OF THE SCIENTIFIC PEER REVIEW PANEL ON THE METHODOLOGIES SUPPORTING THE PROPOSED MINIMUM FLOW FROM MADISON BLUE SPRING

Section Page

Section Page

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.

Madison Blue Spring (MBS) is one of 33 first magnitude springs in Florida (Florida Geological Survey 2002). A first magnitude spring is one with a median flow of at least 100 cubic feet per second (cfs) (64.6 million gallons per day). As a first magnitude spring, MBS is expected to be a major contributor to the flows in the Withlacoochee River below the point of discharge. MBS is State owned and managed for recreational purposes.

SRWMD determined that it would proceed to establish an MFL for MBS. The District enlisted a team of technical consultants to develop a proposed MFL, pursuant to the direction and guidance provided within the Florida Statutes (summarized in the preceding paragraphs). Shortly thereafter, the District chose to enlist 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 consists of Dr. Scott Emery, Dr. Ann Hodgson, and Dr. Ken Watson. Resumes of the qualifications of these three 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 Constraints

1. *The selection of Madison Blue Spring as a water body 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 given.*

Specific Charge to the Peer Review Panel for TASK 1

Determine whether the method used for establishing the minimum flows is 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 imprecisions 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.*

III

The Peer Review Panel Received a draft document titled: "Development of Madison Blue Spring-Based MFL, Draft Technical Report," Suwannee River Water Management District, Department of Water Resources, Report WR03/04-05, by Water Resource Associates, Inc., on June 15, 2004. That report included five sections and approximately 200 pages describing the approach taken to recommend a proposed MFL. The appendices contain an additional 700 pages of supporting information.

The Peer Review Panel was given a deadline to have a draft of its Peer Review Report to the District by July 12, 2004. This was accomplished on schedule, with a detailed Draft Peer Review Report 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.

Following the submittal of the Draft Review Report, the Panel members teleconferenced with SRWMD staff concerning the Draft Peer Review Report. The Panel was requested to separate its questions, comments, and suggestions into two different categories:

1. items that could improve the report but do not invalidate the proposed MFL; and

2. items that represent serious methodological or procedural flaws that might invalidate the proposed MFL.

IV

The stated goal of the draft technical report "Development of Madison Blue Spring-Based MFL" is to "adopt and implement an effective MFL that will prevent significant harm, as defined by the SRWMD Governing Board, to Madison Blue Spring and its related ecological and resource values." In the report, the proposed MFL for MBS was presented as 70 cfs when the stage at the Pinetta gage is below 55 feet NGVD.

There are five stated objectives in the report:

1. Utilize "best available information" to provide a basis for the MFL analyses.

2. Utilize recognized and accepted methods and practices in the analyses of best available information.

3. Receive input from interested parties in the determination of the MFL.

4. Provide clear and understandable results, conclusions and recommendations for MFL adoption.

5. Provide an MFL that can be effectively implemented by the SRWMD.

The authors of the report examined available data relating to multiple hydrologic and ecologic factors that were of possible relevance to the establishment of an MFL for MBS. Information that was examined but eventually not directly utilized in the final set of methodologies used to develop the MFL included

- water quality data;
- benthic invertebrate data;
- cave biology data;
- groundwater level data; and
- precipitation data.

The final set of methods used to develop the proposed MFL provided estimates of water depths over shoal areas (and associated wetted areas) within the Withlacoochee River downstream of MBS. These depths are correlated with varying discharge amounts from MBS. From the literature, a minimum water depth for fish passage of 0.6 feet over the pooled shoal area is taken as the standard with which to compare the water depths on the shoals. The proposed flow of 70 cfs is recommended based upon an estimated loss of fish passage area of 7.7% over these shoals.

In Section 5 of the report, brief discussions are provided regarding whether the proposed MFL of 70 cfs, when the gage at Pinetta is below 55 feet NGVD, would serve to protect the ten water resource values listed in Chapter 62-40.473 Florida Administrative Code. Data are presented relevant to a portion of one out of the ten water resource values (Fish and Wildlife Habitat and the Passage of Fish).

The draft report states that five of the ten factors listed statutorily for establishing MFL's were considered in the establishment of the MFL for MBS. Five of the water resource values were specifically excluded as not relevant at MBS. Consequently, the ecological analysis presumably emphasized hierarchical evaluation of the relevant data. The following values, in priority order, were potentially either directly or indirectly applicable to the MFL analysis: fish and wildlife habitats and the passage of fish; maintenance of freshwater storage and supply; recreation in and on the water; aesthetic and scenic attributes; and water quality.

The following five ecological and resource values were not considered to be applicable to the MFL developed for MBS: (1) estuarine resources - MBS is a fresh water system that does not have an immediate connection to an estuary; (2) filtration and adsorption of nutrients and other pollutants - MBS does not have a vegetative component that provides water quality improvement; (3) navigation - the spring is not a navigable waterway and the spring run, although technically navigable by small, non-motorized craft under infrequent stage conditions, would not be considered a navigable waterway in the context

of the FDEP criteria; (4) transfer of detrital material – this criterion is not applicable to spring systems; and (5) sediment loads - this criterion is not applicable to spring systems.

The amount of physical information available to make a determination on an appropriate minimum flow from MBS is not extensive. Specifically, the Peer Review Panel now understands that the discharge data available from MBS appears to be limited to 22 data points provided by SRWMD and to more recent data from a newly installed monitoring station (data from this monitoring station were not directly utilized in the establishment of the MFL).

With such a small data set of actual flow/discharge data from the spring with which to work, mathematical techniques to synthesize long-term data were needed. Substantial data synthesis was a major part of the methods and procedures used to determine the 70 cfs number for the MFL. Because of the importance of these data synthesis tasks, we have provided a summary of our understanding of how the syntheses were accomplished in the following paragraphs.

Summary: How the MFL for MBS Appears to Have Been Established

The authors of the report faced multiple data problems. Not only was there little discharge information available from MBS, there were no long-term data records for the Withlacoochee River at the Madison gage (the river gage closest to MBS). The data set for the Withlacoochee River at Lee (nine miles downstream from where MBS enters the river) was not extensive. There were only two river stations with long-term data available (Pinetta and Ellaville), and only one of these (Pinetta) was located on the Withlacoochee River.

The authors first synthesized river stage data for the Withlacoochee River at Lee based on river stage data from downstream on the Suwannee River at the Ellaville gage and the upstream gage location at Pinetta. The stage data records for Lee and Pinetta were then used to create a synthesized stage data set for the river gage at Madison. At the completion of these record extensions, there were data sets (either synthesized or actual) for stage at three locations on the Withlacoochee River and one location on the Suwannee River.

From these stage data, river discharge information had to be synthesized. This process involved the use of a stage-fall-discharge rating curve. The authors explained some of the difficulties inherent in this approach, given that the confluence between the Withlacoochee and Suwannee Rivers is known to create “backwater” conditions.

Based on the synthesized river flow information, MBS discharge record also was extended. The 22 actual discharge data records for MBS were compared with the synthesized flow regime for the Lee gaging station, about nine miles downstream of MBS, and also with the difference in discharge at the Pinetta and Lee gages. The final

discharge regime synthesized for MBS was subsequently used to help determine the proposed MFL of 70 cfs when the stage at Pinetta is below 55 feet NGVD.

The HEC-RAS model (US Army Corps of Engineers) was used to translate the actual and synthesized stage and flow data from the rivers and from MBS into water elevations at six shoal areas in the river downstream from MBS. Multiple cross-section elevation surveys of the shoals provided bottom elevations that were mathematically summed and averaged. A 0.6 foot minimum water depth taken from the literature was used to compare pooled total shoal area inundated at different discharge values from MBS.

After evaluating the above procedures, the Panel determined that the best presentation of the results of its specific charges would be to discuss each of its specific charges as they relate to the hydrologic data and methods, and then discuss each charge as it relates to ecological data and methods.

■

Specific Charge to the Peer Review Panel for TASK 1

> *Determine whether the method used for establishing the minimum flows is 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.*

The supporting data for the development of a minimum flow at MBS were acquired from a variety of sources and summarized in Sections 2, 3, and 4 of the report. The general characteristics of the area relevant to discharge at MBS are discussed in Section 2 and include discussions and references to 1) geology and morphology, 2) hydrostratigraphy, 3) Withlacoochee River hydrology, 4) karst geology, 5) springs of the Withlacoochee corridor, and 6) land use. Section 3 includes the hydrologic analyses accompanied by with a discussion of the hydrologic data (i.e., spring, stream flow, precipitation, and groundwater) and the analyses procedures. The ecological evaluation is presented in Section 4, along with additional hydrologic analyses as they relate to fish passage.

The general characteristics of the MBS area presented in Section 3 include a series of useful figures and associated discussion relevant to the geology and geomorphology of the area that leads to a discussion of the hydrostratigraphy, Withlacoochee River hydrology, karst geology, and, finally, the spring system (including MBS). Much of the background geology and geomorphology is referenced to Florida Geological Survey publications by Scott (1988 and 1991) and White (1970), which are assumed to be reliable and peer-reviewed sources. The information and data most relevant to the

development of the MFL are related to the Withlacoochee River hydrology, karst geology, and spring flow.

Historical river flow characteristics based on historical data evaluations referenced to U.S. Geologic Survey publications by Giese and Franklin (1996) and Franklin (1995) are assumed to reliable and peer-reviewed. Surface-water drainage basins are identified and referenced to U.S. Geological Survey report by Foose (1981). Additional information specific to karst geology and the local spring system is referenced to Suwannee River Water Management District reports and communications.

Most of the hydrologic analyses are presented in Section 3 of the report. The data for the hydrologic analyses were provided by the SRWMD. These data include the following:

1. Madison Blue Spring Data – recent stage and discharge data (last two years) and some limited historical discharge data dating back to 1932.

2. Streamflow Data – stage and discharge data for three locations on the Withlacoochee River [upstream (Pinetta, long-term), downstream (Lee, short-term) and immediately upstream of MBS (Madison, long-term but infrequent)], and one location on the Suwannee immediately downstream of confluence with the Withlacoochee River (Ellaville, long-term).

3. Precipitation – various station data examined but data not used. Correlograms were prepared and rainfall was tested in regression models but was not significant in models that had stage from nearby gages as independent variables.

4. Groundwater – various well data (water level) examined but data were not used in the quantitative analysis for setting the MFL. A potentiometric contour plot and a contour error plot were generated that define the groundwater basin boundary associated with the MBS.

The authors acknowledge the lack of long-term stage and discharge data on the Withlacoochee River (at and immediately downstream from MBS) and the small data set for stage and discharge at MBS.

The Panel extensively discussed the synthesized discharge data for MBS. The report includes graphs that show spring discharge to be increasing slightly from 1932 to 1972 and then declining over the subsequent 30 years. There is an assertion in the report that the period of 1982 to 2002 was a post-development period. This 20-year period was compared with a pre-development period from 1932 to 1952.

Conclusions of Peer Review Panel with Respect to TASK 1(a)

The Panel members concur that the background information and hydrologic data are appropriate for the hydrologic analyses performed and the stated objectives of the analyses. We fully expect that these data are the best available.

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.*

The technical approach for establishing minimum flows and levels include using the data sets described above; various statistical models of association were used to extend short-term stage and discharge records, develop rating curves, estimate MBS discharge, develop inundation curves, and develop relationships between MBS discharge and stage at selected shoals on the Withlacoochee River and area of inundation. To examine the effect of a range of MBS discharges on the stage of the river over a series of shoals, the hydraulic model HEC-RAS was used. A U.S. Army Corps of Engineers early version of the HEC-RAS model (HEC-2) was re-calibrated to low flow conditions, and the model domain was reduced to the river section between the Pinetta and Lee gages. HEC-RAS is commonly used for simulating river stages and flow for simple and complex river systems given appropriate boundary conditions. The Panel considers the record extension techniques and the use of the various statistical associations to be appropriate and applicable procedures, in general. Likewise, HEC-RAS is considered to be an appropriate modeling tool for developing stage-discharge relationships at various locations along the river.

Cross-sectional surveys were conducted at six shoals along the river (26 cross-sections). These data were used in the inundation area analyses, but the data could not be incorporated in HEC-RAS for reasons that were not explained within the report. Additional information was provided to the Panel to help clarify this problem. The cross-sections at the shoals were interpolated using tools in HEC-RAS.

For the purpose of establishing MFLs, the main parameters in HEC-RAS are river geometry, boundary conditions (flow and/or stage), and roughness coefficient. The model was calibrated by varying the roughness coefficient as a function of flow. The calibrated HEC-RAS model was used to develop rating curves at six shoal locations on the Withlacoochee River. Discharge at the shoals (from HEC-RAS) was related to discharge at the Lee gage, which in turn was related to discharge at MBS through statistical relationships.

The paucity of actual measured flow/discharge data from MBS results in the need for extensive manipulation of the 22 measurements of available data. Long-term data for stations on the river and MBS had to be synthesized. In Section 3.2.4 there is a brief discussion of uncertainty along with a statement that more discussion will take place further on in the report. The Panel was not able to locate significant discussion of errors in subsequent sections of the draft text. Subsequent versions of the draft text did contain additional discussion of errors.

The authors use another comparison, that of the 22 actual spring discharge measurements with inflows to and outflows from the Withlacoochee River using the Pinetta gage (actual data) and the Lee gage (synthesized data). In Figure 3-14, a polynomial best-fit equation is developed. From a perusal of Figure 3-14, it is evident that there can be a wide range of measured spring discharges at a given synthesized river flow at Lee. For example, at a river flow at Lee of 1,000 cfs, actual discharge from MBS may be as high as 160 cfs or as low as 70 cfs. Moving farther along the curve, at a river flow of 1,400 cfs in the river at Lee, discharges from MBS can also range from 160 cfs to 70 cfs.

The authors state that a good linear relationship exists between total inflows/outflows to the river and MBS discharge but indicate that this relationship breaks down at extremes in flows (page 3-21). The Panel notes that the range of measured spring discharges is still relatively wide for a given river inflow/outflow, even at low flows (river inflows/outflows can more than double, from about 130cfs to about 300 cfs, while measured spring discharge only varies from about 51 cfs to about 60 cfs).

Conclusions of Peer Review Panel with Respect to TASK 1(b) – Hydrological Analysis

It is the Peer Review Panel's conclusion that, while the assumptions inherent in the synthesis of the data were not always clearly stated, the assumptions were appropriate, given the lack of data, and minimized to the extent possible.

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 imprecisions 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.*

The basis of the MFL is related to the MBS contribution to base flow. This requires a long-term record of stage and discharge at and downstream of the MBS on the Withlacoochee River. The objective of the analyses presented in Section 3 is to generate long-term data records for locations with short-term or no data using other long-term data records and statistical association models. The following analyses were performed.

1. A long-term stage record at the Lee station was synthesized using an association (based on regression) developed between the Lee data and the Pinetta and Ellaville data (Figure 3-6). The authors looked at lagged stage and rainfall, along with contemporaneous stage, and found both not to be significant.

2. A long-term stage record for the Madison station was developed in similar fashion as above.

3. Rating curves were developed for the Lee and Madison gage locations using a stage-fall-discharge rating method. That is the rating stage was computed from measured stage and discharge values.

   Polynomial equations were then developed (using regression) for the rating discharge versus stage association. The polynomial equations were solved for each simulated stage value at the gages (1 and 2 above), then simulated discharge was computed using the stage-fall-discharge relationship. Simulated discharge is shown in Figures 3-10 and 3-11.

   The polynomials were developed with stage = f(rating discharge) but then solved for rating discharge.

4. MBS Discharge – 22 measured MBS discharge values were compared to measured discharge at the Lee gage (polynomial/regression) (Figure 3-14). Data are limited to low flow at Lee. The difference between flow at the Lee and Pinetta gages with discharge at MBS is compared in Figure 3-16.

5. Hydrologic Analysis (HEC-RAS) - To examine the effect of a range of MBS discharges on the stage of the river over a series of shoals, HEC-RAS was used. A U.S.-COE early version of HEC-RAS model (HEC-2) was re-calibrated to low flow conditions, and the model domain was reduced to the river section between the Pinetta and Lee gages. HEC-RAS is commonly used for simulating river stages and flow for simple and complex river systems given appropriate boundary conditions. For the purpose of establishing MFLs, the main parameters are river geometry, boundary

conditions (flow and or stage), and roughness coefficient. The model was calibrated by varying the roughness coefficient. The model was calibrated against simulated Madison gage data. The calibrated HEC-RAS model was used to develop rating curves at six shoal locations on the Withlacoochee River. Discharge at the shoals (from HEC-RAS) was related to discharge at the Lee gage, which in turn was related to discharge at MBS through statistical relationships.

On page 3-18 referencing Figure 3-14, 22 MBS discharge values are plotted against Withlacoochee River discharge at the Lee gage, and a polynomial relationship is developed. It is stated that the relationship is valid for Lee discharge of less than 2,500 cfs. As discussed on pages 3-18 and 3-19 and referencing Figure 3-15, plotting predicted MBS discharge versus total river inflows/outflows (i.e., difference between discharge at Pinetta and Lee gages) provides scattered results at high predicted MBS discharge. At this point it is stated that the relationship between MBS discharge and river discharge is valid when MBS discharge is less than 80 cfs.

Further on page 3-19 and referencing Figure 3-16, the authors present a graph and relationship between MBS discharge and the total inflow/outflow as defined above. They further state that, if this relationship holds for the full range of inflow/outflow, a complete period of record of MBS discharge can be developed.

In the third paragraph on page 3-19, inherent assumptions in the relationship depicted in Figure 3-16 are discussed, particularly as they relate to river level. However, Figure 3-16 is a relationship between inflows/outflows as determined by discharge difference – i.e., the relationship to stage has not been established other than indirectly through Figure 3-14. This paragraph is confusing and may not be necessary.

On page 3-20 and related to Figure 3-17, the authors provide an independent line of evidence that favors the relationship in Figure 3-16 over Figure 3-14 but argue that both methods were acceptable at stable low stage in the river. However, on page 3-21 (first paragraph), it is stated that the relationship in Figure 3-16 breaks down at the extremes of MBS discharge and that all MBS discharge readings were taken at relatively low river stage. This breakdown is not evident in the figure.

The report then moves into a discussion of HEC-RAS setup, calibration and results. The model was calibrated to a low flow regime. More importantly, on page 3-23, in Section 3.3.3.2, the report states that HEC-RAS stage-discharge results were extracted for the model for six shoals and that discharge was extracted at the Lee gage location. The Lee gage discharge and relationship in Figure 3-14 were then used to calculate MBS discharge. These values of spring discharge and stage at the shoals were used to calculate shoal inundation for various MBS discharge. There is little information or supporting data presented associated with the HEC-RAS model that allowed the Panel to evaluate these relationships. We can state that the model is appropriate for this application and assume that the calibrations (and calibration parameters) are reasonable.

The Panel has noted the graphical comparisons of MBS discharge as simulated from inflows and outflows with actual MBS discharge as measured by the new USGS gage (Figure 3-17). The Panel has observed that the simulated MBS discharge from about January 2003 to about March 2003 over-estimates discharge for the most part. The discharge range involved is similar to the range examined with respect to an MFL (70 cfs, 85 cfs, and 100 cfs).

Following Section 3, the hydrology discussion/analyses begins again on page 4-24 where the term Q_t is introduced. This is the estimated MBS discharge at time t (date). The same (presumably) Q_t is found in the equation on page 4-26. The results are discussed in Section 4.8.3.

In Section 4.7.4 on page 4-28, the procedure for developing a MBS flow duration curve (fdc) is described. Presumably the Figure 3-16 relationship is used because the relationship in Figure 3-14 is valid only at low flows. The key results are discussed in Section 4.8.3. Based on Figures 4-47 through 4-52, the low flow regime was used as defined by the domains of the regression models. These relationships were then used to construct estimated inundated surface areas of the shoals using the relationship on page 4-27.

If we have followed the discussion correctly, discharge at MBS is related to the discharge at Lee (and the difference between Pinetta and Lee). Discharge at Pinetta is derived from long-term records, discharge at Lee is synthesized – first by synthesizing a long-term stage record and then by synthesizing a long-term discharge record using a rating curve. The stage record was synthesized using a relationship developed by comparing the stage at Lee with data from two nearby gages, and the rating curve was developed using the short-term record data at the Lee gage.

The Panel was not able to locate any data or data run results on the HEC-RAS model efforts in the June 15 draft. Some information was supplied to the Panel in late July. Consequently, the Panel had insufficient information to make any detailed determination on HEC-RAS results. The Panel has assumed the modeling runs used in the MFL determinations contained appropriate parameter inputs and that results were reasonable with respect to those inputs.

Conclusions of Peer Review Panel with Respect to TASK 1(c) – Hydrological Analysis

The Peer Review Panel concludes that the HEC-RAS model is a widely used hydrologic tool for riverine systems. To the extent possible with the information provided it, the Panel concludes that the procedures and analyses used were appropriate and reasonable and based on the best information available; the procedures and analyses incorporated appropriate factors; the procedures and analyses were correctly applied; limitations and imprecisions in the information were reasonably handled; the procedures and analyses are repeatable; and 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 provide suggested remedies;*

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.*

The hydrologic analyses were performed by competent and recognized professionals, and the reviewers did not find any of the methods to not be scientifically reasonable. The report provides a sufficiently thorough review of MBS basin characteristics, and the analyses rely on appropriate, albeit, minimal, data. From the review of Task 1, the Panel offered questions, mostly related to clarification and some in an attempt to expand on important areas of the analyses and reduce or eliminate data, analyses, and discussion that do not seem to enhance the discussion. These questions and suggestions are enumerated at the end of this Peer Review Report.

Conclusions of Peer Review Panel with Respect to TASK 2 – Hydrological Analysis

The Peer Review Panel has not found specific scientific deficiencies. We repeat our conclusions that the data synthesis techniques appear scientifically appropriate and that HEC-RAS is a widely used hydrologic tool for modeling rivers.

■

Specific Charge to the Peer Review Panel for TASK 1

Determine whether the method used for establishing the minimum flows is 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.

The data referenced in Section 4 related to ecological resources are assumed, where stated, to be derived from reliable sources and peer reviewed. Some data were obtained

from anecdotal sources and would not be expected to have been peer reviewed; however, they were crucial to the preparation of the analysis and were appropriately included. Available data were identified, collected and analyzed; however, the report states that a primary constraint for developing quantitative relationships between ecological integrity and MBS discharge was the limited availability of data relative to biological integrity, physical habitat availability, and water quality.

As stated in the report, data used in the identification of biological criteria for MFL development included the estimated discharge data from MBS, the estimated flow record at Lee, surface water quality data from the Withlacoochee River, benthic biological data from the Withlacoochee, and cross-sections of six shoals in the river downstream of the spring. The authors acknowledge that the lack of available data within the spring, spring run, and the aquatic cave system was an important initial constraint in the exploration of relationships between ecological integrity and flow but reiterate that estimated MBS discharges to the Withlacoochee River were available and that physical habitat availability data, biological data, and water quality data were available for the river.

The description of basin and riverine characteristics includes a cursory description of the river channel and floodplain morphology and of the forested floodplain wetlands adjacent to the river. Biological data for the spring, spring run, and Withlacoochee River include macroinvertebrates, fisheries, and limited morphometric information for MBS and the river. Recent photographs of the six shoal areas selected for analysis are included.

The authors report that the ecological characterization of the MBS was limited because little biological sampling has been conducted in Blue Spring and in the spring run to the Withlacoochee River. They provided the results of recently conducted (BRA 2004) benthic macroinvertebrate studies in the spring and spring run and a useful summary table of the macroinvertebrate community characteristics. Algal species growing in the spring run were tentatively identified ("Mats of filamentous green algae (possibly *Cladophora* and/or *Rhizoclonium* spp.) are found growing on rock and other hard surfaces in the spring pool."). Fish occurrence in the spring and spring run was very briefly identified ("Fish use of the spring pool and run is moderate, with centrarchids such as Largemouth bass (*Micropterus salmoides*) and sunfish (*Lepomis* spp.) commonly observed. Other fish likely to occasionally be observed in the spring would be Bowfin (*Amia calva*), catfish (Ictaluridae), and minnows (Cyprinidae)."); however, fisheries information was descriptive, not quantitative, and a discussion of habitat requirements of these spring-dependent or riverine fishes was not included, perhaps because such data are not available.

Detailed data for the physical and biological cave system were not available. The limited discussion of the Blue Spring cave system describes its morphometry and hydrology, and observations of troglobytic and trogrophilic organisms are presented, with qualitative population estimates (BRA 2004, Franz et al. 1994, Morris, unpublished data).

An abbreviated discussion of the morphological and ecological characteristics of the Withlacoochee River is presented. The characterization of the floodplain wetlands

adjacent to the river is limited to page 4-1, within a description of the geomorphology of the river: "As a consequence of this geomorphology, the river is not very "interactive" with its floodplain (i.e., it takes a substantial flood to inundate the floodplain)." "Riverine wetlands are only found in low-elevation slough or strand areas branching off the river channel. These are typically bottomland hardwood wetlands." The reported tree species are all obligate or facultative wetland species and the "narrow strip of wetland-type vegetation" could be characterized as a palustrine forested system. These riparian wetland forests typically occur within the primary floodplain of incised rivers, are extraordinarily important in the maintenance of Florida's ecological diversity, and are an integral component of state, national and international ecological conservation strategies participated in by Florida natural resource management agencies.

A summary of riverine algal occurrence and an expansive review of macroinvertebrate communities were presented. Although limited analysis of the data was included in the text, an extensive series of charts in the appendices showed the complex relationship of these organisms to various iterations of in-stream flows. These data were ultimately not used in the development of the MBS MFL. A review of relevant fisheries literature and fisheries data suggested that little information about fish populations in the river is available.

Federally- and State-listed threatened, endangered and sensitive species expected to occur in the vicinity were well summarized in Table 4-3. The discussion appropriately identifies that future studies should be conducted to further characterize and quantify the use of the MBS cave system and spring run by federally- and/or State-listed species.

Available water quality data were limited to 483 records during 1989-2003 from four stations on the Withlacoochee River (three stations above MBS and one station below and near MBS) but were not available from the MBS or spring run.

A cursory analysis of three evaluation parameters (maintenance of freshwater storage and supply; recreation in and on the water; and aesthetic and scenic attributes) was conducted.

Peer Review Comments on the Information in the Appendices

The authors appropriately included detailed biological data in the appendices. Appendix B1, pp. 280-293, presents water quality parameters versus flow; Appendix B2, pp. 294-298, presents a statistical analysis of dissolved oxygen versus flow; Appendix B3, pp. 299-301, presents two charts of macroinvertebrate diversity versus flow; and Appendix C1-C7, pp. 302-971, is an extensive series of plots of macroinvertebrate species, families, orders and functional group data versus various flow parameters. These detailed analyses were considered in the development of the MFL recommendations and used as stated in the text to varying degrees.

Conclusions of Peer Review Panel with Respect to TASK 1(a) – Ecological Resources

Ecological data, as available, were presented for in-stream aquatic resources. Data were assumed to be peer-reviewed. The authors are to be commended for reviewing a substantial amount of diverse data to establish a feasible approach to setting the MBS MFL. We conclude that the data reviewed are likely the best available information and are used appropriately in support of the method employed to calculate the MFL.

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.*

The ecological technical assumptions for establishing the MBS MFL included literature reviews, anecdotal reports, and field studies conducted by various researchers relative to the spring, spring run, and Withlacoochee River. These data were coupled with the hydraulic modeling described in the preceding section of this Panel report. Ecological data were presented where available qualitatively or quantitatively, although portions of the analysis were limited by the lack of quantitative information, and statistical analyses were presented where possible. No specific data regarding in-stream recreation or aesthetics were included, and the report states that these values were assumed to be protected.

The Panel agrees with the authors that "Impacts and changes to habitat are more easily measured than changes in species composition within ecosystems (p. 4-12)", where those relationships are known. The authors logically evaluated the relationships of several potential parameters to in-stream flow to determine their usefulness in developing the MFL recommendation. These factors included water quality parameters, macroinvertebrates, and fishery populations.

The relationship of modeled flow versus water quality was moderately correlated (R^2=0.68), but water quality parameters were eventually not recommended as criteria for setting the MBS MFL, because the authors determined that dissolved oxygen, particularly, would not be limiting during low base flow ("The results of the regression analysis defined a statistically significant relationship (R^2=0.68, p-value <0.0001) between low dissolved oxygen conditions (10th percentile) and flow, and the results are presented graphically in Figure 4-36.").

The report presents 669 pages of unsummarized macroinvertebrate versus variable flow plots, although it was determined after extensive investigation that "the application of

flow versus benthic invertebrate abundance to defining candidate minimum flow levels is not recommended, because the correlations obtained for the study area should not be interpreted as reflecting an accurate relationship between benthic invertebrate abundance and flow (*note*: slightly paraphrased)".

Consequently, the authors focused on establishing a flow-morphometry relationship at six selected shoals and determined that the relationship of flow versus physical habitat availability at these shoals would adequately characterize the spring, spring run, and river. The authors conclude that the six shoals downstream from MBS are likely to be affected by small changes in base flow and can be used as surrogates for other shoals occurring on the river.

The fish discussion was limited to fish passage over six representative shoals in the Withlacoochee River. A discussion of additional fishery biology requirements, such as holding pools or within-river temperatures under low flow conditions, was not included. The fish passage criterion of 0.6 feet minimum depth (Hupalo et al. 1994, SWFWMD 2002; Gore et al. 2002) has been used in two other recent MFL studies. The criterion appears to be valid, although the suite of fish species (Florida gar, various centrarchid fishes (bass and sunfish), bowfin, and minnows) listed as occurring in the river differs from the trout species on which the criterion is based. As an additional justification for the 0.6 feet fish passage criterion, the authors may wish to consider the peer review of the Upper Peace River study (Gore, Dahm and Klimas 2002), which references the transference of southeast United States fish body dimensions relevant to the species complex occurring in the Withlacoochee River.

The assumption that in-stream biological integrity can be maintained by providing sufficient water to maintain 'target habitats' (page 4-13) is stated clearly and is valid. The authors were limited by the number of available in-stream cross-sections to the selection of six shoals as surrogates for the other shoals in the river reach. Cross-sectional data for each of the six shoals were analyzed and the change in total shoal area was calculated under varying MFL scenarios.

As mentioned previously, a technical assumption made, but not fully described, is that by using the shoals the ecological system of the river would be protected. A limited discussion of the presence of a narrow floodplain along the river is included, although the floodplain habitat and values are not described.

While biological data are available for the Withlacoochee River, similar data are not available for MBS. The description of species occurring in the cave and spring run is limited, and a tentative, subjective analysis of the habitat requirements of spring species was conducted. In this analysis, use of the river data is valid, but it is important to separate the requirements of ubiquitous riverine vertebrates and invertebrates from the unique requirements of troglophylic and troglobytic organisms.

Water quality data were not considered in setting the MFL because the authors determined there was not a significant relationship between base flow and water quality parameters, specifically dissolved oxygen.

Conclusions of Peer Review Panel with Respect to TASK 1(b) – Ecological Resources

The Panel concurs with the rationale for establishing a minimum flow for Madison Blue Spring based on a correlation of the modeled flow with within-river morphometry, without establishing channel maintenance or seasonally variable flows. While the Panel found the description of the use of individual shoals and pooled shoal information difficult to follow, we find the use of the shoals and the fish passage criteria to be reasonable and consistent with the best information available. The Panel has determined that the assumptions were eliminated to the extent possible, based on available information.

Using the best available data, as presented in the report, it is not possible to definitively determine the validity of the assumption that if the spring is flowing, then spring and spring run species will be protected.

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 imprecisions 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.*

The output from the HEC-RAS model and field survey at six shoals, each with a variable number of transects, provided the basis for establishing the MBS MFL scenarios. Although a number of other in-stream parameters were initially considered, these were eventually excluded, and a combination of a fish passage depth criterion and maintenance of shoal habitat area were selected as the criteria against which the MFL would be evaluated. Fish passage depth related to an acceptable reduction in acres of wetted shoal

habitat was used to establish the proposed MFL of 70 cfs when the stage at Pinetta is less than 55 feet NGVD.

The report specifically focused on setting a minimum flow and level, while excluding additional recommendations for stream channel maintenance or seasonally variable MFLs. We agree that this is a reasonable approach for this relatively unaltered river system. The Panel supports the continued collection of ecological, hydrologic and water quality information for the MBS system, given that the currently available information is extremely limited. Such information can be used in future years to demonstrate that within-channel and riparian ecosystems are being adequately maintained by the established flow regime.

An extensive analysis of the information was conducted. The overall assessment was thorough and included a review of apparently relevant parameters. Available literature and unpublished data were considered. The extent of analysis varied among the five factors relevant to setting the proposed MFL. The relationships between water quality parameters and flow in the river channel were examined in order to identify any potentially useful quantitative relationships, but none were incorporated. A cursory analysis of recreation and aesthetics was conducted, and analysis of freshwater storage and supply was provided by inference.

Conclusions of Peer Review Panel with Respect to TASK 1(c) – Ecological Resources

Minimum flows for macroinvertebrate production and fish passage are proposed to be set at 70 cfs. Fish passage depth related to an acceptable reduction in acres of wetted shoal habitat was used to establish the proposed MFL of 70 cfs when the stage at Pinetta is less than 55 feet NGVD. The data analyses support this recommendation. The Panel agrees that this is a reasonable approach for this relatively unaltered river system, given the lack of information available on the spring, spring run, within-channel and riparian ecosystems. The prodedures and analyses for assessing ecological integrity criteria were scientifically appropriate and reasonable, based upon the best information available. The procedures and analyses incorporate appropriate factors (e.g., fish passage at limiting points such as the shoals). The procedures and analyses were correctly applied, with the shoals examined both individually and through a pooling process. The limitations and imprecisions in the information were reasonably handled. The procedures and analyses are repeatable, and 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 provide suggested remedies;*

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.*

The report states conclusively that the focus of analysis includes the aggregated river reach. The Panel disagrees with this comprehensive conclusion.

The report provides a relatively thorough review of variable data sets available for many ecological resources, while data were depauperate for others. In the near term, inequalities in the availability of data will persist, but the SRWMD's commitment to continue analysis is an encouraging approach to ensure that missing data are obtained in the future and applied as appropriate to the MFL.

Conclusions of Peer Review Panel with Respect to TASK 2 – Ecological Resources

The charge to the team undertaking the development of an MFL for MBS was to employ the best available information. In the case of MBS, many data gaps exist, especially with respect to the ecological systems that comprise MBS, the spring run, and the downstream portion of the river. The investigators and the SRWMD technical staff have met their charge of developing the proposed MFL based upon scientifically reasonable methodologies and procedures, given the information available to them.

The Peer Review Panel has determined that the methods and procedures used for establishing the minimum flows are scientifically reasonable. The Panel assumed, per direction from SRWMD, that data and information used were properly collected and that reasonable quality assurance assessments were performed. The Panel's review of the data used for the development of the minimum flows leads us to conclude that these data were the best available. The Panel reviewed the technical assumptions inherent in the methodologies used. The Panel determined that the assumptions used could be more clearly stated. However, the Panel was able to eventually determine that the assumptions used were reasonable and consistent with the best information available and that assumptions were minimized to the extent possible. The procedures and analyses utilized were appropriate and reasonable. They incorporated the appropriate factors and were correctly applied. The paucity of data available resulted in limitations and imprecisions. While the explanations of these could have been more thoroughly discussed in the text, the Panel's examination has lead to the conclusion that these limitations in information and resulting imprecision were reasonably handled. The procedures and analyses are repeatable, as they employ widely-used models and record extension techniques. The

conclusions reached in the report based on the procedures and analyses are supported by the data.

The Panel has determined that the methods used were scientifically reasonable. The Panel examined the entire report in great detail, and developed a set of suggestions and recommendations to possibly strengthen the work effort .

[redacted]

Issues from Panel on Draft Report Received on June 15, 2004

The following issues were identified by the Panel as being of sufficient importance to warrant comment but not sufficient to make the analyses unscientific or unsupportable. Some of the comments and suggestions have been addressed in the current version of the MFL report, while some have not. The Panel has chosen to present all of its comments below, for completeness of the record.

HYDROLOGY SECTION:

H-1. The text of the draft report presented a somewhat confusing discussion regarding the amount of actual data available for the spring itself. The text mentioned 23 data points in several places. The text referenced "approximately 25" data points in one section. The figures appeared to show 22 data points. The Panel requested and received clarification in an e-mail and phone call (July 2, 2004). There are 22 data points. This clarification was made in subsequent drafts.

H-2. The Panel questioned the rationale for the decision to divide the synthesized period of record discharge data for MBS into two periods of time (1932-52 and 1982-02) and received clarification as to the rationale for these time periods in an e-mail (July 6, 2004). Specifically, the Panel now understands that the year 1952 was chosen as the last year of pre-development hydrologic conditions, based upon a report by Johnston, et. al. (1980).

H-3. The report described one time frame for spring discharge (1932-72) as exhibiting an increasing trend and a second time period (1973-2002) as demonstrating decreasing trend. An examination of rainfall trends, particularly with respect to measured and calculated discharge trends over the period of record, would be a potentially useful exercise to attempt to ascribe causality.

H-4. The Panel noted one apparent discrepancy between text and table presenting data. In Section 3.1.1.2, Table 3-1 is noted as including maximum stage and discharge measurements. We were unable to find these measurements in the table.

H-5. Given that the cross-sections define the shoals, it would seem that interpolation would result in an overestimation of water depth (within HEC-RAS), calibration

problems, and would generate error in predicted stage. It would be helpful to include a discussion of this technical assumption.

H-6. The Panel noted that the HEC-RAS model run data were not included and recommends including these in the appendices and tabulating them in the text. We were unable to locate tables or text that describe what roughness coefficients were actually used. A latter version of the draft report does include these.

H-7. There were certain technical assumptions made inherent in attempts to synthesize information. It would be useful for the report to explain more fully what the major assumptions were and to discuss in more detail where error is most likely to be introduced.

H-8. Our understanding of the procedure was that the HEC-RAS model was calibrated against simulated Madison gage data. It would be useful to calibrate the model against real data as it becomes available.

H-9. If possible, a statistical examination of the error should be included and the results described in the final version of the report. Confidence intervals (at least qualitative or discussed) associated with the estimated data would be useful.

H-10. The Panel suggests a brief explanation of the simplified form of the equation used in this analysis (i.e., the rating curve) be provided. Were the parameters "y" and "a" fit using the statistical model or through trial-and-error? What are the best-fit values for these parameters? Also, an explicit definition of the data set in terms of the number of values and time frame (or reference to Table 3-1) would be useful.

H-11. The Panel suggests that the final report include an explanation of why equations (in Figures 3-8 and 3-9) were not developed with rating discharge as the dependent variable.

H-12. The Panel suggests that the final report include a plot of MBS discharge (y-axis) versus discharge difference.

H-13. A discussion of the more recent data from the new gage begins on page 3-20. Figure 3-18 is referenced in the first paragraph on page 3-20, but the Panel thinks it should be Figure 3-17 that is referenced. It is not clear in the draft report why these more recent data are not used in developing the equation in Figure 3-16. Also, on page 3-21, in the top paragraph, it is stated that the relationship breaks down at the extremes – this is not obvious from the graph. An explanation would clarify this point.

H-14. The authors may consider eliminating the use and discussion of lagged stage data as it is expected that unlagged (or contemporaneous) stage from gages so close to the short-term gage would provide the best association, and the correlogram discussion, while interesting and appropriate in general, adds unnecessary complexity. The impact of lagged rain is already manifested in the stage data with the possible exception of the

lagged effect of rain on MBS flow. The authors may want to explicitly define the data set in terms of number of values and time frame (or reference Table 3-1). The authors may want to speak to issues related to serial correlation of the data and correlation between the "independent" variables.

H-15. The Panel had difficulty following the analyses beginning with Section 3.3.2 "Predicting Spring Discharge", as it is not clear throughout the remainder of the analyses through Section 5 what relationship(s) were used and over what range of data.

H-16. It is not clear why the difference in flow between Madison and Lee gages was entered uniformly along the reach. Is this evenly distributed flow largely the MBS discharge?

H-17. It would clarify the report to explain how the determination has been made that the relationship in Figure 3-14 is the most appropriate to use for estimating MBS discharge.

H-18. A description in the text of the final report of why an apparent overestimation by HEC-RAS is not significant with regards to the decision to recommend a 70 cfs MFL would assist in clarifying the results of the report.

H-19. Regarding the relationship on page 4-16, it would clarify the rationale to explain why a functional relationship is necessary.

H-20. If the relationship shown in Figure 3-14 was not used in developing the flow duration curve, please clarify what data were used.

H-21. The Panel believes that a more concise explanation of how the MBS discharge data and the duration curves were developed would strengthen the report.

H-22. What is the relationship between the Madison stage and the Pinetta stage only (with constant)? The Panel suspects that fit is very good.

H-23. Shifting the discharge duration curve down while maintaining shape is equivalent to subtracting a constant at all discharge values. This would seem to suggest a strategy of water withdrawals that is independent of discharge. An MFL of 70 cfs does not preclude larger reductions of water at greater than minimal flow at MBS.

H-24. What percentage of total river flow is provided by MBS at various river flows, particularly at low river flow?

H-25. The text could include a description of how a minimum flow of 70 cfs yields a median flow of 100 cfs. The Panel suspects this statement is intended to relate to the fact that a first magnitude spring is defined as having a median flow of at least 100 cfs.

H-26. The Panel recommends that the final version of the report include a discussion of some of the major technical assumptions required to use synthesized data.

ECOLOGY SECTION:

E-1: In the absence of published literature, personal communications should be specifically referenced and adequately documented in the final version of the report. This was done in a subsequent draft.

E-2: The source and date of each photograph should be inserted, throughout the final version of the report. This was done in a subsequent draft.

E-3: Additional support could be developed by including a summary of the habitat requirements of observed fish species by life stage, and results from detailed studies (Page 4-5).

E-4: The authors could consider assessing historical, existing and predicted future land use changes within the watershed or recharge area relative to the spring recharge function similarly to the landscape level discussion in Dierberg and Wagner (2001).

E-5: Tabular summaries of the information would assist readers and simplify analysis of the results. This would be especially true of the voluminous benthic information.

E-6: The discussion of sensitive species could identify which fishes participate in the life cycles of the referenced mollusk species (page 4-8).

E-7: With specific reference to the gulf sturgeon (*Acipenser oxyrinchus desotoi*), the gulf sturgeon recovery plan (Wakeford 2001) notes that gulf sturgeon make limited use of the Withlacoochee River. Yet there is historical evidence that this species used to utilize this river. Are there data or evidence to suggest why the river is no longer utilized?

E-8: Results referenced in the discussion could be enhanced by an evaluation of water quality above and below MBS and some identification of significant inputs within the watershed that alter water quality (see Wakeford 2001).

E-9: Data were disproportionately presented; data for some resources were extensive (e.g., macroinvertebrates), while data for other resources for which the Panel would anticipate additional data to be available were not included (e.g., FWC fisheries creel census data). Limited data were presented for floodplain forests, which have an integral role in maintaining the ecological integrity of the river.

E-10: Some analysis of how larger fishes (we assume that the reference to “nearly all individuals” obliquely refers to larger fishes in the population) may be affected may be

desirable. The report could reference emerging fishery literature and the importance of larger mature fishes' contribution to the breeding success of the population.

E-11: The Panel suggests that the examination of each individual shoal could be more thoroughly described so the reader may ascertain that there is not one single shoal that totally or largely blocks upstream fish passage (the text simply states that shoal #2 has higher elevations than the others). The Panel understands the rationale for also pooling the shoal morphometric data in addition to examining each shoal individually.

E-12: There was minimal discussion of wetted perimeter within homogeneous river reaches, or of the relationship of the shoals to the rest of the river reach. A description of the desirability of such information and emphasis on the lack of such data would be useful.

E-13: Given the paucity of data, it is not possible to completely determine whether the assumption is valid that, if the spring is flowing, then spring and spring run species will be protected. It would be useful to provide a description in the text that at the proposed 70 cfs MFL a "full" pool condition in the spring would be maintained.

E-14: The Panel commends the monitoring recently implemented to help provide additional data.

E-15: The Panel understands why the shoals were selected as surrogates for not only other shoals but the entire river reach. The fact that there is little or no information on other reaches of the river to show cross-correlations could be stressed in the final report.

E-16: Additional analysis of medium and high flows related to the maintenance of the riparian wetlands both on-stream in the narrow floodplain below the bluffs, and in backwaters that require residual inundation, is important to the long-term ecosystem of this stretch of river.

E-17: The Panel appreciates the limitation of the analysis of the spring itself due to the lack of data to relate the relationship of the intra-cave ecology and proposed MFL.

E-18:The Panel recommends that more statistical analysis, where applicable, be used in the report, and that a sensitivity analysis be applied, if possible.

E-19: As the recommended minimum flow is based on a limited set of channel habitat measurements, we suggest future consideration of an in-stream habitat model as an approach that could further support the assessment conducted in the report. As available information on the system increases, the Panel believes the Instream Flow Incremental Methodology (IFIM) (Stalnaker et al. 1995; Bovee et al. 1998) and its associated software (Physical Habitat Simulation – PHABSIM) would provide an extremely useful tool to the SRWMD to further examine the reach of the river from MBS downstream to the confluence with the Suwannee River, including the six shoal areas. A succinct

discussion of the Physical Habitat Simulation Methodology (PHABSIM) developed by the National Biological Service (Stalnaker et al. 1995) was presented by Gore, Dahm and Klimas (2002). PHABSIM is a widely used technique that bridges the gap between a hydraulic model of a river reach and a prediction of available microhabitat in a model that interrelates depth, velocity, substrate and cover. The draft report acknowledged the importance of many instream habitat conditions, including submerged woody debris, substrate, and sediment transport. Many of the relationships that were examined in the draft MFL report could be addressed in more detail at a future time with the benefit of more data using this broader model. An important aspect of such an analysis would be the characterization of the river at additional transects within homogeneous river reaches to confirm that adequately deep pools will be maintained to provide holding habitat under low flow conditions. The Panel recommends that the Suwannee River Water Management District consider the applicability of PHABSIM, and its accompanying decision matrix model 'Instream Flow Incremental Methodology', in future examinations of the MBS system.

E-20: With respect to the ten water resource and human use values listed in 62-40 FAC, the Panel was unable to find any presentation concerning wildlife habitat (part of the same water resource value as is fish habitat and fish passage). The report provides no data on spring pool depths as they may relate to recreation in and on the water, nor is there any discussion of recreational use on the portion of the Withlacoochee River that is the direct recipient of the discharge from MBS. The Panel did not note any discussion of the 70 cfs flow as it might relate to aesthetic and scenic attributes. The Panel suggests that the U. S. Forest Service visual analysis criteria, or other methods, could be utilized to examine this particular water resource value. From the Panel's viewing of various photographs of MBS (*cf.* photos 1-5 WRA report; Scott et al. 2002, p.97), it is clear that varying stage level has a significant effect on exposed bank and spring pool.

E-21: The approach for determining macroinvertebrate production and fish passage depths across six shoals was technically appropriate. Information on the typical in-stream flow velocities that would be expected from the proposed MFL would be valuable. Both high range and low range velocities affect various organisms.

E-22: Sediment transport flows are important throughout the year to maintain normal channel morphometry and habitat integrity. In future years, an evaluation of the flow velocity regime relative to sediment transport capability could be conducted to expand confidence in the proposed MFL regime.

LITERATURE CITED

All documents referenced in the Peer Review Report are listed below. Those documents actually examined by the Panel as part of the Peer Review Process are identified with a (*)

Biological Resource Associates. 2004. Madison Blue Spring. Baseline/First Annual Monitoring Report. Report submitted to Nestle' Waters North America, Inc., Zephyrhills, FL 27 pp. plus 1 Appendix.

*Dierberg, F. E. and K. J. Wagner. 2001. A Review of "A multiple-parameter approach for establishing minimum levels for Category 3 lakes of the Southwest Florida Water Management District. Southwest Florida Water Management District, Brooksville, FL.

*Chapter 373.042 (1)(a), Florida Statutes.

*Chapter 373.042 (1) (b), Florida Statutes.

*Chapter 373.042 (2), Florida Statutes.

Foose, D.W. 1981. Drainage Areas of Selected Surface-Water Sites in Florida: U.S. Geological Survey Open-File Report 81-482, 83 p.

Franklin, M.A., G.L. Giese, and P.R. Mixson. 1995. Statistical summaries of surface-water hydrologic data collected in the Suwannee River Water Management District, Florida. U.S. Geologic Survey, Open File Report No. 94-709, 173 p.

Franz, R., J. Bauer, and T. Morris. 1994. Review of biologically significant caves and their faunas in Florida and South Georgia. Brimleyana, No. 20. The Journal of the North Carolina State Museum of Natural Sciences, Raleigh, NC.

Giese, G.L. and M.A. Franklin. 1996a. Magnitude and frequency of low flows in the Suwannee River Water Management District, Florida. U.S. Geological Survey, Water Resources Investigations Report No. 96-4308, 62 p.

Giese, G.L. and M.A. Franklin, 1996b. Magnitude and frequency of floods in the Suwannee River Water Management District, Florida. U.S. Geological Survey, Water Resources Investigations Report No. 96-4176, 14 p.

*Gore, J. A., C. Dahm and C. Klimas. 2002. A review of "Upper Peace River: An analysis of minimum flows and levels". Southwest Florida Water Management District, Brooksville, FL.

*Hupalo, R.B., C.P. Neubauer, L.W. Keenan, D.A. Clapp and E.F. Lowe. 1994. Establishment of Minimum Flows and Levels in the Wekiva River System. Technical Publication SJ94-1. St. Johns River Water Management District, Palatka, Florida.

Johnston, R. H., R. E. Krause, F. W. Meyer, P. D. Ryder, C. H. Tibbals, and J. D. Hunn. 1980. Estimated potentiometric surface for the Tertiary Limestone Aquifer System, Southeastern United States, prior to development. U. S. Geological Survey, Open File Report 80-406, map with text.

Morris. personal communication (unpublished data), from WRA 2004 report.

Scott, T.M. 1988. The Lithostratigraphy of the Hawthorne Group (Miocene) of Florida. Florida Geological Survey Bulletin 59, 148 p.

Scott, T.M., J.M. Lloyd, and G. Maddox. 1991. Florida's Groundwater Quality Monitoring Program – Hydrogeological Framework. Florida Geologic Survey Special Publication No. 32, 97 p.

*Scott, T.M., G.H. Means, R.C. Means, and R.P. Meegan. 2002. First Magnitude Springs of Florida. Florida Geological Survey, Open File Report, No. 85, 138 p.

*Southwest Florida Water Management District (SWFWMD). 2002. Draft Report: Upper Peace River: an analysis of minimum flows and levels. Southwest Florida Water Management District, Brooksville, FL.

*Stalnaker, C., B.L. Lamb, J. Henrikson, K. Bovee and J. Bartholow. 1995. The Instream Flow Incremental Methodology. A Primer for IFIM. Biol. Rpt. 29, National Biological Service, Washington, D.C.

*U.S. Army Corps of Engineers. 2003. HEC-RAS 3.1.1 Hydrologic Engineering Center River Analysis System.

*Wakeford, A. 2001. State of Florida Conservation plan for gulf sturgeon (*Acipenser oxyrinchus desotoi*). FMRI Technical Report TR-8. Florida Marine Research Institute, Florida Fish and Wildlife Conservation Commission, St. Petersburg, FL.

White, W.A. 1970. Geomorphology of the Florida Peninsula: Florida Geological Survey, Bulletin 51, 164 p.

APPENDIX A

RESUMES OF THE PEER REVIEW PANEL