St. Johns River Water Management District

Ann B. Shortelle, Ph.D., Executive Director

FINAL TECHNICAL MEMORANDUM

Date: March 2019

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Subject: Response to Peer Review Comments in "Review of HSPF and HEC-RAS Models Development and Documentation for Wekiva Basin, Florida" by Dynamic Solutions, LLC.

This technical memorandum provides responses to peer review comments provided by Dynamic Solutions on 12/31/2018 (DSLLC, 2018). Peer review comments were based on a review of hydrologic model development for Wekiva River MFLs. The following documentation and files provided by the District were peer reviewed:

- Draft Report, Wekiva River Hydrology and Hydraulic Modeling for Minimum Flow and Level Evaluations (Seong and Wester, 2018), and associated model files.
- A presentation summarizing the model development and calibration (https://www.sjrwmd.com/static/mfls/MFL-Wekiva/ModelPresentation_2018_0926_final.pdf)

It should be noted that, as a result of the peer review, both HSPF and HEC-RAS models were recalibrated, and the modeling report was updated. Below are the peer review comments followed by our responses.

Review Questions

1) Assess the adequacy and appropriateness of the data used in model development and calibration

- **Watershed Delineation**

Comment # 1. *Watershed delineation and the sub-division into sub-watersheds appear to be adequate and appropriate for the purpose of this study.*

However, it would be very helpful to the reader if a color-shaded topographic map of the watershed is provided in the report.

Response # 1. As requested, the color-shaded topographic map of the watershed (below) was added to the final report.

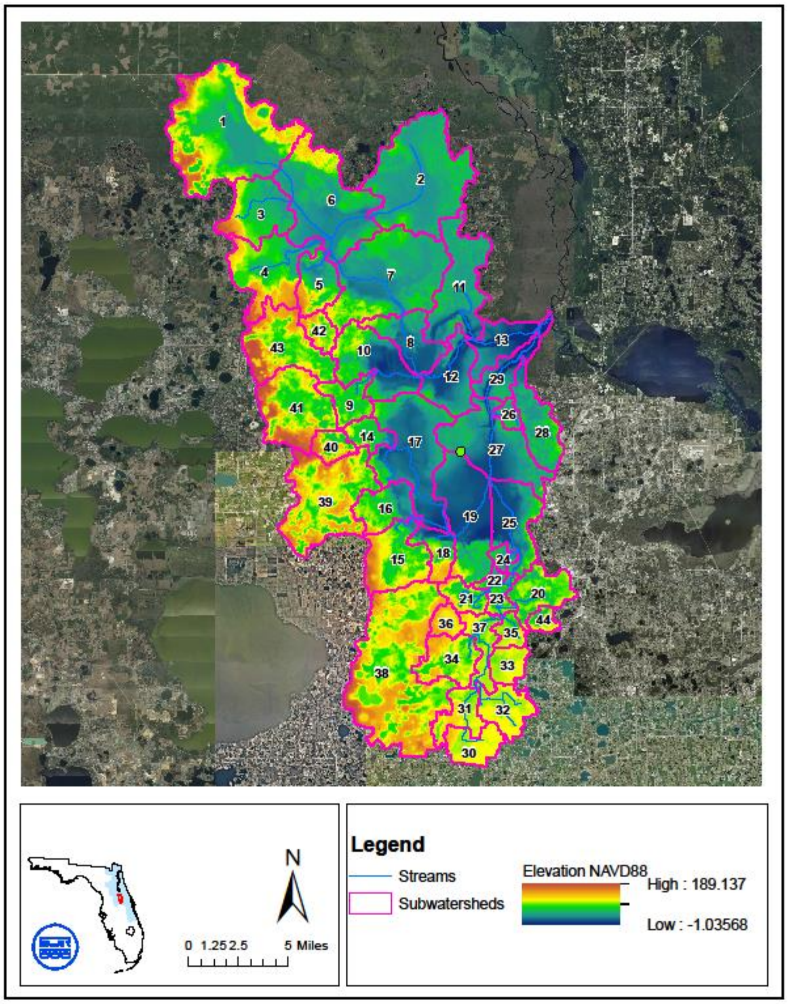

Figure 5. Topographic Map of the Wekiva Sub-basin. NAVD88 DEM.

- **Land Use and Land Cover**

Comment # 2. *Since the simulation period of the watershed model is from 2003 to 2016, selection of the 2009 land use and land cover data appears to be an appropriate choice and adequate for the purpose of the study, although more recent 2014 land use and land cover became available post model calibration. It should be noted that comparison of the 2009 land use and land cover data to the 2014 data revealed that a very minor change in the land use and land cover occurred during that time window.*

Response # 2. As recommended, the statement was added in section 2.2. The text now reads: *"This comparison revealed a very minor change in the land use occurred during this time window."*

- **Spring Discharge**

Comment # 3. *It should be pointed out that a total of thirty-fix (35) springs were modeled in the hydrological models (UCI files). However, thirty-four (34) springs were mentioned in the text of the report, twenty-seven (27) were reported in Table 5 and twenty-four (24) in Table A-1 of the report (SJRWMD, 2018). For consistency, the same number of springs should be discussed throughout the report, as well as in the hydrological models, or some explanations are needed if different numbers are used in the different parts of the report and the models.*

In Table 5 of the report, the average discharge of Wekiva Falls for 1995-2007 and 2007-2016 should be equal to 18.58524 and 13.1852 cfs, respectively.

Response # 3. Although Wekiva Falls was modeled as a spring, it is not considered a spring because it is a manmade feature. The Wekiva Falls discharge in Table 5 has been corrected to the accurate respective values. Wekiva Falls and 26 named springs in the Wekiva River watershed were modeled and the text was revised to reflect this. The final report was updated to include the missing 3 springs.

- **Point Source Discharge**

Comment # 4. *Sixty (60) permitted point source discharge sites in the Wekiva River watershed (SJRWMD, 2018) were identified by Florida Department of Environmental Protection (FDEP). However, only two wastewater treatment dischargers (Wekiva Hunt Club and Altamonte Springs/Swofford wastewater treatment facilities) were included in the hydrological models. Annual average effluent discharges of the two dischargers were stored in the WDM file – Wekivadata_2017.wdm. However, it was found that annual average effluent data (in MGD) in the WDM file do not match those in Table 8 (SJRWMD, 2018). The report shall clearly state the reason why the other fifty-eight (58) permitted point source dischargers were not included in the hydrological models and discuss the impact of exclusion of those dischargers on the model results.*

Response # 4. These sites were chosen because they discharge at least 0.1 mgd and are permitted by NPDES to discharge into the Wekiva River. This was clarified in the final report. The annual average effluent data in Table 8 was corrected to reflect the values used in the wdm file.

- **Stream/River Cross Sectional Data**

Comment # 5. *The spacing of cross-sections (XS) throughout the reach is generally adequate for the stated purpose, with the exception of:*

● *The reach of the Little Wekiva above the "MFL_Sabol" cross-section. The model is adequate to compute the elevation at the surveyed cross-sections in this reach, but great caution should be used when extrapolating water levels between the surveyed cross-sections.*

● *The reach of ROK from "ROK3" to "ROK7" cross-sections. The model is adequate to compute the elevation at the surveyed cross-sections in this reach, but great caution should be used when extrapolating water levels between the surveyed cross-sections.*

Response # 5. The best available cross-sections data were used for the hydraulics modeling. The density of cross-sections are adequate to fulfill the purpose of the study although surveyed cross-sections in Rock Springs Run and Little Wekiva River are less dense than those in Wekiva River. As suggested, we added discussion of the limitations when simulated water levels are extrapolated between the cross-sections, especially in the Little Wekiva River and Rock Springs Run reaches. The final report now states: *"Water levels simulated by the model are most accurate at or near surveyed cross-sections; therefore, simulated water levels further from surveyed cross-sections should be used cautiously."*

Comment # 6. *There are some questions and inconsistencies regarding cross-section elevations: There is no mention of Digital Elevation Model (DEM) information in the report; however, a DEM seems to be utilized in model development. If the DEM was in fact utilized, please state the source, datum, and resolution.*

Response # 6. The best DEMs available were used. A 1-foot contour map of Lake and Orange Counties was used to produce a DEM for that area. For other counties, the Florida 15m DEM in NAVD 1988 was used.

Comment # 7. *The cross-sections lines shown in the HEC-RAS model (both the "Geometric Data" and "RAS Mapper" windows) do not show the full, true extent of the cross-sections. The XS lines* *shown are shorter than the width shown on the station-elevation plots for the XS. This makes it difficult to evaluate the model geometry, as we do not have a reference for the true location of the station-elevation data for each cross-section. This is particularly relevant near the confluence of the Wekiva – Little Wekiva junction, where the XS ends from each branch should end on a common "match line."*

Response # 7. Some of cross-sections (XS) were extended and modified directly in the "edit cross section data window" in the HEC-RAS model, initially based on the cross-sections processed in GIS program. This produced some inconsistencies between the "Geometric Data/RAS Mapper" window views and actual XS data. This is a known projection error since the RAS is not fully interactive with its GIS tool and cross section editor. However, the visual inconsistency doesn't affect model simulation results.

As the reviewer commented, data availability was limited at the junction between Little Wekiva River and Wekiva River. Based on field observation and knowledge in the Wekiva River area, we determined XS 30.50 (WK18) was representative for the downstream part of Little Wekiva River.

Comment # 8. *On the Little Wekiva River reach, XS 245.69 downstream to XS 30.5 are unbounded at high flows. It is possible this is okay on "river left," as they will match with the Wekiva River XSs, but "river right" should be bounded by topography.*

Response # 8. The XS in the Little Wekiva River were extended to bound high flow profiles using 15m DEM. As mentioned in the comment, "river left" XS in the Little Wekiva River, such as XS 30.50 and XS 71.13, were simulated as being unbounded for the highest flow profile.

Comment # 9. *On the Wekiva River, Wekiva_riv_down reach, XS 405.9 (MFL_RailRoadGage), XS 319.75 (MFL_SR46E), and XS 318.81 (MFL_SR46B) are unbounded. It is likely the vertical wall approximation of being unbounded is justified here, but it is unknown. It is better to add station-elevation points to each side to bound the section.*

Response # 9. The XS 405.9, 319.75 and 318.81 were updated to keep the water within the bound, based on 1ft and 15m DEM dataset.

Comment # 10. *On the Wekiva River, Wekiva_riv_down reach, XS 0 to 76.89 (XS1), the XSs are unbounded. The steady state flow profile indicates there is energy loss (slope) through these XSs,* *so the width does indeed influence conveyance. A test where the lower three cross-sections were widened by 400 feet showed a 0.5-foot difference at XS1 decreasing 0.05-ft at SR46E for the PF13. (Note: We realize that these sections exist within the floodplain of the Saint Johns River so the cross-sections may be truly unbounded. However, the best approximation of the width of the active flow should be utilized.)*

Response # 10. The XS at the downstream part of Wekiva River, XS 0 to 76.89, were extended based on 1ft and 15m DEMs. The extended XS include St. Johns River flood plain as well as those of Black Water Creek. The best approximation of the width of the actual flow XS was implemented by utilizing "ineffective flow area" option in HEC-RAS.

- **Hydraulic Structure Data**

Comment # 11. *The report states that data for the SR46 Bridge was taken from the 2016 SJRWMD work. The original source or survey information should be given for completeness of this report.*

Response # 11. The original source and more details are given in section 4.1.3 of the final report: "*The Wekiva River bridges at SR46 and at the end of Miami Springs Drive were included in the HEC-RAS model (Figure 33). The geometric data of the bridge at SR46, such as pier and deck geometric data, were derived from a previous HEC-RAS modeling work (Jia, Y. and Suarez, G., 2016) and was verified through field observation. The bridge geometry located at the end of the Miami Springs Drive, was collected from a field trip in 2018.*"

- **Observed Flow and Stage Data**

Comment # 12. *Based on the data presented in the documentation and knowledge of additional data sources, it appears that fifty-eight (58) permitted point source dischargers mentioned in the report were not included in the hydrological models without appropriate justification. In the report, it should clearly state the reason why those dischargers were not included in the models and discuss the impact of exclusion of those dischargers on the model results.*

As those point sources are general small, use of those point sources in the hydrological models would not significantly affect the model results.

Response # 12. See Response #4

2) Assess the validity, defensibility and appropriateness of the model development and calibration.

a. Determined if the model is appropriate, defensible, and valid, given the District's MFLs approach.

Comment # 13. *However, hydrological soil group data were not used to estimate the infiltration rates for each sub-watershed in the hydrological models although the infiltration rates used in the calibrated models appear to be within the acceptable range*

Response # 13. The distribution of soil types in the watershed has been added in the final report. The soil data was used as a reference to set the initial infiltration parameters used for HSPF calibration.

b. Evaluate the validity and appropriateness of all assumptions used in the model development and calibration.

Comment # 14. *For the hydraulic HEC-RAS models, an additional assumption should be added stating the idea that water levels simulated by the model are most accurate at or near surveyed cross-sections, use caution for water levels further from surveyed cross-sections*

Response # 14. The suggested statement was added to the final report in section 4.1.

Comment # 15. *Figure 30 in the report shows Manning's n as a function of water level (Figure 30a) and flow (Figure 30b). The physical reasons for Manning's n showing a "more consistent" relationship with flow should be discussed. We hypothesize that stage and flow data from all years were used to make these plots, so the reason the flow produces a cleaner relationship is because the base level changes from the gage are accounted for implicitly. If this is correct, this should be addressed in the report.*

Response # 15. This is correct and has been addressed in the final report.

"HEC-RAS model provides options for varying Manning's n by flow or depth. A preliminary analysis, based on the period of 2008-2016, was conducted to calculate Manning's n at SR 46; its results showed more consistent relationship between Manning's n and flow (Figure 32). This cleaner relationship is because the base level changes from the gage are accounted for implicitly in the model. Therefore, Manning's n was varied with respect to flow in the HEC-RAS model to simulate low to high flow regimes for both steady and unsteady simulation. In the steady state simulation, the "Vertical Variation in Manning's n Values" option under cross section data

editor was used to vary Manning's n, while the "flow roughness factors" option was implemented during the unsteady state simulation."

Comment # 16. *Regarding Manning's n versus stage and flow relationships in Figure 30, it may be useful to recreate Figure 30a using only data from 2008 forward, when the gage datum is at the current base level. This may yield a "more consistent" relationship between water level and flow. Using the relationship of Manning's n versus stage may change results of the HEC-RAS models. However, we understand that functionally in HEC-RAS, varying Manning's n as a function of flow is much more efficient. However, as stated above, this discussion should be included in the report.*

Response # 16. Figure 30 in the draft report was originally created based on data from 2008 forward as we selected the time domain of 2008-2016 for the hydraulics modeling. We specified the data period used for Figure 30 in the final report. The discussion of why we used Manning's n versus flow rather than Manning's n versus stage was added in the final report.

c. Review model input and output data including but not limited to:

Comment # 17. *Raw elevation data were not provided for review to verify that the same datum was used consistently.*

Response # 17. We used the NAVD88 vertical datum for elevation data throughout the modeling process. The final report was updated to include vertical datum information.

Comment # 18. *Output file for model warnings (full flow channels, flooded nodes, etc.); There were two warnings that consistently appeared.*

(1) Warning that "cross-section end points had to be extended vertically." This issue was addressed in the "Stream/River Cross Sectional Data" section, when it was recommended that cross-sections be extended to bound all flows.

Response # 18. Cross Sections used in the HEC-RAS model were extended to bound all flows that had sufficient data available. Please see Responses #7 to #10.

Comment # 19.

(2) Warning about the "conveyance ratio" being too high or too low. This warning indicates that cross-section spacing may be too large. This warning should be addressed by adding to the report the assumption that (as stated above): "water levels simulated by the model are most accurate at or near surveyed cross-sections, use caution for water levels further from surveyed cross-sections."

Response # 19. We added the statement in chapter 4 of the final report as suggested.

Comment # 20. *Water budget to check for reasonableness;*

Water budget information was not provided in the report and model outputs.

A table showing the water budget of the basin such as ET, rainfall, spring flows, surface runoff, interflow, and baseflow should be provided in the report.

Response # 20. The water budget for each of the sub-basins is presented below and included in the final report. We provided all the sub-watershed water balance calculations for each land-use in the appendix of the final report.

Watershed	Rainfall (in/ac/yr)	ET (in/ac/yr)	Recharge (in/ac/yr)	Spring (in/ac/yr)	Upstream and PS (in/ac/yr)	Outflow (in/ac/yr)
Black Water Creek	50.6	41.8	1.9	4.6	0.0	12.3
Little Wekiva River	51.4	33.4	8.8	9.8	0.2	20.3
Wekiva River	53.0	40.5	2.2	26.9	39.7	78.0
Total	51.4	39.9	3.2	11.5	0.0	20.6

Summary

Comment # 21. *Provide a summary table of key hydrological parameter values and discussion;*

Response # 21. The updated summary table was included in the final report.

Comment # 22. *Provide a water budget table of ET, rainfall, surface runoff, interflow, baseflow at minimum by land use category and discussion;*

Response # 22. Please see Response #20

Comment # 23. *Provide a general description how FTABLE was developed for each reach;*

Response # 23. A general description about the development of FTABLEs used in the model is presented in 3.1.1, which reads "*The geometric and hydraulic properties of a RCHRES are represented in HSPF by a piecewise-linear function table called FTABLE, which describes the relationships between stage, surface area, volume, and discharge for the reach segment (Bicknell et al., 2001). The FTABLEs are mainly derived from the modeling results of the ICPR models developed by CDM (2005) and the SJRWMD's HEC-RAS model, which is described in the next chapter. In addition, cross section survey data, lake bathymetry, observed stage and discharge relationships are used for FTABLE development. In total, 44 reaches are represented in the Wekiva River Watershed HSPF model.*"

Comment # 24. *Document the reason why the other fifty-eight (58) permitted point source dischargers were not included in the hydrological models and discuss the impact of exclusion of those dischargers on the model results;*

Response # 24. See Response #4.

Comment # 25. *State assumptions in regard to the accuracy of the model between cross sections;*

Response # 25. The model is less accurate as the distance between cross sections increases. The below statement was added into the final report.

"Water levels simulated by the model are most accurate at or near surveyed cross-sections; therefore, simulated water levels further from surveyed cross-sections should be used cautiously".

Comment # 26. *Discuss the use (or not) of the DEM in the model;*

Response # 26. The DEM used to delineate sub-watersheds for the HSPF model was the most updated Florida 15m DEM in NAVD 1988, which was developed by FDEP/FGS. When determining the cross sections for the HEC-RAS model, a 1-foot contour map of Lake and Orange Counties was used to produce a DEM for that area. For other counties, the Florida 15m DEM in NAVD 1988 was used.

Comment # 27. *Discuss how the stream centerline was determined;*

Response # 27. Description about the stream centerline was added to the final report. It reads “the stream centerline was originally derived from SJRWMD HydroEdge (SJRWMD, 2014) data and modified based on SJRWMD digital orthophotography”.

Comment # 28. *Extend cross-sections so that all flows are bounded.*

Response # 28. The cross-sections were extended and documented in the final report.

Comment # 29. *Provide full-extent, geo-referenced cross-sections.*

Response # 29. The full-extent, geo-referenced cross-sections were included in the final model.

Comment # 30. *Use a consistent number for the springs in the watershed throughout the report and models.*

Response # 30. The Wekiva Falls discharge in Table 5 has been corrected to the accurate respective values. Wekiva Fall and 26 named springs in the Wekiva River watershed were modeled and the text was corrected to reflect this. Table A1 was updated to include the missing 3 springs.

Comment # 31. *In Table 5 of the report, the average discharge of Wekiva Falls for 1995-2007 and 2007-2016 should be equal to 18.58524 and 13.1852 cfs, respectively.*

Response # 31. The change was made to Table 5 and included in the final report.

Comment # 32. *In Table 12 of the report, the last column is labeled “% flow at SR46”. We believe this should be labeled as “non-exceedance probability”*

Response # 32. To come up with Comment #33, the label was changed as “Exceedance probability” in Table 12 of the final report.

Comment # 33. *To be consistent with Figure 33, it is advised to that these values should be changed to “Exceedance Probabilities.”*

Response # 33. The values were changed to “Exceedance Probabilities” in the final report.

References

Dynamic Solutions, LLC (DSLLC), 2018. Independent Technical Peer Review Services- Review of HSPF and HEC-RAS Models Development and Documentation for Wekiva Basin, Florida. Memo, Knoxville, TN.

Jia, Y. and Suarez, G. 2016. Draft report - Wekiva River Minimum Flows and Levels Hydrological Modeling Report. SJRWMD, Palatka, FL. Available at https://www.sjrwmd.com/static/mfls/MFL-Wekiva/Technical_Report_WekivaMFL_2018_update_0928_Draft.pdf

Seong, C.-H., and A. E. Wester, 2018. Wekiva River Hydrology and Hydraulic Modeling for Minimum Flow and Level Evaluations, SJRWMD Draft Report, Palatka, Florida

SJRWMD, 2012. *The St. Johns River Water Supply Impact Study*, Chapter 3: Watershed Hydrology. Appendix 3.B: HSPF Common Logic for the SJRWMD

SJRWMD, 2014. *St. Johns River Water Management District HydroEdge (Streams, Canals, Arfificial Paths).* Vector digital data, Palatka, Florida