St. Johns River Water Management District

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

TECHNICAL MEMORANDUM

Date: June 2019

By: Awes Karama, PhD

Subject: **Long Term Simulation HSPF Model for Lake Weir in Marion County, FL**

Introduction

Lake Weir is in southern Marion County, Florida. The lake area is about 6,269 acres. Figure 1 shows the watershed of Lake Weir. The lake system is comprised of Lake Weir, Little Lake Weir, and south west lobe of Sunset Harbor. A drainage canal connects Lake Weir with Ocklawaha River through a fixed elevation weir of about 20 ft that controls discharges off the lake. The crest of the weir is at 56.37 ft NAVD.

Model Update Description

The St. Johns River Water Management District contracted Dynamic Solutions to develop and calibrate an HSPF model of the watershed for re-evaluation of Lake Weir MFLs (Dynamic Solutions, 2016). The original model of the watershed is calibrated for a period of record (POR) 1/1/2003 to 12/31/2014.

The model is updated to run a long-term simulation of the watershed. The long-term model simulation covers a period of record from 1/1/1948 to 12/31/2017. All model input data are extended to cover the long-term period of record as described below.

Rainfall Data

The original HSPF model used rainfall data from SJRWMD station of Smith Lake at Belleview. The Smith Lake station has a period of record from 5/27/1988 to current. A composite long-term rainfall data was developed using available data from NOAA station at Lynne and Smith Lake station. Lynne station covers the period of record from 1/1/1948 to 5/26/1988. Figure 2 shows the location of both rainfall stations. Figure 3 shows the annual rainfall of the composite data. Table 1 presents the annual summary statistics of composite rainfall data for the period of record 1/1/1948 to 12/31/2017.

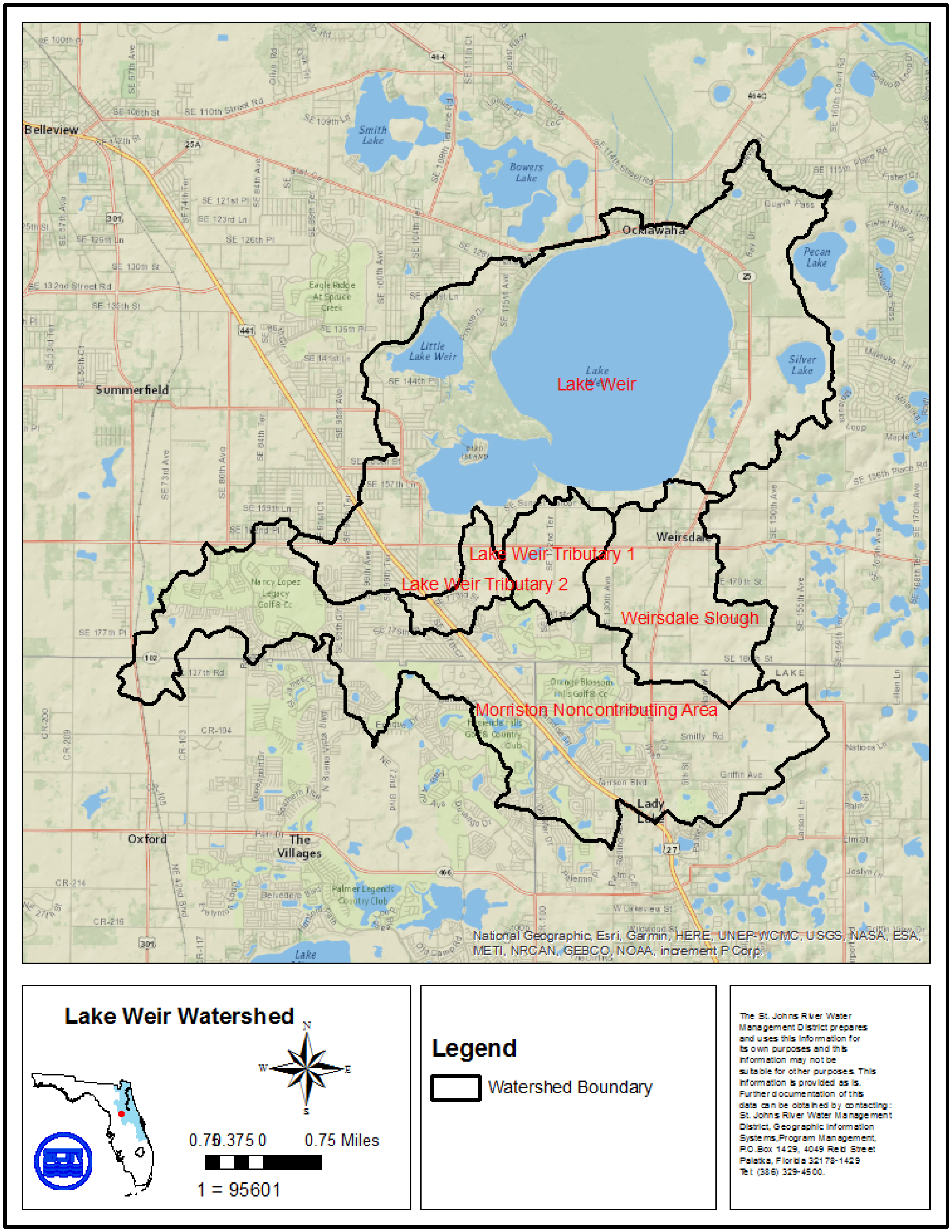

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Figure 1. Lake Weir watershed.

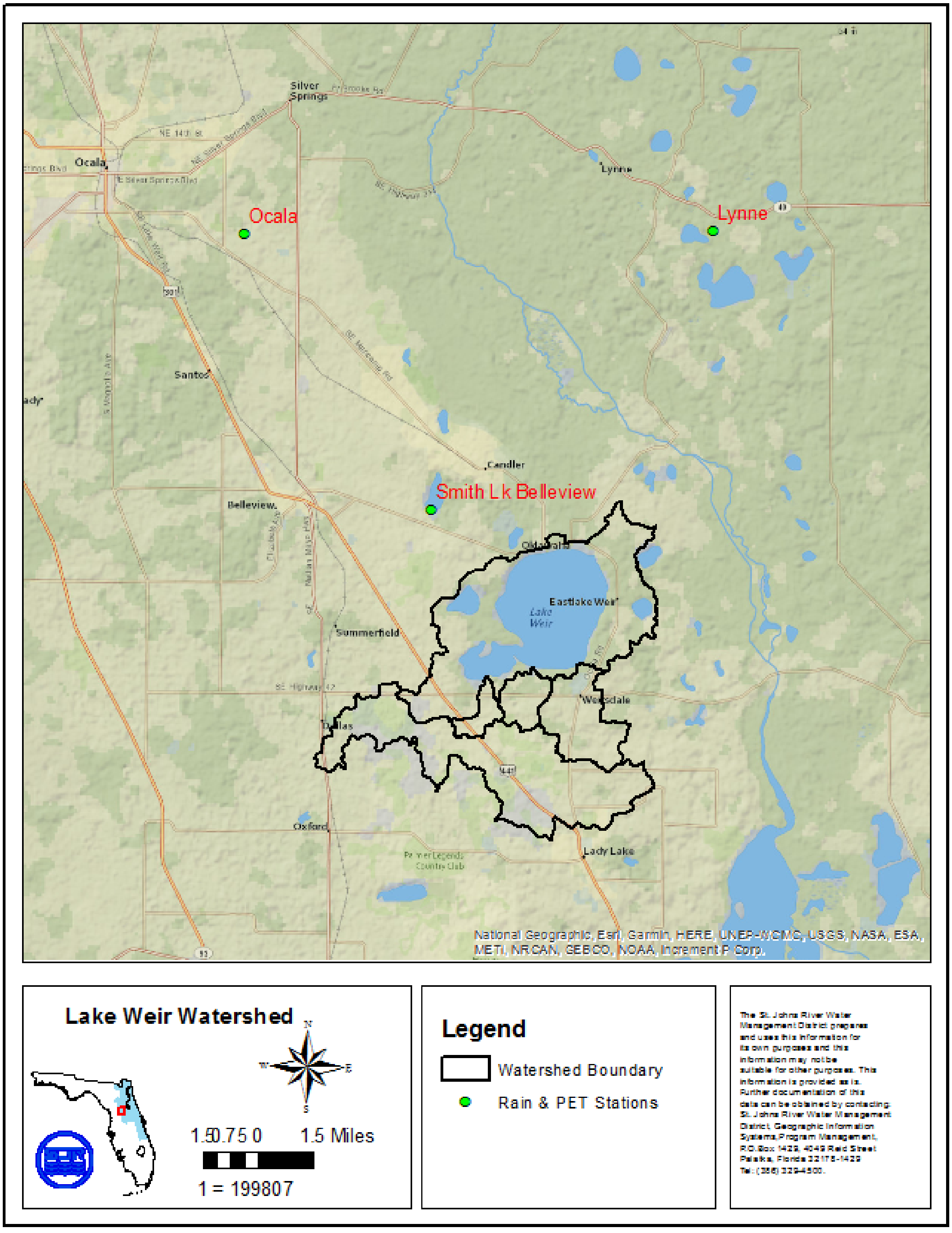

Figure 2. Rainfall and PET stations.

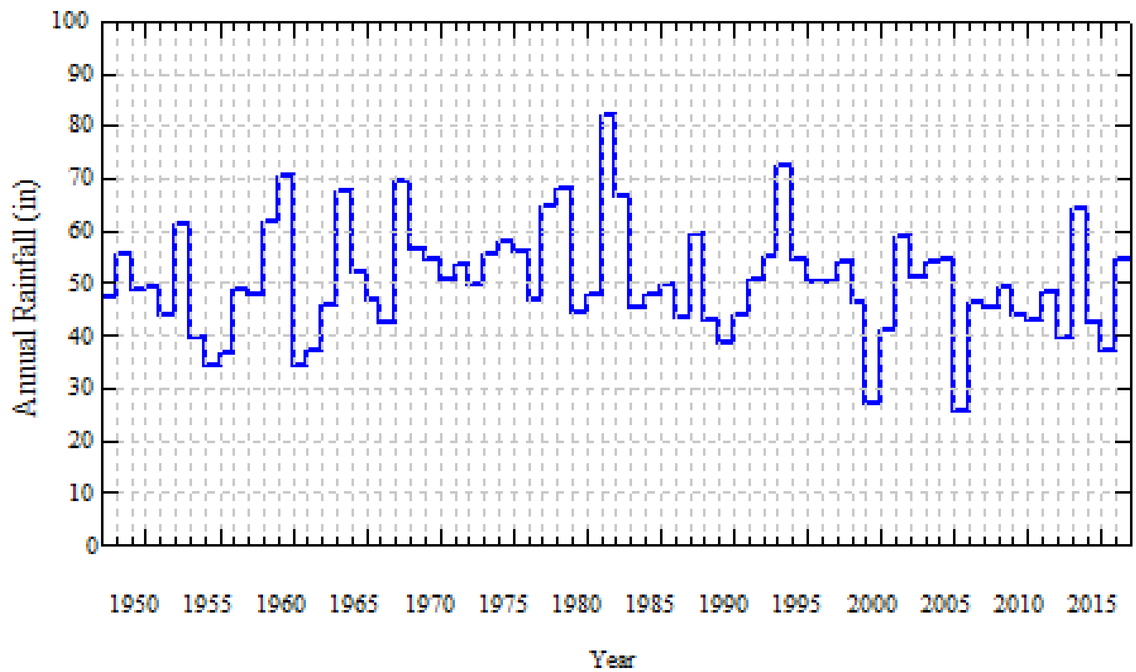

Figure 3. Annual composite rainfall.

Table 1. Annual statistical summary of composite rainfall.

Parameter	Composite Rainfall (in) for POR 1948-2017
Mean	50.42
Median	49.33
Standard Error	1.25
Standard Deviation	10.44
Minimum	25.69
Maximum	81.96

Potential Evapotranspiration (PET) Data

Computed PET data at Ocala station of the original were used. The data were extended for long-term simulation. Figure 4 shows the annual PET at Ocala station for a period of record 1/1/1948 to 12/31/2017. Table 2 presents the annual summary statistics of the PET data.

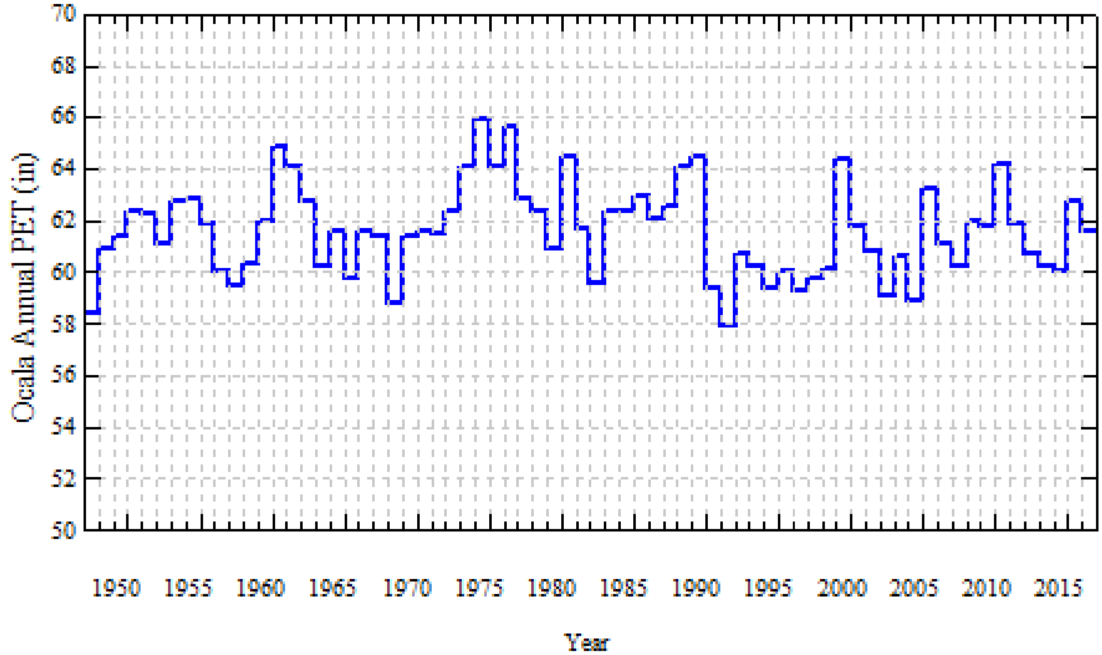

Figure 4. Ocala station annual PET.

Table 2. Annual statistical summary of Ocala PET.

Parameter	Ocala Annual PET (in) for POR 1948-2017
Mean	61.60
Median	61.59
Standard Error	0.21
Standard Deviation	1.78
Minimum	57.95
Maximum	65.90

Floridan Aquifer Well Data

The Dynamic Solutions' HSPF model (Dynamic Solutions, 2016) used Lake Weir Middle School Well data at Lady Lake. Lady Lake Well stage data has a period of record from 9/26/2001 to current. A closer well at Blue House Starkes Ferry has a longer period of record stage data from 3/15/1936 to current. Figure 5 shows the locations of the wells. Figure 6 shows well elevations at both Starkes Ferry Well and Lady Lake Well.

To extend the Lady Lake Well data, its data were related to Stakes Ferry well data using Line of Organic Correlation (LOC) in R software package. The LOC had yielded the following regression equation:

$$Y = 1.085758\,X - 8.548992$$

With coefficient of determination (r^2) = 0.83. Figures 7 to 9 show the resultant LOC plots. Table 3 summarizes residuals analysis of the LOC regression.

Table 3. Summary of residual analysis for the LOC regression.

Parameter	Stages (ft, NAVD)
Mean (Observed)	46.81
Mean Error	-0.23
Mean Absolute Error	0.83
Root Mean Squared Error	1.00
Standard Deviation of Error (Standard Error)	0.98

The LOC equation was used to extend the Lady Lake Well data. Figure 10 shows the extended Lady Lake Well data.

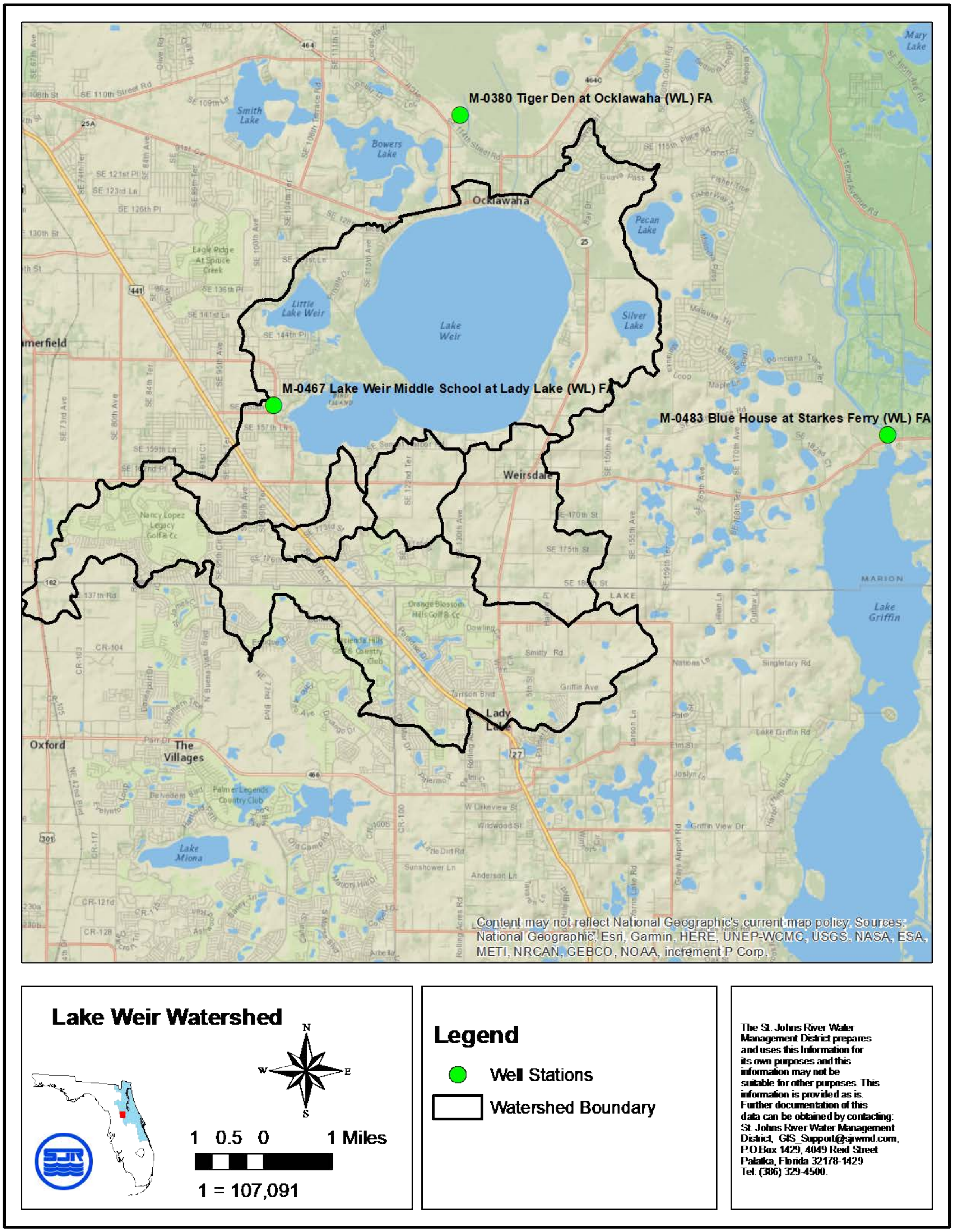

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Figure 5. Well stations in the watershed.

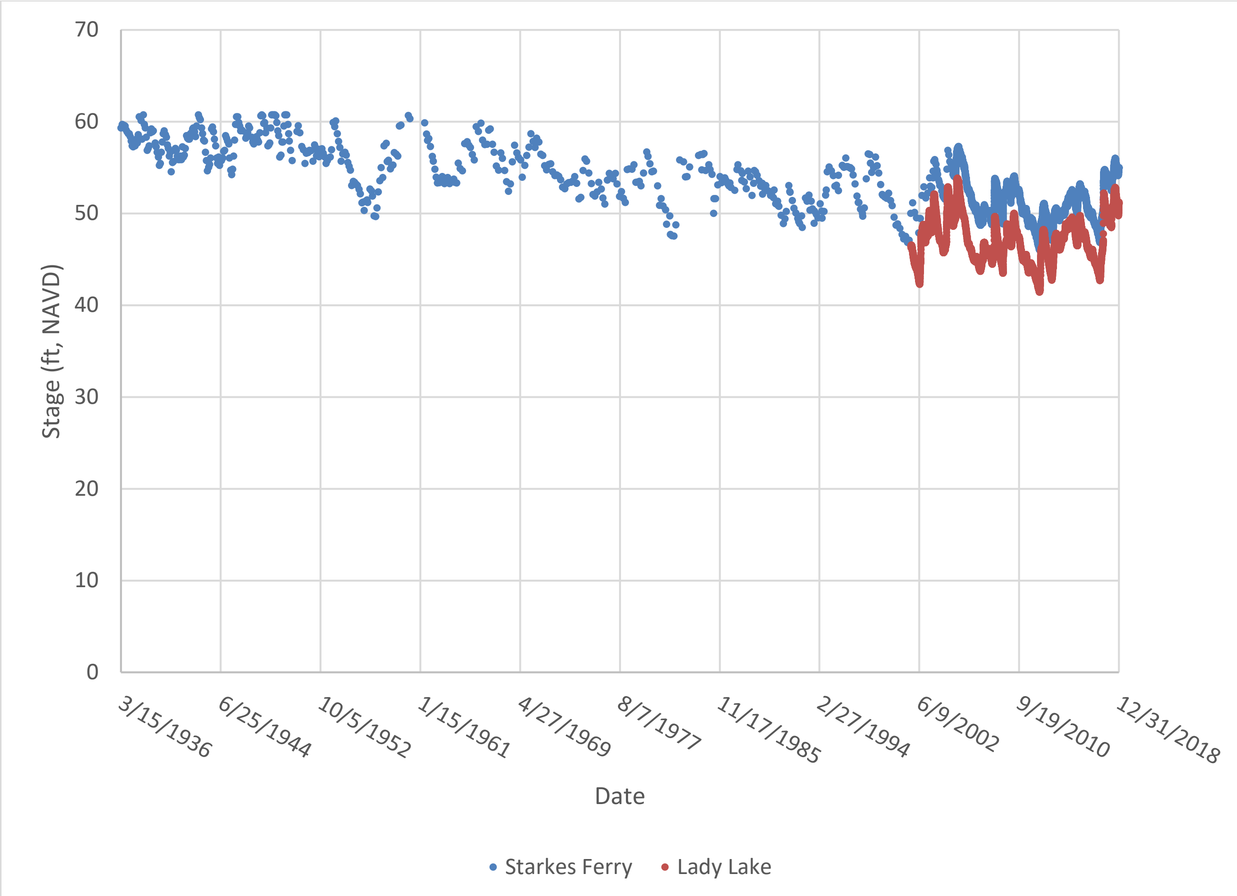

Figure 6. Well elevations at Starkes Ferry and Lady Lake.

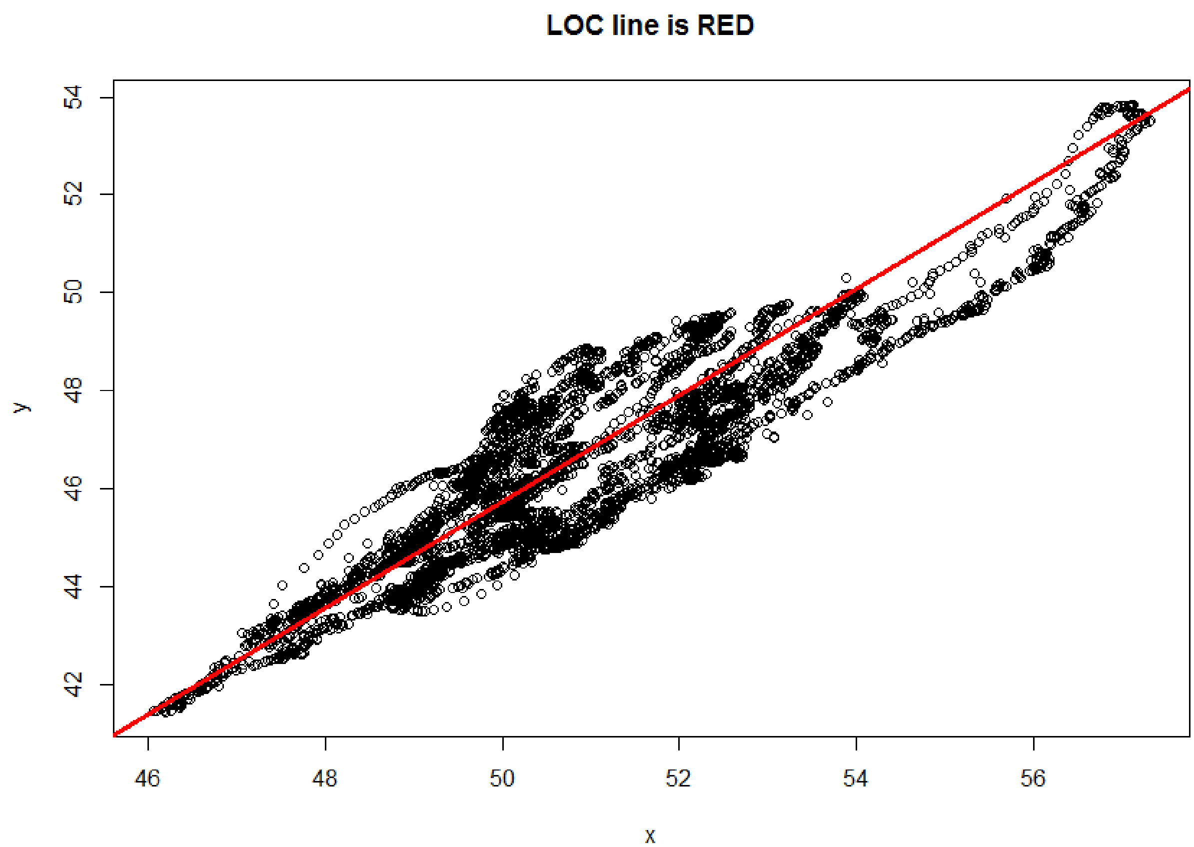

Figure 7. Lady Lake Well (x-axis) and Starkes Ferry Well (y-axis) LOC relationship.

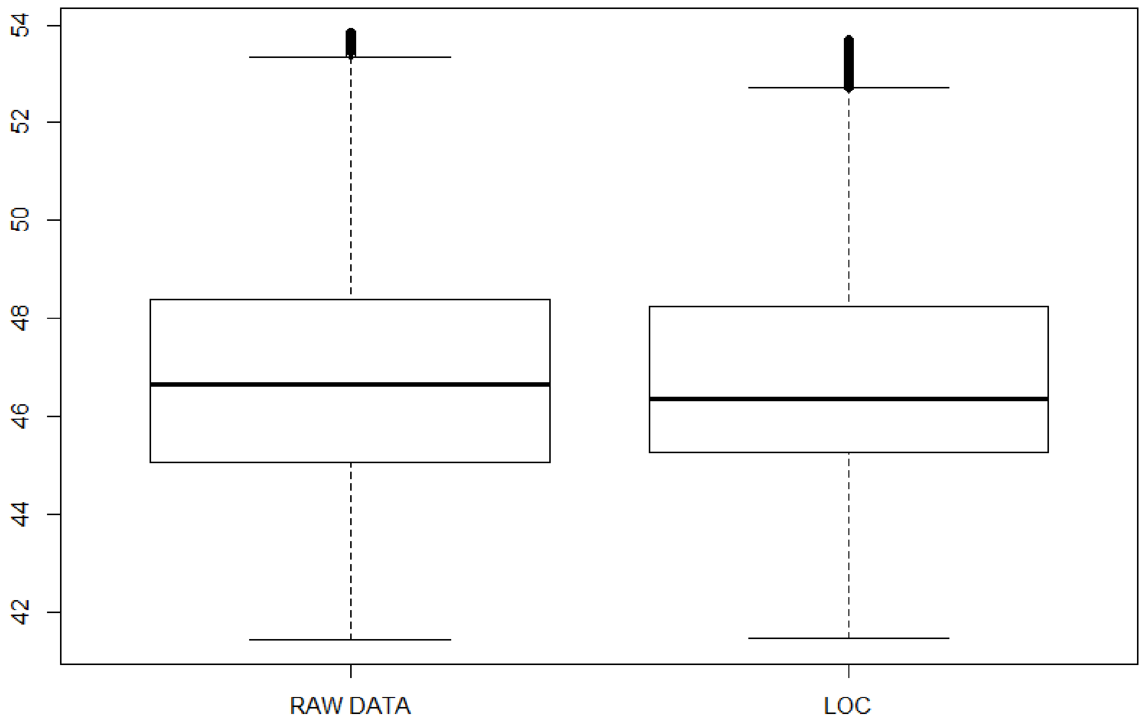

Figure 8. Boxplot of the raw data and LOC data.

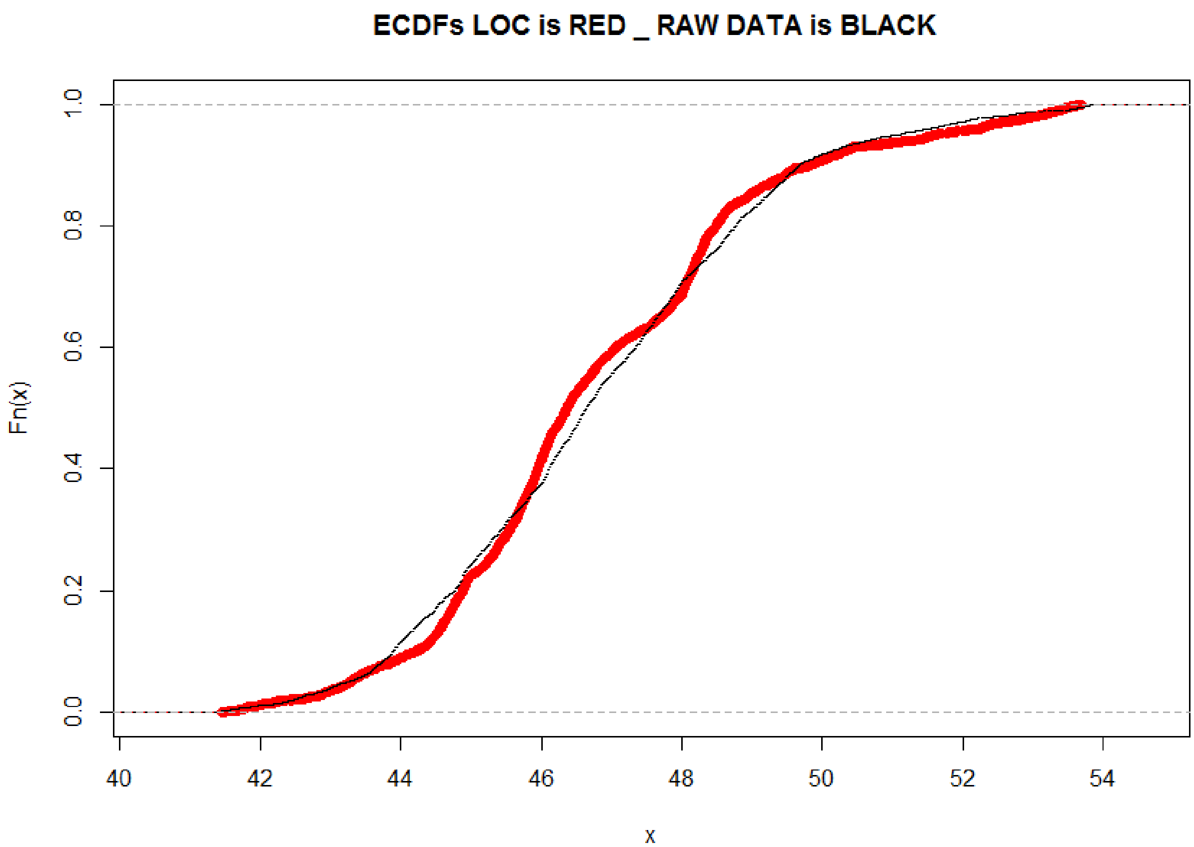

Figure 9. Cumulative density distribution of raw and LOC data.

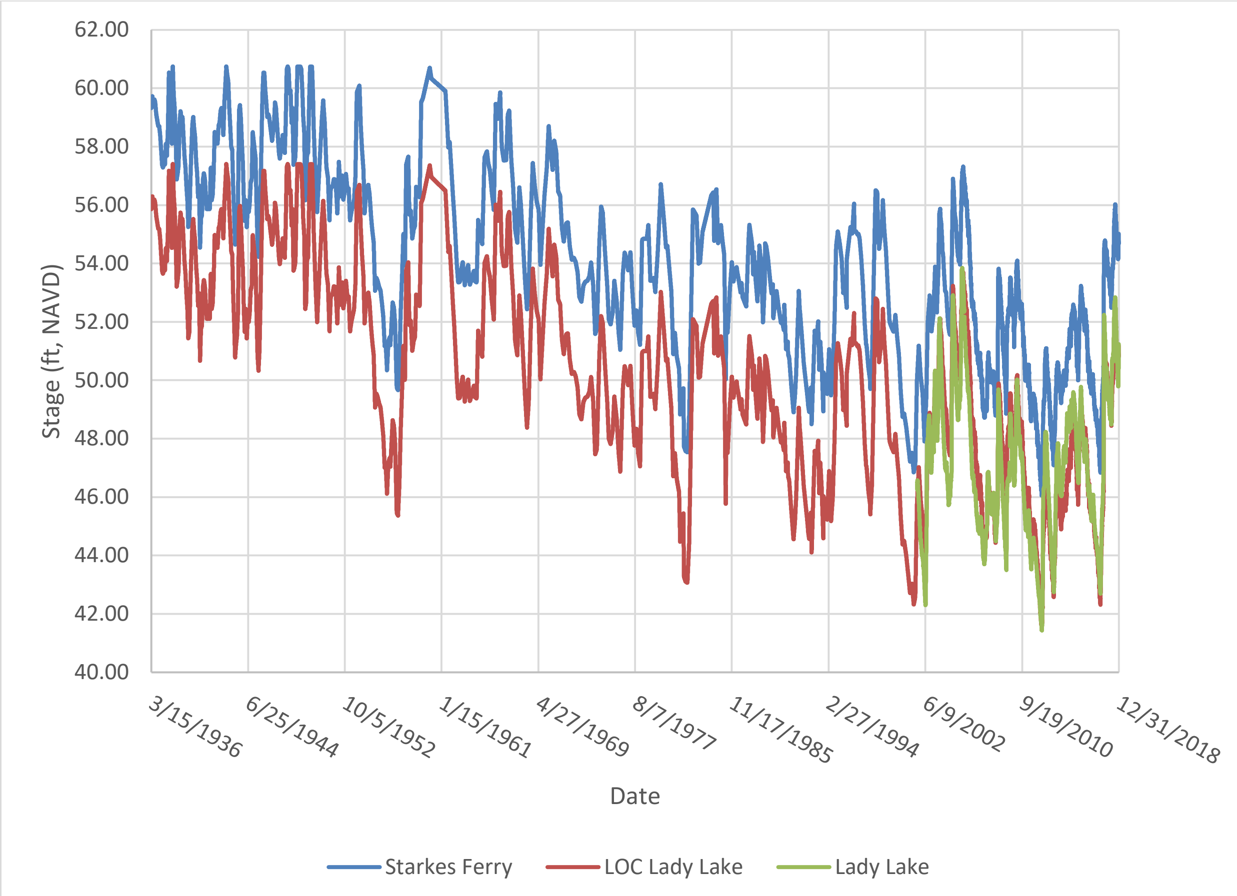

Figure 10. Well elevations with extended data.

Long-Term HSPF Model Simulation

The long-term Lake Weir HSPF model uses the calibrated Dynamic Solutions HSPF model (Dynamic Solution, 2016) with the previously explained extended data. The simulation model covers a period of record from 1/1/1948 to 12/31/2017. Figure 11 shows the comparisons of observed and simulated Lake Weir stages. Figure 12 presents stage duration curves of the observed and simulated data. Table 4 presents some statistics of goodness of fit for the long-term simulation model. Figures 11 and 12 as well as Table 4 indicate that the long-term model performed very well in matching the observed data except for a period from 1994 to 1999. Lack of local rainfall for that period would likely be the reason for the poor match.

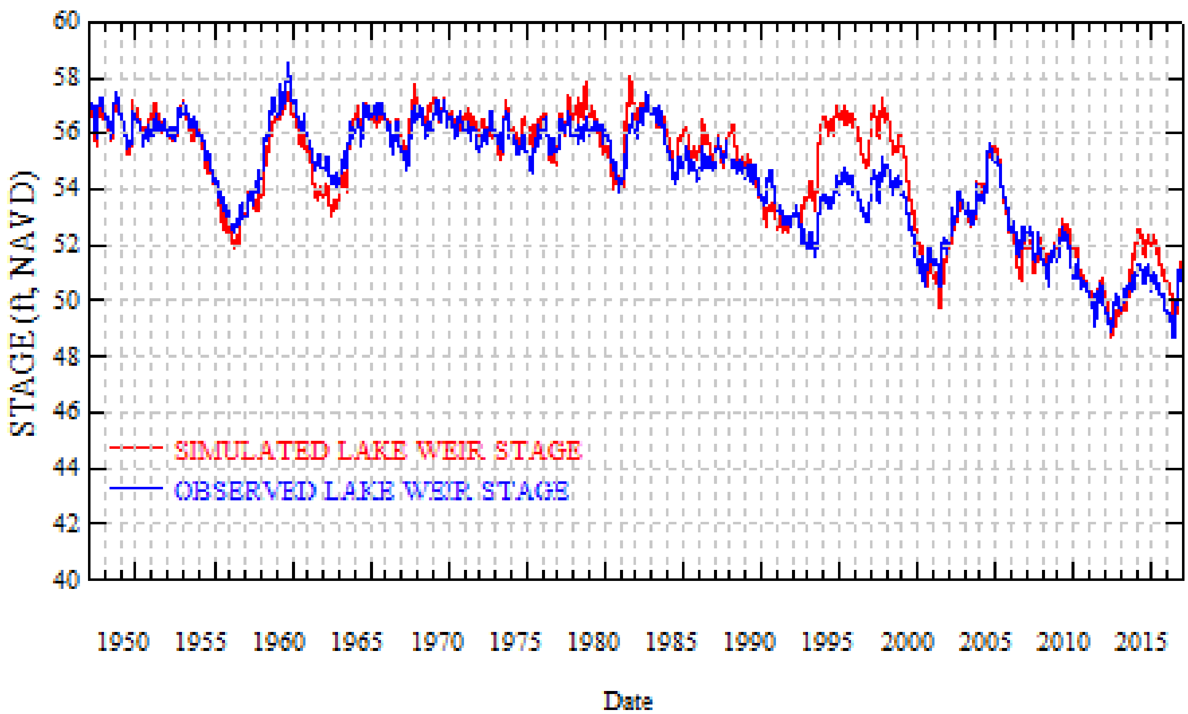

Figure 11. Comparison of observed and simulated stages of Lake Weir.

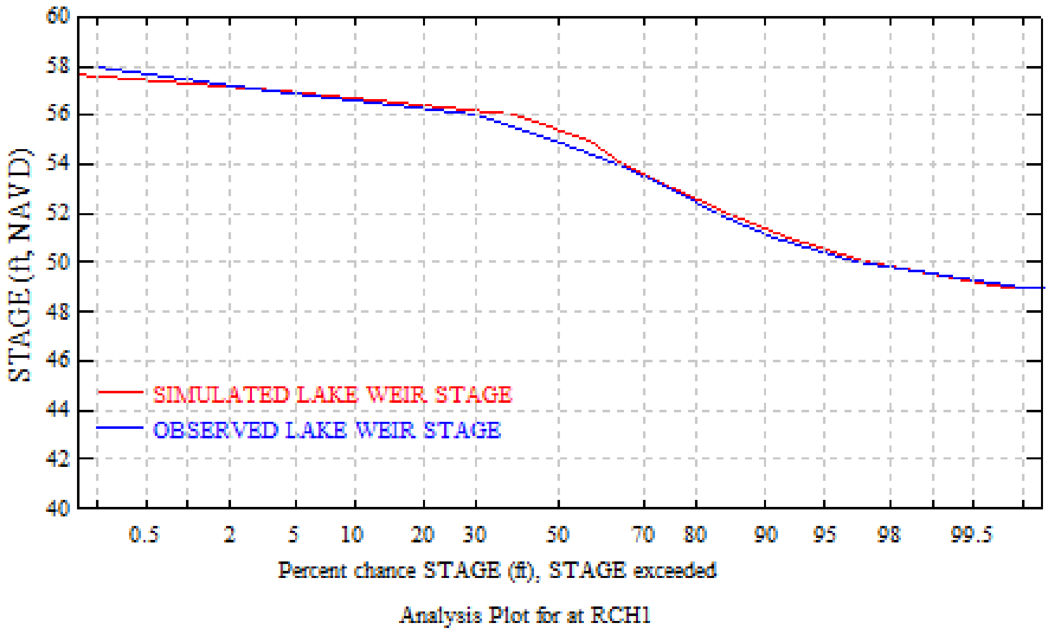

Figure 12. Duration curves of observed and simulated stages of Lake Weir.

Table 4. Goodness of fit of the long-term simulation of Lake Weir.

Statistic Parameter	Value
Bias	0.26
Percent bias	0.48
Absolute percent bias	1.07
Root-mean-square Deviation (RMSD)	0.83
Centered Root-mean-square Deviation (CRMSD)	0.79
Correlation coefficient (r)	0.93
Coefficient of determination (r^2)	0.86
Nash-Sutcliffe Efficiency	0.84
Index of agreement	0.96

References

Dynamic Solutions, 2016. Lake Weir Model Calibration. St. Johns River Water Management District. Palatka, Florida.