watson, and J.L. Keller. 1987. Comparison of models that describe the transport of organic compounds in macroporous soils. Env. Tox. and Cehm. Vol 6, p. 251-257.

Watson, K.W. 1979. In-situ unsaturated hydraulic conductivitiy measurements on two Kentucky soils. M.S. thesis, Agronomy Department, University of Kentucky.

Watson, K.W. 1982. Effect of conventual tillage and no-tillage on the infiltration and initial distribution of added water. Agronomy Abstracts p. 167 American Society of Agronomy, Madison, Wisconsin.

Watson, K.W. 1983. Stochastic modeling of the initial distribution of surface applied water and dissolved solutes. Ph.D. presentation, Agronomy Department, University of Kentucky.

Watson, K.W. and R.E. Phillips, in review. Estimating pore water velocity distribution parameters using solute tracer data. Soil Science Society of America Journal.

Watson, K.W. and R.E. Philips. 1984. Estimating pore water velocity p.d.f. parameters using solute tracer data. Transactions, AUG 65 (16), p. 206.

Watson, K.W. and R.J. Luxmoore. 1984. Estimating macropore distribution to total water flow in a forest watershed. Agronomy Abstracts, p. 177. American Society of Agronomy, Madison, Wisconsin.

Watson, K.W. and G.R. Southworth. 1985. Comparison of three transport codes for describing the movement of reactive organic compounds. Transactions, AUG 66 (8), p. 264.

Watson, K.W. and R.J. Luxmoore. 1986. Estimating macroporosity in a forest watershed by use of a tensoin infiltrometer. Soil Science Society of America volume 50: p. 578-582.

Watson, K.W., January 1997. What's New in Water Quality Permitting. Environmental Permitting Short Course. Florida Chamber of Commerce, Orlando, Florida.

Watson, K.W., June 1996. Wellhead Protection in Florida. Environmental Permitting Short Course. Florida Chamber of Commerce, Marco Island, Florida.

Watson, K.W., January and July 1998-2005. Water Quality Permitting, **including application of CORMIX and PLUMES mixing zone models**. Environmental Permitting Short Course. Florida Chamber of Commerce, Marco Island and Orlando, Florida.

Griffin, T.W. and Watson, K.W., 2002. A Comparison of Field Techniques for Confirming DNAPLs, Manuscript in Press for Ground Water Monitoring and Remediation. Spring 2002.

Griffin, T.W. and Watson, K.W., 2002. DNAPL Site Characterization – A Comparison of Field Techniques. In proceedings from Remediation of Chlorinated and Recalcitrant Compounds, Battelle Press, May 2002.

Griffin, T.W., Bardsley, D.S., and Watson, K.W., 2002. Confined Aquifer Horizontal Recovery Wells for Contaminant Source Reduction. in proceedings from Remediation of Chlorinated and Recalcitrant Compounds, Battelle Press, May 2002.

SCOTT H. EMERY, Ph.D.
Senior Technical Consultant/Ecologist

CREDENTIALS/CERTIFICATION

Ph.D., Ecology, Biological Sciences, SUNY at Stony Brook, N.Y. 1984
M.S., Zoology, Clemson University, S.C. 1978
B.A., Biology, Williams College, MA. 1975

PROFESSIONAL AFFILIATIONS

IES Board of Directors, University of South Florida, 1993-present
Minimum Flows/Levels Committees/Sub-committees, 1996-present
Chairman, FDEP Groundwater Rule TAC, 1996-present
American Water Works Association
Ecological Society of America
Society of Wetland Scientists
Courtesy Associate Professor, University of South Florida 2003 – 08

FIELDS OF SPECIALIZATION

- Minimizing impacts from water supply development projects
- Assessing impacts from groundwater withdrawal on lakes/streams/wetlands
- Resource Management
- Water conservation and demand management
- Water supply development, treatment, and testing
- Ecological risk assessments

RELEVANT PROJECT EXPERIENCE:

Minimum Flows and Levels Rules. Dr. Emery has been one of Hillsborough County's primary technical representatives to the various committees developed by the SWFWMD to develop methodologies and actual flows and levels in various lotic and lentic water bodies. Dr. Emery spent years working with the District technical experts and others on the different methods for evaluating Category I, II, and III lakes, evaluating cypress wetlands, springs, and river/stream flows. This is an ongoing project, with emphasis on river and springs MFL development in 2003-04. **Among the rivers Dr. Emery has/is working on: Alafia River, Hillsborough River, Little Manatee River, Palm River, Brooker Creek, Rocky Creek.**

Minimum Flows and Levels for the Upper St. Johns River. Dr. Emery is the Project Manager for the project for the SJRWMD to determine whether the proposed MFLs for a major portion of the St. Johns River meet the water resource protection and human use values specified by Chapter 62-40 Florida Administrative Code.

Hillsborough River Greenways Task Force and Suncoast Greenways Projects: Dr. Emery was the Professional Facilitator and project manager for these award-winning, multi-year efforts sponsored by 1000 Friends of Florida. The projects identified numerous water quality, water quantity, land use, mining, transportation and habitat issues within the Hillsborough, Upper Peace, Alafia, Little Manatee, and Manatee River systems. These projects involved detailed discussions on the development of position statements regarding 5 large spring systems within the different rivers.

Development of hydrobiological monitoring programs for the Tampa Bay Estuary and major rivers in the area. Dr. Emery was one of two principal developers of Hillsborough County's Independent Monitoring Program, designed to detect impacts from water supply projects on the Tampa Bay Estuary and its major rivers and spring systems. Subsequently, Dr. Emery has assisted the local regulatory agency (EPC) in subsequent biological and water quality sampling, using his fully equipped sampling vessel. Dr. Emery was a member of the Technical Advisory Group that helped develop the Hydrobiological Monitoring Program for the Tampa Bay Estuary. Dr. Emery continues to examine data collected from these monitoring efforts on behalf of Hillsborough County.

Spring Flow Limitations on a Water Use Permit Issue. Dr. Emery was one of Hillsborough County's technical experts in a legal matter between a major regional water supply authority and the County regarding impacts from a newly permitted wellfield on the flow from Lithia and Buckhorn Springs. Dr. Emery helped develop the methodology used to assign a minimum flow/level below which wellfield pumping would have to be reduced or eliminated.

Spring Flow Limitations on a Water Use Permit Issue. Dr. Emery was on of Hillsborough County's technical experts in deliberations on how much water was to be allowed to be diverted from Sulfur Springs to augment the base of the Hillsborough River Dam with a minimum flow. This was a highly controversial matter, in as much as the City of Tampa relies heavily upon the river for its potable water supplies, and given the importance of the springs to the ecology of the lower river.

Evaluation of multiple plans to develop new water supply sources in west-central Florida, with emphasis on potential impacts to wetlands, lakes, springs, streams and estuaries. Dr. Emery has evaluated multiple groundwater and surface water projects for their potential to impact natural systems within and around Tampa Bay. Dr. Emery continues to act in this capacity for Hillsborough County and Hillsborough County Environmental Protection Commission (EPC).

Ecological evaluations of hundreds of wetlands and lakes in west-central Florida, with emphasis on detecting impacts from water withdrawals. Dr. Emery provides on-going monitoring and analytical services to public sector local and regional governments in this regard. He maintains complete set of field sampling vehicles and equipment, including power boat with specially designed booms for benthic sampling.

Northern Tampa Bay Water Resource Assessment and Supply Development Project. Dr. Emery has acted as Hillsborough County's Technical Representative on this multi-year project since its inception. The project is designed to determine the sustainable limits to groundwater pumpage within a large area of north of Tampa Bay. The project has included years of wetland work, well tests, hydrologic monitoring, and modeling.

Feasibility analysis for proposed large reservoir. Dr. Emery was the principal author of a feasibility report concerning the proposed development of a large water supply reservoir to be located within Hillsborough County, Florida.

Water Use Caution Areas, Rule Developments. Dr. Emery has been involved in the Northern Tampa Bay Water Use Caution Area and the Southern Water Use Caution Area (including its predecessor areas, the Eastern Tampa Bay Water Use Caution Area and the Highlands Ridge Water Use Caution Area) since the initial meetings in the mid 1980's. Dr. Emery has served on advisory boards, and has assisted local governments on various ecological, water quality and hydrologic aspects of these efforts. He continues to be involved in the latest developments within the WUCAs. All these projects are intended to determine sustainable levels of withdrawals of water. Dr. Emery's focus has usually been on impacts to surficial features such as lakes, wetlands springs and streams, plus impacts to private well users.

Four Wellfields Administrative Hearing. Dr. Emery was a major participant in one of the largest Administrative Hearings ever held, involving over-pumping and adverse impacts to lakes, and wetlands. Multiple parties were involved on both sides. Dr. Emery represented one of the parties seeking to have wellfield pumpage reduced. Dr. Emery was deposed as an expert witness as part of this case. The resultant Findings of Fact clearly indicated that wellfield pumpage had caused impacts to lake and wetland systems, and that such impacts were adverse.

Governance Agreement and Partnership Plan. As a direct result of the Four Wellfields Administrative Hearing, the parties involved began intense, long-term negotiations for reducing pumpage within impacted areas. Dr. Emery acted as a technical advisor to the Hillsborough County Administrator and Board of County Commissioners for both the development of the new Governance Agreement (greatly re-structured the former WCRWSA) and the Partnership Plan between the local governments, the new Tampa Bay Water, and the SWFWMD. As a result of these agreements, permitted wellfield pumpage was to be reduced by more than 50%.

Ecological investigations and ecological risk assessments (ERA) associated with Work Plans and RCRA Facility Investigations for more approximately two dozen projects at various locations within Florida, including Kennedy Space Center, Cape Canaveral Air Station; Titusville, Pinellas Park, Sanford, Temple Terrace and Winter Haven. These projects involve evaluations of ecological habitats and animal/plant receptors, analyses of potential contamination in surface water, groundwater, soils and sediments, and modeling of potential toxicological impacts.

Preliminary risk report of mercury in a surface water body used as a public water supply for a regional government in southwest Florida. Dr. Emery developed a report/brochure for the Peace River /Manasota Regional Water Supply Authority on the issue of mercury in portions of the Peace River. Florida's Department of Environmental Protection provided compliments on the manner in which the report was developed so as to be easily understandable to non-technical individuals, and requested permission to utilize part or all of the report.

Evaluations of borrow pit use and phosphogypsum use in roads for University of South Florida. Dr. Emery was part of a multi-disciplinary evaluation of the use of borrow pits for road material compared with the use of phosphogypsum. The study identified multiple issues with either source of road bed material.

Analysis of land use and surface water/drainage changes in Hillsborough County. Dr. Emery authored a report on historical changes in land use and surface water drainage in an area of high groundwater pumpage.

Expert witness services to governmental and private interests dealing with wetlands and lakes, Water Use Permitting and water quality issues.

Director of Resource Management/Director of Environmental Services, West Coast Regional Water Supply Authority (1984 – 92). Developed/implemented innovative, state-of-the-art ecologic, hydrologic and water quality monitoring and analytical programs (>$3 million/year) for each wellfield/source of supply designed to identify potential impacts from groundwater production and developing mitigating methodologies (including well rotation and augmentation programs). Developed and directed all activities associated with the Authority's fully certified (DHRS, DER, EPA) analytical testing laboratory; directed all in-house and consultants in developing policies and programs for managing and protecting the resource. Directed all activities in management of Authority water supply facilities (serving 1 million people) with total asset value of $150 million. Authority's in-house expert on all issues pertaining to matters of ecology and wellfield impacts, water quality, water treatment, and public health considerations. One of the top five applicants to head the Florida Department of Natural Resources (1991).

TRAINING COURSES:

- Toxicology for Chemists
- National Wetlands Inventory and Wetlands Mapping
- Pesticides in Groundwater
- Gas Chromatography
- Principles of Accounting
- Essentials of Management/Management Principles
- Radiation Safety/Nuclear Soil Gauge Certifications
- Budgeting

COMMITTEES, BOARDS:

- AWWA Water Resources Sub-committee, 1990-92
- AWWA Water Quality Sub-committee, 1990-92
- AWWA Yearbook Assistant Editor, 1992
- IES Board of Directors, University of South Florida, 1993-present
- Minimum Flows/Levels Committees/Sub-committees, 1996-present
- Chairman, FDEP Groundwater Rule TAC, 1996-present

REPORTS, PAPERS, PUBLICATIONS:

- Author/co-author of 8 peer-reviewed published scientific/technical articles.
- Over 60 technical reports.
- Oral presentations at symposia, conferences.

W. MICHAEL DENNIS, Ph.D.

Areas of Specialization:

Wetland delineation, permitting and mitigation; plant taxonomy and ecology; remote sensing and aerial photointerpretation; Threatened and Endangered (T&E) species; and wildlife evaluations.

Experience:

President, Breedlove, Dennis & Associates, Inc. (BDA), Winter Park, Florida. 1997 to present.

Principal, BDA, Winter Park, Florida. 1984 to present.

Vice President, BDA, Winter Park, Florida. 1983 to 1997.

Senior Scientist, Breedlove & Associates, Inc., Gainesville, Florida. 1981 to 1983.

Projects and responsibilities included development of technical data and management of projects in the following areas:

- Vegetation analysis and wetlands jurisdictional evaluations for land development activities in Orange, Osceola, Seminole, Lake, Polk, Wakulla, Martin, St. Lucie, Marion, Hamilton, Brevard, Hillsborough, Sarasota, Dade, Duval, Jackson, Gadsden, Leon, Liberty, Franklin, Citrus, Hernando, Pasco, Volusia, Hardee, Manatee, Palm Beach, Indian River, Flagler, Lee, Collier, Escambia, Walton, Alachua, Putnam, Sumter, Charlotte, Broward, Columbia, Baker, Nassau, Clay, St. Johns, Pinellas, Highlands, Hendry and Monroe counties, Florida.
- Vegetation mapping of plant communities in Florida, Georgia, South Carolina, Alabama, Tennessee, New Jersey, North Carolina.
- Wetlands evaluations for phosphate, sand, and limerock mining activities.
- Wetland evaluations, permitting for Disney Development Company, Universal Studios, and Sea World.
- Airport permitting.
- Wetland reclamation planning.
- Ordinary high water line determinations: Lake Saunders, Lake County; and Peace River Valley, Alafia River, Lake Kissimmee, Lake Hatchineha, Lake Tohopekaliga, Lake Poinsett.
- Power plant and right-of-way siting.
- Technical Advisor in administrative and legislative rule making process.
- Served on Technical Committee advising the Senate Natural Resources Committee on the 1984 Wetlands Legislation.
- Member of the Wildlife Advisory Group appointed by the Department of Community Affairs.

- Member of the Econlockhatchee River Task Force appointed by the St. Johns River Water Management District (SJRWMD).
- Participated in development of Florida Wetland Delineation and Environmental Permitting State Rules during the 1993/1994 Legislative Session.
- Member of the Environmental Constraints and Development Suitability Mapping Project Advisory Committee for Orange County.
- Member of the Technical Advisory Committee for the SJRWMD on the Cumulative Impacts Provision of the SJRWMD's Environmental Resource Permit rules.
- Expert witness testimony--qualified in wetlands evaluation, and jurisdictional determinations and permitting, botanical indicators of ordinary high water line determinations, terrestrial and wetlands ecology, T&E species surveys, and wildlife investigations.

Botanist, Tennessee Valley Authority (TVA). 1976-1981. Responsible for planning, implementing, and presenting studies on the environmental impact of proposed TVA facilities on aquatic macrophyte communities, and ecological and taxonomic studies of aquatic plant species.

Project experience includes:

- Studies of aquatic and wetland plants of the Tennessee Valley.
- Phipps Bend Nuclear Plant environmental report.
- Bellefonte Nuclear Plant environmental report.
- Yellow Creek Nuclear Plant environmental report.
- Future power plant siting studies, Courtland, Westmoreland, Town Creek sites.
- Pumped storage site evaluation report.
- Hydrilla contingency plan for the Tennessee River watershed.
- Aquatic weed control program.
- Study of the vegetation of naturally occurring ponds of the Cumberland Plateau.
- Ecology of mud flat vegetation of Tennessee Valley reservoirs.
- Preparation of a manual of the submersed and floating-leaved plants of the Tennessee Valley.
- Utilization and revegetation of reservoir shorelines.
- Acid rain studies program for assessing impact of acid precipitation on aquatic systems.

- Studies of heavy metals accumulation in aquatic plants, Holston River basin.
- Vegetation study of Towns and Rabun counties, Georgia.

Faculty Associate, University of Tennessee. 1980-present.

Adjunct Professor, University of North Alabama. 1980-1981.

Visiting Assistant Professor, University of Tennessee. 1979.

Graduate Teaching Assistant, University of Tennessee. 1973-1976.

Research Assistant, University of South Carolina. 1973.

Studied floristic composition and ecological parameters in ponds of the sandhill belt of South Carolina.

Research Assistant, University of South Carolina. 1972.

Studied the flora and ecology of the Santee Swamp.

Teaching Assistant, University of South Carolina. 1971-1973.

Medical Laboratory Technician, U.S. Army. 1969-1971.

Education:

Ph.D. University of Tennessee, Knoxville, Tennessee, 1976. Botany.

M.S. University of South Carolina, Columbia, South Carolina, 1973. Biology.

B.S. Emory University, Atlanta, Georgia, 1969. Biology.

Habitat Evaluation Procedure (HEP) 150 - Executive HEP Briefing Workshop, 1989.

HEP 400 - Advanced Recreation Economic Techniques Workshop, 1989.

EL 305 - Expert Witness Workshop, 1990

Civil Service Commission Workshop in Environmental Assessment, 1977.

National Aeronautics and Space Administration Technology Transfer Course, 1976. Basic concepts of remote sensing and data handling techniques as they apply to the analysis of digitally recorded LANDSAT multispectral scanner data and the Earth Resources Laboratory's data analysis system.

Associations:

Ecological Society of America
Association of Southeastern Biologists
Southern Appalachian Botanical Club
Society of Wetland Scientists

Honors:

Distinguished Alumni Award - Oxford College of Emory University, 1987.

Selected Publications and Presented Papers:

Bates A.L., **W.M. Dennis** and T.L. Goldsby. 1978. Experimental use of diquat in Guntersville Reservoir. Aquatic Plant Management Society.

Bates, A.L., T.L. Goldsby, and **W.M. Dennis**. 1978. A prevention and contingency control plan for *Hydrilla*. Aquatic Plant Management Society.

Bates A.L., **W.M. Dennis**, and T.L. Goldsby. 1978. The use of remote sensing for determining effectiveness and planning of aquatic plant control operations in the Tennessee Valley. Aquatic Plant Management Society.

Bates, A.L., **W.M. Dennis**, and T.L. Goldsby. 1980. Eurasian water-milfoil (*Myriophyllum spicatum L.*) identification, distribution, and life history. Proceeding of the Mississippi Aquatic Weed Workshop, 13 February 1980, Mississippi State University.

Bates A.L., **W.M. Dennis**, and T.L. Goldsby. 1980. Prevention and control of *Hydrilla*. Proceedings of the Mississippi Aquatic Weed Workshop, 13 February 1980, Mississippi State University.

Bates, A.L., E. Pickard, and **W.M. Dennis**. 1978. Tree plantings: a diversified management tool for reservoir shorelines. Proceedings of the National Symposium on Strategies for protection and Management of Floodplain Wetlands and other Riparian Ecosystems.

Batson, W.T. and **W.M. Dennis**. 1973. Record trees of South Carolina. South Carolina Wildlife 20(5):12-16.

Bierner, M.W., **W.M. Dennis**, and B.E. Wofford. 1977. Flavonoid chemistry, chromosome number and phylogenetic relationships of *Helenium chihuahuensis* (Asteraceae). Biochemical Systematics and Ecology 5:23-28.

Breedlove, B.W. and **W.M. Dennis**. 1984. The use of Small-format Assessment of Microphyton; collection, use, and meaning of the American Society for Testing and Materials STP 843.

Breedlove, B.W. and **W.M. Dennis**. 1987. Recent changes in and responses to U.S. Army Corps of Engineers 404 permitting. Environmental Land Use Law Section Reporter 10(1):22-23.

Carriker, N.E., **W.M. Dennis**, and R.C. Young. 1981. Quantification of allochthonous organic input to Cherokee Reservoir: Implications of hypolimnetic oxygen depletions. Proceedings of the International Symposium on Inland Waters and Lake Restoration, September 8-12, 1980, Portland, Maine.

Dennis, W.M. 1973. A new record water hickory for South Carolina. Castanea 38:205.

Dennis, W.M. 1974. A synecological study of the Santee Swamp, Sumter County, South Carolina. ASB Bulletin 21(2):51.

Dennis, W.M. 1976. Chromosome morphology of *Clematis*, subsection *Viornae*, (Ranunculaceae). Canadian Journal of Botany 54(10):1135-1139.

Dennis, W.M. 1977. Contributed *Clematis* (in part) to M.C. Johnston and J. Hendrickson, Chihuahuan Desert Flora.

Dennis, W.M. 1978. Contributed Macrophyte section for C.I. Weber (ed.), Office of Water Data Coordination Manual.

Dennis, W.M. 1978. The taxonomic status of *Clematis gattingeri* Small (Ranunculaceae). Brittonia 30:463-465.

Dennis, W.M. 1979. The new combination *Clematis pitcheri* T. & G. var. *dictyota* (Green) Dennis. Sida 8:194-195.

Dennis, W.M. 1980. *Sarracenia oreophila* (Kearny) Wherry in the Blue Ridge Province of northeastern Georgia. Castanea 45:101-103.

Dennis, W.M. 1982. Contributed *Jamesianthus alabamensis* and *Clematis* Subsection *Viornae* to the National List of Scientific Plant Names. United States Department of Agriculture Soil Conservation Service-TP-159.

Dennis, W.M. 1982. Ecological notes on *Jamesianthus alabamensis* Blake and Sherff (Asteraceae) and an hypothesis on its endemism. Sida 9(3):210-214.

Dennis, W.M. 1984. Aquatic Macrophyton Sampling: An overview. Ecological Assessment of Macrophyton: Collection, use and meaning of data, American Society for Testing and Materials STP 843.

Dennis, W.M. and W.T. Batson. 1974. The floating log and stump communities in the Santee Swamp of South Carolina. Castanea 39:166-170.

Dennis, W.M. and M.W. Bierner. 1980. Distribution of flavonoids and their systematic significance in *Clematis* subsection *Viornae*. Biochemical Systematics and Ecology 8:65-67.

Dennis, W.M. and B.W. Breedlove. 1983. "Wetlands Reclamation: A Drainage Basin Approach."

Dennis, W.M. and B.W. Breedlove. 1984. "The Assessment of Environmental Regulations on Agriculture Operations in Florida Through the Use of Small and Medium Format Color Infrared Aerial Photography." Abstract, p. 173. Color Aerial Photography in the Plant Sciences and Related Fields.

Dennis, W.M. and B.W. Breedlove, 1987. "Location of a Court Required Period Specific Ordinary High Water Using Detailed Survey, Tree Aging and Medium Format Color-Infrared Photography." Presentation at the ASPRS/ACSM 1987 Convention; Baltimore, Maryland.

Dennis, W.M., P.A. Collier, E.L. Morgan, and P. DePriest. 1981. Habitat notes on the aquatic lichen *Hydrotheria venosa* Russell in Tennessee. Bryologist 84:392-393.

Dennis, W.M., A.M. Evans, and B.E. Wofford. 1979. Disjunct populations of *Isoetes macrospora* in southeastern Tennessee. Amer. Fern J. 69:97-99.

Dennis, W.M. and B.G. Isom. 1984 (ed). Ecological Assessment of Macrophyton: Collection Use and Meaning of Data. A symposium sponsored by American Society for Testing and Materials Committee D-19 on Water, Ft. Lauderdale, Florida, 15-16 Jan. 1983. ASTM STP 843 122 p.

Dennis, W.M. and C.S. Keener. 1982. The subgeneric classification of *Clematis* (Ranunculaceae) in temperate North America north of Mexico. Taxon 31(1):37-44.

Dennis, W.M., J.M. Neil, and R.C. Young. 1983. Productivity of the Aquatic Macrophyte Community of the Holston River: Implications to Hypolimnetic Oxygen Depletion of Cherokee Reservoir TVA/ONR WR-83/12.

Dennis, W.M., T.S. Patrick, and D.H. Webb. 1981. Distribution and naturalization of *Cyperus brevifolioides* (Cyperaceae) in eastern United States. Sida 9(2):188-189.

Dennis, W.M. and D.H. Webb. 1981. Additions to the flora of Tennessee. Sida 9(2):184.

Dennis, W.M. and D.H. Webb. 1981. The distribution of *Pilularia americana* A. Br. in North America, north of Mexico. Sida 9:19-24.

Dennis, W.M., D.H. Webb, and A.L. Bates. 1988. An Analysis of the plant community of mudflats of TVA mainstream reservoirs. pp. 177-198. In: Snyder, D.H. (ed.). Proceedings of the first annual symposium on the natural history of lower Tennessee and Cumberland river valleys. The Center for Field Biology of Land Between the Lakes. Austin Peay State University, Clarksville, Tennessee.

Dennis, W.M., D.H. Webb, and B.E. Wofford. 1977. State records and other recent noteworthy collections of Tennessee plants. II. Castanea 42:190-193.

Dennis, W.M., D.H. Webb, B.E. Wofford, and R. Kral. 1980. State records and other recent noteworthy collections of Tennessee plants. III. Castanea 45:237-242.

Dennis, W.M. and B.E. Wofford. 1976. Evidence for the hybrid origin of *Proserpinaca intermedia* Mackenz (Haloragaceae). ASB Bulletin 23(2):54.

Dennis, W.M. and B.E. Wofford. 1976. State records and other recent noteworthy collections of Tennessee plants. Castanea 41:119-121.

Tucker, A.O., M.J. Maciarello, B.E. Wofford, and **W.M. Dennis**. 1997. Volatile leaf oils of *Persea borbonia* (L.) Spreng., *P. humilisnash*, and *P. palustris* (Raf.) Sarg. (Lauraceae) of North America. J. Essent, Oil Res. 9: 209-211.

Webb, D.H., H.R. DeSelm, and **W.M. Dennis**. 1997. Studies of prairie barrens of northwestern Alabama. Castanea 62(3):173-184.

APPENDIX B

DRAFT PEER REVIEW COMMENTS SUBMITTED SEPTEMBER 16, 2005

APPENDIX B

RESULTS OF PEER REVIEW

I. Report Overview – Summary descriptions of what is contained in each section of the report.

The MFL report is divided into 6 sections, 5 of which were reviewed by the PRP.

Section 1 provides the regulatory framework of the MFL process, defines the project scope, and identifies water body regulatory designations. In addition, the ten WRVs that are to be afforded protection under the established MFLs are discussed an evaluated with regards to relevance to these particular MFLs. In a 3 page synopsis with 2 accompanying tables most of the WRVs for the springs (7 out of 10) and half of the WRVs for the river are effectively eliminated from additional analysis.

Section 2 contains about 90 pages of text, tables, and figures that assist with providing a sufficiently comprehensive, and well documented and written background of the hydrology, geology, hydrogeology, chemistry and geochemistry, and ecology of the river basin. Cultural practices related to land and water use also are discussed. Section 2 begins with a global view of the river basin and finishes with specific information and references related to the two springs (Fanning and Manatee) and the Lower Suwannee River, the objects of this MFL report.

Much of the referenced literature were texts, peer reviewed journals, USGS, and State Water Resources papers. These sources generally have internal and external peer reviews. Other internal reports of the water management district and consultants are not subject to the same level of review. In many cases these latter sources were used as corroborating sources. The literature sources were sufficiently comprehensive for this MFL report.

The reviewers found the background information to be sufficiently complete for the stated objectives for this MFL report.

Section 3 contains the hydrologic approach used in the development of the MFLs. This includes identifying gage locations and available data, measurement methods, data quality, groundwater data, tidal information, long term trends, and salinity information. Various models, both statistical and numerical, that were used in data analyses are discussed as well as model results.

Discharge at Fanning Spring is highly dependent on water levels in the spring and in the aquifer near the spring. In fact, the hydraulic gradient between the aquifer and the head at the spring (which is nearly the same as the river – see Figure 3-19) drives the spring flow. As such, a statistical model relating spring flow to head (stage) in the river (at Wilcox) and head in the aquifer (well #114) was developed. This was done for both monthly average and daily flow but monthly average was used in the MFL development.

RESPONSE This comment deals with use of monthly versus daily simulations of data from the springs.

We agree with this statement to the extent that discharge from Fanning Spring is partly a function of aquifer head. The stronger factor is, however, river stage as indicated by the slope coefficients for the predictive equations. There is significant tidal and other noise in the Wilcox and Fanning discharge data, which weaken the ability of the multinomial equations to fit the data. As a result, WRA chose to utilize the monthly equation, which eliminated much of the high frequency noise and strengthened ability to estimate discharge. Because the MFLs proposed for Fanning Spring are seasonal and based on monthly stage estimates in the river, WRA also reasoned that a predictive model using the same time frame was appropriate.

We do not propose to change use of equations. However, the following paragraph will be placed in the report.

Action: Place the following paragraph at the bottom of p. 59, after conclusion of the discussion about daily estimates of Fanning discharge.

Because there is significant tidal and other noise in the Wilcox stage and Fanning discharge data, the ability of the predictive equations to fit the daily Fanning Spring discharge data is weakened somewhat. Analysis of manatee passage issues and other factors discussed in subsequent sections of this report indicates that a seasonal MFL is appropriate. Therefore, it was determined that the equation to predict monthly discharge, which eliminated much of the high frequency noise and strengthened ability to estimate discharge, from Fanning Spring is the preferred approach. Because the MFLs to be proposed for Fanning Spring are seasonal and based on monthly stage estimates in the river, it was also reasoned that a predictive model using the same time frame was appropriate.

A similar analysis was performed for Manatee Spring although because some of the spring discharge data were suspicious, less data were available for analysis. While the driving forces controlling flow from the spring are the same as those for Fanning, the authors used stage in the river at Wilcox and flow at Fanning Spring as dependent variables for estimating flow at Manatee Spring. Interestingly, flow at the spring is positively associated with stage at Wilcox.

RESPONSE: This comment deals with data quality at Manatee and use of Fanning Spring discharge for modeling Manatee Spring discharge.

The issue of suspicious spring discharge data is addressed below.

While Manatee Spring is certainly an estavelle and the discharge pattern for all ground-water and river events would show an inverse relationship between spring discharge and river stage (see the response about Manatee data quality below and the new Figure 3-27B where the valid data show a weak inverse relationship), the historic data do not depict the rare events when flooding caused the spring to backflow. As shown in Figure 3-46, the majority of valid discharge data was collected during relatively low flow conditions, which are of concern with respect to

manatee refuge. A portion of this response is because Manatee Spring is far enough into the Suwannee estuary that small to moderate flooding events appear to be partly "damped out" by the proximity to the Gulf and increased flow capacity of the lower river.

Discharge from the spring reflects fluctuations in rainfall and potentiometric head in the springshed, as well as interactions with tides and river stage. The driving forces for Manatee Spring discharge at low to moderate river stage are clearly potentiometric head and river stage. As discussed in the report, well #74 is located very close to Manatee Spring and has a long period of record. Water levels in this well reflect the stage in the nearby Suwannee River, however, and do not reflect the potentiometric head in the springshed. No other well in the vicinity of Manatee Spring has a sufficiently long period of record. In the absence of local ground-water data, Fanning Spring discharge was used as a surrogate variable that reflects the potentials in the ground-water system of the Fanning/Manatee springshed (the two springsheds are coincident and cannot be separated). The term related to stage at Wilcox adjusts the equation to more accurately represent river conditions near Manatee Spring (located some miles downstream from the Wilcox gauge).

It is important to note the number of data points available for establishing the regression. Out of the period of record, 17 months of data were suitable for use. For the regression for daily discharge (p. 3-71), the inverse relationship between river stage and flow is evident. Ability to use this equation is limited, however, because of noise introduced by tidal influences. The monthly discharge equation (p. 3-67) yields a somewhat better fit, but only 17 monthly average discharge measurements are available. Because of the need for seasonal MFLs for protection of the thermal refuges, the monthly simulations were chosen for characterization of seasonal responses of the springs. Fortunately, the best available data provide ability to quantify low flow conditions during the cold season using monthly simulations.

We propose no changes to use of equations. The following paragraph will be placed in the report.

Action: Place the following paragraphs on p. 68 just before 3.2.3.4 Discussion.

While Manatee Spring is an estavelle and the discharge pattern for all river events would show an inverse relationship between spring discharge and river stage, the historic data do not depict the rare events when flooding caused the spring to backflow. As will be shown below (see Figure 3-46), the majority of valid discharge data was collected during low to moderate flow conditions, which are of interest with respect to manatee refuge conditions. The monthly data, especially data taken during low flow to moderate flood in the river (the period of record for the spring), reflect fluctuations in rainfall and potentiometric head in the Fanning/Manatee spring system. Daily discharge data from Manatee Spring show an inverse relationship between river stage and spring discharge. When the river stage rises because of increased rainfall, discharge from the spring is inhibited.

Conversely, when the river is low, Manatee Spring discharge is at a maximum. On a monthly time scale, the small scale variations in discharge, including tidally influenced variations, are masked and the diving forces for Manatee Spring discharge at low to moderate river stage are a result of regional ground-water flow and river stage.

The equation for predicting daily discharge indicates that there are short-term inverse relationships between river stage and discharge, which are discussed in Section 3.2.3.3. These data are affected by tidal variations as well as rainfall-discharge events, however.

Discharge at Fanning Spring was utilized as an independent variable in the Manatee discharge predictive equations because those data are of high quality and reflect the regional interplay between ground-water potentials in the Fanning/Manatee springshed and river. The springs essentially share a single springshed (Upchurch and Champion, 2003a), so discharge behavior in Fanning Spring reflects springshed interaction with the river and ground-water potential distributions in the springshed.

Only one well with a sufficiently long period of record is located in the vicinity of Manatee Spring. Water levels in this well are more representative of stage in the Suwannee River than the potentiometric head in the springshed (Figure 3-21). Therefore, it was decided that Fanning Spring discharge data provide a better variable for aquifer behavior prediction than the available well data. The monthly data provide ability to quantify seasonal conditions by use of monthly simulations while minimizing daily tidal interferences.

Other models/analyses including reach pickup calculations (used in HEC-RAS), HEC-RAS, and a linked groundwater/surface-water model are discussed. The reach pickup numbers are corroborated with other data. HEC-RAS is appropriate for its use in MFL development. No information on the linked groundwater/surface water model is presented to facilitate a peer review.

RESPONSE: This comment deals with the linked ground- and surface-water model developed by the USGS.

This model was initially developed to assist in MFL development in the reaches of the Suwannee upstream from the Wilcox gage. The model was calibrated to data from the Bell gage and other, non-tidal gages upstream, so its use in the Lower Suwannee is limited. It was only mentioned because the model provided an additional estimate of gain in the river.

The USGS report on the model has not been published, so we do not expect you to review it.

We propose no changes to report.

In Sec. 3.1.9, p. 3-25 the report indicates that Tillis (2000) and Janicki Env. (2005) use multiple linear regressions to derive relationships between flow and salinity using several data sources. The Janicki regression uses a larger data volume and produces larger salinity shifts than does the Tillis regression. The Janicki analyses are used in subsequent development of MFL's. The methods used to derive the salinity-flow relationships in Janicki Env. (2005) are reasonable and utilize the best available data. In the absence of a hydrodynamic model of flow-salinity relationships, this approach is acceptable for determination of MFL's.

The discharge data at Wilcox gage (02323500), which accounts for 97% of drainage area, was the primary source of river flow data. The gage has operated since the early 1930s (data set used from early 40s). Other data at Bell (upstream of Wilcox) and near Suwannee (downstream of Wilcox) also were available. Synoptic flow, velocity and salinity data also are available. Data from Wilcox is the primary source because of the period of record (POR) and data quality. POR data used was from1941-2005.

Section 4 contains site specific ecological information that forms the basis for establishing the MFLs. In particular, information regarding the Manatee habitat and thermal refuges, and the estuarine system is documented. The reviewers found the information/data appropriate and adequate for establishing MFLs.

Section 5 presents data, synthesized data, modeling and Manatee sighting information to develop the MFLs for the springs and Lower Suwannee River. The key value being protected at the springs is the thermal regime for manatee during the cold winter months when the manatee use the two springs as a refuge. The key temperature metric is 68 °F.

For Manatee Spring flow was calculated using the relationship between Manatee Spring discharge and stage in the river at Wilcox and water level at well #114. For Manatee Spring and nearby portion of the river, a thermal model was developed using CE-QUAL-W2. The model was calibrated to February 20 – April 30, 2004 data. To examine the effects of changing river and spring flow on temperature, these variables where varied independently from the median values to plus or minus 25% of the median values in several combinations. Based on the model results, a monthly MFL set at the median monthly spring flow for November though March is suggested. For example, the proposed MFL would be 130 cfs during November.

> **RESPONSE: The MFL is set at a cold season MFL since that is the flow that is required to provide a thermal refuge throughout the cold season. Monthly MFLs are difficult to manage and do not present a recognizable improvement from a seasonal MFL which is specifically addressed in the MFL enabling statute.**

The criteria for Manatee protection at Fanning Spring was the stage in the spring run necessary for Manatee passage (i.e., 5 ft depth). Based on rating information at Wilcox, a stage of 2.71 feet was selected. However stage at Wilcox is not a simple function of discharge at Wilcox (i.e., the rating curve has a lot of scatter). Hence the probabilistic approach was utilized. This stage is exceeded 97% of the time during the months of November- April for the median discharge 8,620 cfs at Wilcox.

It is important to note that no protection is afforded the springs during the non-winter months, and no flow MFL is set for Fanning Spring. Potential dry season MFLs for the springs are identified on page 5-69 based on relationships developed in Chapter 3.

RESPONSE: See response to 1.d. below

Lower Suwannee.

For the Lower Suwannee a sufficient inventory of habitats was identified for protection. .The MFL appears to be based only on the SAV 3.5% risk, and at a flow of 6515 cfs.

RESPONSE: The MFL for the Lower Suwannee River was based on a weight of evidence approach including all major habitat types. Submerged Aquatic Vegetation was chosen as the fundamental basis for MFL establishment based on 1) the direct association between salinity and physiological response to adverse condition established from the literature and previous MFL work in the South Florida Water Management District and 1) empirical evidence corroborating the findings of significant harm under historic drought conditions in LSR. The validation exercises (which can be found in Appendix H) further substantiated the flow–isohaline location estimates of from the isohaline regressions. These independent yet consistent findings guided the selection of SAV as a quantifiable indicator of potential ecosystem degradation in response to decreases in freshwater inflow.

II. Primary Issues

1. Manatee Spring
   a. Better rationale and/or justification are needed for not using the entire record of Manatee Spring flow data. There is insufficient justification presented for omitting selected data based on not matching Fanning Spring data. The authors acknowledge that the springs respond differently to river flow conditions. The explanation on the reliability or lack of reliability of the data is couched in words such as "believe".

RESPONSE: Section II Primary Issues, No. 1a:

In this comment, the peer reviewers request additional information as to the reliability of the discharge data from Manatee Springs.

Response: The discussion of data reliability is on page 61 of the report. Here, the word "believe" was carefully selected and placed in quotation marks to reflect our impression of the data. The attached graph will be placed in the text as Figure 3-27B (The existing Figure 3-27 will become 3-27A). The text below will be further used to explain our distrust of the data. As far as use of the word "believe", this word will be replaced by "rely upon."

3.2.3.3 Manatee Spring

As with Fanning Spring, the water level in Manatee Spring generally reflects the stage of the adjacent Suwannee River due to the lack of any significant sill within the spring run. Therefore, discharge from the spring is impeded or enhanced based upon the river stage. Figure 3-26 shows the stage for corresponding measured discharge at Manatee Spring. While portions of the discharge data follow this expected pattern, a significant part of the discharge data do not.

Discharge from Fanning and Manatee springs is controlled by similar environmental conditions. The two springs essentially drain separate portions of a single springshed (Upchurch and Champion, 2003a). The pattern and relative magnitudes of river levels that impede springflow do not vary significantly between the two springs. Therefore, while the magnitudes of spring discharge from these springs may differ, the short-term patterns of discharge variability through time should be similar.

Figure 3-27A shows smoothed (31-day running average) discharge data for both Fanning and Manatee springs. Shading of this figure indicates time intervals where the pattern of variability in spring discharge over time for the two springs are similar (not shaded), and where they are not similar (shaded). The discharge data from Fanning Spring follow a pattern that is expected from the variability of river stage (Figure 2-36).

Figure 3-27B shows the relationship of measured daily stage and discharge at Manatee Spring. The discharge data have been separated into two groups: those data that appear reliable (diamond-shaped symbols) and the data that appear unreasonable (square symbols). Note that the data judged to be reliable show two swarms of data with negative slopes, which indicates that discharge is inversely related to stage on a daily basis. This relationship is reflected in the equation for prediction of daily discharge at Manatee Spring presented in Section 3.2.3.3.2 (below). The data that appear unreliable form large loops on the graph that do not stand scrutiny. One loop shows no relationship with stage and the other suggests that daily discharge increases with stage, which is counter intuitive. These data were recorded during periods when Fanning Spring discharge was responding inversely (and relatively consistently) to river stage.

Therefore, it seems reasonable to rely upon ~~"believe"~~ the entire dataset for Fanning Spring, and to only rely upon ~~"believe"~~ those portions of the Manatee Spring discharge data that mirror the Fanning Spring data.

As a result, the available AVM-derived discharge data for Manatee Spring are much more limited than the Fanning Spring data. Similar to the Fanning Spring analysis, data simulation was carried out using average monthly values due to the significant short-term variability in spring stage and discharge. Only the average monthly discharge values for June 2001 through February 2002 and October 2003 through May 2004 were included in the analysis, as these data appear to reflect actual conditions at the spring while the remainder of the data do~~es~~ not.

The systematic offsets in discharge data from Manatee Springs (Figure 3-30) appear to have resulted from changes in calibration of the gage data.

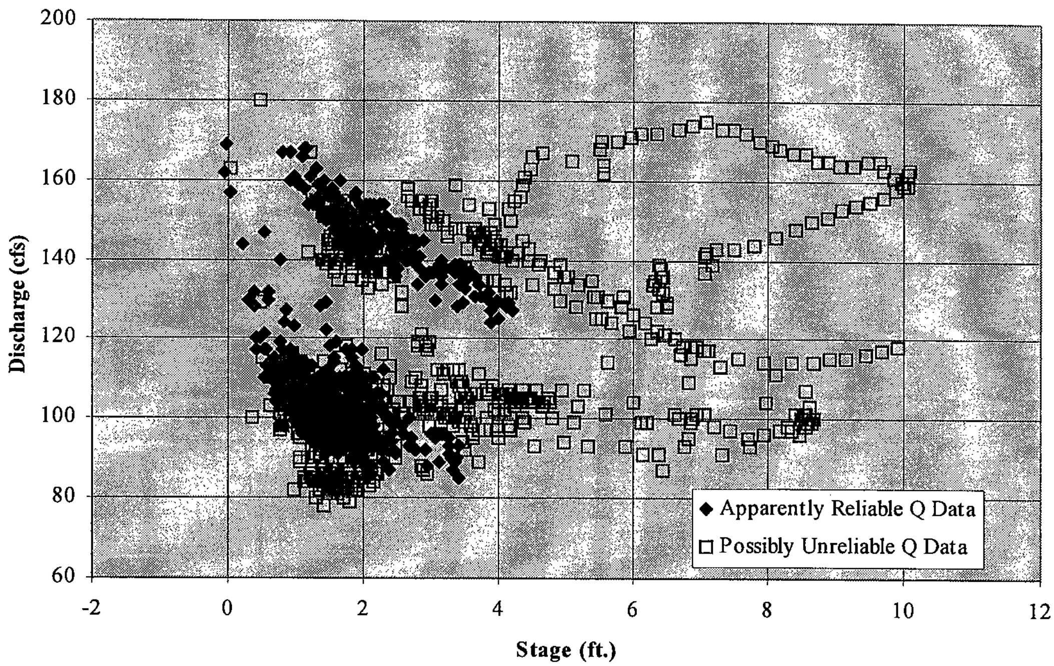

Figure 3-27B - Relationship of measured daily stage and discharge using the AVM gage at Manatee Springs. Discharge data are identified by apparent reliability.

b. Using Fanning Spring flow data in the regression equation for Manatee Spring does not seem justified, particularly given that much of the data that did not appear to correlate well to Fanning Spring data was omitted. Head difference between the aquifer and the river is the driving force for Fanning Spring flow and would seem to provide a more supportable statistical model and more useful management tool.

RESPONSE: Section II Primary Issues, No. 1b:

This issue deals with use of Fanning Spring data to synthesize Manatee Spring discharge. This issue has been previously discussed, but additional clarification may be appropriate.

First of all, the importance of ground-water head should not be overstated. While head is necessary to cause the springs to flow, and a MFL will be adopted to insure that head relationships are preserved, the river stage is the first order control on Fanning Spring discharge. When the river is low, discharge is high, and when stage is high, discharge is diminished or reversed. The ground-water head allows the spring to flow when the river is low enough. Unfortunately, variations in ground-water head do not solely dictate when the spring flows. Setting an MFL would be a lot easier if this were the case.

None of the wells near Manatee Spring are suitable for regression development because they reflect river stage perturbations. This being the case, regression strengths and selection of a suitable metric for ground-water head left only Fanning discharge. It is important to remember that Fanning and Manatee do not have separate and distinct springsheds. There isn't a well developed divide

between the two drainages and there is evidence that they share a single, large basin.

c. The reviewers are not clear on how such a limited portion of the river can be modeled using CE-QUAL and have the results make sense. The plume we observed on 9/8/05 appeared to be much narrower than the grid cells used. The plume was very well defined and distinct from the river water for a large distance along the river edge. All the buoy locations were outside this plume; hence they only observed river water temperatures. This casts doubt on the model validation/calibration as well as on the "mass balance" approach in the model. The model temperature represents the average over entire grid cells and as such cannot resolve the sharp gradient associated with the plume. The model implicitly assumes that the spring water is completely mixed with river water in each cell. More explanation of how the model was implemented is needed.

RESPONSE: First, an observation on 9/8/05 is not representative of the flows present during the Nov-April modeling period and you would not expect a similar plume quantity. The intent of the temperature modeling was not to model the extent of the plume, but rather to use the best available data to estimate the degree to which the area near the eastern shoreline is affected by the discharge from the spring. The only available data were obtained from buoys located within approximately 25 m of the shore, constraining the model cells to be at least this wide. Given that the thermal plume from the spring is sometimes closer to the shore than 25 m, the model provides a conservative estimate of the quantity of spring discharge necessary to maintain a 20° C thermal envelope.

d. Setting only a 5 month cold season MFL for Manatee thermal refuge and not setting an MFL for the rest of the year (one possibility would be to use recreation and aesthetics) does not seem justified. Some information is provided in the last 2 pages of Section 5, but the reasons why no MFL is proposed for the seven months needs to be more explicitly stated.

RESPONSE: An MFL for the remaining seven month period is proposed based upon providing protection from the water bodies from significant harm to aesthetic and recreational values. Specifically, the MFL for Fanning and Manatee springs will be amended to state: .....*and a year round Minimum Flow that will maintain 90% of the historic flow regime which equates to a 20 cfs reduction in flow.*

e. The MFLs in general for Manatee Spring need to be more explicitly stated.

RESPONSE: Please refer to Section 6 provided.

2. Fanning Spring

a. The reviewers encourage setting a flow MFL as well as a depth MFL. A minimum depth alone does not maintain a thermal refuge or protect other values that require a flow from the spring.
Response: See response to 1.d.

b. Only setting a cold season MFL for Fanning and not setting an MFL for the rest of the year (for example, for recreation and aesthetics) does not seem justified. Some verbiage is provided in the last 2 pages of Section 5 but the reasons why no MFL is proposed for the other seven months needs to be more explicitly stated.
Response: See response to 1.d.

c. The MFLs in general for Fanning Spring need to be more explicitly stated.
Response: Please refer to Section 6 provided.

3. Both springs – It seems to the reviewers that given the relationship between spring flow and river level, it might be appropriate to not set independent MFLs in the river and spring.

RESPONSE: Section II Primary Issues, No. 3:

The meaning of this comment is unclear. We think the reviewers are suggesting using the approach we used.

Response: The MFLs for the river and springs were set conjunctively. At Fanning, preserving manatee passage in the spring during the cold season sets a MFL for the river because the river determines if sufficient water depth exists. For the entire year, a spring-based MFL will be specified that minimizes changes in the existing ground-water head. At Manatee, the maintaining discharge to the river for manatee refuge during the cold season sets a discharge-based MFL for the spring. A similar head-maintenance requirement will also be proposed. The river MFLs are set to preserve SAV in the delta and to ensure that the manatee refuge issues are addressed. We can see no other way to establish the MFLs other that by integrating the MFLs.

4. Lower Suwannee

a. The Panel found the resources identification to be adequate

b. The rationale for choosing 3.5% SAV risk is not sufficiently well documented. The authors may wish to consider maintenance of the historical salinity regime, in general, as opposed to the SAV metric in particular. In any event, a clearer explanation of how the SAV metric will be protective of the other important habitats is needed.

RESPONSE: Table 5.10 provides a comparison of the flow associated risk for each of the major habitat types considered for the LSR. The weight of evidence led to the use of SAV as the indicator of potential harm to the LSR. Direct evidence of effects of drought was observed for SAV and was not

observed for the other habitat types assessed. SAV responses to salinity occur on a shorter time scale than other habitat types reinforcing the selection of SAV for establishing an MFL as well as SAV's previous use as a criterion for MFL establishment (See: Caloosahatchee MFL). For a response to maintenance of historic salinity regimes, please see response to 4.1.2 on page 10 of this document.

5. General – The proposed MFLs should be more explicitly stated.

   RESPONSE: Please refer to Section 6 provided.

III. Primary Comments

Page 1-4. Were you able to demonstrate that the target values being protected are conservative in that other WRVs are protected? Example, is recreation at the springs protected, particularly during the summer?

RESPONSE: Please refer to Section 6 provided and response to 1.d.

Page 1-8 thru 1-10. The 3 decision matrix tables. The rankings are qualitative. There is no way for the reader to even guess on how rankings for such items as "Available Data" are developed. Why is weighting for some columns a 1 to 3, and for another a 1 to 8?

RESPONSE: This comment is not germaine to the validity of the MFL.

Scope of MFL: Agree for the reasons stated that both Fanning and Manatee Springs should be included in the Lower Suwannee MFL.

Table 1-1 - Fanning Spring. Under "Available Data", it appears that the extensive data cited later in the Draft (see page 3-28) is not adequately reflected in this category. Note that later on (page 3-44) there is a statement that the data "are not extensive".

RESPONSE: Section III Primary Comments, Table 1-1:

In this comment, the peer reviewers question why Table 1-1 does not reflect the "extensive data" from Fanning Spring cited later in the draft (p. 3-28). They also question the evaluation that data are not extensive at Fanning Spring on p. 3-44.

Table 1-1 evaluates the data by MFL criterion. Data availability is ranked from 0 to 8, and the ranking is somewhat subjective. The evaluation is based on a preliminary compilation and evaluation of data. Once the MFL-development is well underway, more data may be discovered and/or some data may not prove suitable for use. We do not believe that the list of reports and studies on p. 3-28 rises to the level of data availability that would merit higher scores on the Data Availability categories in Table 1-1. The only criterion that received a high score (6) was maintenance of water supply and storage. This was because of the monitoring network established by the District. As it turned out, much of that data

is spotty or temporally unsuitable. We are confident that the data availability and quality issues are properly reflected in Table 1-1.

Given the descriptions of the importance of the Spring as a recreational resource, the Panel suggests that Aesthetic and Scenic Attributes – be a limiting criterion – to protect clear spring water in boil and run.

RESPONSE: This is not a technical review of the MFL but rather a policy decision. In addition, the availability clear spring water in boil and run is subjective and not readily supported by any credible data.

Table 1-2: - Manatee Spring. Under "Available Data", it appears that the extensive data cited later in the Draft (see page 3-28) is not adequately reflected in this category. Note that later on (page 3-44) there is a statement that the data "are not extensive".

RESPONSE: Section III Primary Comments, Table 1-2:

Please see response to the previous comment.

Given the descriptions of the importance of the Spring as a recreational resource, the Panel suggests that Aesthetic and Scenic Attributes – be a limiting criterion – to protect clear spring water in boil and run.

RESPONSE: Repeat of question above.

Page 3-25. The report should clarify whether Jannicki utilized the entire data set used by Tillis.

RESPONSE: The entire dataset used by Tillis was considered but the regression equations are based on data collected from 1993-1994 from district /GFC sampling which took place at high slack spring tides. This reduced the potential confounding effects of tide on regression results and focused on maximal upstream incursions of salinity as a conservative estimate of isohaline location.

Page 3-64. Additional explanation of problem with Manatee Spring data is needed. Simply indicating that it is more reasonable to "believe" one data set over another is insufficient. Please review the statistics, etc. regarding this carefully so we are not overlooking another reason why the data may be different at each spring.

RESPONSE: Section III Primary Comments, p. 3-64:

This comment concerns the quality of discharge data from Manatee Springs and use of "believe" in evaluating it. The reviewers ask that the data be reviewed for other causes of data differences and inconsistencies.

Response: Please see the response to a similar comment above (Item # 2). The text has been appropriately revised.

The data were thoroughly reviewed and all alternative causes for the data responses were investigated. Needless to say, we were loath to "throw the data under the bus" because it limited our abilities to work with the raw AVM discharge

data. As noted above, the data issues cannot be accounted for with "first principles", ground-water pumpage, river fluctuations, or other potential perturbations.

Page 3-67. Used slightly different equation. Since Fanning discharge is a function of stage at Wilcox and water level (wl) at #114, why use discharge at Fanning to characterize discharge at Manatee. The implication is that Discharge at Manatee = stage at Wilcox + flow at Fanning (which is equal to stage at Wilcox + wl at #114). It would be cleaner to test different relationships of stage at Wilcox and wl at well #114 (or a well within the Fanning Spring springshed) rather than using discharge at Fanning. Is synthesized or real data for Fanning being used? One could show Regression using Wilcox stage and water level at well #114 (or another appropriate well in springshed). Also, as a practical matter of evaluating MFL issues, groundwater levels and stream flow are the variables one might be able to impact. What about using head difference between suitable well and spring as the controlling variable?

Response: Section III Primary Comments, p. 3-67:

In this section the reviewers commented on the equation used to simulate Manatee Spring discharge. This has been discussed in Item # 2 (above).

All of the approaches suggested were evaluated. Note also, that Well 114 is approximately 7.5 miles from Fanning Springs, near the eastern edge of the springshed. It is approximately 13 miles from Manatee Spring.

Wells close to either spring are influenced by tides and river stage. They show flow-stage hysteresis loops during floods, indicating that "bank storage" and ground-water flow retardation extend will inland from the river and its springs.

Well 114 was chosen for Fanning flow simulations in order to eliminate the local interferences from the river and better characterize head in the Fanning/Manatee springshed. It is true that the equation for Manatee discharge can be solved for stage at Wilcox and head at Well 114 by substituting the equation for discharge at Fanning into this term. Rather that reach to Well 114 13 miles away, however, Fanning Spring data were used to reflect ground-water conditions.

The reviewers also suggested that ground-water levels and stream flow are variables one might be able to impact with MFLs. We agree, of course, and do not propose to use the regression equations for water management issues. They were developed simply to allow synthesis of sufficient data that MFLs can be evaluated and set. Management of the MFLs will be through use of available ground-water and surface-water models.

Page 3-67. Is the sign in front of the Wilcox stage coefficient correct? Seems it should be "minus"?

RESPONSE: Section III Primary Comments, p. 3-67:

In this comment, the reviewers asked if the sign of the Wilcox head term in the regression equation on page 3-67 is correct.

The sign is correct. As discussed in Item # 2, the equation uses monthly Fanning Spring discharge data, and the stage at Wilcox adjusts the discharge as needed to simulate Manatee Spring discharge.

Page 3-80 Second paragraph clearly states the direct relationship between stage in the River at Wilcox gage and stage in Fanning Spring. Therefore, it seems appropriate to set a River MFL that will provide minimal acceptable stage for manatee, fish, etc. based on a discharge volume in the river; however, the springs MFL must also contain a metric to protect the source of the flow from the spring, otherwise the result of only setting a stage in the springs would be to protect a "backwater" area but one that would be without the characteristics of the springs relative to water temperature, clarity and chemistry. As demonstrated in the draft, the flow from the springs is not particularly significant relative to the overall discharge of the river and the river can and does over come (in Fanning to the point of reversal) the springs and sets the stages, but the character of the springs needs separate protection criteria.

4.1.2 states that SAV "represent one of the major aquatic habitats in the Upper Suwannee Estuary. The small number of acres of SAV (approximately 27.1 acres) reported does not support this conclusion. The reference of substantial SAV in the tidal creeks is not documented in this draft. Having said this, the overall system likely could be protected if the salinity regime which supports these beds of SAV is maintained. The critical objective should be to maintain flow so that the extent of the existing isohaline contours is maintained.

RESPONSE: The sentence regarding SAV as a major habitat type could be reworded but does not take away from SAV's "value" in assessing potential harm to the LSR. In fact, it is its relatively small acreage that suggests its utility as an indicator of significant harm given its established importance within the ecosystem.

We reject the notion that the critical objective should be to maintain isohaline contours. The objective was to evaluate the system in regards to Florida statue 373.042, F.S: which states that "The minimum flow for a given watercourse shall be the limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area".

Other data such as extent of various marsh species should also be used to verify this along with actual physical water quality data. This is discussed in Section 4, but not as effectively used as could be relying exclusively on SAV to set the MFL. Table 4-1 provides a good listing of priority taxa and habitat for development of MFLs.

Page 5-11. Not sure we understand the model scenarios for baseline. Seems like baseline should be based on median flow in river and what the associated flow in Manatee Spring would be based on regression equations in Section 3. For the scenarios, spring flow would move inversely with river flow as they are not independent.

RESPONSE: Section III Primary Comments, p. 5-11:

This section asks for clarification as to the choices for river and spring discharge in the Manatee thermal modeling scenarios.

Modeling scenarios were selected to investigate combinations of flow at the spring and river. No assumptions of variable dependence were made. Manatee Spring discharge does not vary significantly, while the river does. Discharge in the river is the primary controlling factor. The combinations were selected to investigate the effects of river flow on the plume geometry, assuming that the MFL will be set to protect flow in the spring to the extent possible.

Page 5-12. The idea of setting an MFL of the spring independent of the river seems counterintuitive. River stage controls spring flow to some extent (although less for Manatee than Fanning). In fact, based on regression equations, Manatee discharge is inversely related to River stage and directly related to Fanning discharge (which is directly related to wl at well #114). The panel is concerned with the use of an approach that varies spring flow independent of river flow when you have shown they are clearly linked. Perhaps something simple like looking at different river flows, and appropriate spring flow and groundwater level combinations and create a graph showing proportion of spring flow to total flow would help alleviate this concern.

RESPONSE: Section III Primary Comments, p. 5-12:

This comment discusses setting spring MFLs independent of the river. It also suggests exploring groundwater and spring-flow combinations as compared to river flow.

The MFLs are not independent of the river. Flow in the river is unregulated, and it must be assumed that the stage and discharge in the river will follow seasonal patterns. MFLs set for the river are, in part, in order to sustain conditions at Fanning Spring in the cold season. For Manatee Spring, the river cannot be controlled, so one can only address ground-water withdrawals in permitting to insure that the manatee refuge will be supported when the river is following its typical flow patterns.

Most of the reviewers' comments were explored. The data did not allow for the comparisons suggested, however.

Action: None

It seems like the practical aspect of this is that you would need to extract water from the river if the spring flow goes below 130 cfs in the cold season or limit groundwater extraction in the area.

RESPONSE: Section III Primary Comments, p. ?:

This is a statement that, in order to set the 130 cfs MFL for Manatee, water levels in the river may have to be artificially lowered.

Obviously, this is not possible. The 130 cfs MFL for Manatee is for ground-water withdrawals only. Any permit applicants will have to show that the MFL will not be exceeded as a condition for permitting.

Page 5-13. Fanning Spring MFL based on depth of water over in spring run. Is the high stage variability a function of tide? If so, is there a way to filter out the tide variability from the problem? How about a figure (i.e., figure 5-9) based on monthly average? Would this eliminate/reduce tidal effect? How does setting a stage based MFL ensure adequate spring flow?

RESPONSE: Section III Primary Comments, p. 5-13:

This comment deals with the effects of tide on water levels in the Fanning Spring run.

Tides and wind setup both affect stage in the river at Fanning and Manatee. It is because of these ephemeral events that manatees can sometimes pass into the spring runs when measured stage in the spring runs do not indicate passage depths are present.

High stage variability in Figure 5-8 may be due to these events, but they are not typically of the magnitudes indicated. The extreme data and skewness to high discharge is also a result of river stage.

Tide variability was filtered out of the data by use of monthly data. As indicated in the text, Figure 5-9 is based on monthly data.

Page 5-14. Looks like the spread is about the tidal range. Would the use of monthly average like in other stats models be helpful?

RESPONSE: Section III Primary Comments, p. 5-14:

This comment asks if use of monthly data in Figure 5-10 would eliminate tidal variability.

Yes, a stage-flow graph using monthly data would eliminate the tidal variation included in the daily data plotted on the figure. That, however, would defeat the purpose of the graph, which is to depict the daily variability caused by tides, wind sets, and discharge.

Page 5-19. The Panel could not find a discussion of why 0-15% risk is used. The Panel suggests there be some discussion of why it was picked.

RESPONSE: The 0-15% risk was used to reflect a range of potential adverse impact that has been established by other peer reviewed MFLs in Florida. A range greater than 15% could have been used but the 15% limit appeared to be more conservative and protective of the river system.

Page 5-35. What is the regression equation?

RESPONSE: In house publishing will reproduce all the figures such that they are in consistent format. Once this is accomplished the final figures will have the

regression equations inserted. The regression equations can be easily derived from the tables in Appendix H as the majority are univariate regressions.

Appendix H. What are the regression equations? What variables were included? What procedure was used to select the model? For example, Figure H-3 shows a power function with an exponent of 0.4. Was this arrived at by trial and error? One might try a model with the exponent as a fitted parameter.

RESPONSE: Stepwise regression was used for variable selection from a range of power functions of flow (section 5.3.1.2). This could be considered a trial and error approach. The approach was chosen as an efficient means of assessing the relationship between isohaline location and transformations of flow. Attempts were made to use a nonlinear least squares regression to fit a parameter describing the exponent and a parameter to estimate the coefficient for the predictor variable (flow). (i.e b0 +b1*Flow^b2). We found the resulting parameter estimates to be highly correlated. Further, nonlinear equations rely on estimating starting values which can also be considered a trial and error approach.

Page 5-61. (Figure 5-39). Looks like one data point at about 25,000 cfs is skewing the relationship from a straight line. Is there a logical reason for a log function?

RESPONSE: This reference has to do with analysis outside of the study area and was used for background only. A decision has been made to remove it from the report.

Page 5-67. What is the Lower Suwannee MFL? The text is not clear to the Panel.

RESPONSE: Please refer to Section 6 provided.

Page 5-69. Dry (warm) season potential MFLs are identified based on figures 3-45 and 3-46. These figures do not exist – The Panel believes you mean 3-41 and 3-42.

RESPONSE: That is correct, the appropriate figures are 3-41 and 3-42.

Section 5-4. The statement of the MFLs is not as clear as it might be. It appears that 130 cfs for minimum spring flow is selected for Manatee Spring. This may be ok for the minimum, but it should not become the maximum for the spring season period. (See Table 2-3 p. 2-82.) It could be 130 minimum with normal fluctuations up to approximately 160 cfs.

RESPONSE: MFLs are expressed as minimum flows or levels. The report does not express any maximum flows. Please refer to Section 6 provided and response to 1.d.

Lower Suwannee River. It looks like data from all of the habitats identified was used for protection, but then the report relied on the SAV 3.5% risk flow of 6515 cfs. It would be useful to include all the salinity and flow numbers here in this section for each of the habitats to show the "convergence of data" they suggest.

RESPONSE : See Table 5.10 in the Report.

Models

Thermal model:

The text in the report has not convinced the Panel how one can model such a limited portion of the river and have it make sense. The plume we observed on 9/8/05 was much narrower than the grid cells used. The plume was very well defined and distinct from the river water for large distance along the river edge. All the buoy locations were outside this plume, hence they only observed river water temperatures. This casts doubt on the model validation as well as on the "mass balance" approach in the model. The model temperature represents the average over entire grid cells and as such cannot resolve the sharp gradient associated with the plume. The model implicitly assumes that the spring water is completely mixed with river water in each cell. More explanation of how the model was implemented is needed.

> **RESPONSE: The intent of the temperature modeling was not to model the extent of the plume, but rather to use the best available data to estimate the degree to which the area near the eastern shoreline is affected by the discharge from the spring. The only available data were obtained from buoys located within approximately 25 m of the shore, constraining the model cells to be at least this wide. Given that the thermal plume from the spring is sometimes closer to the shore than 25 m, the model provides a conservative estimate of the quantity of spring discharge necessary to maintain a 20° C thermal envelope.**

Salinity model:

Basic concept and application of salinity-flow relationships are sound. The report appears to have used the best data available. Still, application of a dynamical model rather than a statistical approach would be preferable. The Panel suggests that the text should have a section summarizing all the salinity relationships in the beginning, before the risk assessment. It's a bit confusing as presently written.

Specific questions: In sec. 5.3.4.4, why are there not similar problems with estimating the location of the 9 ppt isohaline? In the range of median flow, it appears that the location of both 5 ppt and 9 ppt isohalines are very close. The text states location of the 9 ppt isohaline is RMi 1.82 for a flow of 5320 cfs. From Figure 5-28 (p. 5-43) we estimate the position of the 5 ppt isohalint to be about RMi 1.9. Text should state this.

> **RESPONSE: The 9 ppt isohaline was a relatively smooth function of flow over the range of conditions examined while for the 5 ppt isohaline there was a sharp decrease in location with increasing flows to the median flow but then a sharp flattening of the curve at higher flows. This discontinuity is difficult to model and resulted in either biased predictions toward the boundaries or non monotonic predictions of isohaline location even though the predictions around the median flows conditions were reasonable. When salinity was greater than 5 at the mouth of the passes it was usually also greater than 5 ppt at river mile 1 whereas for the 9ppt isohaline that was not the case. This artifact resulted in few observations for the 5ppt isohaline between rivermile 0 and 1. This coupled with the fact that many**

of the tidal creek connections occurred below river mile 1 and that fish can selectively access tidal creeks when conditions are favorable (e.g. other parts of the tidal cycle when salinity is likely to be lower) reduced our confidence in this tool/habitat combination as a criterion for MFL establishment.

Secondary Comments

RESPONSE: Editorial comments that are appreciated.

Page 1-1. 1.1 (1) The first sentence sounds funny – "water management district as a whole"?

Page 1-3. Should include Manatee Spring on figure.

Page 1-4. Line 32 change "than that" to then that

Table 1-Table 3. In the Tables 1 – 3; i.e. add "Filtration and absorption of" to that criterion in the table to match the text.

Page 2-11. What are the contour lines on the figure showing?

Page 2-13. Unable to reproduce the 14.8 inches of annual runoff. Came up with 13.9. Not a big deal but curious.

Page 2-23. Inconsistent font in table

Page 2-27. For clarity, add station number to table.

Page 2-36. Fourth to last sentence of first paragraph makes no sense.

Page 2-51. Curious as to what agricultural crops will result in such an increase in irrigation demand. 13.0 mgd in 2000 to about 32 mgd in 2020 to about 56 mgd in 2050 for Levy County.

Page 2-85: 1st paragraph under "Conservation Issues": "submerge" should be "submerged".

Page 2-10, sec. 2.1.3, 2nd PP: "5000 feet in thickness"

Often use "affect" when should use "effect" (c.f. p. 2-28, 4th PP)

"dependent" often misspelled "dependant"

Page 2-32, 8th PP: "A historical …"

Page 2-36 Line 3 remove comma between region and with

Page 2.37 (Figure 2-24 remove "-" between titi and blueberry in Reach 1 diagram

Page 2-72 Line 18 change "becomes and" to becomes an

Page 3-22. Linked surface water ground water model MODBRANCH. MODBRANCH simulations look good. What is it used for?

Page 3-3. Gopher River site average and maximum not correct – looks like lat- longs used.

Page 3-10. See comment for page 2-23. Well, Vogel et al. Cleared that up sort of.

Page 3-44. Last sentence not correct?

Page 3-67. The third sentence in 3.2.3.4.2 concerning flow reduction at Manatee seems incorrect.

Section 3.2.3.6. Last sentence above figure incomplete.

Page 3-44: Bullet #2 states there are "fairly short periods of record for the gages at Fanning and Manatee Spring".

Page 3-67: 1st paragraph under Section 3.2.3.4.2: The sentence that states "…while Manatee Spring discharge was only reduced by approximately 20 cfs, from about 50 cfs to 130 cfs" has improper math……we believe the "50 cfs" should be "150 cfs".

Page 3-76: last sentence under 3.2.3.4.3.2 states the "median average daily stage at Fanning Spring was approximately 2.2 feet". This should refer to Manatee Spring, NOT Fanning Spring.

Page 3-5: What is "true value?"

Page 3-10: perhaps some discussion of ENSO variability is appropriate here, reference to Schmidt, N., E. K. Lipp, M. E. Luther, and J. B. Rose, 2001: ENSO influences on seasonal rainfall and river discharge in Florida; *Journal of Climate, 14*, 615-628. Also in Section 3.1.10.1 on p. 3-27. In meteorological/oceanographic literature, AMO is referred to as North Atlantic Oscillation (NAO).

Plots in Figure 3-11 (p. 3-24), Figure 3-12 (p. 3-26) and other similar, caption refers to (A) and (B) but no mention of panels (C) and (D).

Page 3-27, first line – replace "effect" with "affect"; 2nd PP, replace "affects" with "effects"

Section 3.2.3.2.2, p. 3-47, 4th line : …regressions were performed …"; 8th line: "…for an equation …"

Note that the Wilcox gage is used for the primary gauging records due to completeness – but is ranked as only fair by USGS (see p. 3-4 and 3-5). This should be mentioned. I understand that only "best available data" is required to be used, but to the extent this influences the analysis if should be mentioned.

Page 4-1. Line 5 towards to toward

Page 4-2. Line 7 i are

Page 5-1. 3rd PP. Replace "climatological variation" with "climate variability"

Page 5-2. 5th line from bottom: "…is largely ~~be~~ a function of …"

Page 5-11. Last sentence: "… was drier than normal …"

Page 5-16. 3rd bullet: should be "… sample date …"

Page 5-28. Middle of page: should be "… a wide range of variability …"

Page 5-35. Last sentence: "Appendix J" should be "Appendix I"

Page 5-45. 2nd PP: should be "… based on inspection …"

Page 5-46. 2nd sentence: should be "… indirectly related to …"

Page 5-50. Last sentence is incomplete.

Page 5-1. Line 20 assess to allow access

Page 5-41. Figure 5-26 "Bioogically to Biologically"

Page 5-43. Change line 6 to move the ")" to after details.

Appendix J. 3rd page, next to last bullet: "… complicated by ~~to~~ the dynamics …"

Figure J-5: Title has "Observed" and "Predicted" reversed

V. Suggestions for Suwannee River Water Management District

Fanning Spring. Suggest setting up a monitoring program for simultaneously collecting data from rainfall, groundwater wells in the vicinity of Fanning Spring, the Wilcox gage for river level and discharge, Fanning Spring and Little Fanning Spring stage and discharge and the location in the Fanning Spring run of the dark water/spring water interface (an aerial or map of the springs could be produced so that every day the Park Ranger could record the location of the interface) and groundwater withdrawals from the spring shed. At the 5 year review of this MFL, this data set would provide the basis for evaluating the effectiveness of the previously set MFL; and the basis for any needed changes to the MFL.

Manatee Spring. Suggest establishing the same type monitoring program. This would allow a more direct measurement and correlation of data with less reliance needed on statistical predictions and models. Also since Fanning, Little Fanning and Manatee are in the same spring shed, any relative changes resulting from groundwater withdrawal in the spring shed can be assessed on each spring.

END OF DRAFT REVIEW

APPENDIX C

PRESENTATION

Suwannee River Water Management District

Lower Suwannee River, including Fanning and Manatee Springs Minimum Flows and Levels Peer review

October 10,2005

HSW

Specific Charge to the Peer Review Panel

- **Review information:**
  - Assume proper collection
  - Assume reasonable QA
  - Assume the best information available used
- **Review the technical assumptions:**
  - Clearly stated, reasonable, consistent?
  - Eliminated to the extent possible?

HSW

Specific Charge to the Peer Review Panel (Continued…)

- Review the procedures and analyses:
  - Appropriate and reasonable?
  - Incorporate appropriate factors?
  - Correctly applied?
  - Limitations reasonably handled?
  - Procedures repeatable?
  - Conclusions supported by the data?

HSW

Specific Charge to the Peer Review Panel (Continued…)

- If not scientifically reasonable:
  - List/describe scientific deficiencies.
  - Can these be remedied? How?
  - If possible, identify alternatives.
- Overall, were methods and procedures scientifically reasonable?

HSW

Primary Concerns of Peer Review Panel

- Manatee Spring: Apparent problems with discharge data – majority unusable – fixable
- Manatee Spring: Problem with record extension equation – used two highly correlated variables as "Independent" Variables – fixable
- Fanning Spring: Setting a Minimum Level protects manatee passage. A Minimum Flow (warm water) is required to protect the thermal refuge – fixable

HSW

Primary Concerns of Peer Review Panel - Continued

- Both Springs: MFLs proposed for only 5 months (cold months) of the year - fixable

- Initial WRV decision matrices: Qualitative ranking and selection of WRVs – policy decision?

HSW

Suggestions of Peer Review Panel

- Continue hydrologic data collection on Fanning and Manatee Springs
- Inspect Manatee Spring discharge gage to ensure usable data are collected
- Maintain long-term river monitoring
- Develop year round MFL for springs
- Use visitor use data to assist with establishing MFL for the protection of Recreation and Scenic and Aesthetic WRVs
- SAV

HSW