TECHNICAL PEER REVIEW OF RECOMMENDED MINIMUM LEVELS: LAKE SANTA FE, FLORIDA

PREPARED FOR

Suwanee River Water Management District

PREPARED BY

DSV
DUNN, SALSANO & VERGARA CONSULTING, LLC
HELPING CLIENTS MEET THEIR WATER RESOURCE NEEDS

BFA Environmental Consultants
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EXECUTIVE SUMMARY

The Suwannee River Water Management District (District) has included Lake Santa Fe, located in Alachua and Bradford counties, Florida, and with its watershed also extending into Clay and Putnam counties, on its current priority list and schedule for the establishment of minimum flows and levels (MFLs). based on the provisions of Subsection 373.802, Florida Statutes (F.S.). Also, based on the provisions of this Subsection, the District has identified Lake Santa Fe as a water body for which the District will undertake independent scientific peer review.

The District staff has developed recommended MFLs for Lake Santa Fe. These recommended MFLs are described in a document titled *Minimum Recommended Lake Levels: Lake Santa Fe, Florida. Draft Report April 19,* 2018, prepared for the District by Greenman-Pedersen, Inc. (GPI). In support of development of these recommended MFLs, the District contracted with the consulting firm of Environmental Consulting &Technology, Inc. (ECT), for performance of water budget modeling. The work performed by ECT is described in a document titled *Lake Alto and Lake Santa Fe Water Budget Modeling, Technical Report-Draft*, dated November 2017. The review discussed in this document focuses on the report prepared by GPI.

The District has engaged the services of two experts with collective expertise in the fields of hydrology, limnology, and biology to serve as a peer review panel (panel) to review and evaluate information used for development of recommended MFLs for Lake Santa Fe. These panel members are from the water resources consulting firm of Dunn, Salsano & Vergara Consulting, LLC (DSV), which is acting as a sub consultant to the environmental consulting firm of Barnes, Ferland and Associates, Inc. These panel members include

- Donthamsetti Rao, Ph.D., P.E.,
- William J. Dunn, Ph.D.

These two panel members have worked extensively together in matters concerning the development, peer review, and implementation of MFLs in Florida for more than 25 years and have collective professional experience that exceeds 75 years in Florida. Dr. Dunn performed the peer review of the GPI report.

This report utilizes a tabular template for the peer reviewer to address the District's peer review requirements. Included as appendices are two summary tables to capture the two key elements of the technical review. The first, the review comments table, summarizes the reviewer's individual general and specific review comments along with any recommended actions (Appendix A Table 1). Each comment is treated as a separate row in this table. The second table, (the peer review assessment criteria table) includes the reviewer's comments concerning the District's specific peer review assessment criteria, (Appendix B Table 2).

Dr. Dunn's review indicates that the District has done a commendable job in developing the proposed minimum levels as presented in the GPI Lake Santa Fe MFLs report. He agrees with most of the reports basic assumptions, methods of data collection, much of the data analysis and presentation, and the development and selection of two of the three minimum levels, the minimum average (MA) and the frequent low (FL) as presented in the GPI Lake Santa Fe MFLs report. However, Dr. Dunn concludes that the frequent high (FH) is set to a threshold event that is too dry to adequately protect the cypress and hardwood swamp communities. The FH should be assessed again considering his comments and recommendations.

GPI, when developing recommended MFLs for Lake Santa Fe, was also charged by the District to develop recommended MFLs for Lake Alto. GPI's recommended MFLs for both lakes were developed based on the same methodology. This peer review document addresses only recommended MFLs for Lake Santa Fe.

In defining the FH level for the cypress swamp communities at Lake Alto, the authors selected a short-duration event representing the driest site (Lake Gore) sampled of the nine lakes with a cypress swamp community in the surface water inundation and dehydration signatures (SWIDS) database compiled by the St. Johns River Water Management District (SJRWMD). The reviewer concludes that this event will not sustainably protect these forested wetlands in the floodplain of the lake. The hydrological event chosen is not protective enough for two reasons. First, the event at 14 days is too short to meet the ecological basis of the FH level. Second, Lake Gore is indeed the dry extreme of the cypress community in the SWIDS distribution of nine lake sites. It is Dr. Dunn's very strong opinion that by picking the direst extreme of the SWIDS distribution, cypress swamps on Lake Santa Fe will not be protected, and neither would most of the other cypress communities at the other eight lakes in SJRWMD's SWIDS database.

Dr. Dunn makes very specific recommendations for the FH level event. First, Dr. Dunn recommends at least a 30-day continuous duration event. Using SJRWMD's SWIDS database for the cypress community at a 30-day stays-wet event, the midrange value of the return interval (RI) range for the nine lakes is 1.71, which is the value for Pine Island as described in the SWIDS database. Dr. Dunn recommends an RI for this FH level to be in the range of 1.7 to 2. He also points out that the FH levels recently set by the District for Lakes Butler and Hampton were based on 30-day stays-wet events with 2-year RIs.

Dr. Dunn also notes that managing uncertainty, which should be part of every MFLs setting process, is not addressed in an explicit and integrated approach in the District's report. Dr. Dunn believes the management of uncertainty is best accomplished as an adaptive management (AM) process and suggests that a comprehensive assessment of major sources of uncertainty and the magnitude of each source should be addressed in an explicit plan to manage the effects of uncertainty and reduce its impacts in the future using an AM approach.

Dr. Dunn also points out that by their very nature MFLs are adaptive strategies for management of the District's critically important water bodies. Each adopted MFL, as well as the District's entire MFLs program define an adaptive, learn as you go, management strategy. Dr. Dunn has concluded that the District would benefit from an explicit AM approach that is based on identifying and addressing elements of uncertainty.

A very important and significant conclusion from Dr. Dunn's analysis is that the analysis utilized to assess compliance with recommended MFLs may be flawed such that the finding that all minimum levels were being met in the baseline year of 2006 may be incorrect. If, as Dr. Dunn concludes, the recommended FH is not properly defined, then the compliance assessments as to whether the currently recommended FH is met under current, or future conditions is also in question. Compliance with the recommended, redefined FH level under both 2006 and future conditions must be revaluated.

Overall, Dr. Dunn finds that most, but not all, of the conclusions in the GPI Lake Santa Fe MFLs report are supported by the analyses presented. He generally concurs with the data and information collected, the data collection methods, the methods used for analysis and interpretation, and two of the minimum levels recommended. However, Dr. Dunn disagrees with the threshold event for setting the FH level, and thus also the related compliance assessment.

Dr. Dunn also recommends that additional work be done to address two important issues: 1) quality assurance, and 2) the management of uncertainty.

The two issues are intimately linked. Dr. Dunn believes the management of uncertainty is best accomplished as an AM process and suggests that a comprehensive assessment of major sources of uncertainty and the magnitude of each source should be addressed in an explicit plan to manage the effects of uncertainty and reduce its impacts in the future using an AM approach.

INTRODUCTION

OVERVIEW

The Suwannee River Water Management District (District) has included Lake Santa, located in Alachua and Bradford Counties, Florida, on its current priority list and schedule for the establishment of minimum flows and levels (MFLs). based on the provisions of Subsection 373.802, Florida Statutes (F.S.). Also, based on the provisions of this subsection, the District has identified Lake Santa Fe as a water body for which the District will undertake independent scientific peer review.

The District staff has developed recommended MFLs for Lake Santa Fe. These recommended MFLs are described in a document titled *Minimum Recommended Lake Levels: Lake Santa Fe, Florida. Draft Report April 19, 2018*, prepared for the District by Greenman-Pedersen, Inc. (GPI), herein after referred to as the GPI Lake Santa Fe MFLs report. In support of development of these recommended MFLs, the District contracted with the consulting firm of Environmental Consulting &Technology, Inc. (ECT) for performance of water budget modeling. The work performed by ECT is described in a document titled *Lake Alto and Lake Santa Fe Water Budget Modeling, Technical Report-Draft*, dated November 2017.

District staff developed multiple recommended minimum levels for Lake Santa Fe using methods developed and refined by the St. Johns River Water Management District (SJRWMD). The District proposes three minimum levels for Lake Santa Fe.

District staff developed multiple levels to protect critical water resources over the full, dynamic range of the lake's hydrologic regime. Data collection covered a time series of water levels, vegetation, soils, topography, and delineation of wetland to upland break. A baseline lake level record was developed for Lake Santa Fe. Critical resources identified for protection included floodplain inundation, habitats for fish and invertebrates, and maintenance of hydric soils.

SJRWMD methods define MFLs as hydrologic events defined by three components: a magnitude (in this case water depth), a continuous duration (days), and an annual return interval. For Lake Santa Fe, staff proposed three minimum levels a minimum frequent high (FH) level, a minimum average (MA) level, and minimum frequent low (FL) level as follows:

- The recommended FH level is a stage elevation of 140.08 feet (ft) NAVD88, a duration of 14 days, and return interval of 2.5 years.
- The recommended MA level is stage elevation of 137.89 ft NAVD88, a duration of 180 days, and return interval of 1.7 years.
- The recommended FL level is a stage elevation of 136.52 ft NAVD88, a duration of 120 days and a return interval of 5 years.

In support of MFLs development the District contracted with ECT to develop a single water budget model for two hydraulically connected lakes, Alto and Santa Fe. ECT utilized the Storm Water Management Model (SWMM) Version 5.1 to develop the water budget model for Lake Santa Fe and Alto. Model development, calibration, and use of the model for long-term simulation are described in ECT's report. Scientific and technical peer review of ECT's work is covered in a separate DSV document authored by Dr. Don Rao.

The District is committed to the independent scientific peer review of all data, methodologies, and models used in the establishment of MFLs. Accordingly, the District voluntarily engaged the services of two independent experts with collective expertise in the fields of hydrology, limnology, and biology. These experts served as a peer review panel to evaluate and review

information used for development of recommended MFLs for Lake Santa Fe. These expert reviewers are from the water resources consulting firm of Dunn, Salsano & Vergara Consulting, LLC (DSV), which is acting as a sub consultant to the environmental consulting firm of Barnes, Ferland and Associates, Inc., and include:

- Donthamsetti Rao, Ph.D., P.E.,
- William J. Dunn, Ph.D.

PEER REVIEW PANEL'S SCOPE OF WORK

This document provides a summary of the panel's completion of its contracted scope of work, covering the following four major tasks.

> Task 1—Participate in project kick-off meeting and attend a field inspection of data collection sites on and adjacent to Lake Santa Fe.
>
> Task 2—Perform review of relevant documents and publications.
>
> Task 3--Develop a single draft peer review panel report for submission to the District.
>
> Task 4—Produce final peer review report.

The kick-off meeting was completed on May 7, 2018, as a webinar hosted by District staff. This meeting provided the reviewers with an overview of the District's approach to setting MFLs, data collection and data analysis methods, results, and recommended minimum levels. The required field inspection took place on May 11, 2018. The field inspection included an extensive tour of the lake by boat conducted by District staff involved in development of the recommended minimum levels. The field inspection allowed reviewers direct observation of aquatic, wetland, and upland communities; vegetation and soil sampling transects, and other monitoring locations. The inspection trip also allowed reviewers an opportunity to ask questions of staff regarding: methods of data collection and analysis, rationale for selection of sampling locations, types and nature of uncertainty, and any needs for additional data collection that could be useful for implementing the MFLs and assessing compliance in future.

PEER REVIEW APPROACH

Section 373.042, F.S., provides that minimum flows for a given watercourse represent the limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area and the minimum water level is the level of groundwater in an aquifer and the level of surface water at which further withdrawals would be significantly harmful to the water resources or ecology of the area.

Section 373.042, F.S., also provides that MFLs shall be calculated using the best information available, that the Governing Board shall consider and may provide for non-consumptive uses in the establishment of MFLs, and when appropriate, MFLs may be calculated to reflect seasonal variation. The law also requires that when establishing MFLs, changes and structural alterations to watersheds, surface waters, and aquifers shall also be considered (Section 373.0421, F.S.). The State Water Resource Implementation Rule (Chapter 62-40, Florida Administrative Code) includes additional guidance for the establishment of MFLs, providing that:

> "…consideration shall be given to the protection of water resources, natural seasonal fluctuations in water flows or levels, and environmental values associated with coastal, estuarine, aquatic, and wetlands ecology, including:
>
> a. Recreation, in and on the water;

b. Fish and wildlife habitats and the passage of fish;
c. Estuarine resources;
d. Transfer of detrital material;
e. Maintenance of freshwater storage and supply;
f. Aesthetic and scenic attributes;
g. Filtration and absorption of nutrients and other pollutants;
h. Sediment loads;
i. Water quality; and
j. Navigation."

Section 373.042, F.S., also addresses independent scientific peer review of MFLs, specifying the review of all scientific or technical data, methodologies, and models including all scientific and technical assumptions employed in each model, used to establish a minimum flow or minimum water level. In addition, the law requires that the Florida Department of Environmental Protection (FDEP) or the Governing Board shall give significant weight to the final peer review panel report when establishing the minimum flow or minimum water level.

This report utilizes a tabular template for the peer reviewer's comments. Included as Appendices are two sets of summary tables to capture the key elements of each technical review. The first table, the review comments table, summarizes the panel member's individual, general and specific review comments along with any recommended actions (Appendix A Table 1). Each comment is treated as a separate row in this table. The second table, the peer review assessment criteria table, includes each the member's comments concerning the District's peer review assessment criteria, which are described in the following outline (Appendix B, Table 2).

The District's peer review assessment criteria, addressed by the reviewer in Table 2, are as follows:

(A) Determine whether the conclusions in the Lake Santa Fe MFLs report are supported by the analyses presented.

1. Supporting Data and Information: Review the relevant data and information that support the conclusions made in the report to determine:

   (a) the data and information used was properly collected;

   (b) reasonable quality assurance assessments were performed on the data and information;

   (c) exclusion of available data from analyses was justified; and

   (d) the data used was the best information available.

   Note: The peer reviewer was not expected to provide independent review of standard procedures used as part of institutional programs that have been established for collecting data, such as the USGS and District hydrologic monitoring networks.

2. Technical Assumptions: Review the technical assumptions inherent to the analysis used in the GPI Lake Santa Fe MFLs report to determine whether:

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

   b. the assumptions were eliminated to the extent possible, based on available information; and

c. other analyses that would require fewer assumptions but provide comparable or better results are available.

3. Procedures and Analyses: Review the procedures and analyses used in the GPI Lake Santa Fe MFLs report to determine whether:

   a. the procedures and analyses were appropriate and reasonable, based on the best information available.

   b. the procedures and analyses incorporate all necessary factors;

   c. the procedures and analyses were correctly applied;

   d. limitations and imprecisions in the information were reasonably handled;

   e. the procedures and analyses are repeatable; and

   f. conclusions based on the procedures and analyses are supported by the data.

(B) If a proposed method used in the Lake Santa Fe MFLs report is not scientifically reasonable, the Peer Reviewers shall:

1. List and describe scientific deficiencies and, if possible, evaluate the error associated with the deficiencies;

2. Determine if the identified deficiencies can be remedied.

3. If the identified deficiencies can be remedied, then describe the necessary remedies and an estimate of time and effort required to develop and implement each remedy.

4. If the identified deficiencies cannot be remedied, then, if possible, identify one or more alternative methods that are scientifically reasonable. If an alternative method is identified, provide a qualitative assessment of the relative strengths and weaknesses of the alternative method(s) and the effort required to collect data necessary for implementation of the alternative methods.

(C) If a given method or analyses used in the GPI Lake Santa Fe MFLs report is scientifically reasonable, but an alternative method is preferable, the peer reviewer shall:

1. List and describe the alternative scientifically reasonable method(s)) and include a qualitative assessment of the effort required to collect data necessary for implementation of the alternative method(s).

SUMMARY OF REVIEW PANEL COMMENTS/ QUESTIONS

As described, reviewer's detailed comments are Included in Appendices as a set of two summary tables that capture the two key elements of the technical review. The first the review comments table, summarize the reviewer's individual general and specific review comments on the GPI Lake Santa Fe MFLs report along with any recommended actions (Appendix A, Table 1). Each comment is treated as a separate row in this table. The second table provides the reviewer's conclusions for each of the District's peer review assessment criteria (Appendix B, Table 2).

SUMMARY OF COMMENTS/QUESTIONS SUBMITTED BY DR. WILLIAM J. DUNN

Dr. Dunn's review indicates that the District has done a commendable job in developing the proposed minimum flows. He agrees with most basic assumptions, methods of data collection, much of the data analysis and presentation, and the development and selection of three minimum levels. Dr. Dunn does, however, conclude that the threshold event that defines the FH level is not protective of the cypress and hardwood swamp communities.

Dr. Dunn very strongly agrees with report's authors that whenever possible MFLs should be based on statistically defined protective hydrological events composed of 1) a magnitude (flow and/or level), 2) continuous duration for the specific inundation or drying period, and 3) with a return interval.

Dr. Dunn concludes, however, that the threshold event defining the FH level is too dry, and as such will not adequately protect the cypress and hardwood swamp communities. He recommends that the duration be increased to 30 days or more. He notes that the GPI Lake Santa Fe MFLs report specifically states that the driest example of cypress swamps from SJRWMD's surface water inundation and dehydration signatures (SWIDS) database was selected.

In defining the FH level for the cypress swamp communities at Lake Santa Fe, the authors selected a short duration event representing the driest site (Lake Gore) sampled of the nine lakes with a cypress swamp community in the SJRWMD's SWIDS database. Dr. Dunn concludes that this event will not sustainably protect these forested wetlands in the floodplain of the lake.

Based on cooperative discussions with SJRWMD staff, the District decided to use the statistical events reported in SJRWMD's SWIDS database to define statistical events for Lake Santa Fe, in this case the FH level. As part of this technical review Dr. Dunn examined the SWIDS database in MS Excel spreadsheet format as provided to him by District staff member, Louis Mantini. The cypress swamp portion of the database includes transect-based data from nine lakes in SJRWMD

Dr. Dunn finds that GPI chose to define the FH level as a 14-day stays-wet event for Lake Gore. Authors state that for the 14-day event the Lake Gore cypress community is the driest example of the nine lakes in the SWIDS database. Dr. Dunn has confirmed that for the 14-day stays-wet event Lake Gore is indeed the driest end of the SWIDS distribution. Dr. Dunn considers this a choice that will provide inadequate protection of the cypress and mixed hardwood swamp communities on Lake Santa Fe. The choice is not protective enough for two reasons. First the event at 14 days is too short to meet the ecological basis of the FH level. Second, the selection

of Lake Gore, the driest sample in the SWIDS database, is indeed the dry extreme of the cypress community in SWIDS distribution of nine lake sites. It is Dr. Dunn's very strong opinion that by picking the direst extreme of the distribution, cypress swamps on Lake Santa Fe will not be protected; and neither would most of other cypress communities at the other eight lakes in the SWIDS database.

First, concerning the duration of the FH level event, Dr. Dunn concludes that the event's duration itself must be tied to an ecologically/biologically relevant event directly contributing to sustainably and maintaining key structures and functions of the wetland community considered. For the cypress community and other community types found in the floodplain, the FH level is intended to protect the wetland nature, species diversity, species composition, structural features of the forest, etc. It is Dr. Dunn's opinion that a 14-day duration is too short to provide the intended protection and that the proper duration is in the range of 30 to 45+ days stays-wet. A 14-day duration would be adequate to protect mineral hydric soils in the floodplain typically found at the upland edge of the floodplain. A 14-day duration will not protect the species composition, forest structure, and functional values of the cypress and mixed hardwood swamp communities found on Lake Santa Fe. Therefore, it is critical that a longer duration event, in the range of 30 to 45+ days stays-wet, be used as the basis of setting the FH level.

To demonstrate, a comparison of the events for the wet and dry ends of the SWIDS distribution for cypress swamps was made. Using the SWIDS database provided to the reviewer by SRWMD staff, the reviewer compared the 14-day and 30-day stays-wet events for dry and wet ends of the nine-lake SWIDS distribution. Using the site Boggy Marsh 2 as representative of the wet end of the SWIDS distribution we find:

> For the 14-day event, Boggy Marsh 2 has an annualized occurrence of 90.03%, while Lake Gore's is 39.84%. Converting these values to an annual return interval (RI) yields values of 1.11 years for Boggy Marsh 2, and 2.51 for Lake Gore.
>
> For the 30-day event, Boggy Marsh 2 has an annualized occurrence of 89.47%, while Lake Gore's is 10.57%. Converting these values to an annual RI yields values of 1.12 years for Boggy Marsh 2, and 9.46 for Lake Gore.

Because Dr. Dunn concludes that the 30-day stays-wet event is a more correct and better choice of event duration, the 14-day event will not be discussed further. The difference for the 30-day and the 14-day stays-wet events for the two lakes is very instructive. The RIs for these events are dramatically different, roughly a 10 to 1 difference. It is a very strong opinion of Dr. Dunn that the 9.46-year RI will not protect the cypress and mixed hardwood swamp communities of Lake Alto. Dr. Dunn prudently recognizes that picking the wettest end of the SWIDS distribution is not the wisest management choice either for setting a FH level that will be protective of the floodplain swamp communities on Lake Santa Fe. Using the SWIDS data for the cypress community at a 30-day stays-wet event, the midrange value of the RI range for the nine lakes is 1.71, which is the value for Pine Island as described in the SWIDS database. Dr. Dunn recommends a RI for this FH level in the range of 1.7 to 2. The reviewer also points out that the FH levels recently set by the District for Lakes Butler and Hampton were based on a 30-day stays-wet event with a 2-year RI.

Finally, these recommendations for setting the FH level are based on a review of the SWIDS database for cypress dominated communities from nine lakes. It would be informative to do the same analysis for hardwood dominated swamp communities and mixed cypress-hardwood swamps.

Dr. Dunn also questions why the estimated freeboard in the Upper Florida aquifer for Lake Santa Fe is 9 ft greater than that estimated for nearby and hydraulically connected Lake Alto.

Dr. Dunn notes that Santa Fe Swamp is an extremely large forested wetland system comprising the north end of the lake. The swamp is hydraulically connected to the lake and the lake and swamp together form the headwaters of the Santa Fe River. Dr. Dunn asks if the proposed MFLs will also provide adequate protections of this significant wetland,

Dr. Dunn notes that managing uncertainty, which should be part of every MFLs setting process, is not addressed in an explicit and integrated approach in the District's report. Dr. Dunn believes the management of uncertainty is best accomplished as an AM process and suggests that a comprehensive assessment of major sources of uncertainty and the magnitude of each source should be addressed in an explicit plan to manage the effects of uncertainty and reduce its impacts in the future using an AM approach.

One of the District's peer review assessment criteria asks the reviewers whether reasonable quality assurance assessments were performed on data and analyses. Dr. Dunn finds that the GPI Lake anta Fe MFLs report lacks a comprehensive quality assurance (QA) component. Since QA is specifically addressed in Item A.1.b., Dr. Dunn recommends that a QA assessment be added to the report. A QA assessment could be integrated into a section of the report covering evaluation, characterization, and management of sources of uncertainty.

On the topic of AM, Dr. Dunn points out that by their very nature MFLs are adaptive strategies for management of the District's critically important water bodies. Each adopted MFL, as well as the District's entire MFLs program define an adaptive, learn as you go, management strategy. The District would benefit from an explicit AM approach that is based on identifying and addressing elements of uncertainty.

The field of AM has been developed over the last several decades specifically to deal with the effects of uncertainty in making and implementing resource management decisions, such as the management of water resources through MFLs. The basic tenets of AM are:

- All resource management decisions and resource management plans have elements of uncertainty; yet, management decisions must be made.
- Decisions should be made based on the best science, knowledge, and information available, while clearly identifying sources of uncertainty and accounting for their range of impact on predicted outcomes
- Uncertainty can be characterized, its effects can be described, and it can be managed, thus allowing prudent water resource decisions using the best available information.
- Monitoring of the condition of the resource of concern and its response to change is necessary to make better-informed future management decisions.

As an example, an AM approach integrated into the minimum flow regime for Lake Santa Fe would include:

- Use the proposed minimum flows as the initial condition, representing distillation of the best available information and analysis.
- Understand, describe, and quantify the sources of uncertainty affecting development of the minimum flows.
- Implement specific monitoring and compliance requirements that will reduce the effect of uncertainty and improve management decisions in the future.
- Collect and analyze monitoring data.
- Use data, analytical tools, and models to evaluate responses of resource values being tracked.
- Assess whether minimum levels are being met. If not, then revise relevant portions of the minimum flows.
- Implement changes to minimum flows as needed.

This AM approach can also encompass the District's MFLs compliance assessments done as part of both water use permitting decisions and the District's water supply planning process. For MFLs, the congruence between the development of MFLs for water bodies and the classic AM approach provides a framework for prudent use and protection of water resources, while also providing goal seeking, adaptive strategies for dealing with uncertainty.

APPENDICES

APPENDIX A
TABLE 1. WILLIAM J. DUNN, PH.D.'S INDEPENDENT TABULAR COMMENTS FOR THE LAKE SANTA FE TECHNICAL MFLS REPORT

Table 1. William J. Dunn, Ph.D.'s independent tabular comments for Tasks 1-4 of the Lake Santa Fe technical MFLs report Minimum Recommended Lake Levels: Lake Santa Fe, Florida. Draft Report April 19, 2018, prepared for the District by Greenman-Pedersen, Inc. (GPI) Technical Report – MFLs Establishment for Lake Santa Fe

Comment No.	Figure, Table, or Page and Paragraph Number	Does Comment Directly and Materially Affect Conclusions of Report? (Yes/No)	To be completed by Reviewer(s) Table 1		To be completed by Report Author(s)
			A. Reviewer's Specific Comments	B. Reviewer's Specific Recommended Corrective Action	C. Action to be Taken in Response to Comment
1	General comment	No	Report needs to have an integrated treatment of the sources of uncertainty	Add a discussion on the effect of sources of uncertainty on the development of the recommended minimum levels.	
2	General comment	No	Report should have a concise assessment of how each of the relevant water resource and human use criteria (from statute) are addressed by the recommended minimum levels. The authors claim that the MFLs focus on protection of fish and wildlife habitat, and that protection of this WRV will also be protective of all other WRVs. This assumption, however, is not validated explicitly in the report.	Further action is needed to support and validate.	
3	General comment	No	AM theme should be added.	The AM theme can be introduced in the analysis of uncertainty as covered in Comment 1, above.	
4	General comment	Yes	The reviewer concludes that the threshold hydrologic event chosen for the frequent high level (FH) is too dry to be protective of the cypress swamp community.	Authors state that the driest example of the cypress swamp community in SJRWMD's SWIDs database was chosen to define the 14 day stays wet event. Selecting the dry extreme of the distribution is not a prudent decision.	
5	General comment	Maybe	The impact of the regional drawdown in the Upper Floridan aquifer potentiometric surface in northeast Florida on the Lake Santa Fe watershed should be addressed.	Address the relevance of the regional aquifer drawdown to the water budget of the Lake Santa Fe watershed.	

Comment No.	Figure, Table, or Page and Paragraph Number	Does Comment Directly and Materially Affect Conclusions of Report? (Yes/No)	To be completed by Reviewer(s) Table 1		To be completed by Report Author(s)
			A. Reviewer's Specific Comments	B. Reviewer's Specific Recommended Corrective Action	C. Action to be Taken in Response to Comment
6	General comment	Yes	The relevant Weibull plots are not included. These plots should be added to the report, possibly as an appendix. These plots are critical to understanding both the setting of the MFLs and the compliance assessment.	Please add the relevant Weibull plots to the report or included in an appendix.	
7	General comment	Maybe	The logging history in the bordering wetlands, especially Santa Fe Swamp Should be described if possible. The MFLs report mentions that cypress stumps were encountered along the sampling transects in the cypress and hardwood swamp communities.	Include relevant discussion in the report.	
8	General comment	Maybe	The District report should describe the extent to which the Santa Fe Swamp is also protected by the recommended MFLs. This swamp is a very large and significant ecological and hydrologic feature of the Lake Santa Fe watershed.	Include relevant discussion in the report.	
9	General comment	Maybe	The extent to which recent fire in Santa Fe Swamp has caused changes that affect the interpretation of Transect 1 should be addressed. For example, if the recent fires burned off surface horizons of organic soils, then the successional recovery of this burned wetland would be influenced by the lowered base elevation.	Include relevant discussion in the report.	
10	General comment	Maybe	A fire history of Santa Fe Swamp should be included in the District report.	Include relevant discussion in the report.	

Comment No.	Figure, Table, or Page and Paragraph Number	Does Comment Directly and Materially Affect Conclusions of Report? (Yes/No)	To be completed by Reviewer(s) Table 1		To be completed by Report Author(s)
			A. Reviewer's Specific Comments	B. Reviewer's Specific Recommended Corrective Action	C. Action to be Taken in Response to Comment
11	General comment	Yes	Compliance analysis shows 16 ft of freeboard for Lake Santa Fe, but only 7 ft for adjacent and connected Lake Alto	Provide an explanation of the 11 ft difference in freeboard between these two adjacent and hydraulically connected lakes.	
12	General comment	Maybe	No analysis or discussion of hydrologic indicators is included in the report. The report and supporting appended materials indicate that elevations of hydrologic indicators were collected on the sampling transects.	Through the analysis of hydrologic indicator data it is possible to learn about recent and historic hydrologic regime conditions in the wetland communities. The indicator data gives a separate and independent way to assess ecological hydrological relationships. With data collected to support both methods, then results can be compared/contrasted results. Reviewer recommends more comparative analysis to characterize how well the two approaches agree or disagree.	

13	Executive Summary: Pages 1-2, and Table 1-1.	Yes	The reviewer very strongly concludes that the statistical hydrological event chosen by the report's authors for the FH level will not be protective of the cypress and mixed hardwood swamp communities on Lake Santa Fe. In defining the FH level for the cypress swamp community at Lake Santa Fe the authors (GPI) selected a short duration event representing the driest sample of the cypress swamp community in the SWIDS database compiled by SJRWMD. The reviewer concludes that this event will not sustainably protect these forested wetlands in the floodplains of the lakes. As part of this technical review Dr. Dunn examined the SWIDS database in MS Excel spreadsheet provided to him by District staff member, Louis Mantini. The cypress swamp portion of the database includes transect based data from nine lakes in the SJRWMD. GPI chose to define the FH level as a 14-day stays-wet event as exemplified by Lake Gore. GPI states that for the 14-day event the Lake Gore cypress community is the driest example of the nine lakes in the SWIDS database. Dr. Dunn has confirmed that for the 14-day stays-wet event Lake Gore is indeed the driest end of the SWIDS distribution. He considers this choice as inadequate to protect the cypress and mixed hardwood swamp community on Lake Santa Fe. The choice is not protective enough for two reasons. First the event at 14 days is too short to meet the ecological basis of the FH level. Secondly, the selection of Lake Gore, the driest sample in the SWIDS database, is indeed the dry extreme of the cypress community in the SWIDS distribution of nine lake sites. It is the reviewer's very strong opinion that by picking the direst extreme of the distribution, cypress swamps on lakes Alto and Santa Fe will not be	Address the significant concern over the definition of the FH event. It appears to be too dry to protect the cypress swamp community.	

			protected, and neither would most of other cypress communities at the other eight lakes in the SWIDS database. Concerning the duration of the FH level event, the reviewer concludes that the event's duration itself must be tied to an ecologically/biologically relevant event that directly contributes to sustainably maintaining key structures and functions of the wetland community considered. For the cypress community and other community types found in the floodplain, the FH level is intended to protect the wetland nature, species diversity, species composition, structural features of the forest, etc. It is the reviewer's opinion that a 14-day duration is too short for the FH level, and that the proper duration is in the range of 30 to 45+ days stays-wet. A 14-day duration would be adequate to protect mineral hydric soils in the floodplain typically found at the upland edge of the floodplain. A 14-day duration will not protect the species composition, forest structure, and functional values of the cypress and mixed hardwood swamp communities found on Lakes Santa Fe. Therefore, it is critical to use a long duration event in the range of 30 to 45+ days stays-wet. To demonstrate, a comparison of the events for the wet and dry ends of the SWIDS distribution for cypress swamps was made. Using the SWIDS database provided to the reviewer, he compared the 14-day and 30-day stays wet events for dry and wet ends of the nine-lake SWIDS distribution. Using the site Boggy Marsh 2 as representative of the wet end of the SWIDS distribution we find: For the 14-day event: Boggy Marsh 2 has an annualized occurrence of 90.03%, while Lake Gore's is 39.84%. Converting these values to an annual		

			return interval (RI) yields values of 1.11 years for Boggy Marsh 2 and 2.51 for Lake Gore. For the 30-day event: Boggy Marsh 2 has an annualized occurrence of 89.47%, while Lake Gore's is 10.57%. Converting these values to an annual RI yields values of 1.12 years for Boggy Marsh 2 and 9.46 for Lake Gore. Because this reviewer concludes that the 30-day event is a more correct and better choice of event duration, then the 14-day event will not be discussed further. The difference for the 30-day event for the two lakes is very instructive. The RI for each is dramatically different, roughly a 10 to 1 difference. It is a very strong opinion of the reviewer that the 9.46-year RI will not protect the cypress and mixed hardwood swamp communities of Lake Santa Fe. The reviewer prudently recognizes that picking the wettest end of the SWIDS distribution is not the wisest management choice either for setting a FH level that will be protective of the floodplain swamp communities on Lake Santa Fe. Using the SWIDS data for the cypress community at a 30-day stays-wet event, the midrange value of the RI range for the nine lakes is 1.71, which is the value for Pine Island as described in the SWIDS database. The reviewer recommends an RI for this FH level in range of 1.7 to 2. The reviewer also points out that the FH levels set recently by the District for Lakes Butler and Hampton were based on 30-day stays wet events with 2-year RIs. Finally, these recommendations for setting the FH level are based on a review of the SWIDS database for cypress dominated communities from nine lakes. It would be informative to do the same analysis for hardwood dominated swamp		

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			A. Reviewer's Specific Comments	B. Reviewer's Specific Recommended Corrective Action	C. Action to be Taken in Response to Comment
			communities, and mixed cypress-hardwood swamps.		
14	Pages 5, Section 2.4 Management Concerns	Maybe	Author highlights a management concern, but does not give the reader a clear picture as to the relevance of this particular MFL to the water supply planning process in north Florida	Author should expand on the importance of the NFRWSP. Add additional information to this short paragraph. Address whether this MFL's water budget modeling will be validated by the new northeast Florida model.?	
15	Pages 5-6, Section 3.0 Setting and Description	Maybe	Reviewer agrees with the setting and description of Lake Santa Fe's watershed. The first paragraph mentions that Lake Santa Fe is an Outstanding Florida Water (OFW). It does not appear that the implications of this are addressed in the remaining sections of the report.	Address the OFW question, especially in the conclusions section.	
16	Page 5, Section 3.0 Setting and Description	Maybe	The end of the second paragraph mentions underlying, relatively impermeable materials. The presence of an effective aquiclude underlying the lake basin is important component of the lake's hydrology.	If this is relevant to the degree of connection between the lake and the underlying Floridan aquifer, then added discussion seems relevant and warranted.	
17	Pages 7-8, Section 3.1 Background Stage Data, and Figures 3-2 & 3-3.	No	The reviewer concurs that the time series from multiple gages are needed to compile a long period of record (POR).	No further action required unless otherwise indicated by peer review comments prepared by Dr. Don Rao, DSV, for the ECT report.	

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18	Pages 9-10, Section 3.2 Wetlands, and Figure 3-4	No	The reviewer agrees that the data sources used are the best available for this purpose.	No further action required.	
19	Pages 11-12, Section 3.3 Soils, and Figure -5	No	The reviewer agrees that the data sources used are the best available for this purpose.	No further action required	
20	Page 13-16, Section 4.0 MFLs Methodology, first paragraph	No	It would be helpful to cite examples of other similar lake systems for which SRWMD or SJRWMD have set three levels, FH, MA, and FL.	Revise text.	
21	Page 12, Section 4.0 MFLs Methodology, second paragraph	Yes	The reviewer concurs with the use of the MFLs methods and protocols developed by the SJRWMD. The reviewer concludes that the FH is set to too dry a condition to adequately protect the cypress swamp community. The reviewer notes that the FH level event recently set by the District for Lakes Hampton and Butler had 30-day durations and return intervals of 2 years.	The District should reconsider the recommended FH threshold event. Specific recommendations are provided in Comment 13, above.	
22	Page 13-14, Section 4.1 Site Selection, and Figure 4-1	No	The reviewer concurs with sampling site selection process, as described, and the transect locations chosen and shown on Figure 4-1.	No further action required.	
23	Page 15, Section 4.2 Site Survey	No	The reviewer concurs with site survey and data collection methods, as described.	No further action required.	

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24	Page 15, Section 4.3 Vegetation Sampling	No	The reviewer concurs with vegetative community sampling and data collection methods, as described.	No further action required.	
25	Page 16, Section 4.4 Soils Sampling	No	The reviewer concurs with soils sampling and data collection methods, as described. This is especially true for the decided focus on the histosols and histic epipedons.	No further action required.	
26	Page 16, Section 5.0 Data Analysis	Yes	The reviewer concurs with District staff's decision to use the cypress and mixed hardwood swamp as the estimate of the FH, and the datums selected to estimate the MA and FL levels. These choices align with the SJRWMD methods. The reviewer does not agree with the threshold event defined for the FH level.	Address the reviewers significant concern over how the FH level was set. Specific recommendations on redefining the FH level are provided in Comment 13, above.	
27	Pages 17-18 Section 5.2 Consideration of Basin Alterations, last paragraph in section	No	The reviewer generally agrees with staff's decision to treat current conditions of vegetation and soils as the valid basis for developing protective levels for Lake Santa Fe. The reviewer does however ask the author to comment on the potential impacts of the regional declines in Floridan aquifer water levels that are generally a concern of water managers in northeast Florida	Address the northeast Florida regional groundwater level decline issue.	
28	Pages 18-19, Section 5.3 MFLs Compliance Assessment, first paragraph	Yes	The reviewer agrees with the report's authors that the Lakes Alto Santa Fe water budget model is the best tool for assessing MFLs compliance of any proposed water management action in the lake basin.	Further action required to address the concern over the event chosen for the FH.	

Comment No.	Figure, Table, or Page and Paragraph Number	Does Comment Directly and Materially Affect Conclusions of Report? (Yes/No)	To be completed by Reviewer(s) Table 1		To be completed by Report Author(s)
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29	Pages 19-20, Section 6.1 Lake Santa Fe Vegetation, and Figure 6-1	No	The reviewer agrees with the summary of the results of the elevation statistics of the various vegetative community types.	No further action required.	
30	Page 21, Section 6.2 Soils, and Table 6-2	No	The reviewer agrees with the summary of the results of the elevation statistics of the various soil series types.	No further action required.	
31	Page 22 Section 6.3 MFLS Compliance Assessment	Yes	As already stated the reviewer has concerns that the FH has been set at too dry a condition. This is even more critical since the compliance analysis shows that the FH is the controlling level.	Address the concern about the FH level.	
32	Pages 22, Section 6.3 MFLs Compliance Assessment	Yes	The compliance assessment concludes that there is 16 ft of freeboard in the Upper Floridan aquifer. This estimate comes into question if the FH level is not set properly. Also, the reviewer questions the significant difference in estimated free board compared to Lake Alto, which has an estimated freeboard of only 7 ft.	Further action is needed. Explain why these two adjacent and hydraulically connected lakes have dramatical y different free board estimates.	
33	Page 22 Section 7 Conclusions and Recommendations, including Table 7-1	Yes	The reviewer agrees with two of the three recommended hydrologic events (magnitude, duration, return interval) recommended as the minimum levels for Lake Santa Fe	Further action is required to address concerns raised over the event selected for the FH. Specific recommendation for redefining the FH are provided in Comment 13, above.	

Comment No.	Figure, Table, or Page and Paragraph Number	Does Comment Directly and Materially Affect Conclusions of Report? (Yes/No)	To be completed by Reviewer(s) Table 1		To be completed by Report Author(s)
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34	Page 22 last paragraph	Maybe	The final paragraph is a nice summary of the assumptions, and sources of uncertainty in the water budget modeling. Are there any more elements of uncertainty in the development and use of the water budget model that need to be added?	An explicit comprehensive AM section to the Section 7 should be added. This should clearly address all sources that can affect the MFLs setting process, and compliance/freeboard analyses.	
35	Page 27 Appendix A: Lake Water Budget Modeling	Maybe	The reviewer is concerned that if the FH level is set for too dry an event, then the compliance assessment shown in the Weibull plots (see Figures in ECT reports) are not accurate.	Address this concern.	
36	Pages 28-30 Appendix B: Site Survey	No	I found the information presented in Appendix B to be clearly presented and easy to follow, and complete.	No further action required.	
37	Pages 31-64 Appendix C: Vegetation Sampling Methods, Analyses, and Results	Maybe	The reviewer agrees with the plant community sampling methods selected and applied. The approach and methods outlined are standard vegetation sampling methods for data collection and analysis and follow the protocols of the SJRWMD methods for lake MFLs. Results covered on pages 35-64 are complete and support the relevant results, and discussion presented in the main body of the Lake Santa Fe MFLs report. The reviewer notes that the transect profiles included in the Appendix C of the Lake Alto report are more detailed and informative than the ones in this report for Lake Santa Fe.	The reviewer notes that the transect profiles included in the Appendix C of the Lake Alto report are more detailed and informative than the ones in this report. If possible add the more detailed transect profiles like those in the Lake Alto report.	

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38	Pages 65-106 Appendix D: Soil Sampling Methods, Analyses, and Results	Maybe	The reviewer agrees with the soils sampling methods selected and applied. The approach and methods outlined are standard soil sampling methods for data collection and analysis and follow the protocols of the SJRWMD methods for lake MFLs. Results covered on pages 66-106 are complete and support the relevant results, and discussion presented in the main body of the GPI Lake Santa Fe MFLs report.	No further action required.	

APPENDIX B
TABLE 2. WILLIAM J. DUNN, PH.D.'S TASKS 1-4 DETERMINATIONS FOR THE LAKE SANTA FE TECHNICAL MFLS REPORT

Table 2. William J. Dunn, Ph.D.'s Tasks 1-4 determinations of whether the methods used for establishing the minimum flows are scientifically reasonable as described in the Lake Santa Fe technical MFLs report titled *Minimum Recommended Lake Levels: Lake Santa Fe, Florida. Draft Report April 19,* 2018, prepared for the District by Greenman-Pedersen, Inc. (GPI)

Task	Subtask	Sub-subtask	Reviewer's Specific Comments Table 2, Dunn
1.Determine whether the methods used for establishing the minimum flows are scientifically reasonable	A. Supporting Data and Information: Review the data and information that supports the method and the proposed minimum flows, as appropriate	1. Data and information used was properly collected.	Reviewer assumes that the data and information used in the GPI Lake Santa Fe MFLs report and the associated ECT report were properly collected. This includes data and information collected for vegetation, soils, topography and ground surface elevation, lake surface level time series, wetland hydrologic indicator elevations, precipitation, and evapotranspiration.
		2. Reasonable quality assurance assessments were performed on the data and information.	Reviewer assumes that reasonable quality assurance assessments were performed on the data and information. However, a complete, integrated picture of quality assurance (QA) is not provided in the document. Regarding statistical analyses, the results are stated, but the summary statistical support is often not given. As such, the reviewer cannot confirm or verify the result presented. The reviewer suggests that an integrated summary of important QA elements could be addressed in an analysis of uncertainty. The uncertainty analysis should include recommendations for how the District can improve its management and protection of Lake Santa Fe ecosystem.
	B. Review the technical assumptions inherent in the methodology	1.Determine if the assumptions are clearly stated, reasonable and consistent with the best information available	Yes, reviewer found this to be true; recognizing that often tradeoffs must be made in selecting the best available source of data depending on the analytical method, tool, or model used.
		2. Assumptions were eliminated to the extent possible, based on available information.	Yes, the report and supporting material in the respective appendices had many assumptions, which the reviewer generally found to be clear and reasonable. In the few cases where assumptions and/or logic were not clear, the reviewer's concerns are expressed. (see Appendix A, Table 1).
	C. Procedures and analyses: Review the procedures and analyses used in developing quantitative measures and determine qualitatively whether:	1. The procedures and analyses were appropriate and reasonable, based on the best information available.	Yes, reviewer generally found this to be true, with one significant exception. The reviewer found that the threshold event for the FH level is too dry and recommends that a wetter event be developed. Specific recommendations are made to redefine the FH level's statistical event.

Task	Subtask	Sub-subtask	Reviewer's Specific Comments Table 2, Dunn
		2. The procedures and analyses incorporate all necessary factors.	Yes, reviewer found this to be true. The reviewer, however, makes recommendations for improving the strength of the underlying technical support of the recommended levels. This is especially true regarding the management of the primary sources of uncertainty.
		3. The procedures and analyses were correctly applied.	Yes, reviewer found this to be true. The reviewer cites the specific problem with the FH level as defined in the report. Reviewer also makes recommendations for improving the strength of the underlying technical support of the recommended levels. This is especially true regarding the management of the primary sources of uncertainty.
		4. Limitations and imprecisions in the information were reasonably handled.	Yes, reviewer found this to be true. The reviewer, however, makes recommendations for improving the strength of the underlying technical support of the recommended levels. This is especially true regarding the management of the primary sources of uncertainty.
		5. The procedures and analyses are repeatable.	Yes, reviewer found this to be true. The reviewer, however, makes recommendations for improving the strength of the underlying technical support of the recommended levels. This is especially true regarding the management of the primary sources of uncertainty.
		6. Conclusions based on the procedures and analyses are supported by the data.	Yes, reviewer found this to be true. The reviewer, however, cites the specific problem with the FH level as defined in the report. Reviewer also makes recommendations for improving the strength of the underlying technical support of the recommended levels. This is especially true regarding the management of the primary sources of uncertainty.
2. If a proposed method used in the report is not scientifically reasonable the reviewers shall identify:	A. Deficiencies: List and describe scientific deficiencies		Reviewer has identified a problem with the hydrological event definition of the FH level. Specific recommendations for the hydrologic event are given in the main body of this report, and in Comment 12 in Appendix A, Table 1. Reviewer has also identified the failure to discuss the management of uncertainty as a deficiency. In Appendix A, Table 1 reviewer notes several specific remedies to manage uncertainty.
	B. Remedies: Determine if the identified deficiencies can be remedied.		Yes, Specific recommendations for the FH level hydrologic event are given in the main body of this report, and in Comment 13 in Appendix A, Table 1. For the management of uncertainty, an integrated management plan for handling key sources of uncertainty should be developed. Specific recommendations as to how to do this using AM approach are provided in the summary comments in Discussion section of this report, and in specific comments in Appendix A, Table 1.

Task	Subtask	Sub-subtask	Reviewer's Specific Comments Table 2, Dunn
	C. If the identified deficiencies can be remedied, then please describe the necessary corrections and, if possible, an estimate of the time and effort required to develop and implement. .		Reviewer notes that when the FH level is refined, the compliance assessment for determination of whether the proposed MFLs are met under 2006 and future conditions must be repeated.
	D. If the identified deficiencies cannot be remedied, then, if possible, identify one of more alternative methods that are scientifically reasonable, based on published literature to the extent feasible.		It is expected that making the recommended change to FH level will address the deficiency. It is also expected that sources of uncertainty can be controlled to the extent that the District uses the best available information and best available analytical tools to develop MFLs. Specific recommendations as to how do this using an AM approach are provided in my summary comments in the Discussion section of this report.