St. Johns River Water Management District

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TECHNICAL MEMORANDUM

Date: October, 2019

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Subject: Sylvan Lake long-term hydrologic simulation

Introduction

The SJRWMD's Minimum Flows and Levels (MFLs) Program is a District-wide effort to establish MFLs for priority lakes, streams and rivers, wetlands, springs, and groundwater aquifers. SJRWMD has identified Sylvan Lake as a priority lake, which is listed on the 2019 MFLs priority list, and scheduled for completion by 2020. Sylvan Lake is located in Seminole County, Florida, in the Sanford/Lake Mary area. It is a large lake (nearly 200 acres) within the Yankee Lake Watershed. Sylvan Lake MFLs will be assessed using the recently updated hydrologic model.

MFLs designate the minimum hydrologic conditions that must be maintained in these systems to prevent significant harm resulting from permitted water withdrawals. MFLs assessment requires frequency analysis of lake levels. Due to the presence of short- and long-term climatic cycles, the frequencies of lake levels could be significantly different in wet periods such as in the 1960s than dry periods such as in the 2000s. Thus, it is important to perform frequency analysis using long-term lake levels so that the effect of short- and long-term climatic variations on lake levels can be captured. Therefore, long-term lake levels need to be simulated using a hydrologic model to ensure the MFLs are met.

Sylvan Lake Long-term Simulation

In 2017, SJRWMD contracted with CDM Smith, LLC (CDM Smith) to develop and calibrate a continuous simulation hydrologic model of Sylvan Lake using HSPF (CDM Smith, 2017). This

model was completed in late 2017. The model was calibrated based on model results and observed lake stages for the period of 2008 through 2016 and validated for the period of 1997 through 2007. The model performs well at reproducing observed lake stages during dry and wet periods and is considered appropriate for long-term model simulations in support of MFL analyses.

Extension of Sylvan Lake simulations from the calibration and verification years (1997–2016) to a long-term simulation (1948-2016) requires extension of three time series: hourly rainfall, hourly Potential Evapotranspiration (PET), and daily Upper Floridan Aquifer (UFA) groundwater levels. In addition, the Sylvan Lake outflow structure was improved in 2014. The long term simulation uses the stage-discharge relationship of the new lake outfall structure, which represents the current conditions.

Long-term rainfall data

The calibrated model used two different rainfall stations. A long-term NOAA rainfall record at the Sanford station was from 1997 through September 2007, while a newer and closer USGS gage in Sylvan Lake Park was used from October 2007, when it became available, to the end of 2016. The long-term simulation uses these same two sources, simply extending the Sanford station back to beginning of 1948. The annual rainfall ranges from 32.8 inches in 2000 to 74.0 inches in 1953, with the average annual precipitation of 52.1 inches. The annual totals for the combined record are shown in Figure 1.

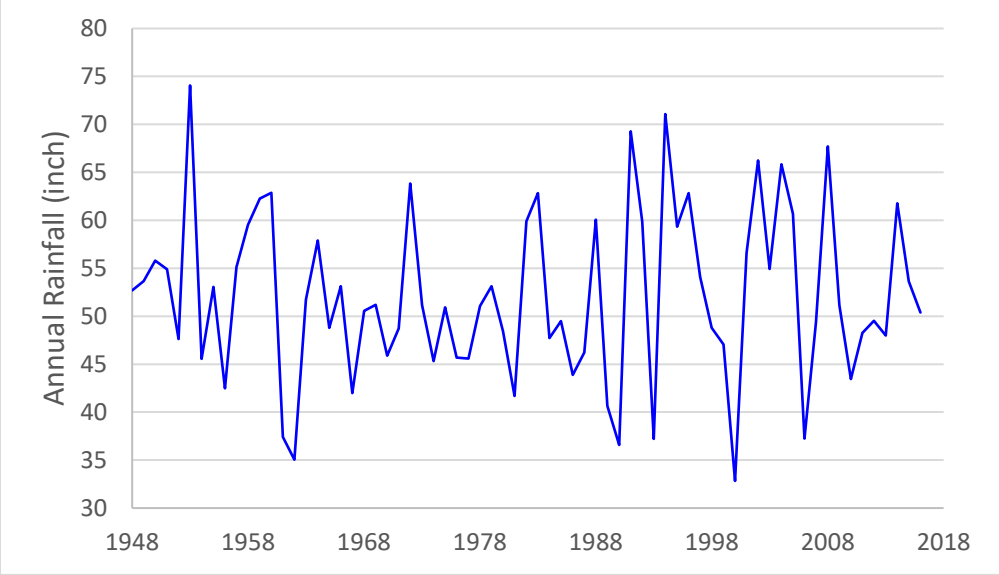

FIGURE 1. ANNUAL RAINFALL AT SANFORD (1948-2007) AND USGS (2008-2017) STATION

Long-term potential evapotranspiration data

The hourly potential evapotranspiration data (PET) at the Sanford station, used for the calibrated model, was also used for the long-term simulation. The Sanford PET is available from January 1, 1948 to December 31, 2016 and a correction factor was applied, as specified in the CDM report. The corrected annual PET at Sanford ranges from 49.5 inches in year 1983 to 56.3 inches in year 1971, with the average annual PET of 53.0 inches (Figure 2).

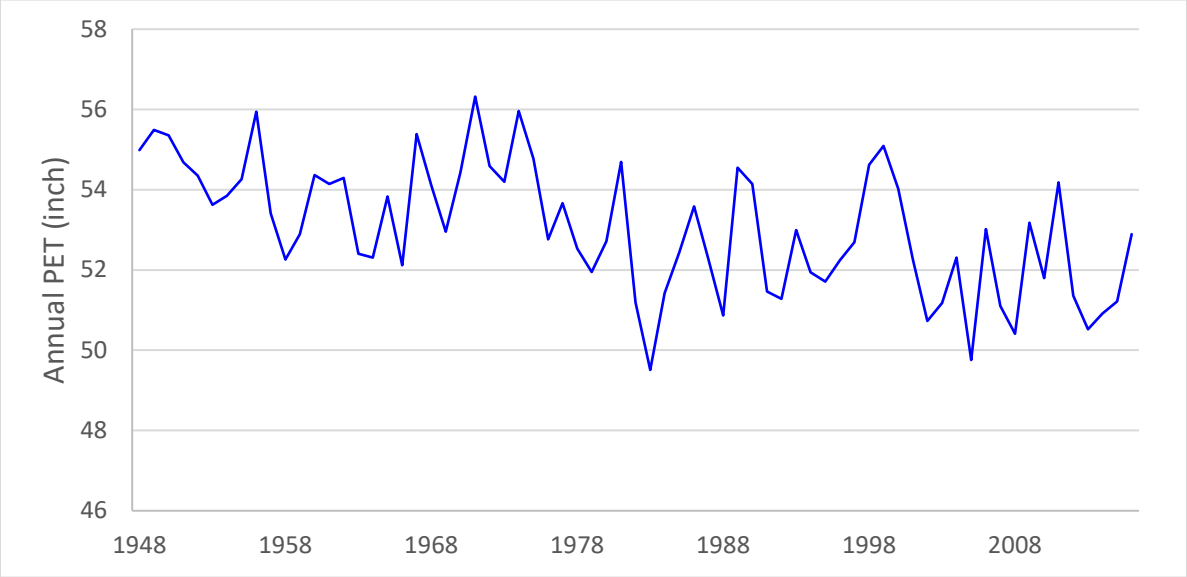

FIGURE 2. ANNUAL PET AT SANFORD STATION

Long-term UFA groundwater levels

There are several UFA groundwater monitor wells near Sylvan Lake, including S-0718, V-0101, L-0045, L-0043 and OR-0047. The S-0718 well is at the lake and is the preferred data source. Data are available at that well for the period of February 2009 through April 2017, including daily records from July 29, 2009 onward and single measurements in February 2009, April 2009 and May 2009 (Table 1). CDM Smith reviewed the time series data from the other wells to determine which well(s) showed the best correlation between levels at the well(s) and levels at well S-0718. Of the four other wells, well OR-0047 levels showed the best correlation with S-0718 well levels. Synthesized values based on well OR-0047 were used to fill the data gap at well S-0718 prior to July 2009 in the calibration/verification model. The synthesis applied the USGS program Streamflow Record Extension Facilitator (SREF) version 1.0, using the maintenance of variance extension type 3 (MOVE.3) method.

The established equation using the MOVE.3 method is as follows:

(1) S-0718 Elevation (feet NAVD) = 1.633 * (OR-0047 Elevation) 0.7521

The same method and equation were used to extend the Sylvan UFA groundwater timeseries from January 1, 1948 to December 31, 2016. The long-term levels are shown in Figure 3.

Table 1. UFA Groundwater Stations near Sylvan Lake

STATION NUMBER	STATION NAME	LATITUDE	LONGITUDE	Data Start	Data End
30342858	S-0718 Sylvan Lk Wells at Sanford (WL) FA	284805.849	812302.51	2/11/2009	7/30/2017
09272094	OR0047 Obs Well at Orlo Vista (WL) FA	283253.984	812833.442	9/30/1930	3/16/2017

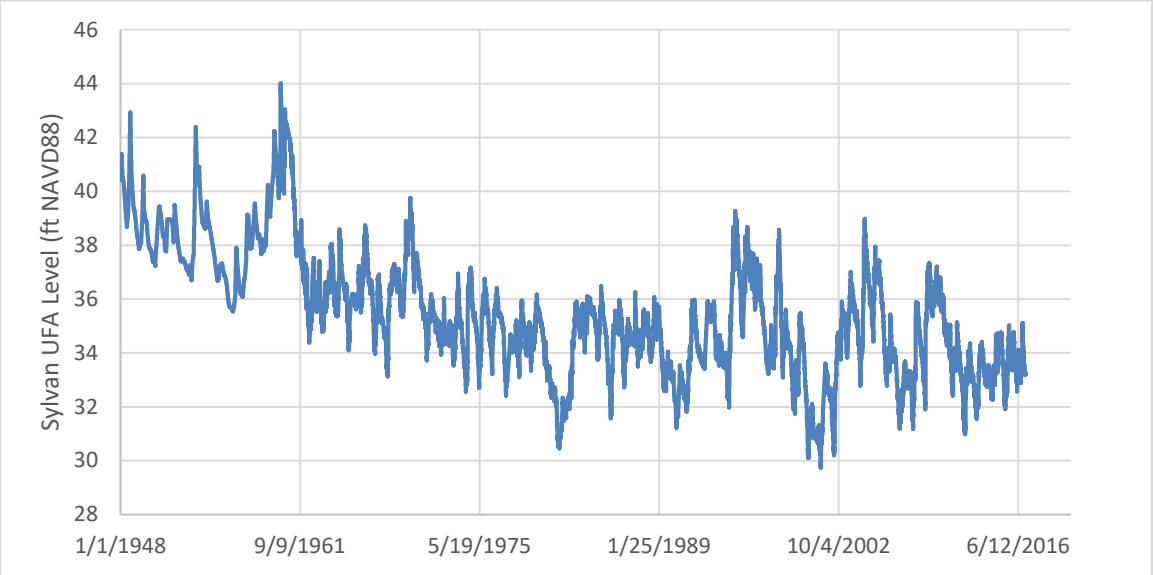

Figure 3. Extended long-term UFA groundwater levels at Sylvan

Long-term Simulation

After the extensions of the hourly rainfall, PET, and daily UFA groundwater levels, the calibrated model was run from January 1, 1948 to December 31, 2016. All the hydrologic parameters were kept the same.

Sylvan Lake has an observed record (n=370), starting from January 12, 1979 until April 30, 2014. Figure 4 shows the long-term simulated stage compared with the observed stage. It appears that in general, the long-term simulation is within reasonable range of historic values, and the modeled stage varies up and down in a similar pattern to the observations. However, there is a period during 7/13/1979-8/11/1980 that simulated stages are much lower than observed values.

The differences between the observed data points and the simulated stage could be because the long-term simulation reflects the stage-discharge relationship of the new (post-2014) Sylvan Lake outflow structure; further, the model is based on 2009 land cover, computed groundwater levels, and historic records of rainfall and PET. In some cases, the timing of some peaks is slightly off. These early and lagging responses could be due to the distance between the lake and the Sanford rainfall station, which was used prior to October 2007.

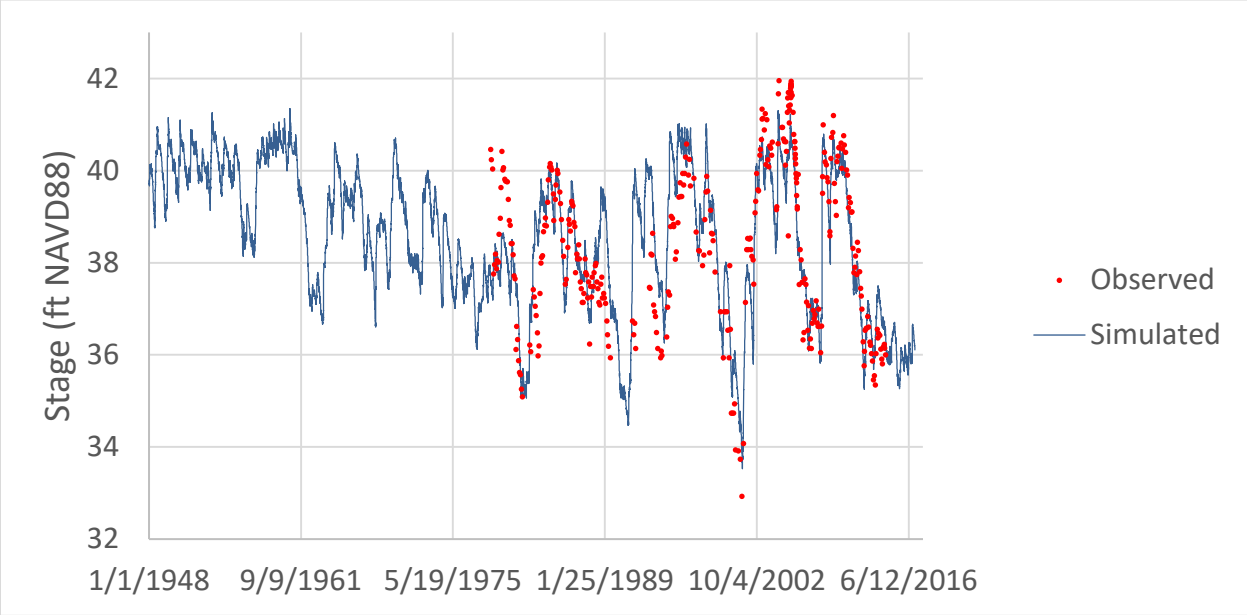

Figure 4. Long-term simulated Sylvan Lake stage (1948-2017)

References

CDM Smith. LLC. 2017 Sylvan Lake MFL Evaluation