SCIENTIFIC REVIEW OF THE DETERMINATION OF MINIMUM FLOWS FOR THE LOWER MYAKKA RIVER

Scientific Peer Review Report prepared for the

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December 10, 2010

Summary and Recommendations

The Southwest Florida Water Management District (the District) is mandated by Florida statutes to establish minimum flows and levels (MFLs) for state surface waters and aquifers within its boundaries for the purpose of protecting the water resources and the ecology of the area from “significant harm” (Florida Statutes, 1972 as amended, Chapter 373, §373.042). The District implements the statute directives by annually updating a list of priority water bodies for which MFLs are to be established and identifying which of these will undergo a voluntarily independent scientific review.

This document represents an independent scientific review of the District’s proposed MFL for the Lower Myakka River. An MFL is already in place for the Upper Myakka River, which flows approximately 34 miles until it reaches Lake Myakka, after which the Lower Myakka River continues downstream approximately 32 miles (52 km) to its mouth in the upper bay and estuary of Charlotte Harbor. The watershed of the entire Myakka River, which measures some 602 square miles (1,559 km^2), is ecologically valuable because of the abundance, diversity and quality of its living ecosystem. It contains more freshwater wetlands than any other area in Charlotte Harbor region and it also includes extensive tidal wetlands. The central portion of the watershed features a large complex of public conservation lands. As a result, much of the Myakka River watershed has been given special protective designations as a State of Florida Wild and Scenic River, an Outstanding Florida Waterway and a State of Florida Aquatic Preserve. The watershed even has large expanses of dry prairie that are considered a globally imperiled habitat. The remainder of the watershed contains ecologically characteristic depressional marshes interspersed with pine flatwoods and hammocks.

The Lower Myakka is tidally affected over much of its length. The wetland plant community along the river includes hardwood forest upstream and then grades through tidal freshwater, oligohaline, and salt marshes (mixed with mangroves) towards the mouth. The area is home to diverse and abundant fish and zooplankton that support the resources of the river (e.g. wading birds), and serves as a prime nursery for several economically important fisheries in the Charlotte Harbor region, including mullet, snook, red drum, tarpon, spotted seatrout, pink shrimp and blue crab. The Charlotte Harbor Estuary, an Outstanding Florida Water, is one of Florida's most pristine estuarine ecosystems, containing extensive seagrass meadows, mangrove swamps and intertidal salt marshes, which provide food and shelter to the Florida subspecies (*Trichechus manatus latirostris*) of the endangered West Indian manatee, and serve as nurseries for shrimp, crabs, and estuarine-dependent marine fishes. Further, the Southwest Florida Water Management District’s (the District’s) Surface Water Improvement and Management (SWIM) program lists the area as a priority waterbody for restoration and protection.

Freshwater inflow to the Lower Myakka has been highly modified due to changes in the watershed, primarily because of increased discharge from irrigated agriculture. The District’s MFL Report describes the conversion of agricultural lands since about 1972 into croplands that require substantially more irrigation, and how the resulting agricultural return flows bring large quantities of groundwater to the upper Myakka River creating a situation of excess flows. The District has developed a Myakka River Watershed Initiative to create management plans for reducing/removing excess flows in the upper river reaches. At the same time, water has been diverted from the Lower Myakka through the Cow Pen

Slough and Blackburn Canals, although these diversions are only important during periods of above normal flows. There is currently one permitted withdrawal on the Lower River: the City of North Port withdraws water from the Myakkahatchee Creek.

The District's approach for setting the MFL for the Lower Myakka River was to determine inflows to the system without the excess flows from the upper portion of the watershed, and to compare this with current conditions (which were taken as baseline). Excess flows were estimated using a water budget model of the watershed (the MIKE SHE modeling platform). Three hydrodynamic / salinity / temperature models were used in determining the MFL for the Lower Myakka River. A three dimensional (3D) model of the entire Charlotte Harbor and a portion of the Gulf of Mexico (45 km off shore) that was developed by the University of Florida was used to provide boundary conditions to a combined 3D (LESS3D) and laterally averaged (LAMFE) 2D model of the UCH-LMR-LPR system. The University of Florida (UF) 3D model utilizes a boundary fitted grid in the horizontal plane and a sigma stretched grid in the vertical plane. This model was run for the same simulation periods that were run in the combined 3D / 2D model of the UCH-LMR-LMP system. Also, to aid in estimating ungaged flows for input into the UCH-LMR-LPR 3D/2D model, a HSPF watershed model of the lower basin was employed.

Baseline flows, as well as various inflow reduction scenarios (removing excess flow and then removing additional water beyond this amount), were evaluated, as was the effect of the City of North Port's withdrawal. These observations were used in association with a hydrodynamic model to predict estuarine salinity. The model was used to evaluate changes in river bottom area and water volume in various salinity zones for the different scenarios. Regressions were used to predict the location of the 2 psu isohaline in response to changes in inflow as a way to evaluate effects on oligohaline tidal freshwater wetlands in terms of both shoreline length and area; additional inflow regressions were used to evaluate the abundance and center of distribution of selected fish and invertebrate species in the river.

The District's management goal for the Lower Myakka River is to maintain ecosystem integrity and, thereby, protect ecological health and productivity. As a result, the District's MFL was developed to limit potential changes in aquatic and wetland habitat availability associated with reductions in freshwater inflows (SWFWMD 2010). When biologically meaningful thresholds or breakpoints were not found in the more or less continuous physical, chemical and biological responses, as is often the case in field studies, a criterion of no more than a 15% loss of habitat or other resources, as compared to the estuary's baseline condition, was used as the limit for "significant harm."

The District's analysis showed that the maximum permitted withdrawals from the City of North Port made little difference to the Lower River. However, removal of excess flows, without any further withdrawals, caused some parameters to show more than a 15% decrease as compared to the baseline condition (in terms of shoreline length and area of wetlands as well as abundance of some fish and invertebrates), particularly during the driest part of the year (Block 1). The centers of distribution of the organisms also moved upstream as flows decreased. During other parts of the year, when flows are higher, the predicted changes caused by the removal of excess flows was generally less than 15%.

The proposed MFL for the Lower Myakka River is to allow no more than the removal of excess agricultural flows (up to 130 cfs) until gauged streamflows at the Myakka River near Sarasota exceed 400 cfs. Above 400 cfs, the District proposes the allowance of 10% of the daily flow at the Sarasota gage, determining that this will not cause significant harm to the lower river and its living resources. The City of North Port withdrawals will be allowed to remain in place.

The major conclusions and recommendations of the Panel are as follows:

1. Because of the generally good ecological heath of the lower Myakka river in its current condition, the Panel agrees with the District's choice of the existing flow regime of the river as the baseline for assessing the effects of future withdrawals. However, it would be useful to compare the scenario in which excess agricultural flow is removed from the current conditions, which were simulated for this report, with the historic condition (e.g. before these diversions were in place and before excess flow augmented runoff in the upper watershed).

2. Several models were used in this analysis. The MIKE SHE model was used to estimate runoff to the river. A distributed hydrological model like the MIKE SHE model can potentially provide a more accurate prediction of daily stream flow and water table depth under varying climatic conditions, and the Panel agrees with the model evaluation and selection based on the Myakka River Watershed Initiative criteria. The Panel further concludes that the UCH-LMR-LPR numerical hydrodynamic / salinity / temperature model is an appropriate model to be used to predict salinity in the estuary.

3. The HSPF model was used to compute ungaged flows, and these predictions had to be reduced by approximately 50% to arrive at a good calibration of the UCH-LMR-LPR hydrodynamic model. When one has to adjust boundary conditions to match model results with recorded data in the interior, it is always a reason for concern. Despite its drawbacks, the Panel does acknowledge that the HSPF model was an appropriate model to be applied in an attempt to estimate the ungaged flows in the LMR and LPR sub basins, and that the District employed the best available data. Although there is substantial room for error in the absolute inflow values, as long as the inflow estimates are used consistently, as they were, then the relative numerical differences between one modeled scenario run and the next will be the same across all hydrologies.

4. The Panel accepts the District's plan to remove excess flows in the upper watershed as established policy. However, the amount of excess flow that is being remove will be substantial (predicted average flow during Block 1 would be reduced by almost 20% during the minimum flow study period, from 122 to a predicted 98 cfs). Moreover, the District's analyses show that removal of excess flows, without any further withdrawals, will cause most parameters in the Lower Myakka to show more than a 15% decrease as compared to the baseline condition during low flow conditions. The District has argued that this is acceptable because the River will be restored to its condition before flow augmentation began. However, it is difficult to accept that a substantially lower flow will protect the ecological health and productivity of this tidally affected river and the receiving bay and estuary system. Given these results, the Panel has several recommendations:

a. The District should estimate a conservative threshold to determine what flow levels during Block 1 will constrain the reductions in habitat to 15% or less.

b. The District should consider monitoring the removal of excess flow under the MFL, so that they will be in a position to know when this removal is approaching the flows that will result in changes in resources greater than 15%. The Panel understands that estuaries like the Lower Myakka River are highly non-linear, which means that impacts will be magnified during low flow periods, both seasonally and interannually.

c. The District should choose a sensitive indicator such as OTF distribution or one of the more sensitive fish and continue to monitor the system for the purpose of determining whether the reduced flows have the effects predicted in the MFL analysis.

d. If removing excess flows does cause a substantial change in resources, the District should consider options to at least partially replace lost excess flows during low flow periods, especially in the springtime when estuarine nursery habitat usage is highest.

5. The large amount of water scheduled to be removed in the upper watershed, coupled with the level of uncertainty in the statistical and mechanistic models used in the MFL analysis, makes it difficult to support the estimated allowable 10% flow reduction at high flows. Moreover, it is unclear why 400 cfs was chosen as the threshold above which 10% withdrawals would be allowed. The hogchoker, for example, would be better protected if the threshold were > 700 cfs (see Fig. 8-46C). The panel recommends this high flow threshold be revisited.

6. Given the scope of this MFL, the District's focus on the Lower Myakka, as opposed to determining the inflow needs of the entire bay and estuary system at once, means that it was appropriate to focus on freshwater and resident brackish water taxa to evaluate the effect of inflow changes. Presumably this means that the District will have to add up the MFL's for the various riverine parts in order to obtain the freshwater needs for the total coastal system, an eventual goal of most freshwater inflow analyses. If the sum of the parts does not comport well with the needs of the entire coastal bay and estuary system, and their living resources of ecological and economic importance, then some revisions in the MFL's may be in order.

7. The report provides several suggestions for ongoing analysis and additional data collection that the Panel supports, as these are good opportunities to improve the hydrology and the other important statistical and numerical models, not the least of which is to continue to collect more and better data so that a revised MFL can be determined in the future. These include:

a. Continued seine and trawl sampling would potentially strengthen the inflow relationships observed between nekton abundance and distribution in the lower Myakka River. In particular, additional data collection during dry years would be helpful in learning more about the response of the fish community to steep salinity gradients with much compressed salinity habitats in the Myakka River. However, the Panel does not feel that the Myakkahatchee Creek is as important here, since the natural channel was destroyed long ago and water control structures provide barriers to mobile species.

b. Continued monitoring for the purpose of verifying that the MFL is having its intended effect of maintaining ecological health and productivity of the Myakka River System, especially if the minimum flows are at unreasonable variance with current conditions that seem to be maintaining the lower river and the braided reach of nursery habitats above the confluence with Salt Creek. The verification monitoring should include streamflows, tidal flows, basic water quality (including temperature, salinity, pH, DO and chlorophyll), benthos and nekton, particularly during the dry season, which coincides with the beginning of peak utilization of nursery habitats by the young of estuarine-dependent fish and shellfish species.

c. Finally, the panel thinks it is very important to keep the new gages in place, to be able to accurately assess freshwater inflow to the lower portion of the River. In particular the gage below Blackburn Canal should be maintained so that it will be possible to estimate how much water is diverted. Flows in Myakkahatchee Creek are also an important contribution. When sufficient data exist additional model simulations should be made, which will likely yield more accurate computations and improve the results of the 2D/3D model and the MFL as well.

8. The Panel recognizes that setting this MFL is one piece in a larger context that is affected by activities in the Upper Myakka River and watershed, the adjacent Rivers, and Charlotte Harbor itself. We also understand that MFLs are set using the best available data. In the case of the Lower Myakka River, the Panel strongly encourages the District to take an adaptive management approach in this system and to evaluate the options for offsetting ecological changes the lower river might experience as the result of removing excess flows in dry periods. We also encourage the District to re-evaluate this MFL once additional data are available.

9. Editorially**,** this report is not as clear and readable as desired. It is repetitive and several of the chapters are poorly organized (particularly Chapters 4 and 6, see specific suggestions in Section 3). There is also a tendency to present information in several ways (e.g. showing regressions developed for one vs. several gages; evaluating things for all flows and then just the domain of the regression, etc). Although these additional analyses can provide additional information, it made the report confusing in places and more like a data exploration (plus, it makes for a very unwieldy report). On a related note, the document presents data for a lot of different time intervals. In the final analysis the 10 year period of the SHE modeling and the 4 year period of the hydrodynamic modeling were used. The Panel agrees that showing both a wet and a dry period can be instructive (and we understand the constraints imposed by the modeling period), but all of the different intervals were confusing. In order to improve the readability of the report, it seems like it would be better to only present the analyses that were actually used in the MFL or otherwise considered the most important or the most conservative in the main document, and put the rest of the analyses in appendices. Likewise, the Panel suggests that the District consider picking two time periods to present in the main body of the report, with additional information included in appendices.

Review

The District's MFL report provides information on the physical and hydrological characteristics of the watershed of the Myakka River and the changes that have occurred over time. It describes the current characteristics of the estuary, including its bathymetry, shoreline features, salinity, water quality, and flora and fauna. The review below is divided into three sections: Section 1 is an evaluation of the modeling aspect of the project; Section 2 presents comments on the other aspects of the report and reviews the setting of the MFL; Section 3 provides detailed comments and questions on a chapter-by-chapter basis; Section 4 presents the Panel's response to the recommendations of the Charlotte Harbor National Estuary Program. At the end of the document (Appendix A) is a list of errata and minor editorial comments. **The Panel's conclusions are written in bold**, and our <u>suggestions for further study or questions for the District are underlined</u>.

Section 1. Modeling

Three hydrodynamic / salinity / temperature models were used in determining the MFL for the Lower Myakka River. A) A MIKE SHE model of the upper Myakka River watershed was used to estimate flows into the lower Myakka River. B) A HSPF watershed model of the lower basin was employed for estimating ungaged flows. Both were used as inputs into the Upper Charlotte Harbor - Lower Myakka River – Lower Peace River (UCH-LMR-LPR) 3D/2D model. C) A three dimensional (3D) model of the entire Charlotte Harbor and a portion of the Gulf of Mexico (45 km off shore) that was developed by the University of Florida was used to provide boundary conditions to a combined 3D (LESS3D) and laterally averaged (LAMFE) 2D model of the UCH-LMR-LPR system.

Each of these models is reviewed individually below, but an overall suggestion is that <u>the District should consider conducting quantitative uncertainty analyses on the models it uses for flow recommendations.</u> Along these lines, the U.S. Army Corps of Engineers has instructed all its Districts to consider uncertainty in their projects, particularly those related to flood alleviation and ecosystem restoration. Determining the level of uncertainty in a model, or a cascade of models, is a normal procedure in some scientific disciplines, but it is only just beginning to be applied to water resources projects.

1A. MIKE SHE

The MIKE SHE model was used to determine the excess flows into the lower Myakka due to increased runoff from agricultural irrigation in the upper Myakka basin. The MIKE SHE model (Interflow 2008) is an integrated surface and ground water simulator that tries to account for all the major land-based processes of the hydrologic cycle from rainfall to river flow via various physical pathways such as overland flow, infiltration into soils, evapotranspiration from vegetation, groundwater flow in both saturated and unsaturated strata, and surface/ground water interactions. This model was used during the MFL analysis for the Upper Myakka River and hence has already been reviewed as part of that process. However, a few comments are provided here.

Sensitivity of the MIKE SHE model to structural parameters such as grid size and time step, and to the functional parameters, including hydraulic resistance coefficient, surface and subsurface hydraulic properties, has been investigated previously (Xevi et al. 1997). The results indicated that peak overland flow and the total overland flow were very sensitive to the flow resistance parameters and to the vertical hydraulic conductivity of the surface soil, while the peak aquifer discharge and the total aquifer discharge were sensitive to the horizontal hydraulic conductivity in the saturated zone. The model output variables considered were not affected to a significant extent by the vegetation parameters or by the specific storage coefficient.

Problems with such distributed models include over-parameterization and uncertainties in model predictions due to variability in the large number of input parameters. In many cases, the model parameter values are simply not available, which makes it difficult to properly set up the model. As a result, model use requires a great deal of technical expertise and the learning curve is steep for new users. Because of the high uncertainties, distributed models may perform poorly even if they are calibrated well using data from another time period, and similar problems can occur when models are tested against data from different study sites (Dai et al. 2010). As a result of the model's complexity and data requirements, some investigators have reported difficulties in using this commercial modeling package to produce reliable simulations of flow. Other investigators have concluded that a simple lumped parameter model could perform equally well at the monthly temporal scale for modeling stream flow under average climatic conditions. However, **the Panel agrees with the model evaluation and selection of MIKE SHE** based on the Myakka River Watershed Initiative criteria.

The application of the MIKE SHE model to the Myakka used a grid cell resolution (125 m) for both the groundwater and surface water models, which appears to be reasonable. The NEXRAD rainfall adjustment factors, using measured rain gage data, conforms to standard engineering practices and the soils and land use discretization are reasonable. For the purpose of computing water balance, the two-layer groundwater model is adequate and the general order of magnitude of the various water budget components appears to be reasonable. The model calibration and verification are fairly good. However, based on the Double-Mass analysis of the Myakka River State Park NWS gage, additional investigation should be conducted to determine why there is a gage discrepancy compared to surrounding gages. If the gage was moved during the period of record, the rainfall records should be adjusted to reflect the amounts being measured at the current location.

Bridges and culverts at road crossings were not simulated because their effects were assumed to be localized and significant only during flood events. Given the detail that the modelers used in the other areas, in addition to modeling continuous period of records with computational time steps on the order of seconds and minutes, in future applications modeling bridges and culverts at road crossings should be considered. The mild slopes of this area could cause back water effects to propagate further than the localized area. In addition, water storage in the floodplain due to back water caused by these obstructions could cause changes in flow timing.

1B. HSPF

HSPF is a well known watershed model that has been used in many studies of rainfall runoff over the United States. HSPF simulates hydrologic and associated water quality processes on pervious and impervious land surfaces and in streams and well-mixed impoundments. The HSPF model in this effort was primarily constructed to provide estimates of the ungaged flows in the Lower Myakka and Lower Peace River sub basins for input to the numerical hydrodynamic and salinity model discussed in the next section. (About 16% of the Lower Peace River sub-basin and 50% of the Lower Myakka River sub basins are ungaged.)

The reviewers agree that the HSPF model is well known and tested, often producing more precise estimates than a simple drainage-area ratio or similar shorthand techniques for estimating runoff, but it too is filled with input parameters that must be specified accurately. Unfortunately, assessments of model performance indicated the ungaged flow values predicted by the HSPF model might be too high, as the estuarine model tended to under-predict salinity. The District adjusted the daily ungaged flows produced by the HSPF model by a constant coefficient (0.507) derived by comparing mean HSPF modeled flows to mean flow values from unit area runoff estimates for rural versus urban areas made by SDI consultants. This 50.7% reduction in the estimated ungaged flows improved performance of the estuarine hydrodynamic (circulation and salinity) model; however, the District reports that application of the estuarine model to different gauged inflow scenarios in the MFL determination for the years 1999-2002 only used ungaged flow values computed by SDI consultants.

The Panel notes that the HSPF model was calibrated using three gages, only one of which (Deer Prairie Slough at Power Line near North Port Charlotte) is shown in Table 2-2 of the report. The other two gages used for model calibration were Big Slough at North Port Charlotte and Gator Slough in southern Charlotte Harbor, the latter of which doesn't contribute to Myakka River inflows. The Panel suggests that existing records from the other inputs to the lower River (Deer Prairie Slough, Warm Mineral Springs/Salt Creek, and Big Slough/ Myakkahatchee Creek), although short-term, would still be valuable for checking the output from the rainfall runoff model (i.e., the HSPF model) from these important sub-basins. Another approach would be to use the hydrodynamic models of the receiving bay and estuary as another estimate of how much freshwater is mixing with sea water to produce the observed salinity gradient. In this case, the UCH-LMR-LPR model could probably have been applied in a sensitivity sense to arrive at the ungaged flows that gave a good calibration, negating the need for the HSPF model.

The fact that the HSPF flows had to be reduced so much leads one to question the model results. However, **the Panel does acknowledge that the HSPF model was an appropriate model to be applied in an attempt to estimate the ungaged flows in the LMR and LPR sub basins and employed the best available data.**

1C. UPPER CHARLOTTE HARBOR – LOWER MYAKKA – LOWER PEACE HYDRODYNAMIC MODEL

In order to develop a hydrodynamic model of the Lower Myakka River (LMR), one must also consider the interaction of the LMR, the Lower Peace River (LPR) and the upper part of Charlotte Harbor (UCH). The

Lower Myakka and Peace Rivers provide freshwater flows into Upper Charlotte Harbor, and the hydrodynamics and salinity conditions in the Harbor impact the circulation and salinity conditions in the Rivers. Thus, it is important to develop a numerical model that includes all three segments in order to model the LMR.

The flow pattern in the UCH is generally three dimensional (3D), so a 3D hydrodynamic model (including salinity and perhaps temperature) is required for this area. However, as one moves up into the LMR and the LPR the flow pattern is more two dimensional (2D), with the dimensions being along the river and over the depth. Thus, a 2D laterally averaged hydrodynamic model can be employed in the upper portions of these rivers. The hydrodynamic modeling was performed using the District's LESS code that dynamically links a laterally-averaged 2-D model (LAMFE) to a 3-D hydrodynamic model (LESS3D).

Assuming that the elevation of the river bed does not rise above mean sea level, the 3D model could be extended up to cover the LMR and the LPR. The report states that the bed elevation in the LMR doesn't intercept the mean sea level until above river km 40. However, additional resolution would be required in the 3D model in the upper reaches of the LMR and the LPR. Thus, modeling those portions of the rivers with the 2D model is appropriate.

The discussion below answers the following questions: (i) was the appropriate model employed, (ii) was there sufficient geometric / bathymetric data available to generate a numerical grid, (iii) does the numerical grid have sufficient resolution to address issues the modeling is expected to resolve, (iv) are there sufficient data to set boundary conditions, and (v) was the model sufficiently calibrated / validated.

1Ci. Was the appropriate model employed?

The LESS3D and LAMFE models constitute the two models that make up the UCH-LMR-LPR model (LESS). The LESS3D model is a hydrostatic 3D model that computes a 2D water surface field and 3D fields of velocity, salinity, and temperature. The LAMFE model is a 2D laterally averaged hydrostatic model that makes computations for a one dimensional (1D) water surface field along the river and 2D fields of velocity, salinity, and temperature along the river and over the depth. Both LESS3D and LAMFE are well developed models. They both employ a finite difference solution scheme to solve the governing equations of motion. Both models are quite efficient due to employing a semi-implicit solution scheme that removes the very restrictive speed of a free surface gravity wave from the allowable computational time step. Thus, the basic restriction on the magnitude of the time step is determined by the speed of a water particle and the size of the spatial steps in the numerical grid.

Both the LESS3D and LAMFE models utilize a Cartesian coordinate system in both the longitudinal and vertical direction. In 2D vertically averaged and 3D models, some finite difference models (e.g. the 3D UF model) utilize a transformed boundary fitted coordinate system in the horizontal dimensions and a type of vertical boundary fitted coordinate system often referred to as a sigma grid. With a vertical sigma coordinate system, a coordinate line always follows the free surface and a line always follows the bottom topography. Interior lines and the line following the water surface then move in time with the rise and fall of the water surface. Such a grid system is able to model the bottom topography quite well. However, the problem with a sigma vertical coordinate system is that water column stratification cannot be maintained very well near significant slopes in the bottom topography unless the grid resolution is quite fine. This problem is not encountered in models that utilize a Cartesian vertical grid since derivatives of the horizontal pressure gradient terms in the momentum equations are evaluated along levels of constant pressure. Thus, a grid system that utilizes a Cartesian vertical grid but still models the bottom topography accurately would seem to be the best of both worlds. The LESS3D and LAMFE models do this through representing the bottom topography in a piece wise linear fashion while still utilizing a Cartesian system over the remainder of the water depth. This procedure does present some rather complicated control volumes along the bottom of the water body, but once the computer coding is accomplished presents no particular complication in the computations.

A special feature of the UCH-LMR-LPR model is the manner in which the 3D LESS3D and 2D LAMFE models are coupled. Computations for the water surface elevations at the boundary of the two models are performed in such a way that they are computed simultaneously. Final velocities at the new time step are calculated after the final water surface elevations in both the 3D and 2D domains are computed. The new velocities are then employed in the transport equations for the salinity and temperature. Thus, the computations are fully coupled such that there is a two way feedback between the 3D and 2D domains.

The Panel concludes that the UCH-LMR-LPR numerical hydrodynamic / salinity / temperature model is an appropriate model to be used to aid in setting the MFL for the LMR.

1Cii. Was there sufficient geometric / bathymetric data available to generate a numerical grid?

The report does not explicitly state the source(s) for the bathymetry data employed in the creation of the numerical grid. However, based on the fact that other rivers in the SWFWMD have good bathymetry data, **the Panel feels that the best available bathymetry data were employed**. <u>The District should state in the report the source(s) for the bathymetry data used in the UCH-LMR-LPR numerical model. If changes are suspected from tropical storms, hurricanes, or human activities, then the District should consider updating the bathymetry before the next round of modeling.</u>

1Ciii. Does the numerical grid have sufficient resolution to address issues the modeling is expected to resolve?

The numerical grid is a rectilinear or Cartesian grid that allows for a variable cell size. Thus, in the 3D grid there are many grid cells that are land cells. However, as the water level rises some land grid cells can become water cells and are treated as active computational cells at the new time step.

The 3D grid covers the UCH, 13.8 km of the LMR, 15.5 km of the LPR, and 1.74 km of the lower Shell Creek. There are 108 cells in the E/W direction, 81 cells in the N/S direction, and 13 vertical layers. The size of the cells vary from 100 m to 500 m in the horizontal plane and 0.3 m to 1.0 m in the vertical.

The 2D grid covers the LMR up to river kilometer 13.8, the LPR to 38.4 km, the LPR from 15.5 km to Arcadia, the Shell Creek from 1.74 km to the dam, 4.16 km of the Myakkahatchee Creek, and various other branches of the LPR. The upper limit of the LMR did not extend to the upper limit of the lower river at about 51 km since there was little data and a reduced likelihood of significant harm. All of the 2D grid segments consist of a total of 356 longitudinal cells and 17 vertical layers. The 13 layers of the 3D grid correspond exactly to the same 13 layers of the 2D grid. <u>There appears to be some confusion in Table 2 of Appendix 5. Are the headers for the 3D and 2D grids interchanged?</u>

The Panel agrees that the coupled 3D / 2D grids of the UCH-LMR-LPR model have adequate resolution to resolve the hydrodynamics / salinity / temperature computations of the modeled system.

1Civ. Are there sufficient data to set boundary conditions?

Data required to specify boundary conditions for the UCH-LMR-LMP numerical model consist of freshwater inflows; water surface elevations, salinity and temperature at the UCH grid open boundary; winds over the numerical grid domain; and meteorological data at the water surface over the modeled domain. Freshwater inflow data consisted of both gaged and ungaged flows.

The simulation period for the calibration / validation of the numerical model was from 6/13/2003 to 7/12/2004. For this period gaged daily flows for input to the UCH-LMR-LPR were available. These were prescribed at the upstream boundaries of the LMR (38.4 km), LPR (Arcadia), the Myallahatchee (4.16 km) and Shell Creek (dam) of the 2D domain of the modeled system. Regression equations were used to estimate the exchange of flow between the LMR and Dona / Roberts Bay through Blackburn Canal. Two sets of equations were developed. One related canal flow to measured flow at the Sarasota gage on the Myakka River while the other related canal flow to the measured water depth at the Sarasota gage. It appears these regressions give good results on estimating the flow in the Blackburn Canal.

As previously noted, about 16% of the LPR basin and about 50% of the LMR basin are ungaged, which represents a significant part of the total freshwater flow. The HSPF model of the modeled system provided estimates of the ungaged flows that were generally much too high and had to be adjusted downward. **When one has to adjust boundary conditions to match model results with recorded data in the interior, it is always a reason for concern. However, it appears there was no choice in this effort.**

The 3D UF hydrodynamic model of the Charlotte Harbor also included the LMR and LMP along with a portion of the gulf extending out for about 45 km off shore. It is difficult to ascertain the grid resolution in the UF model from Figure 18 in Appendix 5 of the report. <u>Rather than developing the 3D / 2D UCH-LMR-LPR model, one might question why the UF model wasn't used to aid in establishing the LMR MFL. Other than the argument about modeling the river better with a 2D laterally averaged model, were there other reasons for not using the UF model to assess the impact of flow reductions on bottom area, water volume, and shoreline lengths for different salinity zones.</u>

The UF model was run for the same 13 month period of 6/13/2003 to 7/12/2004. Water surface elevations, salinities, and temperatures from the UF model were saved at the southern boundary of the UCH-LMR-LPR grid and employed as boundary conditions. Unlike the coupling of the 3D and 2D models of the UCH-LMR-LPR at the boundaries where the computational domain transitioned from a 3D domain to a 2D domain, <u>there is no feedback between the UF model and the UCH-LMR-LPR model. The District should discuss whether they feel this is important.</u>

Wind data were taken from the UF station in Upper Charlotte Harbor and used to compute shear stress on the water surface. These shear stresses were considered spatially constant.

Meteorological data such as solar radiation, air temperature, etc. were collected at the UF station and at a station near the Peace River Manasota Regional Water Supply Authority. These data were used to compute the surface heat exchange at the water surface that is needed in the temperature computations.

The Panel feels that the data available for setting boundary conditions during the calibration / validation simulation as well as for the four year production simulation are adequate.

1Cv. Was the model sufficiently calibrated / validated?

There were eight interior stations where water surface elevations, salinity, and temperature data were available to aid in the calibration of the model. There were three stations in the LMR (El Jobean, North Port, and Snook Haven), three stations in the LPR (Punta Gorda, Harbor Heights, and Peace River Heights), one station on Shell Creek, and the UF station in UCH. In addition, water velocity data were available at several vertical locations at the UF station.

There is very little stratification in salinity except at the lower stations, e.g. El Jobean, Punta Gorda, and the UF station. Except during an extremely dry period in June 2004, no salinity appears at the upper stations of Snook Haven on the LMR and Peace River Heights on the LPR.

Data collected during the period of 12 Dec 2003 to 9 Apr 2004 were employed in the calibration of the model, with data from 13 Jun 2003 to 9 Jan 2004 and 19 Apr 2004 to 11 Jul 2004 used to verify or validate the model. In the simulations, the first 30 days of the simulation were used to spin up the computations. Thus, there was no attempt to try to accurately specify the initial salinity field. Model parameters such as bottom roughness, background eddy viscosities and diffusivities were varied during the calibration phase with no variation during the verification phase. This two step procedure of calibration and verification is the accepted procedure when conducting numerical modeling studies.

Model results were compared with water surface elevation, velocity, and salinity data at the stations listed above. Temperature results were also compared, but these computations had very little impact on the salinity and hydrodynamics. Generally the computed water surface elevations matched well except at the upstream ends of the LMR and LPR. This is likely due to inaccurate bathymetry data for the floodplains.

Velocity data were available at the UF UCH station. Given that measured velocity data are at a point and that the grid resolution near the UF station is relatively coarse, the agreement is relatively good.

A visual comparison of the computed salinities with the measured data reveals that at times the agreement is good but not as good as at other times. However, the extent of salinity intrusion is computed well. Considering the uncertainty in the ungaged freshwater flows, boundary conditions obtained from the UF 3D model, etc, the agreement is considered acceptable. This is especially true since differences in model simulations are used in setting the LMR MFL rather than absolute values. Generally the match between model results for the calibration phase is a little better than for the verification phase. This is to be expected.

Visual comparisons of model results and field data are subjective and only provide a qualitative assessment of how well the model matches the field data. The District also computed several statistics to quantify how well the model matches field data. These statistics included a skill parameter using an equation developed by Wilmont (1981), mean errors, mean absolute errors and R^2 values. These statistics are listed in Tables 3-5 of Appendix 5. The Wilmont skill parameter varies between 0 and 1, with 1 being a perfect match. The average value for the skill parameter over all stations was 0.91 for the water surface elevations, 0.84 for the one velocity station, and 0.87 for the salinity. These are actually fairly good given the uncertainties mentioned above.

The Panel accepts that the calibrated UHC-LMR-LPR numerical hydrodynamic and salinity model is based on the best available data and can be used in setting the LMR MFL. As more of the system becomes gaged for freshwater flow, additional simulations should be made and will likely yield more accurate computations.

Section 2. Chemical and Biological Analyses, MFL Evaluation

The section below presents some of the Panel's comments on the chemical and biological analyses, and the MFL evaluation. Additional feedback on these areas are provided on a chapter-by-chapter basis in Section 3.

2.1. Dissolved Oxygen

The District reports that if flows increased gradually, then salinity in the lower Myakka River was depressed and the resulting plume from additional higher flows had insufficient relative buoyancy to result in stratification. On the other hand, if the wet season begins abruptly while the lower river is still relatively saline, then a moderate increase in flow can result in a buoyant plume of fresh water, stratification, and subsequent hypoxia that threatens most fish and shellfish species. This creates potential violations of Florida's state water quality standards, which contain DO criteria for Class III marine waters such as these that call for an instantaneous minimum of 4 ppm and a daily average of not less than 5 ppm (4 and 5 mg/L DO concentration, respectively). This standard may be practical and scientifically appropriate for inland freshwaters, but it is problematic in warm shallow estuaries with high biological productivity. For example, with 100% saturation of 25ºC (77ºF) freshwater (0 psu) at sea level atmospheric pressure (760 mm), the DO concentration is 8.4 mg/L, declining to 6.2 mg/L when both salinity and temperatures are high (35 psu at 30ºC or 86ºF), and this is for sterile water with no biological or chemical oxygen demand. If the coastal waters are alive with biota and contain any pollutant runoff, then there is no way to consistently maintain DO concentrations above 4 mg/L at night when plants switch from O_2 production (i.e., sunlight-driven photosynthesis) to O_2 consumption (i.e., plant respiration).

The District concludes that flow reductions are unlikely to impact the occurrence of hypoxic conditions in the low salinity habitats upriver if these are the product of the addition of DO depressed water from adjacent flood plain storage (unless reduction techniques include shallow groundwater withdrawals). Downstream below river kilometer 5, hypoxic events could be reduced by flow reductions if withdrawals modify the establishment of stratification. In addition, the District suggests that hypoxic events would likely be reduced if withdrawals either reduced the total flow (perhaps below 400 cfs) or if the rapid increase in flow at the onset of the rainy season is attenuated such that stratification does not form as rapidly. **Based on the data presented, it is apparent that summertime hypoxic conditions in the primary bay, Charlotte Harbor, are also associated with large freshwater inflow events.**

2.2 Chlorophyll

It is interesting to note that the District reports chlorophyll *a* maxima greater than 20 µg/l in any portion of the river were typically limited to when flows were less than ~600 cfs**. This suggests that chlorophyll *a* maxima may be expected to increase and move upriver under any significant reduction in flows**, although the degree of change is uncertain because it cannot be quantified from the present information, according to the District. Overall, chlorophyll *a* values in the Lower Myakka seldom exceed

20 µg/l, and the median value for the lower river (5 µg/l) is less than the median chlorophyll *a* value (8.5 µg/l) for Florida estuaries, **which suggests that the augmented flows and nutrients from upstream agricultural activities have not had a significant deleterious effect on water quality in the Lower Myakka River.**

2.3 Fish

While the MFL determination seems to depend more on the sensitive freshwater and resident estuarine organisms in the brackish waters of the lower river, it is really the marine species that are the object of most coastal fisheries management. Without food, cover, and physiologically advantageous water quality conditions in their inshore nursery habitats, the coast becomes a poor producer of many of these economically important fishery species (shrimp, crabs and marine fishes). Oysters and clams, like several of the resident estuarine fishery species, are adapted to variable salinity conditions, rather than the stable conditions most often required for freshwater and marine habitats. Indeed, the variation in daily flows protects them and others from biological “over dominance” wherein a winner in the competition for salinity habitats continues to outcompete others to the detriment of the desired ecosystem’s ecological health and productivity. Salinity variation also protects against an overwhelming invasion/infestation of marine predators, parasites and disease organisms into the estuarine nursery areas. **Nevertheless, the District’s use of freshwater and resident brackish water taxa was appropriate given their goal of determining the MFL of the lower river only, as opposed to determining the inflow needs of the entire bay and estuary system at once. Because the Lower Myakka River is highly non-linear, any impacts will be magnified, particularly on these low (< 2 psu) salinity species, and especially during low flow periods.**

2.4 Fish, macroinvertebrates and plankton

Fishes and macroinvertebrates were collected from the Lower Myakka River and Myakkahatchee Creek during 2003 and 2004, an unusually wet period that compressed some salinity habitats and in general moved isohalines substantially downstream (Peebles et al. 2006). Additional planktonic samples were taken during a prolonged dry period with low flows from February through June 2008 (Peebles 2008). Bay anchovy (*Anchoa mitchilli*) larvae and juveniles were both the most abundant fish species and most frequently collected. Hogchoker (*Trinectes maculatus*) was the second most abundant species.

Fish eggs were more abundant near the river’s mouth and declined upriver. Peebles et al. (2006) found percomorph eggs, probably from sciaenid fishes (i.e., drums, croakers and seatrouts), to be the most abundant of the planktonic fish life stages in the lower Myakka River. They had a center of abundance at river kilometer 8.6 and a weighted mean salinity of 22.6. Further, the planktonic stages of all fish and invertebrate taxa collected exhibited a spring maxima in the month of April. Larval densities were also high during the spring. Juveniles, on the other hand, were most abundant in the winter months. The numbers of taxa present in both the ichthyoplankton and the invertebrate zooplankton generally increased from a winter low to a spring maximum, followed by a decline through the late summer to the fall.

Peebles et al. (2006) and Peebles (2008) also presented regressions to predict the abundance of different life stages of various fish and invertebrates species in the river as a function of freshwater inflow. A number of regressions (i.e., 9 from the plankton sampling and 4 from the seine and trawl sampling) relating the abundance of taxa with river flow were selected for use in the District's minimum flows analysis. Interestingly, the District concluded that the regressions for the plankton samples were more robust because they covered a greater range of flows and, thus, they were given greater emphasis in the minimum flows analysis than the predictions developed from the seine and trawl samples.

In addition, the distribution of fish and invertebrate taxa collected in the plankton samples was quantified as Km_u, or the density weighted center of catch per unit effort, expressed in river kilometers. This parameter does not describe the variability of a population about its mean value, but it can provide useful information about where in the river the population is distributed under specific inflow conditions. Regressions were then developed to predict Km_u as a function of freshwater inflow. The District reports that as flows increased these organisms were displaced downstream. Conversely, when flows declined, populations of these taxa migrated upstream through a variety of transport mechanisms. Shifts in Km_u resulting from reductions in freshwater inflow could result in a loss of recruitment or abundance if a population shifted away from what are the most desirable habitats for that species. In most regions of the lower river, the area and volume of riverine habitats decrease progressively upstream and, therefore, the upstream movement of a population due to large flow reductions can compress that population into smaller regions of the tidal river with less habitat area and volume. As a result, shifts in Km_u were used as an ecological indicator in the determination of the MFL for the lower Myakka River.

The Florida Fish and Wildlife Conservation Commission's Fish and Wildlife Research Institute (FWRI) collected fish and macroinvertebrates using both seines and trawls. The organisms sampled by seine are considered more indicative of shallow-water and shoreline habitats, while a trawl typically samples the deeper water habitats along the middle of the river channel. Species selected for detailed analysis included the pink shrimp (*Farfantepenaeus duorarum*), blue crab (*Callinectes sapidus*), bay anchovy *(Anchoa mitchilli*), sand seatrout (*Cynoscion arenarius*), spotted seatrout (*Cynoscion nebulosus*), and southern kingfish (*Menticirrhus americanus*). Many of these species have peak utilization of estuarine nursery habitats in the springtime and grow out through the summer and fall. For example, the sand seatrout spawns near bay passes or inlets in the Gulf of Mexico between March and August with a spawning peak during spring. Similar to the previous analysis of the planktonic life stages, linear regression of Km_u against freshwater inflow were performed on the taxa collected by seine or trawl, of which over half exhibited significant distributional responses with freshwater inflow.

Unfortunately, the short (20 month) duration of the sampling and the limited variation in inflows made this expensive nekton sampling effort less useful. The District remarks that unlike the additional plankton sampling under low flow conditions in 2008, the seine and trawl sampling was not reinstated due to cost constraints. As a result, the predictive ability of the seine and trawl regressions is limited to higher flow conditions that were not particularly useful for the minimum flows analysis. **The Panel**

agrees that continued seine and trawl sampling would have strengthened the inflow relationships observed between nekton abundance and distribution in the lower Myakka River.

2.5 MFL Evaluation

2.5.1 Baseline conditions

The District chose to use the existing flow regime of the Lower Myakka River as the baseline for assessing the effects of potential flow reductions on natural resources of the lower river. This means that that the baseline condition includes the historical alterations to the Cowpen Slough and the Blackburn Canal. These alterations resulted in a decrease of freshwater from the River. **The Panel agrees that these two diversions are generally more important during high flow times, which would make them less important under the low flow conditions that are the focus of the MFL.** However, the fact that all of the supplementary flows will be removed with the diversions in place means that the lower portion of the river could potentially experience a situation that is worse than historic conditions. It would therefore be useful to compare the scenario in which excess agricultural flow is removed from the current conditions, as simulated for this report, with the historic condition (e.g. before these diversions were in place and before excess flow was delivered from the watershed). In addition to the fact that the two diversions are removing fresh water from the Lower Myakka, there is also the possibility that dredging of Charlotte Harbor and sea level rise may have also served to increase the inflow of saltier water from the ocean. Will removing excess flow from the watershed, as is currently planned, result in the River being saltier than it was under historic conditions? If that is the case, it would then be a useful exercise to estimate how much water would be necessary to bring the system to the historic salinity conditions. There is some language in the document about potentially mitigating for the effect of the removal of the excess flows by storing water and it would be helpful to understand what might be necessary to do this in this context.

2.5.2 Determination of Blocks

It has been a long-standing practice of the District to define the dry season as Block 1 (April 20 to June 20), the intermediate flow season as Block 2 (October 28 to April 19), and the high flow season as Block 3 (June 21 to October 27). However, the seasonal blocks were altered in this analysis such that Block 1 now begins on March 1 (and still runs through June 20). **The Panel supports the District's decision to include inflow in March in Block 1 in order to protect early spring spawners**. The rationale for this adjustment is that in the warm subtropical waters of the Gulf of Mexico, early spring spawners, including a number of important sciaenid fishes (many drums, croakers, and seatrouts) and penaeid shrimp (e.g., brown, white and pink), are present immediately after the winter (January-February), and continue through the spring (March-May).

However, the implications of this adjustment for the other indicators need to be evaluated. Including March flows results in lower salinities for this period, which will affect the predicted reductions in habitat due to withdrawals. This adjustment may be problematic for the OTF analysis, as described below. There is also some confusion in the report where the old Block 1 interval was used in some analyses and the new Block 1 was used in others (and in some cases it's not clear which were used).

2.5.3 Evaluation of the impact of flow reductions on bottom area and water volume.

The UCH-LMR-LPR numerical hydrodynamic and salinity model was used to predict the impact of various flow reductions at the Sarasota gage in terms of the amount of areal (i.e., river bottom), and volumetric (i.e., water volume) habitats within various salinity ranges. The impact of these salinity changes could then be related to impacts on natural resources in the Lower Myakka River.

For this analysis, the calibrated UCH-LMR-LPR model was employed for a four calendar year simulation from 1999 to 2002. Changes in salinity were evaluated for the entire simulation and for three seasonal blocks within the modeled period. These were: Block 1 (March 1 – June 20), Block 2 (June 21 – October 27), and Block 3 (October 28 – end of February). The 1999-2002 period was generally drier than the complete baseline period of 1995-2005 used for other analyses (see below), so it can be considered as a conservative flow period with a built-in safety margin. The same boundary condition data previously discussed were also required in the four year production simulations.

Application of the UCH-LMR-LPR numerical hydrodynamic and salinity model involved modeling the four year period for the existing flow regime and four flow reduction scenarios:

1. Model existing flow regime but remove the maximum withdrawal of freshwater allowed in the City of North Port water use permit. These can range from 3.2 to 9.3 cfs. Model results indicate these withdrawals have virtually no impact on the resources within the LMR.
2. Remove the excess daily flows predicted by the MIKE SHE model from the flows at the Sarasota gage. However, the excess flows to be subtracted were capped at 130 cfs.
3. Remove City of North Port withdrawals and the excess flows predicted by the MIKE SHE model from the Sarasota gage.
4. Model scenario 3 with flow reductions of 10, 20, and 30 percent from the Sarasota gage flows.

Model results from scenario 4 were then compared to model results for the existing flow regime during the same time period.

The District's accepted definition of significant harm to a resource is a 15% decrease in the resource. The salinity regimes for which changes in bottom area and water volume were computed are presented in Table 8-10 of the report. These are based on documented relations between salinity and fish and invertebrate communities in southwest Florida estuaries. When viewed for the entire modeling period, the only flow reduction scenario that resulted in a 15% or greater reduction in bottom area was for the < 2 ppt zone that involved removing the North Port withdrawals, the excess flows, and 30% of the remaining flows at the Sarasota gage. Reductions in water volume produced very similar results since there is little stratification in the LMR. Looking at the bottom area and volume reductions for the seasonal blocks produced different results among the blocks--in Block 1, the 15% criterion was exceeded for most of the salinity regimes for most scenarios, in Block 2 the only violations occurred for a 30% flow reduction for the <2 and <5 % salinity regimes, and in Block 3, no violations of the 15% criterion occurred.

The Panel finds that the District appropriately applied the UCH-LMR-LPR numerical hydrodynamic and salinity model to aid in evaluating bottom area and volume. The fact that removing excess flows and the City of Northport (scenario 3, above) resulted in such large changes in predicted bottom area and water volume during Block 1 (e.g. bottom area in the 2-12 psu zone decreased by 25% as compared to baseline and water volume in the 3-14 psu decreased by 24%) suggests that **there will be a potentially large reduction in the low salinity habitat available to fish and benthic invertebrates if all of the excess flow (up to 130 cfs) is removed.** The District should consider strategies to ameliorate these large reductions, particularly during the dry season, if they are found unexpectedly harmful to the abundance and distribution of ecologically characteristic and economically important nekton species.

2.5.3 Evaluation of the impact of flow reductions on shoreline length.

The District used the isohaline regression equations developed by Mote Marine Lab to predict isohaline locations for the entire baseline period (calendar years 1995-2004) as well as for the more limited, dryer period used to assess changes in bottom area and water volume (1999-2002). Predicted locations of isohalines were used to assess changes in the location and shoreline length of tidal wetlands for the same flow reduction scenarios described above.

These analyses found that the median position of the 2 psu isohaline would shift upstream to varying degrees under the different flow scenarios, resulting in fairly large changes in shoreline length and area of OTF. Under Scenario 3 (removal of excess flow and North Port Withdrawals), there is a 40% reduction in shoreline length and a 42% decrease in area during Block 1, when evaluated for the entire period (1995-2004). These reductions are lower for the shorter, dryer interval, largely because the isohalines have already moved upstream during the dry period and so the starting area is smaller. These are potentially large changes in a key habitat zone, and it is not clear that there is room for these marshes to shift upstream.

As mentioned above, the adjustment in Block 1 may be problematic for the OTF analysis, as the adjusted Block 1 tends to have higher flows, which means that salinities averaged over the period will generally be lower. Given that on page 7-18 it is stated that "movement of the 2 ppt isohaline during block 1 would be the best indicator for potential changes to the OTF marsh community" the Panel recommends evaluating the difference between using the old block 1 and the new block 1 for the location of the 2 ppt isohaline under the different flow scenarios. It is also unclear which blocks were used in the analyses presented on p. 6-23.

2.5.3 Evaluation of the impact of flow reductions on fish, macroinvertebrates and plankton

The District used the fish, macroinvertebrate and plankton surveys described above to calculate percent reductions in the daily abundance of selected indicator taxa. Values for plankton taxa are percent change in total abundance in the river, while values for seine and trawl taxa are for percent change in catch-per unit-effort. Similarly, the District also calculated percent reductions measured as differences in the normalized areas under cumulative distribution function curves. Percent changes in the abundance of taxa, calculated as the difference in the areas under the cumulative distribution function curves for the baseline versus the flow reduction scenarios during 1995-2004, began to exceed 15% during Block 1 dry season flow conditions using the total adjusted flow minus the North Port permit. Additional flow reductions of 10%, 15% and 20% widely exceeded the 15% loss limit in these living resources. Percent changes in the abundance of taxa, calculated as the difference in the areas under the cumulative distribution function curves for the baseline versus the flow reduction scenarios, began to exceed a 15% loss when the total adjusted flow minus the North Port permit was reduced by an additional 10% in Block 3 and an additional 15% in Block 2.

2.5.4 Proposed MFL

Based on the above analyses, the District has set the MFL for the Lower Myakka River as follows. Flow reductions should not exceed the excess flows (capped at 130 cfs) computed by the MIKE SHE model until flows exceed 400 cfs at the Sarasota gage. Above a flow rate of 400 cfs at the Sarasota gage, 10% of the remaining flow above the excess flows can be removed. **This MFL is most applicable to the reach of the river from the river mouth to just upstream of the confluence of the Blackburn Canal at river kilometer 32.** Only under extreme low flow conditions can any brackish (~ 1 psu) waters be found at the upper end of this reach. From there to river kilometer 51, the river is completely fresh; therefore, the MFL presumably will be protective of this segment of the lower Myakka River as well. Further, the proposed minimum flows are very close to the flows the river received before the flow augmentations in the upper river began in the 1970s. In this regard, it should be noted that excess flow after the 1970s has increased the abundance of a number of species such as mysid shrimp (*Americamysis almyra*) and hogchokers (*Trinectes maculatus*).)

The proposed MFL will result in upstream shifts of some ecological communities and reduced abundances of some fish and invertebrate species in the lower Myakka River. The District justifies this as being necessary and appropriate to return the river to a more historical condition. However, <u>the Panel recommends that the District consider implementing adaptive management strategies that include at least partially replacing lost excess flows during low flow periods, especially in the dry springtime when estuarine nursery habitat usage is highest.</u>

Section 3. Detailed comments

Executive Summary

p. xxxix This makes the case that the river is currently in good shape, and that the excess agricultural flows have been balanced to a degree by the loss of freshwater through existing modifications. These other modifications actually exacerbate the situation downstream. Although the Panel accepts that the Diversions are considered part of the existing situation (there are no current plans to change that) so that it makes sense to evaluate the potential effects of flow removal with the Diversions in place, it must be recognized that removal of all of the excess flows will potentially result in a situation that is worse than historic conditions.

p. xl The first paragraph, which describes the meat of the MFL, is difficult to follow. Also, as mentioned in the main recommendations, **the cutoff of 400 cfs may need to be revisited**.

Chapter 2

Most of Chapter 2 describes other methods, such as regression analyses, that were used by various investigators to estimate flows from the small sub-basins, while only the last few pages of the chapter are devoted to describing the large HSPF modeling effort and the unit area runoff estimates for rural versus urban areas made by SDI consultants, which were the ones actually used as the important hydrologic inputs to the hydrodynamic and conservative mass transport models that form the basis for evaluating change scenarios in the final MFL analysis. It is unclear why the District did not use any of the other estimates or produce new ones for the MFL, but if that is the case then **this chapter should focus primarily on HSPF and SDI consultant estimates of ungaged rainfall runoff,** and only mention the other efforts briefly.

p. 2-5 Is more recent land use information available? How much has changed since 1999? (has there been an increase in urban land cover?) Is this what the watershed runoff model is using?

p. 2-8 It would be useful to have a complete map showing all the various gages and places mentioned in the text. Here are some things mentioned in the text: Curry Creek, Cowpen Slough, Laurel, Myakkahatchee Creek, Cocoplum Waterway, Myakka River State Park, county lines and names, North Port.

p. 2-14 5th para, line 5: Reporting that the average flow of the Myakka River near Sarasota is 256 cfs, equivalent to 15.2 inches of runoff per year, is fine as a hydrological observation, but it is not very biologically meaningful. <u>A better measure of central tendency is a median based on the frequency of flow rather than its total volume.</u> In this case, the median flow is only 80 cfs, a factor of 3 smaller than the mean, which indicates the system is dominated by high flow events. It is the median that appears about right for a river of this size as a long-term flow minimum flow need. **Dewatering the river below this central tendency flow, even under the emergency condition that we call drought, needs to proceed with caution.**

p. 2-15 Again, can all of these gages please be laid out on one map?

Although several of the 15 streamgages shown in Table 2-2 have records with as little as 5-10 years of data, they are or at least should have been useful for calibrating and verifying rainfall runoff flows from the ungaged watersheds of the lower Myakka River. Since only one was used, perhaps this is why the uncertainty of the ungaged hydrology is large.

p. 2-26 How might the regressions of fish and invertebrates be affected if flows in Blackburn Canal were included? Is it that the flows from the Sarasota gage haven't been adjusted for the potential loss of water through the Blackburn Canal? If so, wouldn't this mean that a given density of fish corresponds to slightly less actual inflow than is assumed in the relationships. Is that correct? The District should consider using flows from the Blackburn Canal and other missing waterways in the MFL analyses next time (5-10 years) when they revisit the MFL determination of the lower Myakka River.

p. 2-29 Would be nice to have new info. on flow from Warm Mineral Springs. What evidence is there that this might be "significant"?

p. 2-30 If the interval for the blocks was adjusted, why is this section using the old intervals? This contrasts with p. 7-13, where the information is repeated but done with different blocks.

p. 2-31 Why not present rainfall analysis to coincide with interval analyzed for Big Slough (1980-2005) to facilitate comparison? (vs. pp. 2-53, 2-58)

p. 2-34 Here again, if the dates of the blocks are changed for this analysis then it's confusing to see the hydrological analyses using the other intervals. On the other hand, this might be a good place to compare the flows in the old vs. adjusted Block 1 (to show the difference), which could be referred back to if the OTF calculation is re-done. Also, intervals on p. 2-41 are slightly different (June 20 vs 24).

p. 2-35 Last para. refers to a consistent increase in May, but the slope is not very high for this month. Is something missing or have the increases been that incremental?

p. 2-37 Can stats be run on a shorter time period (1987-present) to back up the information in the 2nd para.?

p. 2-47 Does the fact that the excess flows are similar for ag (last para, 7-15 cfs) and total (2nd para) mean that all excess flows in the dry season are due to ag? Should say so.

p. 2-50 There appears to be a discrepancy between the upper river report and the MIKE SHE model, which implies that excess flows may not have increased in the wet season—did the other report show an increase in flow during these months? Seems better to trust empirical evidence than a model. If there is a trend over time towards increased flow, that says they are likely now higher than historic flows as opposed to the condition here that shows times when existing flows are lower than historic. Have there been changes in rainfall?

p.2-53 Talks about how a change to urban land would increase runoff rates, which is true in terms of rapidity but it wouldn't mean an actual increase in water. Would need a new source.

p. 2-57 last para: why not do the same time period at the Sarasota gage to try to tease these apart/separate these effects? It seems like it could be driven by rainfall. Did wet flow at the Sarasota gage increase over the last 25 y?

p. 2-61 2nd para: is it rate of delivery or absolute amount that has increased. Wouldn't change in land use to urban mean the water would get there eventually through GW?

Chapter 4

This chapter was poorly organized and difficult to follow. The outline doesn't make sense (look at the table of contents); parts of the chapter switches to past tense (e.g. section 4.5.4); some of the sections are repetitive. We suggest a thorough re-organization, and separating the material from Temperature on (section 4.4) into a separate chapter. Some suggestions for reorganizing the first 62 pages are to set things up as follows: 1) salinity data, 2) interpolated isohalines, 3) regression methods 3a) factors considered 3b) data sources 3c) approach 3d) results 3e) evaluation of results 4) predictions. Some of the detail here about the regression models could just be in the appendices.

Section 4.5.4 should precede 4.5.3, and they don't seem like they need to be stand-alone sections. Is section 4.5.4 really about straight description of isohaline position without any regressions? If so, the section title is misleading, and we would suggest a new section head on p. 4-39. However, p. 4-39 starts with what the regression found before setting up what went into the regression. It was difficult to understand what was actually done. It seems that once the isohaline positions were interpolated (based on data), regressions were applied to relate their location to flow. Is this the case? If so, it needs to be clearer. Also, the 1st para: on p. 4-39 is about preliminary regressions. Once things were learned from the preliminary investigations, were the models refined?

p. 4-1 2nd para: this seems like it would be better after the description of the regressions.
3rd para: also seems out of place.

p. 4-11 3rd para: were the MIKE SHE predictions used in the regressions?

p. 4-16 Fig. 4-10 caption: are the differences between the periods due to the differences in gages used?

p. 4-28 1st para, last sentence: does this sentence refer to the mean, or to the daily variation in salinity?
Last para, last sentence: does this mean that the variability within a day is similar to the variability observed when comparing the daily mean values of several days?

p. 4-39 1st para: this is about preliminary regressions. Once things were learned from the preliminary investigations, were the models refined?
2nd para: 1st sentence repeats info. from above.

p. 4-41 These all look log-linear. Are there differences in the model form?

p. 4-42 The first paragraph repeats information and is out of place. If stratification is not included in regressions, were vertically averaged positions used? Or were separate regressions done for surface and bottom? Were they evaluated independently? After p. 4-42 is where the information on 4-39 and how the regressions performed. Or perhaps that comes in the following section? It's hard to know whether some data were pulled out for verification, or if it should be included in the section beginning on 4.44. Once regressions are explained (section 4.2.4), can follow with section 4.5.5 (verification).

p. 4-44 A lot of the info is redundant: use of mean tide and weather, differences in flow periods. State one time clearly.

p. 4-47 Seems to start a new section on application at the top of the page.
Info. on fixed station regressions being limited seems out of order.
Does it make sense to use separate variables in the regressions for each isohaline? Are there data on the performance of each one?

p. 4-53 Where are observations from? Which data were modeled?

p 4-54 1st para. seems like another new step. Once data are presented and used to determine the most appropriate model form and break points, then the actual regression/prediction relationships can be applied. And then section 4.5.7 is the application

p. 4-55 This table is difficult to understand. What are the differences between the top and bottom half of the table? What is the reader supposed to be looking at?

p. 4-57 It would be useful to see a scatter plot comparing modeled vs. observed salinity.

p. 4-62 1st para: Where did salinity increase?; what reference gage site?; change in salinity from 0-15 at what station?

2nd para, last sentence: If temperature increased (and was it significant? Right now it just says "appear"), what does that mean/ is it important?

p. 4-66 There is no water quality data in the report—it is all in the Appendix. Seems like one could cut back on a number of figures in the first half of the chapter and include at least a few representative figures here.

p. 4-68 last sentence: The water temperature data aren't shown, but isn't the fact that there's no pattern of DO vs. water temperature in part due to the fact that this is only during warm months (July – Sept).

p. 4-69 last sentence: this does not seem correct: Figure 4-68 shows depressed DO at all stratification levels.

p. 4-70 Is the top figure surface or bottom water, or combined?

p. 4-73 Again, it would be nice to see info. on organic and inorganic N forms. Could that be added to Figures?

p. 4-78 Using the weight:weight ratio of N:P is o.k., although this is usually expressed on a molar basis

p. 4-81 4th para: alternatively, could seasonality in flow lead to downstream shift in chlorophyll during higher flow, rather than a fundamental difference in response between the upper and lower portions of the river?

p. 4-88 The DAYS function is not an approximation of residence time because the basin is being filled with freshwater, which ignores tidal flushing and the presence of saltwater. This means that the approximation would get worse downstream where there is increased flushing and increased salinity. One way to estimate this is to use the freshwater volume rather than the total volume. As it stands, please delete the last phrase in paragraph 1 about this representing tau.

Chapter 6

The description of the wetland community was confusing and often redundant. This could be reorganized and cut way back. Some suggestions: No need to show figures like 6-7 and 6-8. This information could all be in a table.

Section 6.2.4 is out of place, and it is not actually about flow change scenarios. This whole section could be condensed and combined with the information presented on p. 6-13. Section 6.2.5 is also repetitive/reaches the same conclusions already presented on 6-13. The statement about the location of the OTF marshes is repeated again on p. 6-22.

Table 6-2 is redundant with 6-1. And how does it compare to the species listed in Table 6-3?

Section 6.2.6 could be a place for some of the information currently on p. 6-17.

The section on p. 6-26 is extremely rough, with awkward sentences and fragments. There is also no section number.

p. 6-10 3rd para: Why would freezes affect upstream mangroves only? Doesn't make sense unless the buffering effect of the near Gulf provides the difference noted.

<u>p. 6-23 Which blocks were used in this analysis? The original or modified Block 1?</u>

p. 6-28 last para: shouldn't it say that a given species would have a wider salinity tolerance in a system with a **greater** rate of change?

p. 6-36 1st para: Why was this species comparison done? What is the point of Table 6-7?
Last para: It is difficult to discern three faunal clusters—is this supposed to be in the figure?

p. 6-39 This figure is confusing. What is the x-axis/how should this be interpreted?

p. 6-67 1st para: Is the positive response considered a stock response?
2nd para: the word "conversely" implies the remaining 7 (23-16). Is that correct? This is confusing, as the paragraph is set up as a discussion of positive responses. Or are these the other 28 species? (51-23). Please clarify.
3rd para: is this a recruitment or a stock response?

p. 6-74 2nd para describes 82 pseudo-species, but p. 6-76 talks about 98. Was there a different number in the two analyses?

p. 6-76 1st para: were the rest of the responses positive?

Chapter 7

p. 7-1 last para: makes the point that the river can affect the Harbor, but what about the Harbor affecting the River? This shouldn't be discounted. This point was also made in the discussion about using the UF 3D hydrodynamic model to provide boundary conditions for the 3D/2D model.

p. 7-5 The report states that during May (a low flow month), there is no loss of water to the Blackburn Canal. However, additional water is entering the estuary due to excess flows in the watershed (43% of the gaged flow). Are there estimates for the proportion of excess flow during other months?

p. 7-12 It might be worth pointing out that the District has used 15% loss threshold in establishing the MFLs of other estuaries.

p. 7-14 The information in the 3rd and 4th paragraphs is out of place—it is part of the set up and not the goal. This should be moved to an earlier chapter. Also, why introduce salinity schemes that are not used?

Chapter 8

p. 8-4 The numbers in Table 8-1 don't seem quite right: 3rd para says that it's 276 cfs, but 329 – 56 = 273. Similarly, in Table 3 Group 1, Block 3, USGS – total excess (620-116) = 504 and not 510 (as written). Was the excess readjusted for the location of the gage? Minor errors like that occur throughout the table.

p. 8-6 2nd para. Could Method 2 results be added to Table 8-1?

p. 8-8 2nd para. Would be useful to add a third limit (3) flows were added to gaged flows when model predicted that historic flows were greater than flows under current conditions. Is that a realistic scenario given general trends in development?

p. 8-24 1st para: This could probably use a new section head.

p. 8-28 2nd para: This paragraph is confusing. If water runs off quicker now than it did historically (due to changes in watershed storage), there will be less slow release following wet periods than there was historically. Is that the explanation for reduced flows now in comparison with historic conditions? (i.e. are we talking about several days after a rain?) What was simulated for the MFL analysis, and why does it say that the amount that might be removed as part of the management option is greater than these excess flows? Is something backwards?

p. 8-34 This formula is probably unnecessary. It's just the proportion of area in the new scenario as compared to the baseline.

p. 8-38 Fig. 8-27 is unnecessary—it doesn't add info. vs. the table.

p. 8-48 <u>how would these results change with a diff. Block 1 date?</u>

p. 8-50 last sentence: Please explain what this means/how lateral extent of the OTF affects the proportionate change.

p. 8-53 2nd para: The distinction between what can be learned from the median location vs. the CDF/NAUC method is confusing. The fact that there are similarities among scenarios does not explain why the two methods were similar (1st sentence). The 2nd to last sentence again discerns among scenarios, not differences between median and CDF method. Just saying that median and CDF provide the same results. Possible rewording: "methods were **closer**, since"; "< 2 psu **was affected by** flow scenarios" [vs. median location?]

p. 8-55 Why was 5-day flow used in these analyses?

p. 8-64 1st para: does this mean that if a species was outside the regression for any scenario, it was not evaluated at all (values set to 0). If that is correct, does it mean that this analysis was done for less than half the species?

4th para: So plots in Figures generated using only the common set of dates?

p. 8-67 Were these analyses done on all flows or just those within the range of the regressions?

p. 8-69 1st para: were unusual in that changes…were **greater.** Is this backwards?

4th para: It would be useful to see the Tables that are now in 8-U. Taking out some of the redundancies in this chapter would provide room to include them here.

p. 8-70 last para: It's not the CDF method that shows greater reductions—this would be true for any method.

p. 8-72 2nd para: Which taxa were calculated using both methods?

3rd para: The info. in this para. needs to be in a table—it's very difficult to evaluate as presented.

p. 8-77 2nd para: shouldn't it be 9 to **17** percent?

p. 8-79 These figures seem like they could be in the appendices—they don't add very much. Seems like the info. is all summarized in tables.

p. 8-80 1st para: This is confusing. If a regression on log-transformed data is linear, then the relationship to non-transformed flow is **not** linear but rather exponential. The sentence referencing Flannery et al. is just the definition of slope. I also do not follow the next sentence: Negative (not positive) slopes closer to 0 don't necessarily indicate a response to low flows.

p. 8-82 2nd para: which of the relationships in Table 8-21 was used and why? Does the relationship include flow from both gages?

p. 8-90 2nd para: Did Anchoa have a significant inflow regression?

p. 8-91 Can the info. in Table 8-3 be converted to % so that it can be color coded/compared with 15% cut-off?

Section 4. Response to Charlotte Harbor National Estuary Program

Lisa Beever, Director of the Charlotte Harbor National Estuary Program (CHNEP), submitted comments on the proposed MFL for the Lower Myakka River in a memo dated Nov. 22, 2010. The Panel's responses to the four recommendations included in the memo are as follows:

a. Evaluate hydrologic restoration within the last 5-7 years – The CHNEP makes the point that some of the agricultural excess flows have already been reduced due to improvements made after 2003. This would not affect the coupled modeling analyses of bottom area and water volume, which were confined to the 1999-2002 period. However, it does mean that the conditions evaluated for the larger baseline period (1995-2004) could include up to 2 years of data where the Mike SHE model may have over-estimated excess flow. Although these estimates could possibly be refined, **the Panel agrees that this is a moving target and that the District used the best available data**. Moreover, this would not change the overall management strategy of removing excess flow but rather just show that this removal has begun. As described above, the Panel recommends that the District keep track of the excess flow removal in order to be able to evaluate the response of the River.
b. Reduce proposed Block 1 allowable withdrawals to the 15% habitat reduction threshold – The CHNEP urges the District to use the 15% threshold as a cut-off. The District has argued that changes beyond 15% are allowable in this case because they are restoring the watershed to natural conditions, even if that means larger reductions. The Panel feels that this is a case where adaptive management is important. As described above, we recommend that the District calculate what flow would be necessary to keep the reductions at 15% or below during Block 1, track the removal of excess flow, and monitor the upper reach to see how it is responding to the change in flow. The District has suggested that these dry season flows could potentially be augmented by flow reductions through other diversions (see below) and this may be necessary.
c. Account for watershed diversions which counteract "excess flow" – The CHNEP suggests that flow reductions through the Blackburn Canal and Cowpen Slough have not been taken into account, and that these historic modifications served to decrease flow. Although the data suggest that these flow diversions are not important during the critical low-flow times of year, **the Panel agrees that the District should evaluate the historic flows** to determine whether the targeted removal of the agricultural flows will end up reducing the freshwater inflow to the Lower Myakka to lower than historic conditions. If this is the case, the District may again need to consider augmenting these flows or re-evaluating the MFL to account for these circumstances.
d. Establish a link between removal of excess flows and management options for the Lower River – The District suggests management options of Blackburn Canal, Cowpen Slough, or Tatum Sawgrass marsh as a way to partially offset potential reductions in flow, but did not make the MFL contingent on this, and the CHNEP recommends that these be more specifically incorporated. The Panel agrees that these options need to be studied but feels that the decision as to whether it should be formally included in the MFL is a policy decision that should be left to the District. However, the Panel does endorse the call for adaptive management in this system.

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Dai, Z., C. Li, C. Trettin, G. Sun, D. Amatya and H. Li. 2010. Bi-criteria evaluation of the MIKE SHE model for a forested watershed on the South Carolina coastal plain. *Hydrol. Earth Syst. Sci.* 14: 1033-1046.

Interflow Engineering, LLC. 2008. Myakka River Watershed Initiative. Task 2.2.8 – Historical and Future Conditions Modeling Technical Memorandum. Technical memorandum dated May 16, 2008, submitted to the Southwest Florida Water Management District, Brooksville, FL.

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Xevi, E., K. Christiaens, A. Espino, W. Sewnandan, D. Mallants, H. Sørensen and J. Feyen. 1997. Calibration, validation and sensitivity analysis of the MIKE-SHE model using the Neuenkirchen Catchment as case study. *Water Resources Management* 11(3): 219-242.

Appendix A. Errata and minor editorial comments

p. xxxvi line 27: RK stands for "river" kilometer, not "fire" kilometer
p. xxxix Please use the names of the "dominant fish species" and "crustacean"
p. 2-4 The organization of this section is confusing. We suggest moving the information in the first paragraph that describes the layers to the end of the section.
p. 2-5 If the sum of uplands and wetlands is what is important, it's distracting to show them separately because that's what jumps out. Looks like 1972 definitions of wetlands were different than in later years.
1st para, line 3: Change "1972 and 1999" to "1972, 1990 and 1999."
p. 2-13 2nd para, line 10: Remove repeated words "relationship of."
p. 2-19 1st para: change "greater of the smaller" to "greater **at** the smaller"
p. 2-20 This says flow at Big Slough drains 208 km2, whereas Table 2-2 says it's 210 km2
Last para: Insert "**that**" before "was gaged for flow"
p. 2-22 Last para: insert "**of**" before "predicted flows"
p. 2-24 Last para: Insert "**is**" after "Blackburn Canal"
p. 2-25 1st para: change "no operable" to "**not** operable"
p. 2-28 2nd vs. 3rd para: miles or km between gages?
p. 2-29 1st para: change "near" to "**nearly**"
2nd para: insert "**in**" after "included"
3rd para: delete "during"; insert "**a**" before "catchment"
p. 2-30 2nd para: change "initialed" to "**initially**"
p. 2-32 1st para; change "which to "that"; delete "However"
p. 2-33 2nd para: insert "**the**" after "with"
3rd para: delete "is" before "uses"' Change last sentence to "**As seen in the following section**, the Kendall test **on annual data** was influenced **by**" Why is this the case? (that is, why does an increase in flows affect the Kendall results?)
p. 2-35 1st para: should be in the same paragraph as 2-34.
1st para: last sentence: do you mean "average" or "mean"?
2nd para: are these mean flows for block 1 or 2?
4th para: p<**0**.05; change to "observed for November though June"; "graphs" instead of "graphics"
p. 2-37 1st para line 2: Replace "that" with "there" has been an increase.
3rd para: change "years in" to "years"
last para: change "that" to "than"; last sentence should read: "flow trends **that** can affect estuarine resources, **as** many physico….have been **integrated** over preceding…"
p. 2-41 4th para, line 5: Replace "that" with "there" has been an increase.
p. 2-43 1st para: insert "on **the** river"; "of **the** upper river"
3rd para, line 4: Fix "19994"
4th para: delete "**watershed** of watershed"' insert "in **the** upper-river"
p. 2-44 3rd para: delete "excess flows **are** described"

p. 2-45 1st para: insert “in **the** upper river”; change “difference” to “difference**s**”’ insert “and **the** historic scenario”

p. 2-46 3rd para: change “an” to “**and** relative”

p. 2-53 last para: insert “because **the** period” and “at **the** longest-term gage”

p. 2-54 1st para: insert “**the** Myakka River”
2nd para: delete “on record **were** occurred”

p. 2-55 last para: delete “**on yearly**”; change “plot to **plots**”

p. 2-58 last para: delete “**by** is presented”

p. 4-1 1st para: data were generally incorporated into what?

p. 4-28 2nd para: last sentence shouldn’t be in past tense.

p. 4-35 1st para last sentence: change to “flow percentiles **moved downstream with flow,** as expected.”
Change whole page to past tense
Fig. 4-33: please include the salinity values in the caption.

p. 4-45 Figure caption for 4-41 needs to explain the red line and the dotted line. Are the “observed” isohalines interpolated? Which equations were used for modeling?

p. 4-46 Are there stats for these fits?

p. 4-47 1st sentence should be present tense.

p. 4-56 3rd para: insert “Due **to** the larger”; change “regressions which” to “regressions **that**”

p. 4-63 Figure 4-58 is extremely confusing. Please clarify the legend/consider separating the information into more than one plot.

p. 4-73 1st para: what does “PCU” mean?; change sentence to “but increase**d** flow”

p. 4-74 The legend is very hard to see.

p. 4-75 Figure 4-74 caption needs more detail: Are these surface or bottom samples? What is the source of the data?

p. 4-80 How are weighted flows calculated?

p. 4-81 1st para: how were chlorophyll values corrected?

p. 4-83 Fig. 4-81. Is this averaged over a year?

p. 4-84 last sentence: are these data shown somewhere?

p. 4-86 Why are these figures on a log scale?

p. 4-87 Is there information on organic N as well?

p. 4-88 last para: which equation was used to predict chlorophyll?

p. 4-89 The fit on Fig. 4-85 left looks off. Wouldn’t a power function or an exponential decrease work better?
Also, is the fit on 4-85 right significant?

p. 5-4 1st sentence: change “later” to “**latter**”

p. 6-2 Would it be possible to add river kilometers to this figure?

p. 6-3 3rd para, 1st sentence is awkward.
4th para: add “dominated **by** black”

p. 6-5 1st para. Where is Park located (RK?)

p. 6-10 1st para: adding river kilometers to this would help: e.g. location of Counties and Tippecanoe Bay

p. 6-13 2nd para: “further upstream” is transposed
4th para: this is a standard definition of glycophytes (not just Clewell)

p. 6-32 4th para: Isn't it between km -3 and **18** (rather than 20?); what km is the US 41 bridge?

p. 6-34 Fig. 6-19 does not provide any real information: a table would be much better

2nd para: The fact that insects are mostly in the upper portion of the river should be qualified "particularly in June"

p. 6-36 1st para: change to "invertebrate**s**"

p. 6-40 2nd para: do you mean Table 6-**8**?

p. 6-43 Table numbers again off.

p. 6-44 "a**b**undant"

p. 6-45 what was the core size?

p. 6-50 3rd para: is the reference to Montagna 2008 correct?; the last sentence is awkward

p. 6-52 What are the thick lines for? The legend seems wrong (>0-11)

p. 6-53 Since all species listed were present in the Myakka, why denote them with an asterisk? (Table 6-12 could say: All species, with the exception of Hobsonia, were present)

p. 6-56 2nd para: delete "primarily **of** biological"

last sentence: "fish**es**"

p. 6-57 1st sentence: delete "**have**"' add comma "zones**,** which"

p. 6-58 1st sentence: delete "**on**"

p. 6-59 2nd para: minutes' is plural; delete "**was** filtered"

p. 6-61 3rd para: "fish fauna that **were** collected"

p. 6-62 Table caption: "postflex**s**ion"

p. 6-63 1st para: "th**r**ough"; change to "species **would** not be"

p. 6-64 1st para: "appear**s**"; "to **a** variety"

last paragraph: "plankton **tows**

p. 6-66 2nd para: "tide stage **and** at"

p. 6-67 3rd para: "taxa that **have** positive"

p. 6-69-70 Would it be possible to add common names to these lists?

p. 6-70 3rd para: Replace "Menticirrus" with "Menticirr<u>h</u>us," which is spelled correctly in the first paragraph on the same page.

last para: The figure shows the highest catch in Myakkahatchee Creek; also, need to refer to 6-35 here. Insert "in" after "common" in estuaries.

p. 6-76 2nd para: "had maximum abundance" is repeated

p. 7-2 last para: "just upstream **of** the confluence **with** the Blackburn"' "developed for **the** river"

p. 7-3 2nd para:"**the** City of North Port"

p. 7-4 1st para: "gages **will** allow"

2nd para: "schedule**d**"

Last para: "that **the** amount"

p. 7-5 1st para: Figure 2-**14**

last para: "1980s to **the present**"

p. 7-8 2nd para "was **used** for the minimum"

p. 7-9 last para: repeated on p. 7-11 (3rd para)

p. 7-12 2nd para: "to determine **whether**"

last para: "and the abundance **of** resources"

p. 7-13 1st para: “have affected **the** flow regime”; “last sentence is awkward.

3rd para: “and **that** if protection”

Last para: “was to **use** indentify”

p. 7-14 last para: “surveys **that** were conducted”

p. 7-15 2nd para: zones of **a**t < 11 psu”

last para: “analysis **for** it can”’ large number **of**”; “all but one **of**”

p. 7-16 1st para: “was run was”; “and **the** curve”

3rd para: “possibly **by** more”; “geomorphology **of**”

p. 7-17 2nd para: “would not **differ**”

last para: “from **a** large”

p. 7-18 4th para: “for **the** entire”

last para: spotted seatrout repeated

p. 7-19 1st para: are these the correct figures?; what km has less habitat?

3rd para: “stages **of** various” “fish and invertebrate~~s~~”

Last para: “and **for which** the”

p. 8-3 “occurred **over** due”

p. 8-4 3rd para, last line: “This does **not** necessarily mean”

p. 8-5 Table – seems redundant to have flows from all scenarios in all groups – just separate the different estimates of excess and what that means for USGS-excess.

Last para: “value for **the** adjusted”

p. 8-6 4th para: “Since **the** Method 1”; “Excess flows calculated by **the** Method 2… **to model output the gaged record**” is confusing.

p. 8-7 last para: this info. is repeated

p. 8-8 1st para: “in **an** increases”;

2nd para: “removal **of** the”

p. 8-10 1st para: “for **the** entire modeling period”

last para: “for **the** most part”; “was **a** very dry year”

p. 8-13 last para: “plans **that** are being”

p. 8-16 Table 8-5 Please change title of 4th column to “gaged flows during study period”

p. 8-18 Table title “Three cond**i**tions”

p. 8-19 2nd para: “not **as** consistent”; “indic**a**ting **that**”; “water **is stored** in wetlands”

p. 8-23 2nd para: “93% **if** the ten-year values”

p. 8-24 1st para: Is it page 2-22? Also, which regressions are being referred to, HSW or Janicki?

p. 8-25 last para: “along **with** withdrawals”

p. 8-27 1st para: Where is Flatford Swamp?

2nd para: “**other** otherwise remediate”

p. 8-30 section 8.6.3 “area **for** as a”

p. 8-31 “below an**d** elevation”;”than a **given** salinity”’ “**at flows**”

p. 8-32 1st para: “Mean**s** daily”

p. 8-33 figure caption “less than <” Would be useful to point out scale change.

p. 8-34 last para: Replace formula in text with correct one.

p. 8-35 Reference should be to page 8-29; “overall”

p. 8-41 1st line “2 and 3 **because** the other”

p. 8-42 1st para: “zones reported”

last para: “to **evaluate** the percent”

p. 8-46 2nd para: “This is due”

3rd para is quite rough—please review and correct all of the English. Also the references to Figures are off throughout.

4th para: “could **be** potentially”

p. 8-47 1st para: Section 7.11.3

2nd para “the **locations of the**”; “isohalines**,** as they”

Figure caption: what are dotted and solid lines?

p. 8-48 1st para: Do you mean 12 psu isohaline in Block 1?

2nd para: Figure 6-17; Block 1 (21.**6** km); Section 7.**11**.13; “isohalines **during** Block 1”

3rd para “affected **by** long-term”;’” with the **with**”

p. 8-49 Figure caption: What do bars represent?

p. 8-50 last para: “199**9**-2002”’ “area **were** much lower”’ “marshes **do** not”

Table 8-17: too many significant digits (Table 8-18 as well)

p. 8-51 Table 8-18 is 4 psu—headers need changing

p. 8-54 last para: “rates **during which** these marshes”;”if it**s** corresponding”

p. 8-61 2nd para “and **both mean** and median values of predicted daily abundance”“in **the** following”

3rd para: “to the range of flows”

p. 8-63 Table: “o**n**ly”

2nd para: “holbrooki **was** because”

3rd para: Fig. 8-**8**?

last para: “that **fall** within”

p. 8-64 2nd para: “relying on **a** single”

3rd para “for **the** 1999-2002”;”**as examples**”; which appendices?

Section head: “relative **to** baseline”

4th para: “abundance calculated”;“**The** steps”

p. 8-67 1st para: “changes **in** the”; last sentence needs fixing

2nd para: “all flow**s** predictions”

Last para: “and **how** the”’ “**affected changes in the medians**”

Table legend: The first number represents the % based on the flow…and the 2nd…”

p. 8-69 There are numerous typos and missing words, etc. on this page.

p. 8-70 1st full para: Last sentence is sloppy

2nd para: “Example**s** CDF”

4th para: “were **lower** in Blocks”’ “until **with** the”

p. 8-73 last para: “two time**r** periods”

p. 8-74 Which flow domain was used for column B? Also, NP should be written out.

p. 8-78 3rd para: “abundances **in** were observed for **the** total”

p. 8-82 1st para: “gage **to** reductions”; last line: what does “increase the number of high abundance reduction values” mean?

2nd para: “which **15%** reduction”

3rd para: “below **at** 15%”

p. 8-83 If this figure is kept in, it would be useful to include the regression info. in the legend.

p. 8-87 1st para: What was the “corresponding mean flow term” in number of days; “days **in** that”
2nd para “there **was** a large”

p. 8-88 1st para: “are probably **some** further”

p. 8-90 2nd para: 1st 2 sentences awkward

p. 8-91 “three species **is** slightly”

p. 8-92 numbers all seem off: 1st para: isn’t it 0.1 to 0.**7** km?
2nd para: “2.1 to **3** km; “2.**6** to 4 km”; “2.9 **to** 4.6 km”; “not considered appropriate”

p. 8-94 4th para: “in addition **to** the”

p. 8-95 1st para: 2nd sentence is awkward

p. 8-96 All figure numbers seem off (e.g. 8-27B is actually 8-28B, etc.) on this and the following page.

p. 8-97 2nd para: “Compared **with** flows”
4th para: “based on **the** sum”

p. 8-98 2nd para: “for **the** City’s”

p. 8-99 2nd para: “for **the** 1994-“; “on **a** real time”
3rd para: “assess **the** proportion”

p. 8-100 3rd para: “changes **in** the”

p. 8-101“in **the** near term”

p. 9-15 3rd para: Replace “Riv,” with “River,” before “Florida.”